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The Role of E-Commerce in Facilitating International Trade in Africa: A Case Study of Individual Businesses in Ghana

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Abstract

This study examined the role of e-commerce in facilitating international trade in Africa with a focus on individual businesses in Ghana. The important aspects in which the examination was done were on the current state of e-commerce in Ghana, factors that influence the choice of e-commerce platforms by individual Ghanaian business owners engaged in international trade, and challenges faced by individual business owners in adopting e-commerce for international trade. The study adopted the quantitative approach to research whereby a survey with the help of questionnaires was used to gather primary data from small business owners and individuals who use several e-commerce platforms for their business transactions. The collected data were analyzed by using descriptive statistical analysis. The study found that individual business owners use both local and foreign e-commerce platforms to buy different varieties of products. Concerning the local platforms, the predominantly used platform is Tonaton, followed by Jumia, Melcom Ghana, and Jiji. Also for the foreign e-commerce platforms, the predominantly used platform is Alibaba, followed by Amazon, Aliexpress, and eBay. The majority of the individual business owners buy products from these e-commerce platforms monthly and mostly use mobile phones to buy the products. The study revealed that majority of the business owners look out for reliable platforms, followed by platforms that are secured from scams, credible platforms, platforms that are designed to give customer satisfaction, and platforms that are easy to navigate. Moreover, the major challenge of most individual business owners is associated with fraudulent online shops, followed by delays in transaction activities, poor internet networks to access e-commerce platforms, high online transaction costs, and theft of ordered items or products.

Keywords: *Business, Customer, E-commerce, International, Platforms, Transaction.*

Introduction

International trade does not exist between only countries, it also exists between businesses in different countries. One of the major aspects that have critically facilitated international trade is e-commerce. Electronic commerce which has been abbreviated as e-commerce has been described by [22] as the buying and selling of goods and services over the Internet. It mostly involves the transfer of funds and data to facilitate online transactions. The concept of e-commerce has revolutionized the way businesses operate and has become an integral part of the global economy [30]. The integration of e-commerce into international trade has resulted in simpler trade transactions between businesses located in different countries. Also, e-commerce has been proven to facilitate international trade by connecting businesses and consumers across different countries. According to a study by UNCTAD (United Nations Conference on Trade and Development) on e-commerce in international trade, e-commerce has the potential to increase international trade by providing access to new markets [33]. Moreover, e-commerce has digitized various trade processes, making international trade more efficient. Online

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platforms and marketplaces streamline transactions, automate documentation, and simplify cross-border payments [34].

According to [7], e-commerce has different aspects. These are Business-to-Consumer (B2C) which refers to transactions between businesses and individual consumers. Some examples include online retail stores like Amazon, Walmart, and eBay. Another aspect is Business-to-Business (B2B). In this, businesses sell products or services to other businesses. It involves transactions between manufacturers, wholesalers, and distributors. Alibaba.com and ThomasNet are prominent B2B platforms. The last aspect is Consumer-to-Consumer (C2C) which involves individuals selling products or services to other individuals. Online marketplaces such as Etsy and eBay facilitate C2C transactions [7].

For Ghana at the international level, e-commerce has played a significant role in facilitating Ghana's international trade and connecting businesses in the country with global markets. E-commerce has provided Ghanaian businesses with a platform to showcase and sell their products to international customers. It has expanded export opportunities, enabling businesses to reach a broader market beyond traditional trade barriers [31]. E-commerce platforms and online marketplaces have allowed Ghanaian businesses to access global marketplaces easily. Platforms such as Alibaba, Amazon, and eBay provide opportunities for Ghanaian businesses to connect with international buyers and expand their customer base [13]. It has facilitated the digitalization of trade processes, making international trade more efficient. Online platforms and digital tools streamline documentation, automate customs procedures, and simplify cross-border transactions [33].

Furthermore, e-commerce has played a crucial role in enabling secure and efficient cross-border payments for Ghanaian businesses. International payment gateways and digital payment systems have made it easier for businesses in Ghana to receive payments from international customers and engage in international transactions [22]. It has provided opportunities for Ghanaian Small and Medium Enterprises (SMEs) to participate in international trade. It offers a cost-effective way for smaller businesses to access global markets without the need for extensive physical infrastructure [34].

On the local front, e-commerce in Ghana has been gaining traction, contributing to the growth of the country's digital economy. Ghana's e-commerce market has been witnessing significant growth in recent years. According to a report by the [14], the e-commerce sector experienced a compound annual growth rate of 34.7% between 2012 and 2019 [14]. The expanding internet penetration in Ghana has been a driving factor behind the growth of e-commerce. As more Ghanaians gain access to the internet and mobile devices, the potential customer base for online businesses continues to expand [14].

Several studies both international and local have looked at e-commerce in diverse ways. In the area of e-commerce and small businesses, [10] conducted an empirical study to understand the impact of e-commerce on small businesses. They examined the benefits and challenges faced by small businesses in adopting e-commerce strategies. Their study uncovered the benefits of e-commerce adoption for small businesses, such as increased market reach, cost savings, and enhanced customer engagement. However, it also identified challenges related to logistics, marketing, and building customer trust.

Notwithstanding, according to [5], e-commerce in Ghana is growing but many issues need to be addressed. These include issues related to logistics and delivery infrastructure, digital literacy, and consumer trust in online transactions [5]. Other issues include transportation, customs procedures, and digital skills [13]. Based on the aforementioned studies on e-commerce, this study aims to combine the

various trade areas in which e-commerce is predominant to analyze the current state of e-commerce and its role in the facilitation of international trade in Ghana. The primary objective of this study is to investigate the role of e-commerce in facilitating international trade in Africa with a focus on individual businesses in Ghana. In light of the primary objective, the specific objectives of this study are:

1. To examine the current state of e-commerce in Ghana
2. To investigate the factors that influence the choice of e-commerce platforms by individual Ghanaian business owners engaged in international trade.
3. To identify the challenges faced by individual Ghanaian businesses in adopting e-commerce for international trade.

Literature Review

The State of E-Commerce in Trading in Ghana

The e-commerce industry in Ghana has been experiencing significant growth and development in recent years. With the increasing adoption of technology and internet connectivity, more Ghanaians are turning to online platforms for their trading activities. Ghana has witnessed a substantial increase in internet penetration, which has facilitated the growth of e-commerce. As of 2021, the internet penetration rate in Ghana stood at around 39.5% [17]. This increased connectivity has provided more Ghanaians with access to online marketplaces, enabling them to engage in e-commerce activities. According to a report by the [14] in 2019, approximately 43% of Ghanaians had access to the Internet, which provides a significant customer base for e-commerce platforms.

Online marketplaces have played a crucial role in shaping the e-commerce landscape in Ghana. Platforms such as Jumia, Zoobashop, and Melcom Online have gained popularity and become key players in the Ghanaian e-commerce space. These marketplaces provide a wide range of products, including electronics, fashion, household goods, and groceries, allowing consumers to shop conveniently from the comfort of their homes [16].

However, despite the growth of e-commerce, Ghana faces logistical and delivery challenges that impact the industry's efficiency. Issues such as inadequate transportation infrastructure, poor addressing systems, and limited last-mile delivery options can hinder the timely and reliable delivery of goods to customers [28]. However, companies like Glovo and Bolt Food have started providing on-demand delivery services, addressing some of these challenges.

To improve the use of e-commerce, the Ghanaian government has recognized the potential of e-commerce in driving economic growth and has taken steps to support its development. The Ministry of Communications and Digitalization has been implementing initiatives to promote e-commerce and digital trade, such as the National Digital Commerce Strategy [26]. Additionally, the government has put in place regulatory frameworks to protect consumers and promote trust in online transactions [27].

E-commerce has the potential to significantly impact international trade in Ghana by facilitating cross-border transactions and expanding market access for Ghanaian businesses. It enables exporters to reach a global customer base and overcome traditional barriers such as distance and logistics [31].

Cross-border e-commerce platforms play a crucial role in facilitating international trade for Ghanaian businesses. Platforms like Alibaba, AliExpress and Amazon have gained popularity among Ghanaian entrepreneurs, providing them with access to global markets and customers [2].

Studies highlight both challenges and opportunities associated with e-commerce in Ghana's international trade. Challenges include issues related to logistics, customs procedures, payment systems, and regulatory frameworks

[2]. On the other hand, e-commerce offers opportunities for micro, small, and medium-sized enterprises (MSMEs) in Ghana to engage in export activities and connect with international buyers [32]. E-commerce has the potential to boost Ghana's exports and create employment opportunities. A study by [31] found that e-commerce can enhance the participation of small and medium-sized enterprises (SMEs) in export activities, leading to increased export volumes. Additionally, the growth of e-commerce can generate employment opportunities in areas such as online marketing, logistics, and customer service [2].

Challenges of E-Commerce in International Trade

Challenges of e-commerce in international trade encompass various aspects, including legal, logistical, cultural, and technological factors. One of the key challenges of e-commerce in international trade is associated with legal and regulatory complexities. E-commerce involves transactions across different jurisdictions and can sometimes lead to legal and regulatory complexities. Regulations related to data protection, consumer rights, intellectual property, taxation, and cross-border transactions vary across countries, posing challenges for e-commerce businesses [9]. Navigating these legal requirements and ensuring compliance can be time-consuming and costly for international e-commerce ventures.

Another challenge is related to logistics and supply chain management. International e-commerce necessitates efficient logistics and supply chain management to ensure timely delivery and customer satisfaction. Challenges such as customs procedures, import/export regulations, transportation, and last-mile delivery in different countries can impact the overall customer experience [3]. Managing inventory, coordinating shipments, and coordinating with multiple service providers across borders can be complex and require careful planning.

Moreover, the issue of cultural and language differences is another obstacle to e-commerce. E-commerce businesses face the challenge of catering to diverse cultures and languages when operating in international markets. Adapting product descriptions, marketing strategies, and user interfaces to suit local preferences and languages is crucial for success [8]. Cultural nuances, consumer behaviour, and expectations can significantly impact consumer trust and buying decisions.

The issue of payment and currency poses a critical challenge to e-commerce. E-commerce transactions involve different currencies and payment systems, which can create challenges for international trade. Currency conversions, exchange rate fluctuations, and payment security are critical concerns for both buyers and sellers [15]. Providing secure and convenient payment options that are widely accepted in different countries is essential for successful international e-commerce operations.

In addition to the challenges discussed above, several studies have come out with other challenges of e-commerce in international trade. [25] investigated the barriers to cross-border e-commerce. The researchers conducted a comprehensive literature review to identify and analyze the barriers to cross-border e-commerce. After the review, they identified several challenges of e-commerce which included legal and regulatory barriers, logistics and infrastructure constraints, payment and financial issues, language and cultural differences, and consumer trust and protection concerns.

In 2018, [11] researched the challenges in international e-commerce logistics by conducting a systematic literature review to explore the challenges in international e-commerce logistics. The researchers identified key challenges of e-commerce that included customs and import/export regulations,

transportation and last-mile delivery issues, inventory management, information sharing, and reverse logistics.

[29] studied the challenges and solutions for small and medium enterprises in international e-commerce. The researchers utilized a qualitative research approach, including interviews and case studies, to examine the challenges and potential solutions for small and medium enterprises (SMEs) in international e-commerce. The study revealed several challenges of e-commerce in international trade which were legal and regulatory complexity, market entry barriers, logistics and supply chain management, cultural differences, language barriers, and payment issues. They also proposed solutions such as market research, partnerships, localization strategies, and collaboration with logistics service providers.

Strategies for Enhancing E-Commerce in International Trade

Enhancing e-commerce in international trade requires the implementation of effective strategies to overcome barriers and capitalize on opportunities. Several researchers and scholars have come up with different strategies that can enhance effective e-commerce in international trade. [6] explored the various strategies that small and medium-sized enterprises (SMEs) can adopt to enhance their e-commerce activities in international trade. The researchers conducted a comprehensive review of existing literature on e-commerce strategies for SMEs in international trade. The study revealed several strategies for SMEs to enhance their e-commerce, including improving website usability, implementing effective online marketing, and strengthening customer service.

In Ref. [18] investigated the role of digital marketing strategies, such as search engine optimization (SEO) and social media marketing, in facilitating the internationalization of e-commerce businesses. Qualitative methods including interviews and case studies were used to investigate the role of digital marketing strategies in facilitating e-commerce internationalization. The study found that digital marketing strategies, such as search engine optimization (SEO) and social media marketing, play a vital role in enhancing the international presence and reach of e-commerce businesses.

In ref. [35] examined the cross-border e-commerce strategies employed by global retailers and identified key success factors, including localization, logistics optimization, and customer trust-building. The case study utilized qualitative methods, including interviews and analysis of company reports, to examine the cross-border e-commerce strategies employed by global retailers. After the analysis of the data gathered, the study identified key success factors for cross-border e-commerce, which were localization, logistics optimization, and customer trust-building.

In ref. [19] explored the regulatory frameworks and policies that impact cross-border e-commerce activities, highlighting the importance of harmonization and standardization to facilitate international trade. They conducted a comparative analysis of regulatory frameworks and policies affecting cross-border e-commerce. The study uncovered the importance of establishing harmonized and standardized regulatory frameworks to promote cross-border e-commerce in international trade.

In ref. [36] investigated supply chain integration strategies, including information sharing, collaboration, and coordination, to enhance cross-border e-commerce operations and improve customer satisfaction. An empirical approach, including data collection and analysis, was employed by the researchers to investigate supply chain integration strategies in cross-border e-commerce. The study found that supply chain integration strategies, such as information sharing, collaboration, and coordination, play a critical role in streamlining cross-border e-commerce

operations and improving customer satisfaction.

Materials and Methods

Research Design

This study was quantitative investigative research in terms of its design. According to [4], the focus of investigative research is on testing hypotheses and drawing conclusions based on the collected evidence. Moreover, it often requires larger sample sizes to ensure statistical significance and improve the generalizability of the findings [21]. This study was investigative research due to the fact the researcher intended to investigate the role played by e-commerce and its impact on the facilitation of international trade for Ghanaians who are into small business operations.

Population and Sample Size

The population for this study was all business owners and individuals who use e-commerce platforms to perform their online trade activities in Ghana. Currently, there are no recorded data that exist on the entire population of individual business owners who use e-commerce platforms for their personal and business transactions. The sample size, on the other hand, that was selected for this study was five hundred (500) business owners and individuals from Ghana. The selection of this sample size is based on the recommendation of [38] who posits that a sample size of 500 from a population which is above 100,000 gives precision and confidence levels of ±7% and ±93% respectively.

Sampling Technique

Stratified sampling as a probability sampling technique was employed in selecting the samples for the study. In this study, the researcher divided the population into two (2) strata, which are small business owners who use e-commerce for their business transactions and individuals who also use e-commerce for their personal business transactions. A sample size of 250 was selected from each stratum. This was done to allow for a fair representation of members of each population.

Data Collection Method

The method of data collection for this study was the survey method. The use of a survey allows people's opinions on a given issue of public interest to be quantified in research studies [12]. It is concerned with the collection of data to describe and interpret certain conditions, practices, beliefs or attitudes of a large number of people [40]. This study was interested in gathering the opinions of business owners and individuals on the role and impact of e-commerce in their various international trade activities.

Data Collection Instruments

Questionnaires were used to collect data for the quantitative study because they are free of the researcher's bias because responses are of the participant's choosing [37]. The questionnaire focused on asking questions that addressed the study’s objectives, and the questions were arranged in a more orderly manner to help gather data. After the design of the questionnaire, it was printed. Five hundred (500) questionnaires were printed and distributed to the individual business owners who were to take part in the study. The researcher briefed the respondents on the topic and the objectives of the study before they were allowed to respond to the questions. The questionnaires were self-administered which eliminated the need for the researcher to guide respondents at the time of data collection. After the respondents were done filling out the questionnaire, the researcher gathered and arranged the questionnaire for data entry and analysis.

Data Analysis and Analytical Tool

The researcher performed data cleaning before the analysis, identifying and addressing mistakes and missing data to guarantee the precision and dependability of the results. The

data gathered were coded into the analytical tool, Statistical Package for Social Sciences (SPSS version 23.0). The variables to be measured were queued into the SPSS with their corresponding data. After this process, descriptive and inferential statistics were used to analyze the data. Descriptive statistics was used to summarize and describe the main features of the data, which revealed the factors that influence the choice of online shopping platforms, challenges of using online shops.

Results

Current State of E-commerce in Ghana

This section of the results reveals the current state of the adoption of e-commerce in the business activities of individual business owners in Ghana.

Local E-commerce Platforms Used by Respondents

Table 1 below presents the kinds of local e-commerce platforms predominantly used by the respondents. On the use of individual e-commerce platforms, majority of the respondents that is 305 representing 61.0% use Tonaton, followed by Jumia which has 290 users representing 58.0%, Melcom Ghana which has 277 representing 55.4%, and Jiji also having 271 users representing 54.2%. The e-commerce platform with the least number of users is Bolt Food which has 222, representing 44.4%. Some respondents that is 135 representing 27.0% use other e-commerce platforms apart from the aforementioned platforms.

Table 1. Local E-commerce Platforms

Jumia	**Frequency**	**Percent**
Yes	290	58.0
No	210	42.0
Total	500	100.0
Tonaton	**Frequency**	**Percent**
Yes	305	61.0
No	195	39.0
Total	500	100.0
Jiji	**Frequency**	**Percent**
Yes	271	54.2
No	229	45.8
Total	500	100.0
Melcom Ghana	**Frequency**	**Percent**
Yes	277	55.4
No	223	44.6
Total	500	100.0
Bolt Food	**Frequency**	**Percent**
Yes	222	44.4
No	278	55.6
Total	500	100.0
Other	**Frequency**	**Percent**
Yes	135	27.0
No	365	73.0
Total	500	100.0

Foreign E-commerce Platforms Used by Respondents

Table 2 below shows the various foreign e-commerce platforms that are predominantly used by the respondents in the personal and business transactions of their products. The platform predominantly used by the respondents is Alibaba which has 282 users representing 56.4%. The second platform mostly used by the respondents is Amazon which has 281 users representing 56.2%, followed by Aliexpress which has 259 users representing 51.8%, and eBay which also has 195 users representing 39.0%. Apart from the aforementioned platforms, there are 150 users representing 30.0% who use other foreign platforms.

Table 2. Foreign E-Commerce Platforms

Amazon	**Frequency**	**Percent**
Yes	281	56.2
No	219	43.8
Total	500	100.0
EBay	**Frequency**	**Percent**
Yes	195	39.0
No	305	61.0
Total	500	100.0
Alibaba	**Frequency**	**Percent**
Yes	282	56.4
No	218	43.6
Total	500	100.0
Aliexpress	**Frequency**	**Percent**
Yes	259	51.8
No	241	48.2
Total	500	100.0
Other	**Frequency**	**Percent**
Yes	150	30.0
No	350	70.0
Total	500	100.0

Kinds of Products Purchased from the Online Platforms

Table 3 below presents the kinds of products that are purchased by the respondents from the online shopping platforms. From the table, majority of the respondents 278 representing 55.6% buy their electronic devices from online shops. Also, 267 respondents representing 53.4% buy their clothes/apparels from online shops, 250 representing 50.0% buy footwear/shoes online, whilst 231 representing 46.2% buy food items/groceries online. Few respondents, 122 representing 24.4% buy books/stationeries, whilst 73 representing 14.6% buy other products online.

Table 3. Products Purchased from the Platforms

Food items/Groceries	**Frequency**	**Percent**
Yes	231	46.2
No	269	53.8
Total	500	100.0
Electronic devices	**Frequency**	**Percent**
Yes	278	55.6
No	222	44.4
Total	500	100.0
Clothes/Apparels	**Frequency**	**Percent**
Yes	267	53.4
No	233	46.6
Total	500	100.0
Footwear/Shoes	**Frequency**	**Percent**
Yes	250	50.0
No	250	50.0
Total	500	100.0
Books/Stationeries	**Frequency**	**Percent**
Yes	122	24.4
No	378	75.6
Total	500	100.0
Other	**Frequency**	**Percent**
Yes	73	14.6
No	427	85.4
Total	500	100.0

Factors that Influence the Choice of Particular E-commerce Platforms

Table 4 below presents the factors that lead to the decisions of individual business owners to choose a particular e-commerce platform. From the table, majority of the respondents, 349 representing 69.8% always look out for reliable platforms, 300 representing 60.0% look out for platforms that are secured from scams, and 271 representing 54.2% also consider credible platforms. Moreover, 270 respondents representing 54.0% consider platforms that are designed to give customer satisfaction, whilst 245 representing 49.0% also consider platforms that are easy to navigate.

Table 4. Factors of Choosing Particular E-Commerce Platforms

Website is reliable	**Frequency**	**Percent**
Yes	349	69.8
No	151	30.2
Total	500	100.0
Website is secured from scam	**Frequency**	**Percent**
Yes	300	60.0

No	200	40.0
Total	500	100.0
Website is easy to navigate	**Frequency**	**Percent**
Yes	245	49.0
No	255	51.0
Total	500	100.0
Website is designed to give customer satisfaction	**Frequency**	**Percent**
Yes	270	54.0
No	230	46.0
Total	500	100.0
Website is credible	**Frequency**	**Percent**
Yes	271	54.2
No	229	45.8
Total	500	100.0

Challenges of Adopting E-commerce Platforms by Individual Businesses Owners

Table 5 below shows the challenges faced by individual business owners in adopting particular e-commerce platforms. The major challenge of the respondents was fraudulent online shops. Out of the total respondents, 332 representing 66.4% revealed that fraudulent online shops were a major challenge, followed by 318 respondents 63.6% who indicated that delay in transactions was another challenge, and 315 respondents representing 63.0% also indicating that poor internet network to access online shops was a challenge. Moreover, 228 respondents representing 45.6% complained of high online transaction costs, whilst 168 representing 33.6% complained of theft of ordered items or products. However, 134 respondents representing 26.8% complained about other challenges of adopting a particular e-commerce platform.

Table 5. Challenges of Using E-commerce Platforms

Poor internet network to access online shops	**Frequency**	**Percent**
Yes	315	63.0
No	185	37.0
Total	500	100.0
High online transaction cost	**Frequency**	**Percent**
Yes	228	45.6
No	272	54.4
Total	500	100.0
Theft of ordered items	**Frequency**	**Percent**
Yes	168	33.6
No	332	66.4
Total	500	100.0

Fraudulent online shops	Frequency	Percent
Yes	332	66.4
No	168	33.6
Total	500	100.0
Delay in transactions	**Frequency**	**Percent**
Yes	318	63.6
No	182	36.4
Total	500	100.0
Other	**Frequency**	**Percent**
Yes	134	26.8
No	366	73.2
Total	500	100.0

Discussion of Findings

Current State of E-commerce in Ghana

The various types of e-commerce platforms mostly used in Ghana are the Business-to-Consumer (B2C) and Business-to-Business (B2B) e-commerce platforms. According to [20], B2C e-commerce platforms are platforms where transactions between businesses and individual consumers take place. The use of Business-to-Business (B2B) e-commerce platforms also involves transactions between businesses on e-commerce platforms. It involves the exchange of goods, services, or information between businesses through online platforms [23]. It is the most familiar form of e-commerce, where consumers directly purchase products or services from online retailers. This is evident in this current study such that the individual business owners use e-commerce platforms for their business activities. The business owners use the e-commerce platforms for both personal and business transactions. By this, 43.8% use the platforms for their personal business activities, 21.6% solely use the platforms for their business, whilst 34.6% also use the platforms for the combined reasons of personal and business activities. It was revealed that the business owners have been using e-commerce platforms for over some years now. Majority of the business owners (30.6%) have been using the e-commerce platforms for 4-7 years. A report by [16] shows that e-commerce platforms in Ghana such as Tonaton, Jumia, Zoobashop, and Melcom Online have gained popularity and become key players in the Ghanaian e-commerce space. These marketplaces provide a wide range of products, including electronics, fashion, household goods, and groceries, allowing consumers to shop conveniently from the comfort of their homes. In this current study, the finding is consistent with the above report such that individual business owners have been using both local and foreign platforms. Concerning the local platforms, the predominantly used platform is Tonaton (61.0% users), followed by Jumia (58.0% users), Melcom Ghana (55.4% users), and Jiji (54.2% users). Cross-border e-commerce platforms that is foreign platforms play a crucial role in facilitating international trade for Ghanaian businesses. According to [2], platforms like Alibaba's AliExpress and Amazon have gained popularity among Ghanaian entrepreneurs, providing them with access to global markets and customers. This assertion of [2] is consistent with the findings that the individual business owners predominantly use foreign e-commerce platforms which are Alibaba (56.4% users), followed by Amazon (56.2% users), Aliexpress (51.8%), and eBay (39.0%). In the study of [1]

on the analysis of the impact of e-commerce on consumer behaviour, it was revealed that e-commerce has significantly influenced consumer behaviour by providing convenience, accessibility, and a wide range of product choices. This is supported by the findings of this current study that the business owners indicated that they buy different products from these online platforms ranging from electronic devices, clothes/apparels, footwear/shoes, food items/groceries, books/stationeries to other forms of products. The individual business owners buy products from these e-commerce platforms either daily, weekly, bi-weekly, monthly or any other period that seems convenient to them. Whenever these individual business owners buy the products from the e-commerce platforms, majority (54.6%) use mobile phones, followed by laptops (27.8% users), and tablets (14.8%).

Factors that Influence the Choice of Particular E-commerce Platforms by Individual Business Owners

[24] conducted a meta-analysis review of a collection of studies to identify factors contributing to the success of C2C e-commerce platforms and their study revealed that trust, reputation, seller competence, and website usability as key factors influencing C2C e-commerce success. [39] on the other hand investigated the factors that lead to the adoption of mobile commerce with a clear intention to understand why people use mobile commerce and their findings after the analysis revealed the importance of factors such as perceived usefulness, perceived ease of use, trust, and security are driving mobile commerce adoption. [6] explored the various strategies that small and medium-sized enterprises (SMEs) can adopt to enhance their e-commerce activities in international trade and the researchers' findings indicated that several strategies for SMEs to enhance their e-commerce, including improving website usability, implementing effective online marketing, and strengthening customer service. In this present study, the findings of [24], [39] and [6] are supported by the current findings due to the fact that various factors that influence individual business owners' choice of adopting a particular e-commerce platform were uncovered. The business owners are always interested in ensuring that they get the best of transactions from the e-commerce platforms they use. Majority of the business owners (69.8%) look out for reliable platforms, they (60.0%) also look out for platforms that are secured from scams, credible platforms (54.2%), platforms that are designed to give customer satisfaction (54.0%), and platforms that are easy to navigate (49.0%).

Challenges of Adopting E-commerce Platforms by Individual Businesses Owners

One of the challenges of adopting e-commerce is related to delays in the delivery of products to meet customer satisfaction [3]. [11] researched the challenges in international e-commerce logistics by conducting a systematic literature review to explore the challenges in international e-commerce logistics. The researchers identified key challenges of e-commerce that included customs and import/export regulations, transportation and last-mile delivery issues, inventory management, information sharing, and reverse logistics. Moreover, [29] utilized a qualitative research approach, including interviews and case studies, to examine the challenges and potential solutions for small and medium enterprises (SMEs) in international e-commerce. Their study revealed several challenges of e-commerce in international trade which were legal and regulatory complexity, market entry barriers, logistics and supply chain management, cultural differences, language barriers, and payment issues. The findings of the aforementioned studies are consistent with the findings of this current study which revealed that business owners also face

challenges in the quest of adopting e-commerce platforms for their business transactions. The major challenge of most individual business owners (66.4%) is associated with fraudulent online shops. The next major challenge indicated by the business owners (63.6%) is related to delays in transaction activities, followed by poor internet network to access e-commerce platforms (also indicated by 63.0% of individual owners), high online transaction cost (45.6%), and theft of ordered items or products (33.6%).

Conclusion

Based on the research questions, the study revealed the current state of e-commerce in Ghana, factors individual business owners consider in adopting e-commerce platforms, challenges in adopting e-commerce platforms by business owners, the impact of e-commerce on business competitiveness and logistics and supply chain management in international trade.

Based on the findings of this current study, it can be concluded that many individual business owners have embraced the use of e-commerce platforms for their personal and business transactions in both local and international businesses. The use of both local and foreign e-commerce platforms by these individual businesses contributes to international trade business due to the fact that the trade transactions are done between both local and foreign businesses.

It can also be concluded that individual business owners are very careful and sensitive when it comes to adopting a particular e-commerce platform for their local and international business transactions. Since the transactions on these e-commerce platforms involve the exchange of money or currencies, individual business owners are always interested in securing reliable and genuine platforms devoid of scams or fraud for their transactions.

Another conclusion indicated here is that the use of e-commerce platforms has challenges. These challenges disrupt the transaction activities of individual business owners. This reveals that in the use of technology to make life easier and simpler, there can be challenges.

It can be concluded that individual business owners perceive the adoption of e-commerce platforms in their business transactions to contribute to the competitiveness and logistics and supply chain management of their businesses at local and international levels. These individual owners have several perceptions and give credence to e-commerce usage to play a key role in making them competitive with other businesses and also ensuring effective logistics and supply chain management in their local and international businesses.

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Knowledge and Perception of Lassa Fever and Case Detection Among Community Health Influencers in Selected Local Government Areas in Ondo State, Nigeria

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Abstract

Lassa fever (LF), a viral hemorrhagic fever endemic to West Africa, poses significant public health challenges due to its non-specific symptoms, often mimicking other febrile illnesses. This diagnostic ambiguity hinders early detection and prompt medical intervention, increasing the risk of severe complications and mortality. Community health influencers (CHIs) are crucial for effective LF management, especially in resource-limited settings where they serve as the primary link between healthcare systems and vulnerable populations. Their roles encompass early case identification, community education, and facilitating access to treatment, making their understanding of LF paramount. This study aimed to assess the baseline knowledge and perceptions regarding LF among CHIs in selected high-risk Local Government Areas (LGAs) of Ondo State, Nigeria, a region with a historically high LF burden. Employing a quasi-experimental design, the research involved 60 CHIs recruited through multi-stage sampling, ensuring representation from diverse communities within the endemic LGAs. Data collection utilized validated questionnaires, demonstrating robust reliability with a coefficient of 0.70–0.72, to capture demographic characteristics, knowledge levels, and perceptions related to LF susceptibility, severity, and preventive measures. Descriptive and inferential statistical analyses, conducted at a significance level of $p < 0.05$, revealed moderate knowledge levels among CHIs, with an average score of 5.67 ± 1.63. However, significant variations in perceptions were observed, with misconceptions regarding LF susceptibility and severity being prevalent. Limited understanding of LF transmission dynamics and difficulty recognizing early symptoms emerged as key barriers to effective case detection. These findings underscore the critical need for targeted educational interventions tailored to address knowledge gaps and rectify misconceptions among CHIs, ultimately contributing to improved LF control and outbreak mitigation in endemic regions.

Keywords: *Community Health Influencers, Knowledge, Lassa Fever, Ondo State, Perception.*

Introduction

Lassa fever (LF), a viral hemorrhagic fever endemic to West Africa, presents a significant public health challenge in Nigeria. The disease is characterized by non-specific symptoms, often mimicking common febrile illnesses like malaria, which include fever, weakness, headaches, vomiting, and muscle pains [1]. This diagnostic ambiguity hinders early detection and prompt treatment, leading to increased risk of severe complications, such as encephalitis and bleeding, and a higher mortality rate [2]. While the overall mortality rate is approximately 1%, it can surge to 24-33% during sporadic outbreaks [3]. Pregnant women are particularly vulnerable, with LF contributing to a significant proportion of maternal fatalities in affected regions [4]. The absence of an approved vaccine further underscores the urgency of effective prevention and control measures.

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The primary reservoir of the Lassa virus (LASV) is the multimammate rat (Mastomys natalensis), which sheds the virus in its excreta and urine [5, 6]. Human infection occurs through direct contact with infected rodents or their contaminated environment, ingestion of contaminated food, or contact with infected bodily fluids [7, 8]. Human-to-human transmission is also possible, particularly in healthcare settings with inadequate infection control measures. Although Nigeria, Sierra Leone, Guinea, and Liberia are considered endemic countries, serological evidence suggests a wider presence of LASV in West Africa [9, 10, 11]. With over a million estimated cases and 5,000 fatalities annually across the region, LF poses a substantial burden on healthcare systems and communities [12].

Several factors contribute to the persistent challenge of LF control in Nigeria. The non-specific nature of early symptoms leads to frequent misdiagnosis or delayed reporting, hindering timely intervention [13]. Limited healthcare resources, including inadequate diagnostic capacity and trained personnel, further exacerbate the situation. Furthermore, gaps in community awareness and knowledge about LF transmission and prevention contribute to the ongoing spread of the disease. Addressing these challenges requires a multi-faceted approach that strengthens healthcare infrastructure, enhances community engagement, and empowers healthcare workers with the necessary skills and knowledge for effective LF management.

Community Health Influencers (CHIs), as part of the Community Health Influencers, Promoters, and Services (CHIPS) program, play a vital role in bridging the gap between healthcare systems and communities, particularly in underserved areas [14]. They are trained to provide basic healthcare services, health education, and referrals, making them ideally positioned to contribute to LF prevention and control. However, the current CHIPS program does not include specific training on LF surveillance and case detection. Integrating LF-focused training into the CHIPS program can significantly enhance the capacity of CHIs to identify and report suspected cases, promote community awareness, and facilitate early access to treatment.

Knowledge, awareness, and perception are fundamental to improving case detection skills [15]. Comprehensive training programs for CHIs should prioritize the dissemination of accurate information about LF symptoms, transmission routes, and prevention strategies. By enhancing their knowledge and awareness, CHIs can become more effective in identifying potential cases, educating communities, and promoting preventive behaviors. This proactive approach is crucial for early detection, timely reporting, and ultimately, reducing the burden of LF in endemic regions.

Lassa fever remains a persistent public health threat in Nigeria, demanding concerted efforts to strengthen prevention and control measures. Empowering Community Health Influencers through targeted training and integration into LF surveillance activities can significantly enhance early case detection and community engagement. By investing in the knowledge and skills of CHIs, Nigeria can make significant strides towards mitigating the impact of Lassa fever and improving public health outcomes in endemic regions.

This study aimed to assess the baseline knowledge and perception of LF among community health influencers in Ondo State, providing insights into existing gaps and opportunities for targeted interventions. By understanding their level of awareness and attitudes toward LF, this research seeks to inform strategies for strengthening community health systems in endemic areas.

Materials and Methods

Study Design and Area

This study adopted a cross-sectional design including 60 CHIs selected from two endemic LGAs in Ondo State, Nigeria.

Sampling Technique

Multistage sampling was used to select participants for this study. The first stage used retrospective data from NCDC was used to identify 7 LGAs that have reported cases of Lassa fever in the last 3 years. They include Owo, Akure South, Akure North, Ose, Akoko South-West, Akoko South-East, and Idanre LGAs. Purposive sampling was used to select 2 LGAs. Majority of curative services are provided by specialists and general hospitals in the state, yet they are woefully understaffed. Although the government recruited a few health workers, the primary healthcare system has not yet benefited from the recruitment process, leaving it severely lacking in human resources needed to provide high quality healthcare, especially in low population areas. Hence, endemic LGAs with the lowest populations; Idanre and Akoko South-East, were selected to participate in the study. Stage two included Three (3) community influencers were selected from primary health care facilities that serve as the primary points for community health influencers in the 10 wards from each local government using random sampling technique.

Study Variables

The study variables were knowledge and perception. Section B used dichotomous (yes/no) and Likert-scale questions, with scoring based on question construction: positive answers scored higher, and negative answers scored lower. Sections C used a Likert scale of strongly agree to strongly disagree, with correct answers assigned the highest scores.

Instrumentation

A 32-item structured questionnaire, with construct reliability ranging from 0.708–0.726, assessed CHIs' knowledge and perception. Adapted from the Health Belief Model, it comprised five sections: socio-demographics (Section A), knowledge (10 multiple-choice questions, Section B), perception (16 Likert-scale questions on susceptibility, severity, barriers, and benefits, Section C).

Data Analysis

Data was analyzed using SPSS software. Descriptive statistics were used to summarize the data. Inferential statistics, including t-tests were used to compare the changes in knowledge, perception, and skills between the experimental and control groups.

Ethical Considerations

Ethical approval was obtained from Babcock University Health Research Ethics Committee (BUHREC). Informed consent was also given through verbal communication and written consent forms were signed. The information provided by respondents was kept confidential and there was no penalty for not filling in the form or withdrawing at any time

Results

Demographics Characteristics of Participants

All 60 participants had an average age of 44.39 years, with a standard deviation of 6.92 years. This suggests that most of the study population was middle-aged. Religious affiliations were distributed almost evenly, with Muslims making up 48.3% and Christians making up 28.3%. This equilibrium implied that religious background might not have a major impact on the study's findings. 93.34% of the population has completed post-primary education. A usually well-educated participant pool is indicated by this high degree of educational attainment. Most participants

71.67% were married. Accordingly, marital status might be considered while analysing the study's results. Overall, 56.67% of the participants were employed. This information provides valuable context for interpreting the study's results, as employment status can influence individuals' perspectives and experiences.

Table 1. Socio-demographic Characteristics of Participants

Variables	**Respondents N=60**
Age	
Mean age	44.39 ± 6.92
Religion	
Islam	29 (48.30)
Christianity	17 (28.30)
Traditional	14(23.30)
Level of education	
Primary	4 (0.67)
Secondary	40 (66.67)
Tertiary	16 (26.67)
Marital status	
Single	5 (8.30)
Married	43 (71.67)
Widowed	12(20.00)
Occupation	
Employed	34 (56.67)
Self-employed	26 (43.33)
Total	**60(100)**

* $p<0.05$

Knowledge of Lassa Fever

The results of this survey indicate a mixed understanding of Lassa fever among the respondents. While there is strong awareness of the link between rodents and the disease and a general understanding of its preventability, there are knowledge gaps regarding transmission routes, side effects, incubation period, and the full range of symptoms. As shown in table 2. These findings emphasize the critical need for targeted educational interventions to improve knowledge and awareness of Lassa fever, particularly among groups who may play a role in early case detection and community education. Participants demonstrated moderate knowledge of LF, with a mean score of 5.67 ± 1.63 out of a maximum of 10 points. While many respondents (66.67%) correctly identified Lassa fever as being caused by a virus, a significant portion (23.33%) incorrectly attributed it to bacteria, and 10% believed it was caused by fungi. This indicates a need for improved education regarding the viral nature of Lassa fever. There was some confusion regarding transmission routes. Although 46.67% correctly identified that Lassa fever cannot be transmitted through

breastmilk, 30% incorrectly believed touch was not a transmission route, and 23.33% were unaware of the risk of transmission through contaminated food. Furthermore, while 61.67% understood that the disease can spread from object to person, a substantial 31.67% believed it could spread from person to person, which is less common. These findings highlight the need for clearer communication about how Lassa fever is and is not spread. The vast majority (83.33%) correctly recognized that Lassa fever is a preventable disease. This suggests a good foundation for promoting preventive measures. Almost half of the respondents (48.33%) correctly identified deafness as a potential side effect of Lassa fever. However, 30% incorrectly believed blindness was a side effect, and 21.67% thought stroke was a possible consequence. This points to a need for more accurate information about the potential complications of Lassa fever. An overwhelming majority (96.67%) accurately identified rat excreta and urine as a source of contamination for Lassa fever. This demonstrates strong awareness of the link between rodents and the disease. Most respondents (63.33%) correctly stated the incubation period for Lassa fever as 2-21 days. However, 31.67% incorrectly believed it was 1-7 days, and 5% thought it was 4 weeks. This discrepancy underscores the importance of providing clear and consistent information about the disease's timeline. Over half of the respondents (55%) correctly understood that bleeding in the final phase of Lassa fever infection can occur from any part of the body. However, 28.33% specifically associated bleeding with the nose, and 16.67% with the eyes. This indicates a partial understanding of the potential for widespread bleeding complications. A large majority (83.33%) correctly identified blood donation as a practice that does not prevent the spread of Lassa fever. However, 16.67% incorrectly believed rodent control was not a preventive measure, and 1.67% thought environmental sanitation was ineffective. This suggests a need to emphasize the importance of a comprehensive approach to prevention, including environmental hygiene and rodent control. Almost all respondents (93.33%) correctly identified high fever as a symptom of Lassa fever. However, only 5% recognized difficulty in breathing as a potential symptom, and only 1.67% identified jaundice. This highlights the need to raise awareness of the broader range of possible Lassa fever symptoms.

Table 2. Knowledge of Lassa Fever

Variables	**Respondents N=60**
Lassa fever is caused by	
Bacterium	14(23.33)
Virus	40(66.67)
Fungi	6(10.00)
Lassa fever cannot be transmitted through	
Touch	18(30.00)
Ingestion of contaminated food	14(23.33)
Breastmilk	28(46.67)
Lassa fever can spread from	
Person to person	19(31.67)
Object to person	37(61.67)
Person to object	4(6.67)
Lassa fever is not a preventable disease	

Yes	9(15.00)
No	50(83.33)
None of the above	1(1.67)
One of the following is side effect of Lassa fever	
Blindness	18(30)
Deafness	29(48.33)
Stroke	13(21.67)
Lassa fever can be contracted through food items contaminated	
Bat urine	2(3.33)
Dog excreta	0(0.00)
Rat excreta and urine	58(96.67)
Lassa fever incubation period is	
4 weeks	3(5.00)
2-21 days	38(63.33)
1-7 days	19(31.67)
Final phase of Lassa fever infection can result in bleeding from	
Any part of the body	33(55.00)
Nose	17(28.33)
Eyes	10(16.67)
The following measures do not prevent spread of Lassa fever	
Environmental sanitation	1(1.67)
Blood donation	50(83.33)
Rodent control	10(16.67)
The following are symptoms of Lassa fever	
Difficulty in breathing	3(5.00)
Jaundice	1(1.67)
High fever	56(93.33)
Total	**60**

Perception of Lassa Fever and case detection

The average perception score across all participants was 18.37 ± 4.99, indicating (55%) of the respondents had positive perception overall as shown in table 3. Analysing the sub-constructs of perception provided further insights. With an average score of 7.66 ± 2.44 on a 12-point scale, participants demonstrated a moderate perception of their susceptibility to Lassa fever. This suggests that while they were aware of the risk, there may be some underestimation of their personal vulnerability. Participants scored an average of 7.96 ± 2.30 on a 12-point scale for perceived severity, indicating a moderate to high recognition of the potential seriousness of Lassa fever infection. The average score for perceived benefits of Lassa fever case detection was 5.97 ± 1.40 on a 9-point scale. This suggested a moderate understanding of the positive outcomes associated with early identification and reporting of cases. Participants scored an average of 10.94 ± 3.34 on a 15-point scale for perceived barriers, indicating a moderate perception of obstacles hindering Lassa fever case detection. This highlights the need to address these perceived barriers to facilitate more effective reporting and control efforts.

Table 3. Perception of Lassa fever and case detection

Variables	Rating scale	Respondents N=60	*p*-value
Negative (0-24)	48	27(45)	*0.3267*
Positive (28-48)		33 (55)	
Total		**60(100)**	

Discussion

This baseline assessment highlights significant gaps in the knowledge and perception of LF and case detection among community health influencers. Although participants demonstrated awareness of some key aspects, such as the role of rodents in LF transmission, critical knowledge areas including human-to-human transmission, symptom recognition, and preventive practices remain inadequate. These deficiencies may hinder timely case detection and reporting, exacerbating the public health burden of LF in endemic regions. Similar findings have been reported in previous studies, such as [16,17], which identified limited knowledge among health workers in LF-endemic areas.

Participants' perceptions of LF severity and susceptibility were inconsistent, potentially influencing their engagement in case detection activities. The low perceived risk of infection, despite working in endemic areas, reflects a gap in risk communication strategies. Furthermore, the identified barriers including limited diagnostic access and stigma underscore the need for systemic and community-level interventions to address structural and cultural challenges. Research by [18] similarly emphasizes the impact of perception on health behaviors, highlighting the importance of tailored educational programs to reshape attitudes and beliefs.

The findings underscore the critical role of knowledge and perception in shaping health behaviors and outcomes. Addressing these gaps through targeted training and community engagement is essential to strengthening LF surveillance and control. Furthermore, integrating LF-specific modules into existing community health programs, such as CHIPS, offers a sustainable pathway for enhancing capacity at the grassroots level.

Conclusion

The baseline knowledge and perceptions regarding Lassa fever among community health influencers in Ondo State, Nigeria, are crucially revealed by this study. The results validate the significance of this study since misconceptions and modest levels of knowledge can impede efficient case detection and disease control initiatives. This study emphasizes the need for focused educational interventions catered to community needs by highlighting knowledge gaps and opportunities for development. Community health influencers can be better equipped to identify, report, and handle Lassa fever cases if they get targeted training. These initiatives ought to focus on dispelling myths regarding symptoms, transmission, and prevention to promote more truthful and proactive health habits. A scalable and long-term strategy for bolstering community-based disease surveillance systems is also provided by incorporating these interventions into already-existing community health frameworks, such the CHIPS program. These results demonstrate the wider value of improving health knowledge and attitudes to enhance the management of various infectious diseases in settings with low resources, in addition to combating Lassa fever. Future studies should examine how well these treatments work over the long run and how adaptable they are to other cultural and geographic contexts. By doing this, our study adds to the increasing amount of data demonstrating the vital role community health workers play in international public health campaigns.

Conflict of Interest

There is no conflict of interest.

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Training of Medical Laboratory Professionals in Africa Region: A Perspective of the Practicing Laboratory Professionals

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Abstract

Approximately 70% of medical decisions require a confirmatory laboratory test. This reliance highlights the critical role of laboratory medicine in enhancing healthcare outcomes and the need for appropriately trained and skilled laboratorians. To assess levels, types, composition and training of laboratory professionals in response to the changing needs in Africa, we surveyed medical laboratory professionals in Africa on their demographics and challenges encountered during training and what would be consider as a minimum course content for a medical laboratory training program. Of the 285 professionals from 30 countries surveyed, 88% were working within their countries of birth and 82% trained at public institutions. 89.5% were employed and 151 (53%) had a bachelor's degree as their primary laboratory qualification. 63% expressed satisfaction with their career growth. Courses recommended into the primary laboratory qualification were microbiology, biosafety, biosecurity, hematology, chemistry, blood transfusion, immunology, laboratory management, attachment, molecular biology, research methods, histology and cytology. Challenges faced during training were lack of resources and equipment, limited clinical exposure, insufficient curriculum coverage and inadequate faculty staff. 30.9% of the professionals had at least one additional medical qualification. Employment status was significantly associated with satisfaction with one's career growth (p=004). A 4-year bachelor's degree with 12 months of internship is recommended for Laboratory training with microbiology, biosafety and biosecurity, hematology, chemistry, blood transfusion, immunology, laboratory management, internship, molecular biology, research methods, histology and cytology as minimum content. More laboratory-specific disciplines for post-graduate training up to PhD level, associated with defined career paths adequately compensated are recommended.

Keywords: *Bachelor's, Career, Curriculum, Internship, Qualification.*

Introduction

It has been well-recognized that despite accounting for 1-2% of healthcare expenditures, medical laboratory diagnostics are involved in up to 60-70% of clinical decisions, influencing patient management strategies [1, 2] and a critical component of public health interventions and disease surveillance [3]. This reliance highlights the critical role of laboratory medicine in enhancing healthcare outcomes, informing clinical trial endpoints and optimising clinical practices [3, 4]. Other than improving the quality of outcomes, investing in a diagnostic laboratory service improves the cost-effectiveness of healthcare.

The status of the medical laboratory profession in the African region reflects significant progress and ongoing challenges [5, 6, 7]. Since the Maputo Declaration in 2008,

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there have been notable advancements in laboratory systems, particularly in HIV diagnostics, laying the groundwork for addressing broader health threats [5, 8]. However, the profession still faces issues such as underfunding, workforce shortages, and inadequate training, which hinder the effectiveness of laboratory services across the continent [5]. The investment in laboratory systems has been inconsistent and inadequate, particularly in African countries and was evident during the COVID-19 pandemic [9]. This lack of investment has seen about 47% of the global population not having access to diagnostics, with the majority of these in the World Health Organization Regional Office Region (WHO Afro) [10].

The history of clinical laboratory sciences in North America dates back to the 19th century when outbreaks of diseases such as typhoid, tuberculosis, and diphtheria highlighted the need for laboratory testing in patient care [11]. Although its origins can be traced to the American Revolution, the profession became formalized in the early 20th century, with significant milestones like the 1919 American College of Surgeons' requirement for hospital laboratories and the establishment of the Board of Registry by the American Society for Clinical Pathologists in 1928 [12, 13]. Initially viewed as a temporary profession for women during World War I, it has since gained recognition, especially with technological advancements and public health crises like the COVID-19 pandemic [13, 14]. In Africa, laboratory medicine dates back to the late 1800s with limited tests, evolving significantly in the 1950s and 1960s as formal training programs were established [15]. The rise of diseases like HIV/AIDS and tuberculosis increased investment in laboratory medicine, prompting a need to revolutionize training. Today, programs have evolved from training aides to scientists, incorporating accreditation and aligning with international standards to include disciplines like haematology, microbiology, and molecular diagnostics.

However, the profession and discipline of laboratory medicine have always experienced lower visibility and diminished rewards compared to other disciplines of doctors, nurses and pharmacists [1]. Laboratory professionals operating in the background are often perceived as operating automated equipment deserving of no shared clinical leadership. The profession has long been confronted with challenges, including recruitment and retention challenges, inconsistent funding, inadequate learning facilities, inadequate practical placements, unclear career paths for advancement, inconsistency in training standards and curriculum, limited professional development and limited continuing professional development opportunities as compared to other medical and allied professions.

In this study, we surveyed laboratory professionals to assess levels, types, composition and training in response to the changing needs in Africa. Findings can be used to inform decisions of training curriculum and approaches, career development and paths for laboratory professionals.

Materials and Methods

The study only analysed data collected with expressed informed consent and did not involve identifiable individuals.

We used a survey approach to administer a standardised and validated tool to medical laboratory professionals in Africa. Variables included demographics, types, levels, duration of laboratory training (primary and professional training) and challenges encountered. Data was also collected on what medical laboratory practitioners would consider as a minimum qualification and course content for a medical laboratory training program. Survey Data were downloaded/exported into MS Excel and cleaned for analysis. We used descriptive statistics to summarise our findings. We assessed for predictors of training outcomes,

such as perception about the prior training, career growth and development, using Chi-squared tests and logistic regression analysis. All statistical analysis was conducted using STATA version 18 (STATA Corporation, College Station, TX).

Participants were required to provide consent to participate in the survey. However, their participation was completely anonymised.

Results

Demographic Characteristics

A total of 285 Laboratory professionals responded from 30 countries across the African continent, with the most respondents from Zimbabwe (20.8%), Ghana (16.5%), Botswana (n=28) and Tanzania (9.5%). Most of the participants (88%) are working within their countries of birth.

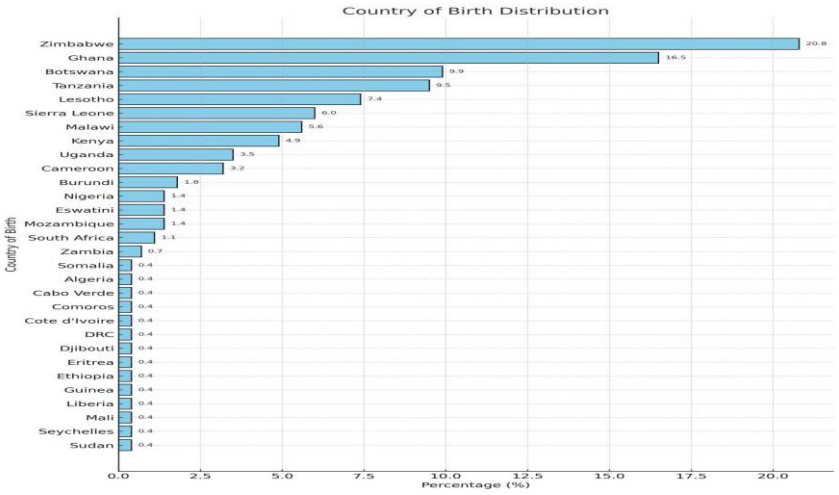

Figure 1. Distribution of the Country of Birth for Laboratory Professionals Participating in the Survey.

Primary Laboratory Training and Qualifications

Most of the professionals were trained at government and or public institutions (n=234; 82%), with the rest at private (n=36; 12.6%), faith-based institutions (n=14; 4.9%) and others (n=1; 12.6%). The majority of the professionals had a bachelor's degree (n=151; 53%) as their first laboratory qualification, with a diploma (n=96; 34%) as the second first qualification, then a certificate (n=23; 8%). Medical Laboratory Sciences was the most used name of the qualification (43%), followed by Medical Laboratory Technologist (20%) and Medical Technology (19%). Figure 2.

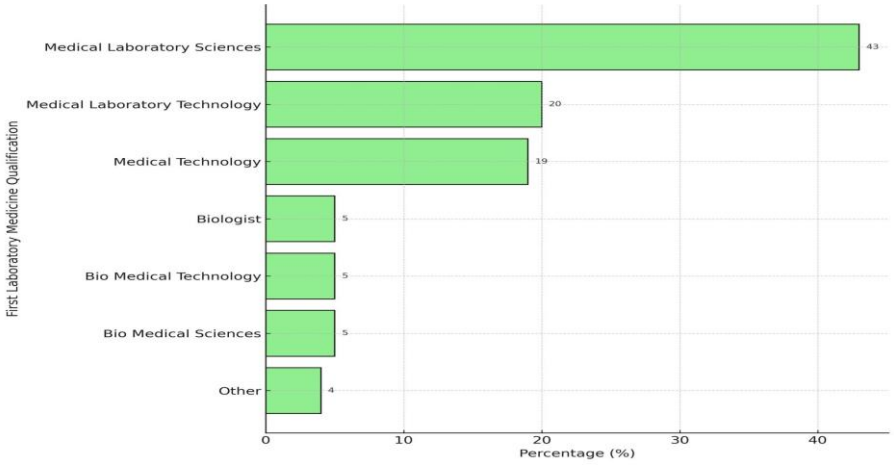

Figure 2. Distribution of the Primary Laboratory Qualification Held by the Laboratory Professionals.

The respondents qualified as medical laboratory professionals between 1990-2024, with the majority qualifying between 2015-2019 (n=72; 25.3%) and the least between 1990 – 1994 (n=9; 4.9%). The duration of the qualification ranged from 1-6 years, with the most at 4 years (n=135; 47.4%), followed by 3 years (n=102; 35.8%), 2,5,1 and 6 years respectively (n=34; 11.9%;), (n=9; 3.2%), (n=3; 1.0%) and (n=2; 0.7%). Those with 4 years duration of training were the ones mostly employed (n=118, 46%).

91.6% (n=261) of the training had an internship program with up to 12 months (n=260; 91.2%) duration as the most common, followed by 13-18 months (n=12; 4.2%), 19-24 months (n=9; 3.2%), 25-20 months (n=8; 2.8%) and 31-36 months (n=3; 1.1%) as the least common. English (n=266; 93.3%) was the most important language of delivery of the training, with French (n=14; 4.9%) and Portuguese (n=4; 1.4%) as the other languages.

The majority (63%) of those satisfied with their first laboratory qualification also expressed satisfaction with their career growth. Those with a bachelor's degree as their first laboratory qualification were the most satisfied (49%) with their qualification.

Curriculum Content and Structure

Most qualifications had content that included genetics, molecular biology, cytology, laboratory management, histology, blood transfusion, haematology, immunology chemistry and microbiology (Figure 3). The laboratory professionals recommended some additional disciplines of biosafety and biosecurity, artificial intelligence, pathogen genomics and bio-informatics not previously offered during their first laboratory qualification. The following modules were recommended by at least 50% of the participants for inclusion as a minimum requirement for the first laboratory qualification: microbiology (86%), Biosafety and Biosecurity (86%), haematology (83%), chemistry (80%), blood transfusion (76%), immunology (76%), laboratory management (76%), laboratory attachment (75%), molecular biology (65%), research methods (64%), histology (61%) and cytology (58%). Figure 3.

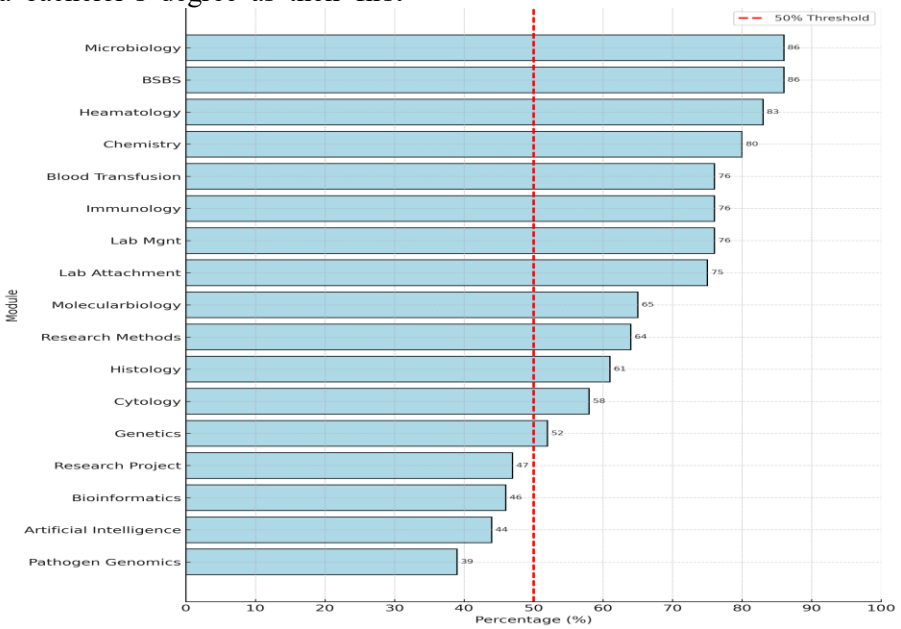

Figure 3. Curriculum Content Proposed for First Laboratory Training Programs

Most (n=118; 41.4%) proposed that the lowest laboratory training qualification be a diploma, while 95 (33.3%) proposed a bachelor's degree, 61 (21.4%) certificate and 11 (3.9%) PhD. The majority (n=227; 79.6%) proposed 3-4 years as the duration of training in

laboratory medicine, while 33 (11.6%) proposed up to 2 years and 25 (8.8%) to be at least 5 years. Most (n=179; 62.8%) of the laboratory professionals were satisfied with their career growth, and 270 (94.7%) would advise young people to pursue laboratory medicine as a career.

Most of the professionals were part of graduating classes that had less than 21 graduates (n=78; 27.4%), followed by classes of 21-30 graduates (n=73; 25.6%), 31-40 (n=45; 15.8%) and 41-50 (n=25; 8.8%). However, there were 64 (22.5%) who were part of a graduating class of more than 50 graduates. 155 (54.4%) indicated that there was a mechanism provided to them to give feedback on the training received for purposes of improving the training.

140 (49.1%) had a mandatory probation period of up to 1 year, 61 (21.4%) between 1 and 6 years, and 78 (27.4%) did not have any form of probation. More than half supported their education (n=158; 55.4%), 85 (29.8%) were on full scholarships, and 42 (14.7%) were partially supported.

Challenges Faced During First Laboratory Qualification Training

The most cited challenge faced during the first laboratory qualification training was lack of resources and equipment (n=107; 37.5%), while limited clinical exposure during training (n=54; 19.0%), insufficient coverage curriculum coverage (n=27; 9.5%) and inadequate faculty staff (n=22; 7.7%) were also mentioned.

However, most professionals (n=166; 58.3%) were satisfied with the first training in laboratory medicine they received, while 90 (31.6%) were very satisfied. 25 (8.8%) were neither satisfied nor dissatisfied, while only 4 (1.4%) were dissatisfied with the training they received.

Highest Laboratory Qualification

97 (34%) of the laboratory professionals had added at least one qualification at the time of the survey. A Bachelor's degree was the most common (n=43; 44.3%) highest qualification achieved, followed by a Master's degree (n=39; 40.2%), PhD (n=21; 21.6%) and only 1 (1.0%) diploma. The most progression was from Diploma to Bachelor degree (n=30; 30.9%) with the least (1.0%) from Certificate to Diploma qualification. Figure 4.

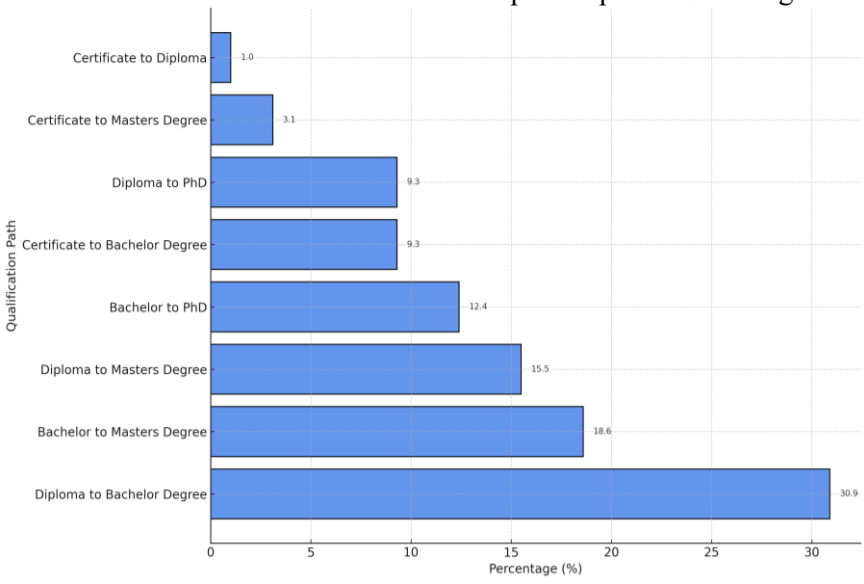

Figure 4: Distribution of Laboratory Qualification Transition from First Qualification to Highest Attained by the Laboratory Professionals

It took between 1-8 years for the professionals to complete their highest laboratory qualification. Most of the professionals (n=62; 21.8%) took 4 years to complete their highest qualification, 51 (17.9%) took 2 years, 41 (14.4%) 3 years, 13 (4.6%) 1 year, 11 (3.9%), 3 (1.1%) 6 years and 1 (0.4%) too 8 years to complete their highest qualification. 191 (67.0%) attained these highest laboratory qualifications at a government or public institution, with 202 (70.1%) using English as a medium of learning.

Most of the professionals were part of graduating classes that had less than 21 graduates (n=79; 27.7%), followed by classes of 21-30 graduates (n=47; 16.5%), 31-40 (n=24; 8.4%) and 41-50 (n=15; 5.3%). However, there were 38 (13.3%) who were part of a graduating class of more than 50 graduates. 126 (46.3%) indicated that there was a mechanism provided to them to provide feedback on the training received for purposes of improving the training.

Challenges Faced During Highest Laboratory Qualification Training

The most cited challenge faced during the highest laboratory qualification training was lack of resources and equipment (n=71; 24.9%), while limited clinical exposure during training (n=37; 13.0%), insufficient coverage curriculum coverage (n=17; 5.6%) and inadequate faculty staff (n=17; 5.6%) were also mentioned.

However, most professionals (n=145; 50.9%) were satisfied with the highest training in laboratory medicine they received, while 62 (21.8%) were very satisfied. 66 (23.12%) were neither satisfied nor dissatisfied, while 4 (1.4%) were dissatisfied, and 8 (2.8%) were very dissatisfied with the training they received.

Highest Other Medical Qualification

88 (30.9%) of the laboratory professionals had another medical qualification. A Master's degree was the most common (n=55; 62.5%) highest other medical qualification achieved, followed by Bachelor's degree (n=18; 20.5%), Diploma (n=8; 9.1%), PhD (n=4; 4.5%) and Certificate (n=3; 3.4%). It took between 1-5 years to complete this highest other medical qualification, with 2 years as the most (n=41; 14.4%). Most (n=82; 28.8%) of these trainings were at a government or public institution and delivered mostly (n=111; 39.0%) in English.

Challenges Faced During Highest Other Medical Qualification Training

The most cited challenge faced during the highest laboratory qualification training was lack of resources and equipment (n=30; 42.9%), while limited clinical exposure during training (n=18; 25.7%), insufficient coverage curriculum coverage (n=13; 18.6%) and inadequate faculty staff (n=9; 12.9%) were also mentioned.

Highest Other Qualification

54 (18.9%) of the laboratory professionals had another non-medical qualification. Most had a Masters degree (n=40; 74%), with 7 (13%) with a bachelor's degree, 4 (7.4%) diploma and 2 (3.7%) a certificate all completed between 2001 and 2024. Majority of the qualification were completed over 3 years (n=26; 48.1%), followed by 2 years (n=11; 20.4%), 4 years (n=9; 16.7%) and 5 years (n=1; 1.9%). The majority (n=52; 96.3%) were completed at a government institution and 50 (92.6%) were delivered in English.

The most reported challenge experienced when training for other qualifications was a lack of industrial and practical exposure (n=26; 48.1%), followed by a lack of resources and equipment to use (n=18; 33.3%) and inadequate staffing (n=10; 18.5%).

Most of the professionals were part of graduating classes that had less than 21 graduates (n=20; 37.0%), followed by classes of 21-30 graduates (n=13; 24.1%), 31- 40 (n=9; 16.7%) and 41-50 (n=2; 3.7%). However, there were 10 (18.5%) who were part of a graduating

class of more than 50 graduates. 126 (46.3%) indicated that there was a mechanism provided to them to provide feedback on the training received for purposes of improving the training.

255 (89.5%) of the medical laboratory professionals surveyed were employed, with the majority (n=76; 30%) as Heads of Departments. Figure 5.

Current Employment Status

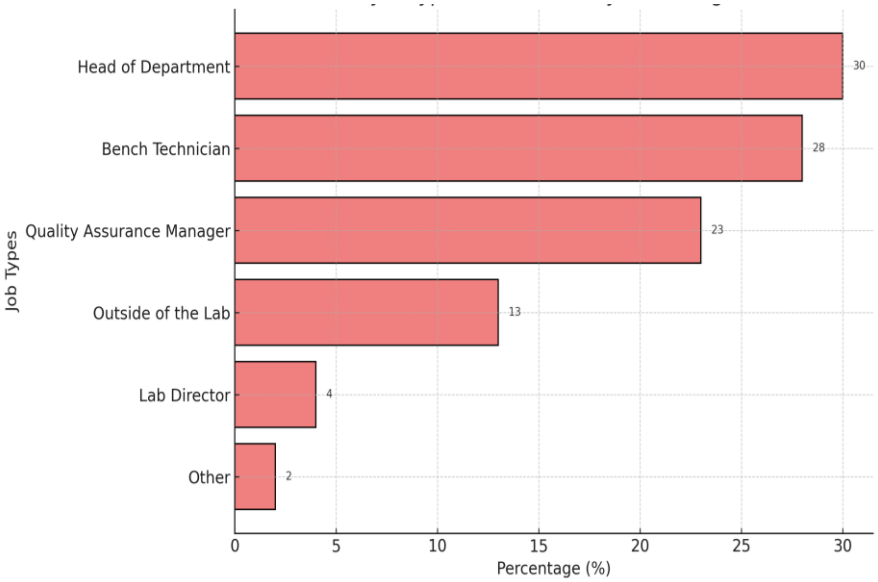

Figure 5. Job Types of Laboratory Professionals Employed at the Time of the Survey

164 (61.6%) were employed within the public sector, followed by Non-Governmental Organizations (n=54; 20.3%), private sector (n=33; 12.4%) and those employed by Faith-based organizations (n=15; 5.6%). The majority (n=234; 82%) and (n=201; 70.5%) indicated that there were opportunities available for continuous professional development (CPD) and postgraduate within their workplaces, respectively.

Employment status was significantly associated with satisfaction with one's career growth (p=004). Although not statistically significant (p=0.11), the majority of those employed (73%) were satisfied with their highest laboratory qualification. 92% of those employed had internships as part of their first qualification training program.

Discussion

Results of this study show that a bachelor's degree in Medical Laboratory Sciences is the most common entry-level qualification. Countries like Botswana introduced a bridging program to convert diplomas to bachelor's degree [16]. The American Society for Clinical Pathology (ASCP) has also offered programs to upgrade medical technologists to the Medical Laboratory Scientists [17]. On average, the duration of training is 4 years, incorporating the internship program consistent with other training programs in Africa [18, 19]. The inclusion of internship in the training offers an opportunity for students to connect theory with practice as well as get exposure to current technologies and testing methodologies [20]. The study also showed that participants who had internships included in their training were more employed, probably indicating a preference for clinically exposed graduates by employees.

Even with just entry-level qualifications, there were high satisfaction levels with the laboratory training as well as career growth. This could be attributed to the high employment rates of these laboratory professionals in this study. Although laboratory professionals in this study added more qualifications up to the PhD

level, the most progression in qualification was from diploma to degree in laboratory sciences. Beyond the degree level, laboratory professionals begin to slightly deviate to other areas of speciality, mostly Masters in Public Health. There is a need to expand options for further studies in laboratory sciences, for example, Masters in Microbiology, Clinical Chemistry, and Blood Transfusion, as examples with corresponding and matching career progression as motivators.

Across all levels of training, most training programs faced challenges in resources from equipment to adequacy of faculty members. The lack of adequate and up-to-date equipment can affect the quality of graduates. The study also showed smaller graduating classes of about 20, which could be a result of a poorly resourced training program. Although laboratory professionals showed high employment rates, most were employed in government hospital institutions, and fewer were returning to participate in the training of other professionals. Given that more laboratorians deviate to other disciplines after their first degree, there could be fewer of them with higher laboratory disciplines specific available. More investment into training programs and incentives can attract laboratory professionals to come back and contribute to training more laboratorians.

Laboratory professionals in employment are better placed to identify what should constitute basic and post-basic training in laboratory sciences. In this study, a diploma was proposed as the lowest allowable qualification in laboratory sciences. This could be attributed to high employment rates even for those with diplomas. The following disciplines were proposed as required at minimum for a qualification: microbiology, Biosafety and Biosecurity, haematology, chemistry, blood transfusion, immunology, laboratory management, laboratory attachment, molecular biology, research methods, histology and cytology. Biosafety and Biosecurity was a discipline proposed that most did not have when they trained. The other emerging areas suggested included artificial intelligence, pathogen genomics and bioinformatics. Consideration should be given to begin to introduce these either as standalone disciplines or as part of existing disciplines, e.g. pathogen genomics and bio-informatics could be part of molecular biology while artificial intelligence could be part of laboratory management.

Conclusion

At a minimum, laboratory professionals should be trained with a 4-year bachelor's degree that includes 12 months of internship at an approved facility. A standardized curriculum for all laboratory degree programs should include, at minimum, microbiology, biosafety and biosecurity, haematology, chemistry, blood transfusion, immunology, laboratory management, laboratory attachment (internship), molecular biology, research methods, histology and cytology. More investment is required in laboratory medicine training programs in modern equipment and appropriately qualified faculty members to increase training institutions' outputs to continue to meet the high demand for laboratory professionals. A deliberate effort is needed to increase the options in laboratory-specific disciplines for post-graduate training up to PhD level. These opportunities must be associated by defining career paths adequately compensated to minimize the observed deviation to other disciplines.

Limitations

Our findings are subject to some limitations. Although we attempted to cover most of the African countries, the response rates were varied, and more than 50% of the respondents came from 6 countries.

Acknowledgments

The authors thank all the laboratory professionals who responded to the survey

Conflict of Interest

The authors report no conflicts of interest in this work. There are no financial conflicts of interest to disclose.

Ethical Approval

The study only analyzed data collected from individuals from multiple countries with expressed informed consent (included on the survey questionnaire) and did not involve identifiable individuals, hence no ethical approval was required.

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Right Hemidiaphragm Rupture After Blunt Trauma with Near-Complete Prolapse of The Liver into the Chest: A Combined Approach

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Abstract

Traumatic diaphragmatic injuries are rare but pose significant diagnostic and management challenges, particularly in acute cases involving blunt trauma. These injuries often present non-specific symptoms, leading to misdiagnosis or delayed intervention. The right hemi diaphragm is less commonly affected than the left, and its involvement is frequently associated with liver herniation and concomitant abdominal or thoracic injuries. We present the case of a 28-year-old female who sustained a blunt thoracoabdominal trauma after being struck by a moving vehicle. She arrived at the emergency department with complaints of pain in the neck, left shoulder, left side of the chest, and right arm. Initial assessments revealed hemodynamic stability, a Glasgow Coma Scale (GCS) score of 15/15, and decreased breath sounds in the right lung field. Imaging studies, including chest X-ray, CT scan, and MRI, confirmed the right diaphragmatic rupture with liver herniation, lung contusion, and a liver laceration. Given the extent of the injury, the patient underwent a combined surgical approach: a right thoracotomy for lung and diaphragmatic repair and a median laparotomy for liver laceration management. The diaphragm was repaired with suturing and mesh placement. Postoperatively, she remained stable, requiring bronchoscopy for lung collapse before successful recovery and discharge on postoperative day 20. This case highlights the importance of early recognition, accurate imaging, and a tailored surgical approach for diaphragmatic rupture. A combined thoracoabdominal approach provides optimal exposure and repair, ensuring favorable outcomes. Further research is necessary to establish standardized guidelines for managing complex diaphragmatic injuries.

Keywords: *Blunt Trauma, Hemi Diaphragm Rupture, Liver Prolapse.*

Introduction

Traumatic diaphragmatic rupture (TDR) was first described by Sennertus in 1541. It remains a rare condition, challenging to diagnose, particularly in acute settings. Epidemiological studies indicate that TDR accounts for less than 0.5% of all trauma cases. While penetrating injuries constitute approximately 67% of cases, blunt trauma accounts for 33% [1,2]. The left diaphragm is more commonly affected, with intra-abdominal organ herniation (e.g., stomach, spleen) into the thoracic cavity being a frequent finding [3]. Motor vehicle accidents remain the leading cause of blunt diaphragmatic rupture [4].

Clinically, TDR presents with dyspnea, chest pain, abdominal distension, and diminished air entry on the affected side [5]. Reduced breath sounds may be misdiagnosed as pneumothorax, potentially leading to unnecessary chest tube placement. A high index of suspicion is crucial for early and accurate diagnosis.

We present a case of severe diaphragmatic injury with transthoracic liver herniation, liver

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laceration, and lung collapse, successfully managed via a combined thoracic and abdominal surgical approach. Given the limited literature on diaphragmatic rupture, further research is necessary to enhance diagnostic accuracy and optimize surgical outcomes.

Case Report

A 28-year-old female was involved in a motor vehicle accident, sustaining blunt thoracoabdominal trauma after being struck by a moving vehicle. She was transported to the emergency department by emergency medical services, presenting with pain in the neck, left shoulder, left side of the chest, and right arm. She denied loss of consciousness, headache, or dizziness.

Medical and Surgical History

1. Past surgical history: Open reduction and internal fixation (ORIF) of an ankle fracture (2013).
2. Past medical history: Unremarkable.

Initial Assessment

On Primary Survey

1. Airway: Patent
2. Breathing: Spontaneous
3. Circulation: Stable (HR: 81 bpm, BP: 95/63 mmHg)
4. Glasgow Coma Scale (GCS): 15/15
5. Exposure: Abrasions on the left forehead, face, abdomen, right elbow, and bruising on the right buttock. Deformity of the left clavicle was noted.

On Secondary Survey

1. Respiratory system: Decreased breath sounds on the right lung field.
2. Abdomen: Soft, non-tender.
3. The urine pregnancy test was positive. Urinalysis revealed 2+ glucose, 2+ proteins, and 4+ bloods.

Table 1. Vital Signs Monitoring During Emergency Room Admission

Time	**2037**	**2200**	**0005**	**0030**
Mobility	Stretcher	Stretcher	Stretcher	Stretcher
Respiration	19	18	19	18
Pulse	81	92	104	94
Temp	36	36	36	35.9
BP	95/63	104/64	116/75	102/70
MAP	76	80	87	82
SpO2	91	99	99	98
Blood sugar	6.4	6.4	6.4	6.4

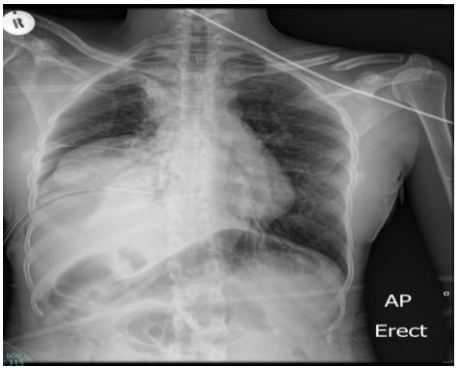

Figure 1. chest X-Ray



Figure 2. CT Scan

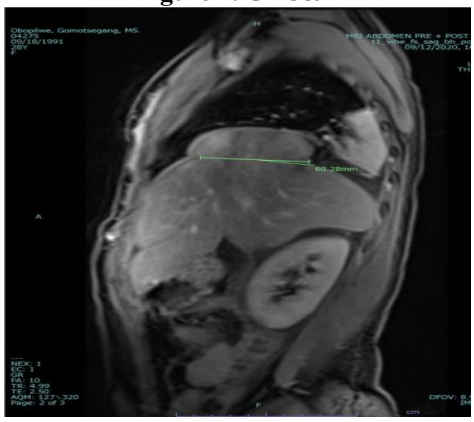

Figure 3. MRI

Imaging and Diagnosis

1. Chest X-ray (CXR): Elevated right hemi diaphragm with right lower lobe collapse, suggestive of diaphragmatic rupture.
2. CT scan and MRI: Confirmed the diagnosis.

Final Diagnosis

1. Right lung contusion
2. Suspected hemothorax
3. Suspected sub-abdominal hematoma at the isthmic point of the uterus
4. Liver laceration

Management and Surgical Intervention

The patient was admitted to the ICU for stabilization, fluid resuscitation, pain control, and intravenous antibiotics. Consultations were made with obstetrics, orthopedics, and general surgery.

Once stabilized, a combined thoracic and abdominal surgical approach was performed:

Right Thoracotomy (7th Intercostal Space):

Findings: Right lung collapse, 10–15 cm diaphragmatic laceration, intrathoracic liver prolapse with a 5 cm liver laceration causing post-traumatic bleeding.

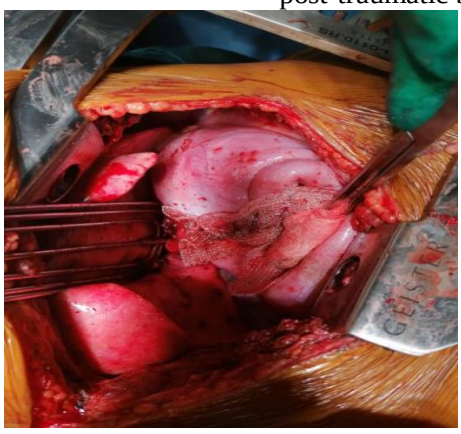

Figure 4. Laparotomy

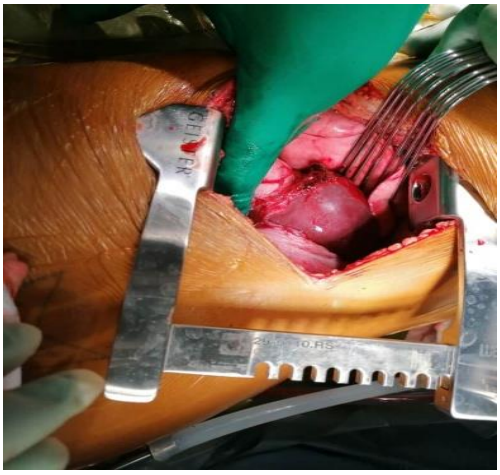

Figure 5. Liver Laceration

Median Laparotomy

1. Sectioning of the ligamentum teres hepatis and falciform ligament.
2. Liver laceration repair with 2-0 Vicryl and surgical glue application.
3. Diaphragmatic rupture repair via suturing and mesh placement.
4. Postoperatively, two thoracic and two abdominal drains (subhepatic and Douglas pouch) were inserted. The thoracic and abdominal cavities were closed in layers.

Postoperative Course

1. The patient was hemodynamically stable and extubated the following day.
2. Managed with respiratory physiotherapy, IV fluids, IV antibiotics, and analgesia.
3. On postoperative day 10, she developed persistent chest pain and discomfort.
4. CT chest: Revealed lung collapse.
5. Bronchoscopy: Performed to release lung collapse.
6. She continued with physiotherapy and was discharged on postoperative day 20.

Discussion

Diaphragmatic traumatic injuries remain uncommon and are challenging to diagnose in the acute phase [6]. Blunt trauma accounts for 0.8%–1.6% of all trauma cases, while penetrating trauma can constitute 10%–15% of cases [7].

Motor vehicle collisions are the most frequent cause, with direct impact forces leading to diaphragm rupture at the rib attachments or transverse tears [8].

Surgical Approaches

The abdominal approach (laparotomy) is preferred in cases of associated intra-abdominal injuries [9]. Studies have shown that laparotomy remains the primary method for diaphragmatic repair [10].

Conversely, thoracotomy is favored for delayed presentations or when diaphragmatic rupture is associated with severe thoracic injuries [11]. In this case, a combined approach was necessary to provide optimal exposure for repairing both the diaphragm and liver.

Postoperative Complications

Atelectasis is a common postoperative complication, as seen in this case [12]. It necessitates bronchoscopy and intensive respiratory physiotherapy to prevent long-term pulmonary dysfunction [13].

Conclusion

Early and accurate diagnosis of diaphragmatic rupture in trauma patients remains challenging. A thorough Intraoperative assessment is essential to prevent missed injuries.

This case underscores the importance of a combined thoracoabdominal approach in

complex diaphragmatic injuries involving liver herniation. While this technique resulted in a favorable outcome, further research is necessary to establish standardized guidelines for optimal management.

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Determinants of Caregivers Knowledge_Attitude and Practice Towards Mcv2 in Adamawa State Nigeria, February 2024

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Abstract

Despite the availability of reliable and affordable measles vaccines, Nigeria is still experiencing low vaccination coverage, resulting in high cases of measles and related complication. This study assessed the determinants of caregivers' knowledge and attitude towards measles and MCV2 in Adamawa State, Nigeria. A three-arm, parallel randomized control trial was conducted in four health facilities sampled through three-stage multistage sampling technique in Adamawa State. Semi-structured interviewer-administered questionnaire was administered to 351enrolled caregivers. Mean age of caregivers was 30.7 (SD±6.7); 212 (60.39%) of caregivers had good knowledge of measles and MCV2 and 265 (75.5%) had high level of positive attitude toward measles and MCV2. Major factors statistically associated with good knowledge of measles and MCV2 among caregivers include: age (X^2=27.1, p-value=<0.001) marital status (X^2=37.0, p-value=<0.001) and Family size (X^2=15.1, p-value=<0.001). Factors statistically associated with positive attitude of mothers towards MCV2 include: marital status (X^2=49.0, p-value=<0.001), religion (X^2=73.3.0, p-value=<0.001) and occupation of caregiver (X^2=11.1, p-value=<0.049) and factors associated with practice of timeliness towards MCV2 uptake were marital status, place of residence, and the age group of caregivers. Several factors influence caregivers' knowledge and attitude towards MCV2. Therefore, the Adamawa State government should implement measures to enhance measles vaccination coverage by increasing awareness of MCV2 through monitoring and addressing knowledge gaps on MCV2.

Keywords: *Attitude, Caregivers, Determinants, Knowledge, MCV2.*

Introduction

Immunization serves as the cornerstone of an effective health system, significantly contributing to the reduction of morbidity and mortality associated with various infectious diseases [1]. It is among the most successful health interventions and continues to be a vital means for achieving the Sustainable Development Goals (SDG) [2, 3].

The World Health Organization Immunization Agenda 2030 (IA2030) strives to reduce morbidity and mortality from vaccine-preventable diseases across the life course which is in consonant with the SDG 2030 priorities of eliminating vaccine preventable diseases and improving access to new lifesaving vaccines [4, 5]. However, for countries to attain the expected level of herd immunity, children have to receive the recommended doses of antigens. In Nigeria, the vaccination coverages of most antigens are still suboptimal with vaccine-preventable diseases accounting for an estimated 29% of childhood deaths annually [6].

The current immunization measles coverage rate falls short of national and global targets of 95% and 90% respectively [7, 8]. The global vaccination coverage survey (2010 to 2019)

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showed decrease in first dose of Measles Containing Vaccine 1 (MCV1) between 84% and 86%, while measles second dose (MCV2) coverage increased from 42% to 71%, reflecting second dose introductions in many countries. From 2019 to 2020, global MCV1 coverage decreased to the 2014 level of 84%, whereas MCV2 coverage was relatively stable at 71% in 2019 and 70% in 2020. MCV1 coverage in 2020 ranged from 68% in the African Region [9]. In Adamawa State, nearly 1 in 4 of all the under-5 children in Adamawa State received no basic vaccinations [10].

Being a highly contagious disease that has caused global morbidity and mortality, tremendous progress has been made in measles elimination, yet resurgence of measles has been observed in recent years. [11]. Worldwide, more than 140,000 people died from measles in 2018, according to new estimates from the World Health Organization (WHO) and the United States Centers for Disease Control and Prevention (CDC) with most of the deaths occurring among children under the age of five years [12]. In Nigeria, a total of 203,089 measles cases were reported to the surveillance system with the overall incidence rate of 200 cases per 1 million population higher in the North exceeding that of the South of 24 cases per 1 million population yearly [13].

To reduce the burden of measles, the World Health Organization (WHO) recommended a coverage of 95% of 2 doses of measles-containing vaccine (MCV) to ensure an immunological response and stop transmission.

In order to interrupt measles transmission and prevent outbreaks, there is need to reach at least 95% coverage with both recommended doses of measles [14]. Studies have revealed that Nigeria is far from reaching its target due to suboptimal RI performance and high measles dropout rate which is a critical concern especially with the low vaccination coverage in northern Nigeria [15].

There is the paucity of information regarding the knowledge, attitude and practices of caregivers towards MCV2 in Nigeria and Adamawa State in particular. Understanding the factors influencing mothers´ knowledge and attitudes towards immunization could guide targeted interventions to improve MCV2 coverage. Therefore, this study was carried determine the determinants of caregiver's knowledge, attitudes, and practices towards MCV2 in Adamawa state.

Materials and Methods

Factors influencing caregivers' knowledge and attitudes were obtained from a three-arm, parallel, randomized controlled trial which is being conducted in four health facilities and involving 351 caregivers in Adamawa State Nigeria. The health facilities included Ngbalang & Gweda Mallam PHCCs of Numan LGA and Major Aminu & Jambutu PHCCs of Yola North LGA. Randomization was applied to health facilities during enrolment with a 1:1:1 allocation ratio of one control arm and two intervention arms.

Participant selection criteria and recruitment Criteria for inclusion into this study included all mothers and/or caregiver who had a 9-month-old child that is vaccinated with MCV1, aged 18 years and older, have a working mobile phone, have resided in the study area at least for 6 months before enrolment and willing to provide consent for participation in the study. Mothers who could not read mobile phone text messages in any of the four languages used in the study (Hausa, English languages, Fulfulde or Bwatiye), Mothers and/or caregivers who had no mobile network access in their house/compound and mothers who planned to relocate out of the study area during the study follow-up period.

The sample size was calculated using the formula by [16] . The largest sample size was obtained for the outcome variable knowledge on measles and MCV2.The sample frame was the list of patients at each recruitment site. Simple randomization with an allocation of 1:1:1 to the control, SMS or Automated Calls

were performed using a list of generated random numbers in all the selected health facilities (1 Control arm and 2 Intervention arms). Units of randomization were mother-infant pairs in each of the study arms of interventions and control. Total number of caregivers assessed for eligibility were 507 caregivers; 156 caregivers were excluded based on the exclusion criteria outlined. (Figure 1).

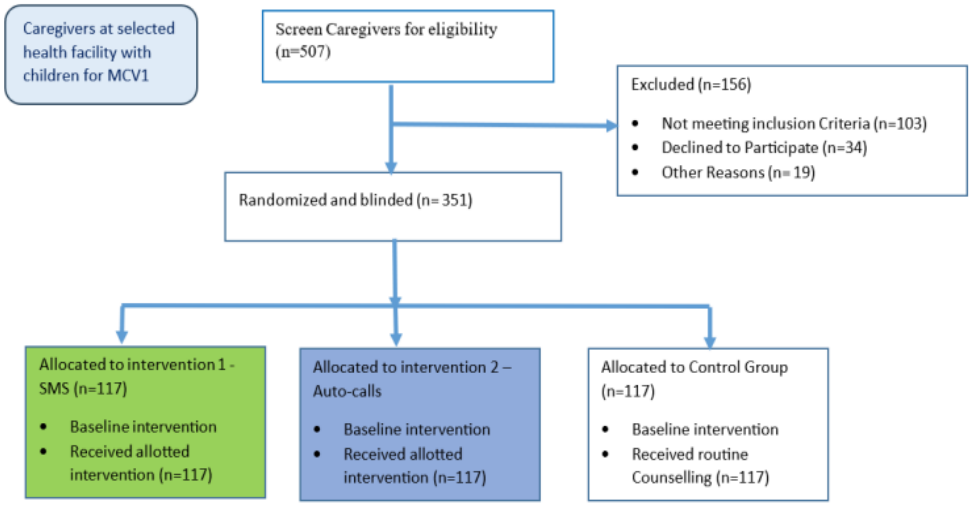

Figure 1. Flow Chart of Randomized Controlled Trial Among Caregivers in Four Health Facilities in Adamawa State

Data Collection Tool/Instrument

A validated and pretested semi-structured questionnaire was employed as the data collection tool. Questionnaires were interviewer administered, and baseline data was obtained from all 351 respondents. The questionnaire was a modified version of those used by [17] , [18] and [19]. It consisted of three sections: Section 1 on socio-demographic variables, Section 2 on knowledge of Caregivers om Measles and MCV2 and Section 3 on Attitude of Caregivers towards Measles. Reliability test for knowledge gave a Cronbach's alpha of **0.621** and that of attitude gave a Cronbach's alpha of 0.742.

Data Analyses

Data was analysed using Epi Info 7™ and Microsoft Excel, test of normality was conducted to ascertain the distribution of data which will determine the statistical test to conduct; Descriptive analysis was conducted where frequencies, proportions, means and standard deviations of variable were be determined. Comparability of the variables was assessed on the baseline characteristics of the study participants randomized to the intervention and usual care groups, using Chi-square tests. Log-binomial regression was used to estimate the relative risk (RR), difference in risk (RD).

Grading of Caregiver's Knowledge and Attitude

Knowledge

Eight questions were asked on knowledge of Measles and MCV2; each correct answer was graded '1' and wrong answer zero (0); Score range was therefore 0-8.

Attitude

Seven (7) variables were assessed for caregivers' attitude towards MCV2; all questions asked were in the negative perspective so the scores were given as: ―Strongly agree; (0 point), ―Agreed‖; (1 point), Disagreed; (2 points) and ―Strongly disagreed‖; (3 points) giving a range of scores of 0-18.

This grading was adapted from previous study [19].

Definition of Terms

Good Knowledge

Caregivers with scores 5-8 (63-100%) are categorized as having good knowledge of measles and MCV2. -rephrase.

Poor Knowledge

A caregiver is categorized as having poor knowledge when he/she scores 0-4 (0-38%).

Positive Attitudes

Caregivers with scores 9-18 (50 -100%) are categorized as having positive attitude towards MCV2 -rephrase.

Negative Attitude

Caregivers with scores 0-8 (0 - 44%) are categorized as having negative attitude towards MCV2.

Ethical Consideration

Approval was sought from the Research Ethical Committee of the Adamawa State Ministry of Health, informed written consent of the participant in the study was obtained, respondents were assured of anonymity and confidentiality of information supplied at all levels of data handling and mothers in control arm were health educated on MCV2 vaccination on completion of data collection even after scheduled time of MCV2 uptake.

Results

Table 1. Sociodemographic Characteristics of Caregivers Surveyed on MCV 2 in Adamawa State

Variables	**Frequency; n (%)**			**Total**	**Test type**	**p-value**
	Intervention 1	Intervention 2	Control Group			
Age group (years)						
15-24	17 (14.53)	21 (17.95)	17 (14.53)	55 (15.67)	X^2	**0.025**
25-34	71 (60.68)	58 (49.57)	64 (54.70)	193 (54.99)		
≥35	29 (24.79)	38 (32.48)	36 (30.77)	103 (29.34)		
Total	117 (100.00)	117 (100.00)	117 (100.00)	351 (100.00)		
Mean (SD)	28.83 (2.90)	28.60 (2.81	29.13 (3.33)	28.85 (3.01)		
95% CI	26.82 – 30.12	21 (17.95)	27.32–31.82	26.24–31.02		
Health Facility						
Gweda Mallam	34 (29.06)	31 (26.50)	34 (29.06)	99 (28.21)	X^2	0.854
Jambutu	26 (22.22)	35 (29.91)	26 (22.22)	87 (24.79)		
Major Aminu	29 (24.79)	25 (21.37)	27 (23.08)	81 (23.08)		
Ngbalang	26 (22.22)	26 (22.22)	30 (25.64)	84 (23.93)		
Total	117 (100.00)	117 (100.00)	117 (100.00)	351 (100.00		
Relationship with Child						
Aunt	8 (6.84)	16 (13.68)	13 (11.11)	37 (10.58)	F	0.509
Father	1 (0.85)	2 (1.71)	2 (1.71)	5 (1.42)		
Grandmother	0 (0.00)	1 (0.85)	1 (0.85)	2 (0.57)		
Mother	107 (91.45)	98 (83.76)	100 (85.47)	305 (86.89)		
Sister	1 (0.58)	0 (0.00)	1 (0.85)	2 (0.57		
Total	117 (100.00)	117 (100.00)	117 (100.00)	351 (100.00)		
Caregiver's educational level						
Informal Edu	9 (7.69)	9 (7.69)	5 (4.27)	23 (6.55)	*X2*	0.912
Primary	23(19.66)	22 (18.80)	21 (17.95)	66 (18.80)		
Secondary	56 (47.86)	53 (45.30)	57 (48.71)	166 (47.29)		

Tertiary	29 (24.79)	33 (28.21)	34 (29.06)	96 (27.35)		
Total	117 (100.00)	117 (100.00)	117 (100.00)	351 (100.00)		
Religion						
Christianity	54 (46.15)	44 (37.61)	55 (47.01)	153 (43.59)	X^2	0.276
Muslim	63 (53.85)	73 (62.39)	62 (52.99)	198 (56.41)		
Total	117 (100.00)	117 (100.00)	117 (100.00)	351 (100.00)		
Marital Status						
Married	95 (81.20)	98 (83.76)	84 (71.79)	277 (78.92)	F	0.070
Separated/Divorced	0 (0.00)	0 (0.00)	3 (2.56)	3 (0.85)		
Single	22 (18.8)	19 (16.24)	29 (24.79)	70 (19.94)		
Widow	0 (0.00)	0 (0.00)	1 (0.85)	1 (0.28)		
Total	117 (100.00)	117 (100.00)	117 (100.00)	351 (100.00)		
Occupation						
Business	35 (29.91)	31 (26.50)	39 (33.33)	105 (29.91)	F	0.385
Civil Servant	12 (10.26)	16 (13.68)	15 (12.82)	43 (12.25)		
Farmer	5 (4.27)	1 (0.85)	3 (2.56)	9 (2.56)		
Housewife	62 (52.99)	69 (58.97)	60 (51.28)	191 (54.42)		
Student	3 (2.56)	0 (0.00)	0 (0.00)	2 (0.57)		
Total	117 (100.00)	117 (100.00)	117 (100.00)	117 (100.00)		
Place of Child Delivery						
Health Facility	98 (83.76)	105 (89.74)	103 (88.03)	306 (87.18)	F	0.622
Home	18 (15.38)	11 (9.40)	12 (10.26)	41 (11.68)		
Traditional Birth Attendant	1 (0.85)	1 (0.85)	2 (1.71)	4 (1.14)		
Total	117 (100.00)	117 (100.00)	117 (100.00)	117 (100.00)		

A total of 351 caregivers were recruited for the study. Mean age of caregivers across the three study arms was 28.85 (SD±3.01) and ranged 18-60 years. Majority of caregivers were mothers (86.9%) and married (78.9%) across the three study arms; About half were Muslim (56.4), housewives (54.4) and with have secondary education (47.29). Majority of children brought for MCV1 were born in health facility (87.5%), are female (53.3%), from a family size of greater than 5 persons (64.1%) and living at a distance of 15-30km (70.7%) from health facility (Table 1).

Table 2. Knowledge of Caregivers on Measles and MCV2 in Adamawa State

Knowledge Questions	Correct Response (%)	Incorrect Response (%)
Heard about measles	299 (85.2)	52 (14.8)
Knowledge of at least 3 symptoms of measles	122 (34.8)	229 (65.2)
What causes measles (Measles virus)	55 (15.7)	296 (84.3)
Aware of measles vaccine	63(17.9)	288 (82.1)

Heard and know about the MCV2	123 (35.0)	228 (65.0)
Age at which MCV2 is given (15 months)	211 (60.1)	140 (39.9)
Benefits of MCV2 (Prevent a child from measles infection)	145 (41.3)	206 (58.7)
Knowledge one potential side effects of the MCV2 vaccine	123 (35.1)	228 (64.9)

Significant majority (85.2%) had heard about measles before, while 14.8% had not. Knowledge of the cause of measles revealed that only 15.7% correctly identified the measles virus as the cause, while 28.5% were incorrect, and 55.8% gave partially correct responses. Awareness of the existence of a vaccine to prevent measles was high, with 82.1% affirming this knowledge, and 17.9% being unaware. Similarly, knowledge about the Measles-Containing Vaccine (MCV2) was substantial, with 65.0% having heard about it, compared to 35.0% who had not (Table 2).

Table 3. Attitude of Caregivers towards Measles and MCV2 in Adamawa State

Attitude Questions	**Agree**	**Disagree**	**Neutral**	**Strongly Agree**	**Strongly Disagree**
MCV2 vaccine is important	221(63.0)	3 (0.9)	69 (19.7)	44(12.5)	14 (4.0)
Trust the safety and effectiveness MCV2	218 (62.1)	9 (2.6)	71 (20.2)	42 (12.1)	11 (3.1)
Vaccines have side effect	174(49.6)	32 (9.1)	114(32.5)	9 (2.6)	22 (6.3)
Would recommend MCV2 to other caregivers?	239 (68.1)	3 (0.9)	27 (7.7)	75 (21.4)	7 (2.0)
Every child should receive two doses of measles vaccine	251 (71.5)	0 (0.0)	20 (5.7)	72 (20.5)	8 (2.3)
Measles vaccine can prevent measles outbreak	243 (69.2)	1 (0.3)	17 (4.8)	87 (24.8)	3 (0.9)

A significant majority of respondents (75.5%) believe that the MCV2 vaccine is important, with 63.0% and only a small fraction disagreed (0.9%). 74.1% of respondents expressed confidence in the safety and effectiveness of the MCV2 vaccine with 62.1% agreeing and 2.6% disagreeing. Nearly half (49.6%) of respondents agreed that too many vaccines could have side effects and stress their children while 2.6% strongly disagreed. The willingness to recommend the MCV2 vaccine to other caregivers was high, with 68.1% agreeing and 21.4% strongly agreeing. The belief that every child should receive two doses of the measles vaccine was widely held, with 71.5% strongly agreeing and 2.3% strongly disagreeing. The belief that the measles vaccine can prevent measles outbreaks in the community was strong, with 69.2% agreeing and only 0.3% disagreed (Table 3).

Table 4. Association Between Sociodemographic Factors and Caregiver's Knowledge on MCV2 in Adamawa State

Variable	Knowledge		Total	χ^2	p-value
	Good	Poor			
Relationship with child	22 (12.0)	15 (10.8)	37 (10.5)	7.67	0.175
Father	5 (2.7)	0 (0.0)	5 (1.4)		
Grandmother	0 (0.0)	2 (1.4)	2 (0.6)		
Mother	183 (86.3)	122 (87.8)	305 (86.9)		
Sister	1 (0.5)	0 (0.0)	1 (0.3)		
Sister in-law	1 (0.5)	0 (0.0)	1 (0.3)		
Total	212 (100.0)	139 (100.0)	351 (100.0)		
Marital status					
Married	188 (88.7)	89 (64.0)	277 (78.9)	37.0	**<0.001**
Separated/Divorced	3 (1.4)	0 (0.0)	3 (0.9)		
Single	21 (9.9)	49 (35.3)	70 (19.9)		
Widow	0 (0.0)	1 (0.7)	1 (0.3)		
Total	212 (100.0)	139 (100.0)	351 (100.0)		
Religion					
Christianity	66 (31.1)	87 (62.6)	153 (43.6)	33.8	**<0.001**
Muslim	146 (68.9)	52 (37.4)	198 (56.4)		
Total	212 (100.0)	139 (100.0)	351 (100.0)		
Caregiver educational level					
No Formal Education	15 (7.1)	8 (5.8)	23 (6.6)	6.4	0.094
Primary	34 (16.0)	32 (23.0)	66 (18.8)		
Secondary	96 (45.3)	70 (50.4)	166 (47.3)		
Tertiary	67 (31.6)	29 (20.9)	96 (27.4)		
Total	212 (100.0)	139 (100.0)	351 (100.0)		
Occupation					
Businesswoman	61 (28.8)	44 (31.7)	105 (29.9)	6.56	0.255
Civil Servant	29 (13.7)	14 (10.1)	43 (12.3)		
Farmer	8 (3.8)	1 (0.7)	9 (2.6)		
Housewife	111 (52.4)	80 (57.6)	191 (54.4)		
Nill	1 (0.5)	0 (0.0)	1 (0.3)		
Student	2 (0.9)	0 (0.0)	2 (0.6)		
Total	212 (100.0)	139 (100.0)	351 (100.0)		
Residence					
Rural	11 (5.2)	1 (0.7)	12 (3.4)	5.21	0.074
Semi-urban	59 (27.8)	38 (27.3)	97 (27.6)		
Urban	142 (67.0)	100 (71.9)	242 (68.9)		
Total	212 (100.0)	139 (100.0)	351 (100.0)		
Sex of Child					
Female	115 (54.2)	72 (51.8)	187 (53.3)	0.202	0.653
Male	97 (45.8)	67 (48.2)	164 (46.7)		

Total	212 (100.0)	139 (100.0)	351 (100.0)		
Birth order of Child					
First	21 (9.9)	22 (15.8)	43 (12.3)	4.48	0.214
Second	52 (24.5)	24 (17.3)	76 (21.7)		
Third	68 (32.1)	46 (33.1)	114 (32.5)		
Fourth and above	71 (33.5)	47 (33.8)	118 (33.6)		
Total	212 (100.0)	139 (100.0)	351 (100.0)		
Place of Child delivery					
Health Facility	181 (85.4)	125 (89.9)	306 (87.1)	2.21	0.331
Home	29 (13.7)	12 (8.6)	41 (11.7)		
Traditional Birth Attendant's	2 (0.9)	2 (1.4)	4 (1.1)		
Total	212 (100.0)	139 (100.0)	351 (100.0)		
Distance of caregiver house to vaccination site					
15-30 Minutes	159 (75.0)	89 (64.0)	248 (70.7)	17.7	**<0.001**
Less than 15 Minutes	16 (7.5)	2 (1.4)	18 (5.1)		
More than 30 Minutes	37 (17.5)	48 (34.5)	85 (24.2)		
Total	212 (100.0)	139 (100.0)	351 (100.0)		
Family size					
Greater than 5	59 (27.8)	67 (48.2)	126 (35.9)	15.1	**<0.001**
≤ 5	153 (72.2)	72 (51.8)	225 (64.1)		
Total	212 (100.0)	139 (100.0)	351 (100.0)		
Caregivers age group					
15 - 24	41 (19.3)	24 (17.3)	65	27.1	**<0.001**
25 - 34	130 (61.3)	53 (38.1)	183		
≥ 35	41 (19.3)	62 (44.6)	103		
Total	212 (100.0)	139 (100.0)	351		

Marital status showed a significant association with knowledge level ($\chi^2 = 37$, $p < 0.001$). Among respondents with good knowledge, 88.7% were married, compared to 64.0% with poor knowledge. Religion also exhibited a significant association with knowledge level ($\chi^2 = 33.8$, $p < 0.001$). A greater proportion of respondents with good knowledge were Muslims (68.9%) compared to those with poor knowledge (37.4%). The distance of the caregiver's house to the vaccination site was significantly associated with knowledge level ($\chi^2 = 17.7$, $p < 0.001$). Respondents living 15-30 minutes from the vaccination site had better knowledge (75.0%) than those living more than 30 minutes away (17.5%). Family size was also significantly associated with knowledge level ($\chi^2 = 15.1$, $p < 0.001$). Among respondents with good knowledge, 72.2% had a family size of 5 or fewer, compared to 51.8% of those with poor knowledge. Caregiver's age group showed a significant relationship with knowledge level ($\chi^2 = 27.1$, $p < 0.001$). The majority of caregivers with good knowledge were in the 25-34 age group (61.3%), whereas a higher proportion of those with poor knowledge were 35 years or older (44.6%). (Table 4).

Table 5. Association Between Sociodemographic Factors and Caregiver's Attitude Towards MCV2 in Adamawa State

Variable	Attitude		Total	χ2	p-value
	Good	Poor			
Relationship with child					
Aunt	21 (9.0)	16 (13.6)	37 (10.5)	5.36	0.374
Father	5 (2.1)	0 (0.0)	5 (1.4)		
Grandmother	1 (0.43)	1 (0.8)	2 (0.6)		
Mother	204 (87.6)	101 (85.6)	305 (86.9)		
Sister	1 (0.43)	0 (0.0)	1 (0.3)		
Sister in-law	1 (0.43)	0 (0.0)	1(0.3)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		
Marital status					
Married	207 (88.8)	70 (59.3)	277 (78.9)	49.0	**<0.001**
Separated/Divorced	3 (1.3)	0 (0.0)	3 (0.9)		
Single	22 (9.4)	48 (40.7)	70 (19.9)		
Widow	1 (0.4)	0 (0.0)	1 (0.3)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		
Religion					
Christianity	64 (27.5)	89 (75.4)	153 (43.6)	73.3	**<0.001**
Muslim	169 (72.5)	29 (24.6)	198 (56.4)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		
Caregiver educational level					
No Formal Education	21 (9.0)	2 (1.7)	23 (6.6)	7.6	0.056
Primary	45 (19.3)	21 (17.8)	66 (18.8)		
Secondary	104 (44.6)	62 (52.5)	166 (47.3)		
Tertiary	63 (27.0)	33 (28.0)	96 (27.4)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		
Occupation					
Businesswoman	62 (26.6)	43 (36.4)	105 (29.9)	11.1	**0.049**
Civil Servant	25 (10.7)	18 (15.3)	43 (12.3)		
Farmer	9 (3.9)	0 (0.0)	9 (2.6)		
Housewife	134 (57.5)	57 (48.3)	191 (54.4)		
Nill	1 (0.4)	0 (0.0)	1 (0.3)		
Student	2 (0.9)	0 (0.0)	2 (0.6)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		
Residence					
Rural	12 (5.2)	0 (0.0)	12 (3.4)	7.2	**0.027**
Semi-urban	67 (28.8)	30 (25.4)	97 (27.6)		
Urban	154 (66.1)	88 (74.6)	242 (68.9)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		
Sex of Child					
Female	127 (54.5)	60 (60.8)	187 (53.3)	0.4	0.516
Male	106 (45.5)	58 (49.2)	164 (46.7)		

Total	233 (100.0)	118 (100.0)	351 (100.0)		
Family size					
Greater than 5	64 (27.5)	62 (52.5)	126 (35.9)	21.4	**<0.001**
≤ 5	169 (72.5)	56 (47.5)	225 (64.1)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		
Caregivers age group					
15 - 24	49 (21.0)	16 (13.6)	65 (18.5)	36.6	**<0.001**
25 - 34	140 (60.1)	43 (36.4)	183 (52.1)		
≥ 35	44 (18.9)	59 (50.0)	103 (29.3)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		
Birth order					
First	30 (12.9)	13 (11.0)	43 (12.3)	8.2	**0.043**
Second	60 (25.8)	16 (13.6)	76 (21.7)		
Third	72 (30.9)	42 (35.6)	114 (32.5)		
Fourth and above	71 (30.5)	47 (39.8)	118 (33.6)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		
Place of Child delivery					
Health Facility	196 (84.1)	110 (93.2)	306 (87.2)	8.4	**0.04**
Home	33 (14.2)	8 (6.8)	41 (11.7)		
Traditional Birth Attendant's	4 (1.7)	0 (0.0)	4 (1.1)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		
Distance of caregiver house to vaccination site					
15-30 Minutes	175 (75.1)	73 (61.9)	248 (70.7)	17.0	**<0.001**
Less than 15 Minutes	16 (6.9)	2 (1.7)	18 (5.1)		
More than 30 Minutes	42 (18.0)	43 (36.4)	85 (24.2)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		

Marital status had a significant association with attitude towards MCV2 ($\chi^2 = 49$, $p < 0.001$). Among those with a positive attitude, 88.8% were married compared to 59.3% of those with a poor attitude. A larger proportion of caregivers with a positive attitude were Muslims (72.5%). Caregiver's occupation also showed a significant relationship with attitude ($\chi^2 = 11.1$, $p = 0.049$). Housewives were more likely to have a positive attitude (57.5%) compared to a poor attitude (48.3%). Residence showed a significant association with attitude ($\chi^2 = 7.21$, $p = 0.027$). Family size was significantly associated with attitude towards MCV2 ($\chi^2 = 21.4$, $p < 0.001$). Caregiver's age group showed a significant relationship with attitude ($\chi^2 = 36.6$, $p < 0.001$). Birth order was also significantly associated with attitude ($\chi^2 = 8.17$, $p = 0.043$). The place of child delivery also showed a significant relationship with attitude ($\chi^2 = 6.43$, $p = 0.04$). Distance from the caregiver's house to the vaccination site was significantly associated with attitude ($\chi^2 = 17$, $p < 0.001$). (Table 5).

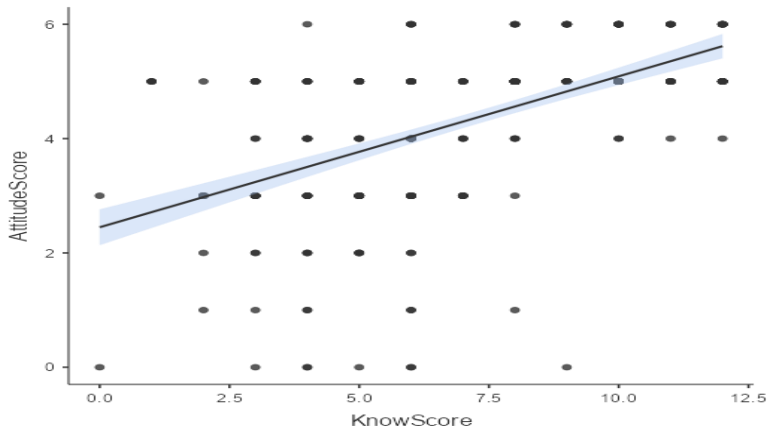

Figure 2. Correlation Between Knowledge and Attitude of Caregivers Towards MCV2 in Adamawa State

Figure 2 demonstrates a strong and statistically significant positive correlation between the level of knowledge and attitude towards the MCV2 vaccine among caregivers. This underscores the importance of educational interventions to improve knowledge, which in turn is likely to enhance positive attitudes towards vaccination.

Table 6. Association Between Sociodemographic Factors and Caregiver's Baseline Attitude Towards MCV2 in Adamawa State (2)

Variable	**Attitude**		**Total**	**χ2**	**p-value**
	Positive	**Negative**			
Sex of Child					
Female	127 (54.5)	60 (60.8)	187 (53.3)	0.4	0.516
Male	106 (45.5)	58 (49.2)	164 (46.7)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		
family size					
Greater than 5	64 (27.5)	62 (52.5)	126 (35.9)	21.4	**<0.001**
≤ 5	169 (72.5)	56 (47.5)	225 (64.1)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		
Caregivers age group					
15 - 24	49 (21.0)	16 (13.6)	65 (18.5)	36.6	**<0.001**
25 - 34	140 (60.1)	43 (36.4)	183 (52.1)		
≥ 35	44 (18.9)	59 (50.0)	103 (29.3)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		
Birth order					
First	30 (12.9)	13 (11.0)	43 (12.3)	8.2	**0.043**
Second	60 (25.8)	16 (13.6)	76 (21.7)		
Third	72 (30.9)	42 (35.6)	114 (32.5)		
Fourth and above	71 (30.5)	47 (39.8)	118 (33.6)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		
Place of Child delivery					
Health Facility	196 (84.1)	110 (93.2)	306 (87.2)	8.4	**0.04**
Home	33 (14.2)	8 (6.8)	41 (11.7)		
Traditional Birth Attendant's	4 (1.7)	0 (0.0)	4 (1.1)		

Total	233 (100.0)	118 (100.0)	351 (100.0)		
Distance of caregiver house to Health Facility					
15-30 Minutes	175 (75.1)	73 (61.9)	248 (70.7)	17.0	**<0.001**
Less than 15 Minutes	16 (6.9)	2 (1.7)	18 (5.1)		
More than 30 Minutes	42 (18.0)	43 (36.4)	85 (24.2)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		

The analysis identifies significant association of timely practices with marital status, place of residence, and the age group of caregivers, all of which are associated with levels of knowledge. (Table 6).

Table 7. Association Between Sources of Information on MCV2 and Knowledge of Caregivers on MCV2 in Adamawa State May 2024

Sources of Information about MCV2 vaccine	**Attitude**		**Total**	**χ2**	**p-value**
	Good	**Poor**			
Friends/Family	12 (5.2)	16 (13.6)	28 (8.0)	10.4	**0.005**
Healthcare Provider	212 (91.0)	93 (78.8)	305 (86.9)		
Media	9 (3.9)	9 (7.6)	18 (5.1)		
Total	233 (100.0)	118 (100.0)	351 (100.0)		

The table examines the relationship between the source of information about the importance of the Measles-Containing Vaccine (MCV2) and caregivers' attitudes. The analysis reveals a statistically significant association between the source of information and attitude towards the vaccine ($\chi^2 = 10.4$, $p = 0.005$). Among caregivers with a good attitude towards the MCV2 vaccine, 91.0% reported learning about the vaccine from healthcare providers, compared to 78.8% of those with a poor attitude. Friends and family were a more common source of information among those with a poor attitude (13.6%) compared to those with a good attitude (5.2%). Information from media sources was cited by 3.9% of those with a good attitude and 7.6% of those with a poor attitude. (Table 7).

Discussion

Measles is an acute and highly contagious viral disease that continues to pose a public health concern, particularly in developing countries. As such, several studies have been conducted to assess the knowledge and attitudes of caregivers towards measles and vaccination in general. These studies aim to better understand the factors that influence vaccine acceptance and to inform interventions that can increase vaccination coverage.

The study showed that majority of caregivers were mothers who were married. This finding highlights the caring attitude of mothers compared to other categories of caregivers. The study provides valuable insights into the roles and responsibilities of most women play in the lives of their children. This is consistent with other findings in Nigeria [19, 20].

Association between sociodemographic variables such as marital status, religion, distance to vaccination sites, family size, and caregiver's age group showed significant association with the level of knowledge about measles and the MCV2 vaccine among caregivers. This underscores the need for targeted educational interventions that consider these demographic and socio-economic factors to improve vaccination knowledge and coverage. This is in congruent to findings of a study in Abeokuta, Nigeria [18] and a study conducted in Pakistan [21].

Marital status, religion, occupation, residence, family size, caregiver's age group, birth order, place of child delivery, and distance to vaccination site were all significantly associated with caregivers' attitudes towards the MCV2 vaccine which is consistent with findings from study in Edo State Nigeria [22] and in Enugu State Nigeria [23] where these variables were shown to be positively associated with mother's attitude towards measles vaccination; however, this is in variance with findings in France[24] where these factors are not significantly associated with attitude. These findings underscore the importance of considering these demographic and socio-economic factors in designing interventions aimed at improving attitudes towards vaccination.

In addition, area of residence was found to be significantly associated with positive attitude towards MCV2. Caregivers who reside in Urban areas are more likely to have positive attitude towards MCV2 than those who reside in rural areas. This was similar to findings in other studies, where most caregivers that reside in urban areas had positive attitude than other caregiver[17,19]s. The occupation of caregivers was also significantly associated with positive attitude towards MCV2. Caregivers that are housewives were more likely to have a positive attitude towards MCV2 than caregivers with other occupations. This was consistent with findings from other studies, where majority of housewives had a positive attitude towards MCV2 than those of other occupations [18].

Healthcare providers are the primary source of information for caregivers with good knowledge about MCV2. The significant association indicates that caregivers who learn about the vaccine from healthcare providers tend to have better knowledge. This is in consonance with findings from other studies in Nigeria [20] and in Myanmar[25] which revealed that majority of mothers obtained information on the vaccination program primarily from the health facilities; though this conflicts with findings from Edo State Nigeria [22] where the media was identified as the major source of information on vaccination for mothers. This highlights the crucial role of healthcare providers in disseminating accurate information about MCV2. Efforts to improve knowledge levels should focus on strengthening the role of healthcare providers in public health education. The significant association indicates that caregivers who learn about the vaccine from healthcare providers are more likely to have a positive attitude. This highlights the important role of healthcare providers in shaping positive attitudes towards vaccination. Efforts to improve attitudes should focus on enhancing the involvement of healthcare providers in public health education.

The survey results highlight relatively high level of awareness and partial understanding of measles and the MCV2 vaccine among caregivers in Adamawa State. However, there is a notable proportion of partially correct and incorrect answers, which could be as result of measles being a common disease indicating areas where public health education and awareness campaigns could be improved to enhance comprehensive knowledge about measles and vaccination. The relatively high level of awareness could be as a result the disease' endemicity in the region, however partial understanding of MCV2 could be due to the fact that the second dose was just recently introduced into the expanded program on immunization in Nigeria. This is similar to findings from other studies Nigeria [18, 19].

The study further reveals a high level of positive attitude towards MCV2 among respondents, with strong beliefs in its importance, safety, effectiveness, and role in preventing measles outbreaks. However, concerns about vaccine side effects and the impact of multiple vaccinations on children were also evident, indicating areas where further education and reassurance may be beneficial. This is similar with findings from

other studies which showed positive attitudes of mothers towards measles vaccination [26][23,24]. Nevertheless, some studies carried out in Bauchi and Cross rivers States Nigeria revealed negative attitudes towards vaccination among the mothers [27].

This study also demonstrates a strong and statistically significant positive relationship between the level of knowledge and attitude towards the MCV2 vaccine among caregivers. This underscores the importance of educational interventions to improve knowledge, which in turn is likely to enhance positive attitudes towards vaccination. This corroborates other studies conducted in Nigeria [19, 23]. Furthermore, caregivers with positive attitude towards MCV2 were significantly more likely to vaccinate their children compared to those with a negative attitude which is similar to findings in other studies in Osun State, Nigeria [20] and in Switzerland [28]. This underscores the importance of fostering positive attitudes towards vaccination to improve vaccine uptake and coverage.

Conclusion

This study shows that the knowledge of caregivers on measles and MCV2 is inadequate. There is partial understanding of measles and MCV2 among caregivers in Adamawa State; however, there is relatively high level of awareness on measles with high level of positive attitude towards MCV2 among caregivers.

Major factors associated with good knowledge of measles and MCV2 among caregivers in Adamawa State include age (caregiver being older than 35years), marital status (being married), religion (being a Muslim), marital status (being married) and distance of caregivers' house to vaccination site (less than 30 minutes' walk to vaccination site). Factors associated with positive attitude of mothers towards MCV2 include marital status (being married), religion (being a Muslim), area of residence (living in urban area), distance of caregivers' house to vaccination site (less than 30 minutes' walk to vaccination site), Birth order (4th order and above) and occupation of caregiver (being a housewife).

A multi-faceted approach is essential to achieve the vaccination coverage needed to eliminate measles in Nigeria. It is essential to continue to monitor and address knowledge gaps and negative attitudes towards measles vaccination to effectively combat measles. Improving vaccination coverage of MCV2 requires increasing awareness of measles and MCV2 through monitoring and addressing knowledge gaps and negative attitudes towards measles vaccinations.

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Declaration of Conflicting Interest

The Author(s) declares that there is no conflict of interest.

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Supervision of English Language Curriculum During and Beyond Covid-19 Pandemic: The Case of Ghana

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Abstract

This study explores the impact of COVID-19 on the supervision of the English Language Curriculum in Ghanaian primary schools, emphasizing practical strategies for enhancing teachers' professional development and students' academic performance. Utilizing desk research, the study synthesizes secondary data from peer-reviewed sources. The findings highlight that while COVID-19 disrupted traditional supervision methods, innovative approaches and strong leadership facilitated continued professional development and problem-solving among teachers. The research suggests adopting blended supervision methods incorporating virtual platforms and recommends flexible and democratic supervision strategies to address challenges posed by the pandemic. Training policymakers, supervisors, and teachers in utilizing digital platforms for effective curriculum supervision is essential.

Keywords: *Blended Learning, COVID-19, Educational Policy, English Language Curriculum, Supervision, Teacher Development.*

Introduction

Background to the Study

Numerous prior investigations by [1] and [2] have underscored the critical role of supervision in achieving quality education. This emphasis on supervision is particularly pivotal within the realm of teaching and learning English, a subject of fundamental importance. Historically, even prior to the advent of the COVID-19 pandemic, [3] and [2] had linked students' underachievement in the English language to deficiencies in supervision. The educational community remains divided over the optimal strategies for addressing COVID-19 safety protocols, especially at the primary education level. For instance, [4] has critiqued the methodology recently introduced by the Ghana Education Service (GES) and the Ministry of Education, asserting that it not only fails to effectively supervise but also exacerbates educational inequalities.

Against the backdrop of these concerns, [5] have raised pertinent questions about the reopening of schools, particularly regarding the implications of mixing asymptomatic pupils with those hailing from households with confirmed COVID-19 cases. Further questions revolve around the efficacy of traditional versus mixed approaches, combining synchronous and asynchronous methods, in enhancing teaching practices and supervisory systems. Given the challenges posed by the new strain of the disease, [6] has argued that teachers may find it onerous to balance curriculum coverage with the supervision of students' adherence to safety protocols. [7] contends that a multifaceted approach is needed to effectively address educational needs and enhance pupils' academic performance.

Rationale of the Study

This study aims to shed light on the significance of supervising the curriculum and

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the reasons for doing so. It delves into how supervision can enhance teachers' professional development and qualifications, both of which are crucial to effective teaching and students' academic progress. Consequently, this research will contribute to our understanding of effective supervisory practices designed to improve teachers' professional qualifications and students' academic achievements. Additionally, it seeks to provide insights into innovative and practical approaches to supervision, particularly in the context of the ongoing COVID-19 pandemic and the emergence of new strains in West Africa [8].

Research Gaps

There exists a notable gap in knowledge concerning the effectiveness of supervising the English language curriculum and its impact on teachers' professional qualifications and students' academic performance [3, 2]. Furthermore, there is a disparity in opinions among education stakeholders and researchers regarding the most effective ways to implement and supervise the English language curriculum at the basic education level during the ongoing COVID-19 pandemic [5-7]. Addressing these gaps forms the core of this study.

Purpose of the Study

This study aims to conduct a qualitative analysis using secondary data to explore practical and outcome-oriented approaches to supervision in basic schools during the COVID-19 pandemic. It seeks to elucidate the implications of COVID-19 safety protocols on effective supervision within the Ghanaian primary school context.

Aims

This study aims to investigate the significant impact of COVID-19 on the effective supervision of the English Language Curriculum in primary schools in Ghana. It specifically focuses on practical approaches to enhance teacher qualifications and improve students' academic performance.

Objectives of the Study

The primary objective of this study is to conduct a comprehensive exploration, based on secondary data, of innovative approaches to effectively supervise the English curriculum during the COVID-19 pandemic in Ghanaian primary schools. The specific objectives include:

1. Assessing the relevance of the English language curriculum and its supervision.
2. Exploring the perspectives of supervisors and primary school teachers regarding what constitutes effective supervision of the English language curriculum as outlined by the Ghana Education Service (GES).
3. Investigating the views of supervisors and teachers on the impact of the COVID-19 pandemic on teaching practices and student academic performance.
4. Identifying novel and practical approaches to supervising the English language curriculum in compliance with COVID-19 safety protocols.

Research Questions

1. How relevant is the English language curriculum and its supervision?
2. What are the perceptions of supervisors and primary school teachers regarding effective supervision of the English language curriculum as specified by the Ghana Education Service (GES)?
3. What are the perspectives of supervisors and teachers regarding the impact of the COVID-19 pandemic on teaching practices and student academic performance?
4. What novel and realistic approaches can be employed to supervise the English language curriculum while adhering to strict COVID-19 safety protocols?

Structure of the Study

This study is organized into five chapters. The first chapter introduces the study, elucidating the problem statement, objectives,

research questions, and the significance of the research. The second chapter delves into a comprehensive review of pertinent literature, including a theoretical framework and conceptual reviews, as well as a discussion of empirical studies relevant to the research objectives. The third chapter outlines the methodology employed in data collection and analysis. Chapter four addresses each research question through in-depth analysis, interpretation, and thorough discussion of the study results. Finally, chapter five offers a concise summary of the study, presents the research findings, draws conclusions, and provides recommendations for further research.

Review of Literature

This chapter critically examines existing literature that forms the foundation for the objectives of this study. The review is organized into three sections: Conceptual, Theoretical, and Empirical. The conceptual framework explores the notion of Curriculum Supervision, while the theoretical framework delves into the Theory of Germs. The empirical review provides an in-depth analysis of the literature pertinent to the study's focus. This comprehensive review aims to provide robust support, both conceptually and theoretically, for the study and aligns with the overarching objective of the research.

One primary goal of this review is to enrich understanding and insight into the study's aim. It will enable a nuanced evaluation of past research findings concerning the supervision of the English curriculum in primary schools, especially within the context of a highly contagious disease. The study asserts that curriculum supervision is an indispensable and crucial element in achieving the broader objectives of education.

However, given the concepts of curriculum supervision and the theory of germs, it is imperative to investigate the extent to which the COVID-19 pandemic might impact curriculum supervision. Furthermore, it is crucial to explore how educational leaders can proactively devise innovative approaches to overcome the challenges posed by the pandemic and continue advancing educational goals at local and national levels. The study will also examine the potential impact of such a novel supervision approach on teachers and students in terms of pedagogy and academic achievement.

Conceptual Framework

Concept of Curriculum Supervision

The concept of curriculum has been approached differently by various scholars and educators over the years [9-11]. It has been viewed as a systematic means to reconstruct knowledge and experiences for students and teachers [12], a way to acquire essential skills and values for successful living [13], and the process of achieving specific educational goals and objectives [9]. These conceptions all share the idea that curriculum involves specific goals and outcomes within an educational context designed to enhance students' academic achievements.

In Ref. [9] suggested that a well-structured sequence of material or checklist should influence pedagogy, supporting [14] assertion that curriculum encompasses subjects or courses, including English language, relevant to thriving in the modern world. For curriculum to fulfill its purpose, [10] argued that it should include 1) content specified by relevant authorities (Intended), 2) content delivered by teachers in the classroom (Implemented), 3) content that students learn (Attained), and 4) content specifically designed to address individual student growth and self-actualization (Processual).

In Ref. [15] emphasized that curriculum should be supervised to enhance teachers' professional competence and instructional practices, thereby improving students' academic performance. While some educators strongly believe that supervision is instrumental in achieving educational goals

[15, 16], others emphasize the manner or context within which supervision is carried out as equally crucial [17, 18, 10].



Figure 1. Conceptual Framework

Source: Researcher's Construct

A closer examination of Figure 1 reveals that supervision often involves close interaction between the supervisor and the teacher and often includes observation of instructional delivery during classes with all students present. The four-pronged aspects of supervision highlight the need for contact between the supervisor, the teacher, and the students. The supervisor must provide constructive criticism through advice or modeling for the teacher and facilitate consultations to provide necessary support for improving teachers' professional qualifications. These meetings serve as forums for sharing vital information to enhance teachers' ability to effectively implement the curriculum, thus promoting students' academic development.

At the lower segment of the framework, it is evident that a curriculum should empower teachers to help students develop critical thinking skills, enabling them to construct knowledge through practical application. This approach aims to enhance students' learning experiences and prepare them as responsible adults capable of contributing to society's sustainability and national progress.

Supervision, when approached carefully by both teachers and students, plays a significant role in an educational setting. However, due to the limited contact imposed by the ongoing COVID-19 pandemic and the importance of a result-oriented approach to supervision, it is essential to explore how effective supervision can be carried out within the context of a highly infectious disease. The following section delves into this topic.

Theory of Germs

Before the fourth and fifth centuries, Hippocrates advocated the concept that diseases were caused by an imbalance in what he referred to as the "Four Vital Humors" [19, 20]. However, in 1624 and throughout the nineteenth century, Giovanni introduced the sustained concept of "Miasmas," suggesting that diseases resulted from decaying vegetation, putrefying carcasses, and the release of poisonous emissions, which, when inhaled, caused diseases like malaria and tuberculosis. Cholera epidemics were also attributed to miasmas.

Louis Pasteur introduced the concept of germs in 1878, building on empirical evidence and the work of John Snow, Ignaz Semmelweiss, and John Lister. Koch, in 1890, further developed Pasteur's ideas, indicating

that infectious diseases could be transmitted directly through contact with another human or indirectly through mediums such as insects or water. Such transmission could lead to either a 'common source outbreak' with a single agent causing infection or a propagated epidemic, often involving more than one agent or site of infection, culminating in a pandemic (inter-border transmission) affecting a large or international community.

In Ref. [21] alerted the world to the outbreak of coronavirus 2019 nCoV in December 2019 in Wuhan, China. It qualifies as a pandemic because it has both primary (animal) and secondary (human) reservoirs or agents of transmission. COVID-19 is highly contagious and deadly, with 116,475,536 cases and 2,586,548 deaths reported as of March 5, 2021 [22]. Several countries imposed strict measures to limit the disease's spread; for instance, Ghana closed all schools nationwide on March 15, 2020 [23].

On January 15, 2021, schools were reopened with a strong emphasis on strict COVID-19 protocols, including hand washing, social distancing, and mask-wearing. Nevertheless, [24] reported 142 COVID-19 cases in Junior and Senior High Schools, raising concerns about the safety of students in schools and its potential impact on effective curriculum supervision [6,25]. Thus, it is essential to investigate how education stakeholders in Ghana are adopting novel approaches to conducting supervision despite the rising rate of COVID-19 cases.

Empirical Review

In a comprehensive study, [26] highlighted the challenges posed by government-imposed educational policies. Taking a historical perspective, they found that whether in decentralized or centralized education systems, school principals or headteachers play critical roles in successfully implementing change interventions within school environments. Headteachers in a centralized system, such as in Ghana, face specific challenges due to the unpredictable nature of needs within the system and a lack of readiness among human resources. As supervisors, headteachers must overcome these challenges to effectively orchestrate curriculum supervision. Proactive and innovative approaches are required to address these challenges, including those posed by infectious diseases.

Examining the impact of proactive leadership in education, [27] employed clinical supervision to explore how developmental supervision could enhance headteachers' supervisory abilities and teachers' professional qualifications. The study revealed that the "SuperVision" strategy could improve teachers' instruction, encourage them to become lifelong learners, and enhance headmasters' decision-making and problem-solving skills. These findings align with the overall objective of this study, emphasizing the need for dynamic leadership that promotes developmental supervision, benefiting both teachers and headteachers' capabilities in pedagogy and leadership.

In Ref. [27] study is conceptually relevant for understanding supervisory behavior, instructional quality, professional development, problem-solving, and decision-making capabilities. Similar to a study by [28] on leadership styles in Ghanaian schools, which showed that headteachers with democratic leadership styles tend to conduct effective supervision and improve teaching practices.

In their insightful study, [2] demonstrated that effective curriculum supervision is integral to higher academic achievement for students. Therefore, education stakeholders must proactively address issues that could hinder effective supervision of the curriculum. This implies that the approach to supervision should prioritize inclusiveness, equity, and strict adherence to COVID-19 safety protocols [24].

However, [5] identified complex issues related to reopening schools when the rate of COVID-19 cases is rising, aligning with a

report by [25] that Ghanaians called for school closures due to the fast spread of the pandemic among students. The present study investigates how education stakeholders are addressing these challenges related to the supervision of the English curriculum in Ghanaian junior high schools.

Conclusion

This chapter has provided insights into the gaps and challenges surrounding the effective implementation of curriculum supervision amid the ongoing COVID-19 pandemic in Ghanaian middle schools. The review highlights the need for further research on how COVID-19 may impact supervision in Ghanaian schools.

Methodology

This chapter provided ample information on the methodology adopted for the study. Methodology is an outline of how the study will be structured in terms of retrieving valuable information through secondary sources. It is, therefore, an essential aspect of the study and was given appropriate attention. This section entails the literature review approach and design, research questions and ethical considerations in selecting and employing secondary research sources.

Data Collection Approach

Data was collected using a "Systematic Literature Review" (SLR), which is vastly different from other approaches to literature review, especially within the traditional settings of research studies, which often involve the subjective opinion of the researcher and perspectives. A systematic literature review is based entirely on specific objectives related to the present study's overall focus or the investigation's purpose. In their studies, [29] and [30] indicated that SLR reduces the subjective nature of traditional literature review and accentuates critical and in-depth investigation and assessment of extant literature, with compelling support for the overall objective of this study.

Selection Criteria for Sources

A systematic approach was adopted for the methodology section. Sources were selected based on whether the research can provide conceptual, theoretical or empirical support for the study. Recent research is viewed as containing up-to-date information; hence, it is among the priorities for selecting sources for the study. Though the study is limited to Ghana, the selection of sources was limited to extant studies meeting the first two criteria within the educational sector of Ghana and other countries.

Peer-reviewed sources in journals of high impact factor such as Taylor & Francis, Wiley, Elsevier Emerald, Journal for Education and Practice and Google Scholar. Other sources such as Educational Conferences, Seminar, Unpublished Thesis, Reports and well-validated research articles meeting one of the three criteria for selection were also included in the list of sources for the study.

In order to retrieve valuable information during searches in reputable databases such as Scopus or Web of Science, keywords are valuable. It helps determine the direction of the search identification of researchers meeting the set criteria. It serves as a means of excluding irrelevant sources which may detract from the focus of the study. As a result, keywords were structured into six different sets of words to elicit relevant sources that facilitated the resolution of research problems.

In connection with supervision, four sets of keywords were chosen, namely: 1) "Supervision in Ghana", 2) "Supervision in Basic Schools", 3) "Supervision Why", and 4) "Supervision during Covid-19". The second keyword was curriculum with four sets of expressions: 1) "curriculum meaning", 2) "importance of curriculum", 3) "English Curriculum in Ghana", and 4) "curriculum at basic school". The third set of keywords dwelled on Covid-19 with two sets of expressions: 1) "Covid-19 meaning", 2) "Covid-19 impact on Supervision", and 3)

"Continuing Supervision amidst Covid-19". The fourth and last sets of keywords were oriented towards novel approaches to continuing curriculum supervision during the COVID-19 pandemic. Hence, it has two sets of expressions: 1) "effective supervision" and 2) "approaches to supervision during Covid-19".

In order to expand the search, a Boolean operator such as "OR" or "AND" was used. For example, phrases such as "Supervision in Ghana" and "Supervision at Basic School" were coined. Likewise, Meaning AND Importance of curriculum" were coined. The following phrases were also joined using "OR: "Continuing Supervision during COVID-19" OR "No supervision". With the approaches mentioned earlier, valuable information meeting the three criteria outlined at the outset was met. The criteria outlined above were used to select well-validated studies relevant to the resolution of the research questions outlined at the outset of this study.

Selection Period

Relevant literature matching the search criteria was set to cover a period of 15 years, starting from March 2006 to March 2021. Search engines and Databases such as Google, Web of Science and Scopus were precious in searching for academic writings within the earmarked year range. Information retrieved was filtered and critically examined within the three criteria for selecting sources for the study. However, to limit information overload, the highlighted keywords were used so that only academic writings within the framework of the study were retrieved. The determined range helped in the selection of very recent information regarding the objectives of the study. The range provided a broad space for careful consideration of the issue at hand, and it was very relevant in facilitating the latest understanding regarding the spate of COVID-19 within the research area (Ghana), how the stakeholders of education are responding to its debilitating effect and practical approaches regarding continuation of supervision amidst the ravaging disease.

Inclusion and Exclusion Criteria

It is worth noting that the abstract or summary of academic writings, in the form of research articles, conference and seminar papers, reports, unpublished thesis or research project, forms part of the information relevant to the study. Although there was a concerted effort to retrieve full-length papers for several articles, the abstract was only obtained for others. Triangulation was also adopted with a view to inclusion and exclusion criteria for relevant sources of information [31,32]. It takes the form of employing both software and manual approaches to selection. At first, the papers generated from the databases were fed into Mendeley or Trifacta software for scrubbing and cleaning duplications in the selected documents [33]. Upon cleaning the data retrieved, it was manually cross-checked to verify the relevance of each article selected within the set parameters and criteria for selecting sources.

Manually cross-checking the selected papers fulfils several vital roles concerning removing duplicates. To manually ascertain the relatedness of an article or an academic writing selected, three steps were paramount. First, each abstract and title were perused to ascertain whether the subject matter was tallied with the overall focus of the study as determined by the three-pronged criteria set for the selection of sources. Hence, any article that discusses issues about the supervision of mathematics curriculum or supervision of health workers was discarded since it does not match any of the criteria for selection. Likewise, any article discussing only COVID-19 concerning its health implications without reference to educational settings was discarded.

The second step of manually cross-checking the retrieved data was to critically evaluate the entire paper's capacity to provide theoretical, conceptual or empirical support to the study.

The third step was to cross-check the reference or bibliography section to determine whether they contain relevant articles that may be included in the current pool of academic writings selected for the study. As earlier indicated, when the abstract or preface of academic writing meets one of the selection criteria, it is included in the sources for the study.

In all, 39 articles were selected for the study. Out of these articles, 18 (n-18) were from peer-reviewed journals, 6 (n-6) were from unpublished theses, 5(n-5) were reports from reputable organisations, the remaining 10 (n-10) articles were from other sources, including newspaper editorials, meeting the three criteria for selection. The manual selection of the articles culminated in the inclusion of only 27 sources in the study. It comprises peer-reviewed articles (12), unpublished thesis (3), reports (3), newspaper editorials (5) and other relevant sources such as blogs or websites (4).

Data Analysis Approach

Analysis was done using mixed methodologies. Both quantitative and qualitative paradigms were used for the analysis. While quantitative entails descriptive analysis of quantitative secondary data, the qualitative paradigm involves in-depth exploration of secondary data intending to underscore emerging trends, patterns or themes [31, 32, 34]. Ref. [31] indicated that using mixed methods aids triangulation because the strength of the two paradigms is consolidated to form a formidable research paradigm, culminating in well-validated and rich findings.

Ethical Consideration

The research data reviewed follows the ethical principles required for a study of this stature. For example, the articles maintained adequate respect for the privacy of individual participants and voluntary informed consent was sought before any participant was included in the study. None of the participants suffered any harm during the study.

It treated each of the selected extant studies fairly and in an unbiased manner because relevant sections of the articles were considered to understand the limitation of the study, which aided in reaching a balanced opinion regarding the findings of reviewed studies. For example, some were limited concerning the instrument for studies with concomitant impact on their findings. It, therefore, means searching for other studies with other types of instruments or research designs [35]. Likewise, the location of a research study is open to its relevance as long as it provides ample support to the focus of the study.

Most of the selected research papers were from peer-reviewed journals, often requiring rigorous proofreading and validation of research processes and findings. As a result, such an article is well-validated and reliable. There is no need to contact the author (s), especially for those from peer-reviewed journals. However, it was fit to contact him regarding an unpublished thesis uploaded by an author on the Research Gate website. He made some references alongside certain truncated and confusing information, which needed clarification.

The researcher contacted the concerned firm, and they provided ample clarifications involving some aspects of the data collection procedure. The researcher relied on the information in several articles reviewed due to their publication in reputable and peer-reviewed journals of high-impact factors, such as Taylor & Francis. Some of the articles selected were indexed in Scopus, underscoring the reliability of their findings and adherence to ethical concerns.

The researcher reviewed several studies whose findings could have been very reliable and valid if a pilot study had been conducted. A critical examination of the closed-ended questions in the questionnaire of these studies needs internal consistency. One of the authors

reported giving it to a colleague. An expert or two could have also perused the instrument alongside conducting a pilot study before administration. The researcher reached this conclusion because the retrieved data needed to adequately resolve the research problem due to the instrument's lack of internal consistency and face validity [36].

Studies selected can be replicated in another setting by another author or researcher. One of the studies discussed what constitutes adequate supervision, and its findings delineate how a supervisor can conduct result-oriented supervision. A few years after that, several studies have referenced this study and at present, some of the approaches in the study I adopted for the present study. Likewise, there are some studies in which their methodologies were efficient and incisive, making them easy to replicate. One such study helped the researcher adopt a mixed methodology for the present study.

Results and Findings

In carrying out the analysis, an effort was made to structure it based on the research questions. A systematic literature review answered the four-pronged research questions as explicated below.

Research Question One

What is the relevance of the English language curriculum and its supervision?

This question was answered using a qualitative approach. Studies reviewed revealed that the English language curriculum is intimately connected with successful pedagogical activities in the English language. The studies examined also indicated that supervision is sine-qua-non to attaining the chief objective of language education – the development of communicative skills and proficiency in English.

For example, critical evaluation of the definition of curriculum by 12 of the reviewed studies shows that curriculum is similar to a format, a benchmark or a checklist that will guide teachers in their instructional approach towards the realisation of the overarching goal of education.

In Ref. [10] view it as a course or subject that helps students become responsible citizens. This tally with [9] submission that curriculum is often structured in sequence by an authority in the educational field to influence pedagogy. Eight (8) studies outlined the content of the curriculum intending to underscore its relevance in a subject such as the English language. Essentially, as captured under the conceptual framework, there are intended content students are required to acquire [37, 38], implemented content delivered by teachers through effective pedagogical approach by teachers [39, 40], Attained content refers to specific content understood by students and Processual which involves content addressing student’s self-actualisation [40].

English language curriculum sets the standard or benchmark for learning English as a Second Language. Underscoring the relevance of supervision in making sure that the four-pronged focus of the English language curriculum is achieved, several studies, sixteen (16) in all, demonstrated that supervision is inextricably linked and intimately connected to horning teachers' competence, content knowledge [18, 9, 27, 11]. indicated that it enhances teachers' professional qualification with concomitant improvement in students' academic achievement due to strict adherence and implementation of the English language curriculum.

In summary, studies reviewed revealed that while the English curriculum is instrumental to improving students' communicative skills and proficiency in English, supervision is suitable in seeing that teachers continually improve their approach and practices in implementing the curriculum.

Research Question Two

What is the perception of supervisors and primary school teachers on what constitutes effective supervision of the English language curriculum as stipulated by the Ghana Education Service (GES)?

Several (11) reviewed studies revealed that effective supervision should ensure curriculum implementation. Six studies indicated that supervisors must know the criteria for effective supervision and exhibit the correct behaviour and approach to ensure success. Though discussed inspection, highlighted the eight stages of clinical supervision, and highlighted the many features of differentiated supervision with a democratic approach, I agree with [27] that the new strategy tagged "SuperVision" which entails developmental supervision is the best approach. Unlike other approaches, SuperVision fosters a lifelong desire among teachers to keep improving their teaching and problem-solving skills. They must not rest on their laurel and keep working to improve instructional approaches to implementing the curriculum to better impact students' academic achievement.

Most of the studies agreed that to be effective, supervisors need to balance the need to meet target goals with the right administrative approach focusing on how individual teachers will be encouraged to become lifelong learners, improve problem-solving skills and enhance student academic achievement. The researcher also feels supervisors should be dynamic to touch on relevant issues while building fine rapport and collaborative effort with English teachers. Dynamism arising from SuperVision will help supervisors carry out adequate supervision irrespective of the impact of the COVID-19 pandemic.

Research Question Three

What are supervisors' and teachers' perspectives on the impact of the COVID-19 pandemic on teaching practice and student academic performance?

A quantitative approach was employed for the analysis of this question. The majority (24) of the studies reviewed revealed that the disease has a negative impact on curriculum supervision. Notwithstanding, the remaining three studies indicated it also positively impacts supervision. Several (18) of the studies employed descriptive statistics to garner supervisors' and teachers' opinions on the impact of the disease on the supervision of curriculum. This is depicted in Table 1.

Impact of COVID-19 on English Language Curriculum Supervision

Studies	Frequency		Percentage (%)	
	Negative		Negative	
Strongly Agree	12		44	
Agree	6		22	
Undecided	3		11	
Strongly Disagree	5		19	
Disagree	1		4	

Table 1. Impact of COVID-19 on English Language Curriculum Supervision

Source: Desktop Research

An in-depth analysis of Table 1 revealed that the majority (18) agreed with the notion that COVID-19 had a negative impact, while three (3) studies were not specific, and six (6) reported positive results.

This means, from the perspective of most of the authors, supervisors and teachers strongly felt COVID-19 had a negative impact on supervision. For example, [4] reported that teachers felt the disease entrenched educational inequality in Ghana. Confirming this, a study by revealed that teachers and supervisors complained that the pandemic further reduced the supervision ratio due to a lack of resources. From the researcher's viewpoint, the pandemic aggravated the autocratic approach some of the supervisors exhibited prior to the spread of the pandemic. [5] indicated that teachers needed clarification about handling school reopening and supervision. The burden of ensuring pupils adhere to the safety protocols and their regular role restricts the regularity of supervision. indicated that some teachers have a negative attitude towards supervision, viewing it as a fault-finding activity. Headteachers and circuit supervisors see COVID-19 as a means of ensuring collaborative efforts between supervisors and teachers. indicated that supervisors advised that teachers should see them as partners in progress and professionals critical to adopting innovative and result-oriented instructional methods to enhance student's academic achievements.

In brief, this section of the analysis revealed that both supervisors and teachers strongly feel that COVID-19 has had a negative impact on supervision. Due to limited access to resources, supervision has drastically reduced; inequality has deepened so that some teachers never receive effective supervision for months. It is paramount to devise or orchestrate an approach to address these issues. This forms the nexus of the final research question.

Research Question Four

What is the novel and realistic approach to supervising the English language curriculum because of the strict COVID-19 safety protocol?

There are few studies on orchestrating a novel and realistic approach to supervision. In all, only 6 of the studies touched on how to devise a practical approach to supervision. The remaining studies (21) only discussed how to conduct effective supervision before the new normal occurred. One of the six studies, a comprehensive study by indicated that due to the ravaging disease, the best approach to supervision is a "mindfulness-based approach" (p. 3). A closer examination of Mette's mindfulness-based approach tallies with the concept of [27] "SuperVision" because both stress supervisors need to be non-judgmental, rigid, and democratic. In effect, this is the time to unlearn particular behaviour towards teachers, embrace diversity of opinion and strive to encourage teachers to continually enhance their instructional approach to raise the bar of excellence for students with improved academic achievement. Notably, there needs to be more clarity on whether online supervision will be appropriate.

Following the framework of the concept of Germs, which demonstrated that COVID—19 uses humans as the host to spread the disease, the [21] installed a strict safety protocol to restrict body-to-body contact and thereby reduce the spread of the disease. Hence, a study by recommended online—based supervision so that the whole process will be carried out virtually over electronic media or social media.

Online-based was viewed as an innovative approach to supervision because it offers real-time evaluation of teachers' instructional approaches during teaching and learning. However, this has its setbacks. There are three-pronged issues ranging from 1) most of the teachers lacks requisite skill for online-based learning, 2) the teachers are incapable of adequately managing the system and orchestrating result-oriented models for students during learning sessions, and finally, 3) most of the teachers lack technological resources to get the appropriate media. In the researcher's view, online-based supervision will further deepen the divide or inequality rampant in Ghana because most students do not

have television at home, let alone an internet broadband connection. The researcher, therefore, felt that it is only practical in schools with internet facilities, and both the supervisors and teachers have the requisite skills to operate it.

Key Findings

Research Question One

What is the relevance of the English language curriculum and its supervision?

This question was answered using a qualitative approach. Studies reviewed revealed that the English language curriculum is intimately connected with successful pedagogical activities in the English language.

English language curriculum sets the standard or benchmark for learning English as a Second Language. Underscoring the relevance of supervision in making sure that the four-pronged focus of the English language curriculum is achieved, several studies, sixteen (16) in all, demonstrated that supervision is inextricably linked and intimately connected to horning teachers' competence, content knowledge [18, 9, 27, 11].

Research Question Two

What is the perception of supervisors and primary school teachers on what constitutes effective supervision of the English language curriculum as stipulated by the Ghana Education Service (GES)?

Several (11) reviewed studies revealed that adequate supervision should ensure curriculum implementation. Six studies indicated that supervisors must know the criteria for effective supervision and exhibit the correct behaviour and approach to ensure success.

Research Question Three:

What are supervisors' and teachers' perspectives on the impact of the COVID-19 pandemic on teaching practice and student academic performance?

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Research Question Four:

What is the novel and realistic approach to supervising the English language curriculum because of the strict COVID-19 safety protocol?

There are few studies on orchestrating a novel and realistic approach to supervision. In all, only 6 of the studies touched on how to devise a practical approach to supervision. The remaining studies (21) only discussed how to conduct effective supervision before the new normal occurred.

Discussion of the Findings

The study's key findings shed light on the impact of the COVID-19 pandemic on curriculum delivery and supervision in Ghana, aligning with existing literature on education crises. The pandemic significantly disrupted traditional curriculum delivery and supervision methods, highlighting the relevance of crisis management and educational resilience as a theoretical framework. This disruption prompted a swift shift to remote learning, initially marked by challenges related to the digital divide, technology access, and teacher preparedness. However, it also underscored the potential of technology in curriculum delivery and supervision, echoing the literature on technology's role in education.

Interestingly, the research revealed positive impacts in the form of technological innovation, with the pandemic accelerating the adoption of technology in education. This led to the development of online platforms and resources that can enhance curriculum supervision. Moreover, educators adapted by finding flexible approaches to curriculum

supervision, accommodating different learning environments. Teachers and supervisors also gained new skills related to online instruction and digital tools, potentially contributing to more effective supervision in the future.

On the flip side, negative impacts included exacerbated disparities in access to education resources, particularly in rural areas, which negatively affected curriculum supervision in those regions. Ensuring the quality of curriculum delivery became more challenging during remote learning, making it difficult for supervisors to monitor and maintain standards. The emotional toll of the pandemic on students, teachers, and supervisors may have also negatively influenced the quality of curriculum supervision.

To address these challenges, several potential solutions were identified:

1. **Digital Divide:** To overcome the lack of access to technology, advocates for government and NGO initiatives should work towards providing devices and internet connectivity to underserved areas.
2. **Quality Assurance:** To ensure curriculum quality during remote learning, clear guidelines for online curriculum delivery should be developed, accompanied by training for teachers and supervisors in online pedagogy.
3. **Emotional Well-being:** To tackle emotional distress among students and educators, schools can implement mental health support programs and incorporate social-emotional learning into the curriculum.
4. **Monitoring and Evaluation:** To address the challenge of monitoring student progress and teacher performance remotely, investments in educational technology that enables real-time monitoring and data collection should be made, accompanied by effective training for supervisors in using these tools.
5. **Resource Allocation:** In response to limited resources for curriculum materials, advocacy efforts should focus on securing increased funding for educational resources, with a priority on curriculum materials that can be used both online and offline.

In conclusion, the research findings provide valuable insights into the impact of COVID-19 on curriculum supervision in primary schools in Ghana. By discussing these findings within the context of existing literature and theoretical frameworks, identifying both positive and negative impacts, and addressing challenges and potential solutions, the study contributes to a better understanding of how educational systems can adapt and improve in the face of crises.

Conclusion

The overall objective of this chapter is to provide a succinct summary of the study, the main conclusion, and suggestions alongside recommendations for policy and practice based on the study's findings. The focus of the summary, conclusion and recommendations is to demonstrate how COVID-19 impacts adequate supervision of the English Language Curriculum in primary schools in Ghana, particularly those involving practical approaches that improve teachers' professional qualifications and pupils' academic performance. It is a desktop study employing relevant secondary data from peer-reviewed and reliable sources.

Summary

An extensive investigation was conducted into effective supervision practices in Ghanaian primary schools during the COVID-19 pandemic, relying on articles from peer-reviewed journals and other trustworthy studies. The research examines how COVID-19 safety measures have affected supervision within these schools.

Specific objectives and research questions were formulated to guide the study and address

research challenges effectively. Our relevant objectives included:

1. The investigation of the significance of supervising the English language curriculum.
2. Exploring the perspectives of supervisors and primary school teachers on what constitutes effective supervision of the English language curriculum, as outlined by the Ghana Education Service (GES).
3. Understanding how supervisors and teachers perceive the impact of the COVID-19 pandemic on teaching practices and student academic performance.
4. Exploring innovative and practical approaches to supervising the English language curriculum in light of strict COVID-19 safety protocols.

To tackle the research problems, four key research questions were developed:

1. What is the importance of supervising the English language curriculum?
2. How do supervisors and primary school teachers define effective supervision of the English language curriculum as specified by the Ghana Education Service (GES)?
3. What are the viewpoints of supervisors and teachers regarding the impact of the COVID-19 pandemic on teaching practices and student academic performance?
4. What innovative and feasible methods can be employed for supervising the English language curriculum while adhering to strict COVID-19 safety measures?

The methodology section employed a systematic approach to source selection. We prioritised sources that could offer the study's conceptual, theoretical, or empirical support. Recent research was favoured for its up-to-date information. While the study focused on Ghana, the source selection extended to existing studies within the educational sector of Ghana and other countries.

In all, 39 articles were selected for the study. Out of these articles, 18 (n-18) were from peer-reviewed journals, 6 (n-6) were from unpublished thesis, 5(n-5) were reports from reputable organisations, and the remaining 10 (n-10) articles were from other sources, including newspaper editorials, meeting the three criteria for selection. The manual selection of the articles culminated in the inclusion of only 27 sources in the study. This comprises peer-reviewed articles (12), unpublished thesis (3), reports (3), newspaper editorials (5) and other relevant sources such as blogs or websites (4).

Major Findings

Studies reviewed revealed that while the English curriculum is instrumental in improving students' communicative skills and proficiency in English, supervision is suitable in seeing that teachers continually improve their instructional approaches and practices in implementing the curriculum. Teachers' professional qualification is paramount, and supervision improved their competence, subject matter and content knowledge.

The study discovered that to be effective, supervisors must balance the need to meet target goals with the right administrative approach focusing on how individual teachers will be encouraged to become lifelong learners, improve problem-solving skills and enhance student academic achievement. Studies also demonstrated that supervisors should be dynamic to touch on relevant issues while building fine rapport and collaborative effort with English teachers.

Dynamism arising from SuperVision entails encouraging teachers to always look for ways to improve their instructional approaches and strategies to improve their pupils' academic achievement. Employing effective supervision, irrespective of the prevailing conditions, supervisors can help English teachers become lifelong learners equipped with ardent interest in problem-solving, irrespective of the impact of the COVID-19 pandemic.

A systematic examination of the studies revealed that supervisors and teachers strongly

feel COVID-19 has negatively impacted supervision. Due to limited access to resources, supervision has drastically reduced; inequality has deepened so that some teachers never receive adequate supervision for months. It is paramount to devise or orchestrate an approach to address these issues.

The study's findings further revealed that supervisors can accomplish much by being realistic, non-judgemental and tolerant instead of having a faultfinder and autocratic approach to supervision. Likewise, a mindfulness-based approach is very suitable in all aspects of supervision. Online—based supervision is also novel. However, supervisors and teachers should receive adequate and result-oriented training with the supply of internet facilities prior to implementation.

Implication for Practice and Policy

Supervisors are saddled with the onerous task of seeing that teachers' professional qualification is enhanced; hence, supervisors should receive additional training on using a blended approach to supervision. Collaboration and interactivity through virtual platforms where necessary and traditional approach where possible. This approach enhances teaching practice because teachers are allowed to contribute salient points to their training and allows supervisors to employ a supervisory approach to what works to improve teachers' skills and professional qualifications.

The study discovered that supervisors should adopt a democratic approach to supervision. It is therefore recommended that in line with the theoretical framework for the present study, the aspect of counselling and advice supervisor should be firm and underscores areas a teacher needs improvement. This means that instead of being prescriptive, supervisors should be democratic, flexible and realistic to improve teachers' teaching and assessment practices.

The policymakers should consider the below implications and factor them into their system of planning and execution.

The study's key findings highlight the pressing need for educational systems to exhibit resilience and adaptability in the face of unforeseen disruptions like the COVID-19 pandemic. This understanding extends beyond Ghana and can significantly inform future educational planning worldwide.

One notable consequence of this crisis is the accelerated adoption of blended learning approaches, where a mix of in-person and online teaching is becoming a permanent fixture in education. This shift necessitates a thorough re-evaluation of teaching methods and resource allocation to ensure effective implementation.

Moreover, the crisis emphasizes the critical role of continuous professional development for teachers and supervisors. Ongoing training in technology integration, crisis management, and curriculum adaptation becomes paramount to enhance the education system's adaptability. The pandemic has also laid bare disparities in access to education resources, particularly in rural areas, underlining the urgency of addressing these inequalities to ensure that all students have equal opportunities in English language education.

In addition to these local implications, the research findings can contribute to policy revisions not only at the national level but also regionally, as a means of better preparing education systems for future crises. This may entail revisiting curriculum frameworks, rethinking resource allocation strategies, and refining teacher support policies to foster resilience.

Lastly, it is crucial to recognize that the significance of this research extends beyond Ghana's borders. Its implications resonate with other nations facing similar challenges in English language education during crises. Thus, the findings can make a valuable contribution to the global discourse on education resilience, providing insights and guidance for educational systems worldwide.

Conclusions

The in-depth exploration conducted on the influence of COVID-19 on effective supervision of English Language Curriculum in primary schools in Ghana revealed that though the pandemic negatively affected supervision, with novel approaches to implementation, teachers' professional qualification can be enhanced and horned with concomitant improvement in instructional practices, and pupils' academic achievement. The supervisory approach often influences the extent to which teachers benefit professionally. Adequate supervision should ensure individual teachers become lifelong learners and improve problem-solving skills relevant to improving pupils' academic achievement. Being life-long learners will enhance teachers' capacity to adjust to varying situations and be capable of improving instructional practices to facilitate pupils' academic achievement.

The in-depth analysis concluded that supervision can only improve teachers' competence and content knowledge when supervisors build a fine rapport with the teacher, encourage contributions and engender a collaborative forum with English teachers. This means supervisors should be democratic and maintain balance to offer constructive criticism where necessary.

This means that during this era of COVID-19, supervisors should maintain dynamism to actively collaborate with teachers to facilitate the best approach to instructional practice. Such collaboration engenders an atmosphere of interactivity where teachers contribute to their development.

The study discovered that due to COVID-19, due to the strict distancing protocol and the low level of economic and infrastructural development in Ghana, inequality in access to education has been deepened, with several teachers receiving little or no supervision since 2020. In effect, COVID-19 has had a negative impact on supervision, suggesting the need to orchestrate an improved means of conducting effective supervision to benefit teachers and pupils.

It was concluded that a blended approach, comprising traditional and online-based approaches to supervision, is essential. It was also seen that supervisors should be realistic, non-judgemental and tolerant instead of being fault-finder and autocratic in their approach to supervision. Likewise, a mindfulness-based approach is very suitable in all aspects of supervision. Because of the implementation of blended supervision, training should be arranged for teachers and supervisors on using Internet facilities for the supervision processes.

Recommendations for Further Research

The study's key findings encompass a comprehensive set of recommendations to enhance the resilience and effectiveness of English language education in primary schools in Ghana and similar contexts.

Firstly, given the pivotal role of technology during the pandemic, the study emphasizes the necessity for primary schools to invest in infrastructure and provide training for teachers and supervisors to effectively integrate technology into the English language curriculum. This involves ensuring access to digital resources, online teacher training, and equipping students with the necessary devices.

Secondly, to ensure educational continuity in varying learning environments, including in-person and remote learning, the study proposes the development of a flexible curriculum framework that can adapt to different circumstances.

Thirdly, specialized training programs for English language teachers and curriculum supervisors are recommended to enhance their capacity for curriculum delivery and supervision, both in traditional and online settings.

In addition, the study suggests that educational authorities allocate additional resources and funding to support schools in procuring essential materials like textbooks and

digital resources, safeguarding the quality of English language education during crises.

Monitoring and evaluation play a critical role, with the study advocating for the establishment of a robust system to continuously assess curriculum delivery and supervision during emergencies. This proactive approach helps identify challenges early and enables timely interventions.

Recognizing the emotional and psychological toll of the pandemic on students and teachers, the study calls for the inclusion of mental health support services within schools to address the emotional well-being of all stakeholders.

Lastly, the study emphasizes the importance of community engagement. It encourages schools to actively involve parents and communities in the educational process, fostering a holistic approach to English language education. Parents, in particular, can play a crucial role in supporting their children's English language learning, especially during remote learning periods.

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Assessing How Effective Capacity Building has been in Strengthening Coordination Among CITES Enforcement Agencies in ZAMBIA

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Abstract

The illegal wildlife trade is one of the biggest dangers to biodiversity worldwide, especially in Zambia, where human activities threaten many species. In 1973, several nations developed the Convention on International Trade in Endangered Animals of Wild Fauna and Flora to combat the unlawful trade in endangered animals. This study examines how capacity training improves CITES stakeholder coordination and collaboration in Zambia to protect wildlife. A key goal of the study was to evaluate how well capacity building has improved CITES enforcement agency coordination in Zambia. The study studied Management Authority collaboration arrangements, training program performance, and stakeholder efforts to promote inter-agency coordination. We collected qualitative and quantitative data using a mixed-method approach. Interviews and questionnaires with former CITE capacity-building program participants and organizers provided primary data. This strategy assessed stakeholder collaboration and training program effectiveness. According to the report, the lack of institutional rules and collaboration mechanisms has prevented capacity building from improving CITES stakeholder coordination in Zambia. Though well-structured, training programs lacked practical elements and did not strengthen stakeholder interactions. Policy reforms and more hands-on, practical training are needed to improve inter-agency coordination. Successful CITES implementation in Zambia requires stronger collaboration and commitment from all enforcement authorities to conserve wildlife and biodiversity.

Keywords: *Biodiversity Conservation, Capacity Building, CITES, Enforcement Challenges, Illegal Wildlife Trade, Inter-Agency Coordination.*

Introduction

The illegal wildlife trade is a significant global issue, threatening biodiversity and accelerating species extinction [1]. The demand for wildlife products for food, medicine, fashion, and tourism, combined with habitat destruction, has exacerbated this crisis [2]. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), established in 1973, seeks to regulate international wildlife trade to protect endangered species. With 184 member countries, including Zambia, CITES emphasizes the importance of global cooperation in combating wildlife trafficking.

Zambia is home to an estimated 7,774 species of organisms, comprising 7% microorganisms, 40% plants, and 44% fauna, with at least 316 species endemic, 174 classified as rare, and 31 endangered or vulnerable. The fauna diversity includes 3,407 species, notably 1,808 invertebrates, 224 mammals, 409 fish, 67 amphibians, 150 reptiles, and 733 birds [3]. Floristic diversity spans approximately 4,600 plant species, dominated by herbs and woody plants, with 211 endemic species. Ecosystem diversity

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encompasses 16 types, predominantly forests, woodlands, grasslands, wetlands, and aquatic systems, with woodlands and forests covering 70% of Zambia, while wetlands account for about 14%. Species diversity often correlates with ecosystems; for instance, miombo woodlands and floodplains host the most mammal diversity, while montane ecosystems, though limited, have the highest number of endemic woody plants. Conversely, biodiversity is lowest in dry deciduous forests [4].

Zambia, renowned for its rich biodiversity and large wildlife reserves, faces substantial challenges in protecting its natural heritage. Zambia is in Category 3 of CITES National Legislation Project (Res. Conf. 8.4 (Rev. CoP15) and legislation to combat illegal trafficking of wildlife resources which are considered to be both plant and animal products. While Zambia is a committed CITES signatory, it grapples with enforcing regulations due to gaps in capacity, coordination, and awareness among enforcement agencies. Poaching and trafficking of species such as elephants, pangolins, and rhinos continue to threaten the country's wildlife population, undermining conservation efforts and Zambia's economic reliance on eco-tourism.

The human beings are at the center of this entire crisis, therefore requiring global collaborations with different stakeholders so that there is survival of some wildlife species which are facing critical extinction especially in Zambia and Africa at large, among them CITES and other wildlife organizations. Efforts to enforce CITES policies have often been undermined by insufficient legislative frameworks and weak inter-agency collaboration [5]. These challenges necessitate capacity-building initiatives aimed at fostering coordination among key enforcement agencies, including the Department of National Parks and Wildlife (DNPW), the Zambia Revenue Authority (ZRA), and the Zambia Police.

The effective enforcement of CITES in Zambia is hindered by inadequate capacity, weak inter-agency collaboration, and limited resources. Despite various training initiatives, the enforcement agencies involved in wildlife protection continue to struggle with coordination. For instance, the Department of National Parks and Wildlife faces challenges in data sharing and joint inspections with the Zambia Revenue Authority at major border posts such as Chirundu and Kasumbalesa [6]. Moreover, equipment shortages and insufficient expertise in monitoring wildlife trade routes exacerbate the problem. Capacity-building programs, although conducted by international conservation organizations, have often lacked sustained follow-up, making it difficult to gauge their long-term impact [7]. Additionally, inadequate funding and inconsistent communication among agencies hinder the development of robust enforcement mechanisms.

While several training programs and stakeholder workshops have been organized, the persistent gaps in inter-agency coordination raise questions about the effectiveness of these initiatives. Addressing these gaps is essential for ensuring Zambia fulfills its obligations under CITES and safeguards its biodiversity.

CITES is an international agreement designed to regulate the trade of wild species to prevent their extinction. Zambia, as a signatory, plays a critical role in ensuring compliance with CITES provisions, particularly given its biodiversity and strategic location as a transit hub for wildlife trafficking [8]. CITES enforcement in Zambia involves collaboration among various institutions, including the Department of National Parks and Wildlife (DNPW), customs, and law enforcement agencies. Effective implementation is essential to curb illegal trade and conserve endangered species.

Capacity building is vital for equipping enforcement agencies with the knowledge and resources required to address wildlife crimes effectively [9]. Training programs, resource allocation, and institutional strengthening are among the measures adopted globally to enhance enforcement [10]. In Zambia, agencies such as DNPW spearhead capacity-building initiatives focused on species identification, intelligence gathering, and border surveillance. Despite these efforts, challenges like inadequate funding and lack of advanced technology persist, limiting the impact of these programs [11].

Coordination among enforcement agencies is fundamental to the success of CITES implementation. Key stakeholders in Zambia include the DNPW, customs, and law enforcement, each playing a distinct role in curbing wildlife crimes [12]. Weak inter-agency collaboration, however, undermines enforcement efforts [13]. For instance, inadequate communication channels and overlapping mandates lead to inefficiencies in resource utilization and enforcement actions [14]. Enhanced coordination, supported by clear operational frameworks and joint operations, is necessary to strengthen compliance.

The effectiveness of capacity-building programs lies in their ability to address structural and operational challenges [15]. In Zambia, training programs have improved the technical skills of enforcement officers, yet their long-term effectiveness remains questionable due to a lack of follow-up evaluations [16]. Additionally, harmonized enforcement protocols and the inclusion of community-based organizations in conservation efforts are essential for improving outcomes [17]. Effective capacity building not only enhances the skills of personnel but also fosters a culture of cooperation among enforcement agencies [10].

In a bid to enhance multilateral aid for wildlife conservation and CITES implementation, the Chinese Government extended its support to Zambia, a developing country, through a knowledge exchange initiative [18]. This program is part of China's broader strategy to invite African nations for capacity-building sessions, aiming to improve wildlife conservation and CITES implementation strategies across the continent. In 2019, Zambia was one of seven African countries selected to participate in a three-week seminar on CITES implementation and wildlife conservation, held in Hangzhou City, Zhejiang Province. Sponsored by the Ministry of Commerce of the People's Republic of China, the seminar provided valuable insights and practical knowledge that are critical for advancing wildlife conservation and CITES implementation efforts in Zambia and other participating nations.

While existing studies acknowledge the importance of capacity building, there is limited research on its influence on inter-agency coordination in Zambia. Most literature emphasizes individual agency performance rather than collective outcomes, leaving a significant gap in understanding how capacity-building initiatives impact collaboration.

The CITES implementation training at China National Bamboo Research Center which was conducted in the past, was well organised and sponsored by the Chinese government, therefore there is need to collaborate and coordinate with the institution for the successful local trainings with stakeholders. This Research therefore was conducted to evaluate the effectiveness of capacity-building initiatives in enhancing coordination among CITES enforcement agencies in Zambia. In order to do so, the following questions were asked;

1. What structures has the Management Authority established to support collaborative CITES implementation in Zambia?

2. What is the nature of past training programs regarding needs assessment, trainer expertise, curricula, and delivery methods?
3. How do participants perceive the training in terms of content, duration, and delivery, and its impact on collaboration?
4. What mechanisms have stakeholders implemented post-training to ensure effective inter-agency coordination, and what challenges remain?

Methods

Data Source

This study was conducted in Zambia, a landlocked country located in Southern Africa. Zambia covers an area of approximately 752,612 square kilometers, with a population of approximately 19 million people, as per the latest census data [19]. The country is bordered by eight countries: Angola to the west, the Democratic Republic of Congo to the north, Tanzania to the northeast, Malawi to the east, Mozambique to the southeast, Zimbabwe to the south, Botswana and Namibia to the southwest [20].

Zambia is home to a rich diversity of wildlife, with several national parks, game management areas, and wildlife reserves scattered across its various ecological zones. The country's major ecosystems include the forested regions in the north, such as the Miombo woodlands, and the savannah regions that cover much of the central and southern parts. These ecosystems are critical for supporting a variety of species, including elephants, lions, buffalo, and antelope, which are central to Zambia's thriving tourism sector.

Zambia's wildlife is managed through the Department of National Parks and Wildlife (DNPW), which oversees 19 national parks and over 30 game management areas across the country. The government is committed to sustainable wildlife conservation, balancing the protection of natural resources with the needs of local communities, particularly in the face of threats such as poaching, illegal wildlife trade, and human-wildlife conflict. The study will focus on understanding how these management structures are being implemented in Zambia and assess the effectiveness of conservation initiatives.

Sample Design

Purposive sampling was adopted for this study to select participants who have specific knowledge or experience in the wildlife management practices and policies in Zambia. The sample consisted of stakeholders from various institutions involved in wildlife conservation and management, including the Department of National Parks and Wildlife (DNPW), the Ministry of Tourism and Arts, the Zambia Police Service, the Department of National Parks and Wildlife (DNPW), and local community-based wildlife management programs.

The study targeted key individuals such as wildlife officers, conservation managers, law enforcement officials, and local community leaders involved in wildlife conservation and management. A total of 100 participants were selected based on their roles in wildlife management, including 30 from DNPW, 20 from the Ministry of Tourism, 10 from DNPW, 15 from local community-based conservation initiatives, and 25 law enforcement officers.

The final sample was chosen based on their ability to provide relevant insights into the study's objectives, and respondents were carefully selected to ensure diversity in their perspectives and areas of expertise.

Data Analysis

The data collected from interviews and surveys were analyzed using both qualitative and quantitative techniques to ensure a comprehensive understanding of the research topic. The qualitative data, derived from face-to-face interviews and open-ended survey questions, were analyzed through narrative

data analysis. This process involved categorizing the data into themes and sub-themes aligned with the study's objectives. The findings were then presented descriptively, incorporating relevant quotes from respondents to emphasize key insights.

For the quantitative data, Microsoft Excel was utilized to perform basic descriptive statistical analyses, including frequencies and percentages. The results were visually represented using frequency tables, ensuring clarity and ease of interpretation. To enrich the analysis, the findings from both qualitative and quantitative methods were triangulated, offering a holistic perspective on the effectiveness of wildlife management practices. Additionally, these findings were compared with previous research conducted in Zambia and other African countries to identify patterns, draw relevant conclusions, and propose actionable recommendations for improvement.

Ethical Considerations

The study adhered to strict ethical guidelines to ensure the rights and welfare of participants were respected throughout the research process. Prior to data collection, ethical approval was obtained from the relevant institutional review board, establishing a foundation for conducting the study responsibly. Participants were fully informed about the study's objectives, their role, and the voluntary nature of their participation, with written consent obtained to ensure informed agreement. Confidentiality was prioritized, with measures implemented to safeguard respondents' identities and sensitive information by anonymizing data and storing it securely. The principle of non-maleficence was upheld by ensuring that no harm or discomfort was caused to participants during data collection. Additionally, official permissions were sought from relevant authorities to access organizational data and conduct research within their premises, ensuring compliance with institutional and legal requirements.

Results

The study involved respondents from different CITES stakeholder institutions, categorized into past training beneficiaries, the CITES Management Authority of Zambia, and past training organizers. Of the total respondents, the largest group consisted of past training beneficiaries (81%), followed by the CITES MA (9%) and training organizers (7%). In terms of gender representation, 59% of the respondents were male and 41% were female. The age distribution revealed that most respondents were between the ages of 31-45 (39%) and 46-60 (42%), with no respondents aged above 60.

Regarding educational backgrounds, 21% of respondents held PhDs, 43% had bachelor's degrees, 27% were postgraduate students, and 9% had diplomas. The majority (48%) of the respondents were employed in managerial positions, followed by 23% in senior management. In terms of work experience, 36% of respondents had between 1-10 years of experience, 27% had 11-20 years, and 22% had 21-30 years of experience.

When asked about the nature of past CITES training, respondents generally attended one or two training workshops, with 46% attending two sessions. Many rated the content of these trainings as average, with a significant number of past training beneficiaries (50%) feeling that the allocated time for these sessions was too short. Additionally, 71% of the respondents believed that CITES should be incorporated into academic curricula in universities and training schools across Zambia.

Regarding the practical application of the training, 67% of past training beneficiaries felt that the training was not practical enough, while 66% rated the resource persons' mastery over the content as high. Despite this, 49% of respondents believed they could identify

CITES-listed species after completing the training. However, when assessing the impact of CITES training on coordination and collaboration, most past training beneficiaries (42%) rated this aspect as average, with a smaller group giving it a higher rating. Similarly, 48% of respondents indicated that the training had a moderate influence on their working relationships with other CITES stakeholders, while 24% rated this influence as high.

Regarding mechanisms for coordination, 57% of respondents felt that the Wildlife Division had not created effective avenues for collaboration among CITES stakeholders, while 9% believed some avenues had been established, but were not sufficient.

Discussion of Findings

The findings of this study provide valuable insights into the perspectives and experiences of various stakeholders involved in CITES-related activities. The respondent group primarily consisted of past training beneficiaries (81%), with smaller representations from the CITES Management Authority (9%) and past training organizers (7%). This distribution highlights the critical role of training participants in the implementation and understanding of CITES-related initiatives.

Demographics and Professional Backgrounds

Gender representation among respondents was relatively balanced, with males (59%) slightly outnumbering females (41%). This suggests some progress toward gender inclusivity in CITES-related activities. However, further efforts are needed to bridge this gap and promote equal participation.

Table 1. Age Distribution

Age Group	Percentage %
30 years and below	0
31-45 years	39
46-60 years	42
Above 60	0

Most respondents were between the ages of 31-45 (39%) and 46-60 (42%), indicating a workforce that is mature and likely well-established in their careers. The absence of respondents above 60 years suggests a potential underrepresentation of more senior professionals or retirees who might contribute historical or policy-level insights.

Table 2. Education Level

Qualification	Percentage %
PhD	21
Postgraduate	43
Bachelor's Degree	27
Diploma	9

In terms of educational qualifications, the majority of respondents held higher education degrees, with 43% possessing bachelor's degrees, 27% being postgraduate students, and 21% holding PhDs. This reflects a well-educated participant pool, likely equipped with the theoretical knowledge necessary for understanding and applying CITES regulations. Additionally, 48% of respondents were employed in managerial positions, and

23% were in senior management, indicating that decision-making roles are well-represented among stakeholders.

Qualitative Results

The qualitative component involved in-depth interviews with key representatives from the CITES Management Authority and past training beneficiaries. Participants shared insights into the effectiveness of current structures, training programs, and inter-agency collaboration mechanisms.

Key Themes Identified

Gaps in Structural Support

Interviewees noted that while the Management Authority has made strides in aligning stakeholders, there is a lack of regular communication channels and clear roles for different agencies in CITES implementation. One participant stated, *"We need a platform where stakeholders can engage regularly, not just during training workshops."*

Relevance and Practicality of Training

Several respondents highlighted a disconnect between the training content and real-world applications. One interviewee commented, *"The sessions were informative but did not provide practical scenarios or simulations to prepare us for field challenges."*

Perceived Impact on Collaboration

While training was generally appreciated for raising awareness, some participants emphasized that it failed to create sustainable collaboration frameworks. As one respondent observed, *"The training inspired teamwork during the sessions, but this didn't translate into long-term collaboration afterward."*

Post-Training Mechanisms

Interviewees consistently pointed to the absence of post-training mechanisms, such as feedback loops or follow-up sessions, to monitor and enhance inter-agency coordination. One key informant remarked, *"There's no follow-up after training to ensure that the lessons are being applied effectively."*

Training and its Perceived Impact

The study revealed critical insights into the effectiveness of past CITES training programs. Most participants attended one or two workshops, with 46% attending two sessions. While the majority rated the content of these training sessions as average, there is a clear need for more comprehensive and practical training approaches. A significant proportion (50%) felt that the allocated time for training sessions was insufficient, suggesting a potential misalignment between training duration and content depth.

Notably, 67% of past training beneficiaries found the training insufficiently practical, which may hinder their ability to apply CITES principles effectively in their professional roles. Despite this, 66% rated the trainers' mastery of the content as high, indicating confidence in the expertise of resource persons. However, only 49% felt equipped to identify CITES-listed species post-training, highlighting a gap between theoretical knowledge and practical application.

Collaboration and Coordination

The findings underscore challenges in fostering collaboration among CITES stakeholders. While 42% of training beneficiaries rated the impact of training on coordination as average, and only 24% rated it highly, this indicates room for improvement in enhancing stakeholder relationships through training initiatives. Similarly, 48% of respondents perceived the training's influence on their working relationships with other stakeholders as moderate.

Mechanisms for stakeholder coordination also emerged as a critical concern. A majority (57%) expressed dissatisfaction with the Wildlife Division's efforts to establish effective collaboration avenues, while 9%

believed that existing mechanisms were inadequate. This calls for the implementation of more robust strategies to enhance stakeholder engagement and create cohesive networks.

The qualitative findings provided deeper insights into the challenges and opportunities associated with CITES implementation in Zambia. Participants emphasized gaps in structural support, noting the absence of regular communication channels and clearly defined roles among stakeholders. While training sessions were acknowledged for raising awareness, respondents highlighted the lack of practical application, with calls for incorporating simulation exercises and field scenarios into future programs. Furthermore, the impact of training on inter-agency collaboration was perceived as limited, as teamwork fostered during workshops rarely translated into sustained partnerships. Notably, participants pointed to the absence of post-training mechanisms, such as follow-up sessions or task forces, to monitor and enhance coordination efforts, suggesting that addressing these issues could significantly improve the effectiveness of CITES initiatives.

Conclusion

In conclusion, this study highlights the significant role of training in CITES implementation, yet it identifies critical gaps in training design and stakeholder collaboration mechanisms. While the expertise of resource persons and the educational background of participants are notable strengths, the insufficient practicality of training and limited coordination efforts impede the effectiveness of CITES-related initiatives. Further, the study reveals the lack of regular communication channels, clearly defined roles, and post-training mechanisms, which hinder sustained collaboration among stakeholders. Enhancing the practical components of training, extending their duration, incorporating field scenarios, and establishing robust engagement frameworks are essential steps toward achieving the intended outcomes of CITES programs.

Recommendations

To improve wildlife trade management and enhance the CITES implementation in Zambia, the following recommendations are proposed:

1. There is need to focus on establishing good bilateral cooperation mechanism with various governments, China as an example, to obtain more opportunities for capacity building and exchanges based on past experience.
2. Pursue international partnerships with other governments and global organizations to secure funding and technical support for capacity-building activities.
3. There is a need to sensitize the government officials who are decision makers about CITES and wildlife crime related issues for easy collaborating with other stakeholders and enforcement agencies.
4. The Department of National Parks and Wildlife (DNPW) should establish a dedicated coordination unit to improve inter-agency collaboration.
5. Formal agreements, such as Memoranda of Understanding (MoUs), should be developed between DNPW and relevant CITES stakeholders to define roles and communication channels.
6. Training content should be tailored to highlight the specific roles of each stakeholder in CITES enforcement and wildlife protection. This would ensure that all agencies understand their unique responsibilities and contributions to the overall success of CITES implementation in Zambia.
7. CITES-listed species identification manuals should be distributed to all trained personnel, ensuring they have easy

access to important information post-training.

8. Future CITES training in Zambia should incorporate practical sessions, such as handling specimens, to make the training more impactful and realistic.
9. Additional training should be extended to other stakeholders, including wildlife exporters, border officials, and Customs officers, to ensure a comprehensive approach to wildlife trade regulation.
10. Establish focal persons in key agencies responsible for coordinating CITES enforcement matters. These individuals would ensure regular communication and collaboration, especially among those who have undergone CITES training.
11. Government decision-makers in Zambia need to be sensitized about the importance of CITES and the implications of wildlife crime. This will help build political will and foster a commitment to more robust implementation of CITES.
12. Zambia's government should allocate more resources to wildlife law enforcement, including funding for logistical support, training, and the establishment of coordination mechanisms.
13. By addressing these recommendations, Zambia can significantly improve the effectiveness of its wildlife trade management and enforcement systems. This will ensure that the country adheres to CITES regulations, contributes to global wildlife protection efforts, and curtails illegal wildlife trafficking.

Conflict of Interest

The author declares that there are no conflicts of interest related to this study. No financial or personal relationships have influenced the content or outcomes of this research.

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Business Data Breaches-Impact on Brand Reputation and Employee Integrity: A Case Study of Desjardins in Canada

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Abstract

The research explored the effects and the impact of business data breaches on brand reputation and employee integrity, using the 2019 Desjardins Group Canada breach as a case study. The breach in question compromised personally identifiable information of over 9.7 million customers and Desjardins members, revealing vulnerability in data security, governance, and organizational culture. In addition to financial losses, the incident eroded client trust and loyalty, created an internal crisis and uncertainty within the organization. The research examines the effects of the breach on stakeholder confidence, business resilience, and employee morale using a mixed research approach which includes interviews, surveys, and secondary data analysis. The research reveals a significant decline in public trust, financial impacts, and brand damage. Employees faced increased stress levels, low morale, and declining confidence in leadership, which highlighted the human toll of cybersecurity failures. The research explores how perceived risks and threats, protective measures, and trust dynamics can influence stakeholder responses. It emphasizes the necessity of a clear crisis management process, transparency, and robust cybersecurity frameworks to mitigate the adverse effects of data breaches. Organizations that acted swiftly and communicated transparently could restore stakeholder trust and confidence. To enhance information security, businesses should invest in governance, employee training, and cultivate a security-focused culture. Additionally, policymakers should advocate for stringent data protection laws and regulations, mandatory breach disclosures, and cross-sector collaboration to strengthen cybersecurity resilience. This research offers valuable insights for businesses, regulators, and scholars confronting cybersecurity risks and threats in an increasingly digital landscape.

Keywords: *Business Data Breach, Customer Loyalty, Customer Trust, Cybersecurity, Employee Integrity, Organization Reputation.*

Introduction

In today's digital economy, data is an essential and fundamental asset that helps drive decision-making, organizational strategic planning, and operational efficiency and optimization in businesses across all sectors [8]. As business organizations continuously rely on IT and digital infrastructures and peripherals to manage sensitive business information, the risks associated with data breaches have increased exponentially, and businesses, especially in the financial industry, are vulnerable and prime targets [10]. Data breaches can be defined as unauthorized access to, or disclosure of, confidential information, resulting in devastating financial losses, legal consequences, loss of customer trust, and long-term reputational damage [17]. These breaches can profoundly affect organizations, damaging their reputation and the integrity of their staff members. This study investigates the impact of the Desjardins data breach on brand reputation and employee integrity; it will shed light on the implications of the breach and offer insights on

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how the organizations can effectively manage the aftermath of such incidents. Brand reputation is significant for any business, influencing customer satisfaction, loyalty, and perceptions [2].

The 2019 Desjardins Group data breach was one of the most significant incidents in Canadian financial history, impacting over 9.7 million Canadians. This breach, caused by an insider threat, exposed the vulnerabilities inherent in even the most robust cybersecurity frameworks and highlighted the multilayered impacts of such breaches on organizational reputation and employee integrity [18]. This study seeks to investigate these dimensions, examining how data breaches influence public opinion, customer loyalty, perception of the brand, stakeholder confidence, and internal organizational culture.

Data breaches have become a recurring phenomenon in the digital age. In this modern age, businesses across the globe heavily rely on technology to analyze data for strategic business decisions, storage, and to maintain their online presence. Many are increasingly falling victim to cyber-attacks from internal or external actors. There are many dire business consequences of a data breach, and the primary concern has shifted to the impact of data breaches on an organization's reputation and employee integrity, the impact on its customer base and loyalty, and continued patronage. With the increasing prevalence of data breaches and the ever-growing integration and interconnectivity of the online world, exploring their impact on business brands is of paramount concern.

Since it is almost impossible to maintain an impenetrable cyber defense in the modern landscape, it is essential to understand how organizations can respond and what steps should be taken in the aftermath to avoid reputation damage and maintain customer trust and loyalty [2]. When a data breach occurs, the process should be written in the organization's policy and procedure, disaster response plan (DRP), and business continuity plan (BCP). An in-depth analysis of Desjardins' data breach, its response, and its impact on business reputation and employee integrity will be conducted. The Desjardin information security practices, pre- and post-data breach incidents, will be reviewed, analyzed, and compared with other data breach incidents that have happened to identify the gap.

Scope and Limitations

This research focuses on the Desjardins Group data breach incident as a case study to provide in-depth analysis and insights into the organizational impacts of data breaches and cybersecurity incidents. The scope includes an analysis of the breach's effects on brand reputation, employee integrity, and the effectiveness of crisis management strategies. While the case study approach allows for detailed exploration, the findings may not be universally generalizable. Additionally, the study relies on primary data (interviews and surveys) and secondary data (Office of the Privacy Commissioner of Canada, financial industry report, Desjardin report, Google Scholar, Research Gate, websites, and media analysis), which may present inherent biases.

Significance of Study

This study holds significant importance and value for both academic and practical purposes. It contributes to the growing body of literature on business data protection, cybersecurity governance, risk management, and organizational behavior for academic purposes. In practical terms, the findings offer critical insights for business organizations, business leaders, information technology professionals, regulators, government, and policymakers aiming to enhance and improve business data protection strategies and crisis response mechanisms. By understanding the correlation between data breaches, brand reputation, and impact on employee integrity, organizations

can better prepare for, respond to, and recover from any data breach incident.

Literature Review

The financial industry's services, products, and roles are crucial to Canada's economy. They facilitate financial transactions like insurance products, investment products, and wealth management for individuals and businesses, enabling them to access their customers' private and personally identifiable information (PII) [18]. However, the increasing dependence and reliance on technologies and digital platforms, coupled with the sensitive nature of data they store in their financial and personal databases, has made financial institutions focal and prime targets for cyber threats, including data breaches. In an industry built on trust and security like this financial institution, any breach can impact customer confidence, negatively impact clients' loyalty, impact employees' morale, affect shareholder value, and result in significant regulatory penalties [24]. As a custodian of people's money and life savings, it cannot afford any data and cyber security incident that shows organizations have weak cybersecurity practices or an inability to protect people's information; this could have a huge impact on reputation, which can erode trust. These breaches can result from external cyberattacks, insider threats, or system vulnerabilities [17]. The increasing frequency and sophistication of data breaches highlight the growing cybersecurity challenges faced by organizations around the globe.

Knowing the impact a business data breach will have on the organization's reputation and employee integrity is important. Brand reputation is a critical intangible asset, goodwill, influencing customer trust, loyalty, and overall business success. Data breaches can severely damage a brand's reputation, leading to loss of customer confidence, adverse media reporting and coverage, and long-term financial consequences [12]. Some existing studies have shown that companies experiencing data breaches more often suffer declines in stock prices, market share and dominance, and customer retention rates [19]. Notably, the breach of consumer data is not the only factor influencing consumer perceptions of brand trust [2]. The response and actions taken by the company in the aftermath of the crisis can have significant consequences on consumer perception and behavior [10]. A delayed response to a breach, evasion of responsibility, or unclear communication, such as legal proceedings or investigations, can all impact consumer perceptions and form opinions of brand reputation [7]. Failing to prevent a data breach is one aspect; however, inadequately managing the aftermath can foster even greater distrust, which can, in turn, negatively affect consumer behavior and attitude toward the brand [2].

Data breaches also have philosophical effects on employee integrity and organizational trust. Employees may feel demoralized, anxious, and distrustful of their organization's ability to protect sensitive information [10]. Data breaches can also result in a decline in trust between employers and employees, especially when it is established that an insider, such as Desjardin Group, caused the breach. Whitener et al. (1998) emphasized that trust is a fundamental component of organizational culture, and breaches can erode this trust, leading to decreased job satisfaction, productivity, and employee retention. An operational and effective security policy and procedure that details cybersecurity governance, risk management, and compliance frameworks is essential for mitigating data breach risks. IT governance strategies provide a structured approach to managing IT risks, ensuring regulatory compliance, and promoting a security-conscious organizational culture (Von Solms & Von Solms, 2004). In designing policies and procedures to secure data, organizations borrow a leaf from different standards and frameworks such as the NIST

Cybersecurity Framework (2018) and ISO/IEC 27001, COBIT, etc., which are widely adopted models that guide organizations in identifying, protecting, and detecting, responding to, and recovering from cybersecurity incidents.

Implementing those frameworks and standards into business operations is important; IT General Controls must be properly designed based on the standards or frameworks that the organization has chosen, and control-protective and detective measures must be ensured to work as intended. Access control mechanisms protect sensitive data and personnel from unauthorized access. Many techniques, such as multi-factor authentication (MFA), role-based access control (RBAC), and encryption mechanisms, are commonly used to safeguard information from unauthorized access [20]. Security controls, including firewalls, intrusion detection systems, and regular security and logs audits, play an essential role in preventing, detecting, and mitigating data breaches [22]. Incident response plans are critical for effectively managing data breaches. As Chatterjee and Sokol said, the response and actions taken by the company in the aftermath of the crisis can have significant consequences on consumer perception and behavior [2]. The ISMS policy should include a business continuity plan (BCP) outlining procedures for detecting, responding to, and recovering from security incidents [1]. Mitropoulos et al. (2006) highlight the importance of communication during a crisis in maintaining stakeholder trust during and after a breach. Organizations with well-developed incident response plans can effectively and significantly reduce the impact of breaches on their operations and reputation.

Research Methodology

This study adopts a mix of quantitative and qualitative research methods, utilizing a case study approach to provide an in-depth analysis and exploration of the Desjardins Group data breach. The qualitative approach allows for a complete and comprehensive understanding of the subjective experiences and perceptions of many stakeholders affected by the data breach [25]. The case study method is suitable for examining complex issues within real-life contexts.

The case study approach enables an in-depth analysis of the Desjardins Group data breach, focused on its impacts on brand reputation and employee integrity. This approach allows for examining the organization's responses, crisis management strategies, and the broader implications of the breach on stakeholders and the business. The case study is both descriptive and exploratory, aiming to discover and uncover patterns and generate insights that can inform best practices in business data protection and cybersecurity governance.

The study uses both primary and secondary data to investigate, analyze, and substantiate the research findings and to have robust information to enhance the credibility of the findings.

Primary Data

The data was collected through semi-structured interviews and surveys. Interviews were conducted with various stakeholders, including Desjardins employees, management, cybersecurity experts, and affected customers. Surveys are distributed to a broader audience to capture quantitative data on perceptions of brand reputation and employee Integrity and trust.

Secondary Data

This includes organizational reports, regulatory documents, the Canadian Office of Privacy Commission's public website, media articles, academic journals, Google Scholar, and industry publications. It provides context and supports the analysis of primary data.

The study uses purposeful sampling techniques to select participants with direct and indirect experience in the financial industry or relevant knowledge of the Desjardins data breach. It also employs customers of other

financial institutions. The sample participants include:

1. Employees of the financial industry, like banks and Insurance companies.
2. Senior executive officers involved in breach response and crisis management.
3. Staff and employees from various departments to understand internal perceptions.
4. Customers affected by the breach to assess its impact on trust, reputation, and loyalty.
5. Cybersecurity experts and industry professionals for expert insights.

Research Objectives

The primary objectives of this research are to:

1. Evaluate and assess the impact of data breaches on brand reputation using Desjardins Group as a case study in the Canadian financial industry.
2. Examine the effects of data breaches on employee integrity, trust, and organizational culture.
3. Identify and analyze the crisis management strategies employed by Desjardins Group post-breach.
4. Provide actionable recommendations for business organizations to strengthen and improve their cybersecurity posture and resilience against reputational damage after the incident.

Research Questions

This study seeks to answer the following key research questions:

1. What are the immediate and long-term impacts of data breaches on the brand reputation of financial institutions, particularly in the case of Desjardins Group Canada?
2. How does a data breach affect employee integrity, organizational trust, and workplace morale?
3. What crisis management and recovery strategies can organizations adopt to restore stakeholder confidence following a data breach?

Research Hypothesis

Based on the key research questions, two research hypotheses were developed to investigate further the impact of the business data breach on business reputation and trust and how it impacts employee integrity and confidence in the organization using the primary data.

Hypotheses One

Null Hypothesis (H_0): Data breaches at Desjardins Group and financial institutions in Canada have no significant impact on brand reputation.

Alternative Hypothesis (H_1): Data breaches at Desjardins Group and financial Institutions in Canada significantly impact brand reputation.

Hypotheses Two

Null Hypothesis (H_0): Data breaches do not significantly impact employee integrity and confidence in the organization.

Alternative Hypothesis (H_1): Data breaches significantly impact employee integrity and confidence in the organization.

Research Questionnaire Design

Impact on Brand Reputation survey design:

Section 1: Demographics

1. What is your age group?
    a) 18-25
    b) 26-35
    c) 36-45
    d) 46-55
    e) 56+
2. What is your gender?
    a) Male
    b) Female
    c) Other

Section 2: Professional Background

3. What is your role at Desjardins/ or your current employer if not with Desjardins?
    a) Customer-facing employee
    b) Back-office employee
    c) Management
    d) Other (please specify)
4. How long have you been employed at Desjardins?
    a) Less than 1 year
    b) 1-3 years
    c) 4-6 years
    d) 7+ years
    e) Not Applicable

Section 3: Perception of Data Breaches

5. Have you been directly or indirectly impacted by a data breach at Desjardins?
    a) Yes
    b) No
6. On a scale of 1-5, how do you perceive the company's response to data breaches?
    a) 1: Very Poor
    b) 2: Poor
    c) 5: Excellent

Section 4: Impact on the Brand Reputation

7. To what extent do you think data breaches affect Desjardins' reputation among their customers?
    a) Not at all
    b) Slightly
    c) Moderately
    d) Strongly
8. Do you think customers' trust in Desjardins has been affected?
    a) Yes
    b) No

Section 5: Impact on Employee Integrity

9. Have data breaches diminished your trust in management or made you feel less confident about Desjardins' systems or the company you work for if you are not with Desjardins?
    a) Yes
    b) No
10. On a scale of 1-5, how likely are you to consider leaving Desjardins due to trust issues related to data breaches?
    a) 1: Not at all likely
    b) 5: Extremely likely

Data Collection Method and Approach

Primary data was gathered through semi-structured interviews with different Financial Institutions, Desjardins employees, management, cybersecurity experts, and affected customers, as stated below. Surveys were distributed anonymously (This means that the identity and information of respondents were unknown) to a broader audience to capture quantitative perceptions of the business data's impact on the organization. Secondary data included the Office of Canada Privacy Commissioner, organizational reports, regulatory documents, media articles, and academic literature. Thematic analysis was also employed to identify recurring themes from the qualitative data [6].

1. Interview Guide: It was designed to facilitate semi-structured interviews about the impact of breaches on business reputation, employee Integrity and confidence, security breach awareness, crisis response, organizational trust, and employee morale.
2. Survey Questionnaire: The questionnaire includes closed- and open-ended questions to capture quantitative and qualitative data on stakeholders' opinions and perceptions of the breach's impact.

The data collected was analyzed using the Chi-Square Test for independence, regression analysis, and thematic analysis for trend and pattern. The thematic analysis includes identifying, analyzing, and reporting patterns (themes) within the data [6]. The process includes:

1. Data familiarization means reading and re-reading transcripts to become immersed in the data to help with analysis.
2. Reviewing Themes, meaning refining themes and patterns to ensure they accurately represent the data.
3. Interpreting Data means connecting findings to research questions and existing literature.

Validity and Reliability

To ensure the validity and reliability of this study, the concept of triangulation was used, and multiple data sources and methods were used to corroborate our findings, in addition to the empirical result of primary data analysis. We ensure the Audit Trail maintains detailed records of data collection and analysis processes for accuracy, reference, and to substantiate the findings.

Ethical Considerations

Ethical considerations are essential, given the sensitivity of data breach incidents. The study adheres to ethical research principles, including:

1. Informed consent was obtained to ensure all participants were informed about the study's purpose, procedures, and rights before consent.
2. Confidentiality to ensure the anonymity and privacy of participants' identities and responses.
3. Data Security, implementing measures to protect the security and integrity of data collected to date.

Limitations of Methodology

While a mixed method using the case study approach provides rich, detailed insights, it has limitations [6]. Findings may not apply to all organizations, especially those in the nonfinancial industry, due to the focus on a single case. The bulk of data used in this research was primarily secondary, and primary data was limited due to concerns about employees and employers. In addition, there might be potential biases in participant responses and researcher interpretations. Limited access to the most recent data from the Desjardin Group may affect the comprehensiveness of the analysis; many members were reluctant to participate, and those who participated did so in anonymity.

Survey Data Analysis

The total number of respondents is 200 (A random sampling of customers, employees, and non-employees of Desjardin who are working in the financial industry and across various departments)

Summary of Survey Response

- **Question 5:** 60% answered directly impacted, and 40% not impacted.
- **Question 6:** Average score: 2.8/5.
- **Question 7:** 70% believed reputation is strongly affected.
- **Question 8:** 80% think customer trust is affected.
- **Question 9:** 65% feel less confident in systems and feel less trusted by the employer.
- **Question 10:** Average score: 3.2/5.

The **Chi-Square (χ^2) formula** is applied as follows:

$$\chi 2 = \sum (Oi - Ei) 2Ei \chi^2 = \sum \frac{(O_i - E_i)^2}{E_i} \chi 2 = \sum Ei(Oi - Ei) 2$$

Where:

- Oi = Observed frequency of each category
- Ei = Expected frequency of each category
- ∑= Summation across all categories

Hypotheses One Testing

Null Hypothesis (H_0): Data breaches at Desjardins Group and financial institutions in Canada have no significant impact on brand reputation.

Alternative Hypothesis (H_1): Data breaches at Desjardins Group and financial

Institutions in Canada significantly impact brand reputation.

The results of the surveys are organized in the Table 1. Reputation Survey Response below:

Table 1. Reputation Survey Response

Response Category	Observed Frequency (O)	Expected Frequency (E)
Not at all	20	50
Slightly	30	50
Moderately	30	50
Strongly	120	50

Total sample size: 200 respondents

Then compute the Chi-Square Statistic based on the formula stated and Table 1 above.

$$\chi^2 = \frac{(20-50)^2}{50} + \frac{(30-50)^2}{50} + \frac{(30-50)^2}{50} + \frac{(120-50)^2}{50}$$

$$\chi^2 = \frac{(-30)^2}{50} + \frac{(-20)^2}{50} + \frac{(-20)^2}{50} + \frac{(70)^2}{50}$$

$$\chi^2 = \frac{900}{50} + \frac{400}{50} + \frac{400}{50} + \frac{4900}{50}$$

$$\chi^2 = 18 + 8 + 8 + 98$$

$$\chi^2 = 132.0$$

Determine the p-value

The **p-value** is calculated using a chi-square distribution table or statistical software.

1. Degrees of Freedom (df) Formula is equal to: Df= Number of categories − 1

Since we have four response categories, the degrees of freedom: Df= 4−1= 3

2. The computed **p-value** = **2.00×10^{-28}**, which is **extremely small**.

Decision Rule

Compare the **p-value** to the standard significance level ($\alpha = 0.05$):

1. **If p-value < 0.05** → Reject the null hypothesis (**H_0**).
2. **If p-value > 0.05** → Fail to reject the null hypothesis (**H_0**).

Since **p-value = 2.00×10^{-28} which** is far less than 0.05, we **reject H_0**.

Interpretation of Result

1. The higher value of χ^2 (132.0) and very low p-value indicate that the observed distribution of trust and reputation perception responses significantly differs from what we expect under a uniform assumption.
2. That means data breaches strongly impacted the organization's reputation and customer trust, as most respondents reported a "Strongly" adverse impact.

Conclusion on Hypothesis One

Reject the Null Hypothesis (H_0) and accept Alternative Hypothesis (H_1) based on the test of hypothesis, which means Data breaches at Desjardins Group and Financial Institutions in Canada significantly impact brand reputation.

Hypothesis Two Testing

1. **Null Hypothesis (H_0):** Data breaches do not significantly impact employee Integrity and confidence in the organization.
2. **Alternative Hypothesis (H_1):** Data breaches significantly impact employee integrity and confidence in the organization.

To analyze and test hypothesis two, the survey response data related to confidence and integrity were tabulated Table 2 below.

Table 2. Confidence and Integrity

Response Category	Observed Frequency (O)	Expected Frequency (E)
Feel Less Confident	130	100
Feel Unaffected	70	100

The responses were categorized as follows:
Total sample size: 200 respondents

Using the Chi-Square Statistic

$$\chi^2 = \frac{100(130-100)^2}{100} + \frac{100(70-100)^2}{100}$$

We break it down as follows:

$$\chi^2 = \frac{100(30)^2}{100} + \frac{100(-30)^2}{100}$$

$$\chi^2 = \frac{100 \times 900}{100} + \frac{100 \times 900}{100}$$

$$\chi^2 = 9 + 9$$

$$\chi^2 = 18.0$$

Then we determine the **p-value**

1. Degrees of Freedom (df):

Df will be Number of categories minus 1, which will be 2−1=1

2. The computed p-value = 2.21×10^{-5} (0.0000221)

Compare the **p-value** to the standard significance level ($\alpha = 0.05$), then:

1. **If p-value < 0.05** → Reject the null hypothesis (**H_0**).
2. **If p-value > 0.05** → Fail to reject the null hypothesis (**H_0**).

Since our **p-value = 0.0000221** is much smaller than **0.05**, we **reject H_0**.

Interpretation of Hypothesis Two

1. The higher value of χ^2 (18) and very small p-value means that observed differences in employee Integrity and confidence are statistically significant.
2. This result means the data breaches harmed employee integrity and confidence in the company's internal systems.

Conclusion on Hypothesis Two

Reject the Null Hypothesis (H_0) and accept Alternative Hypothesis (H_1) that says Data breaches at Desjardins Group significantly impact employee Integrity and confidence in the organization.

Result and Discussion

The analysis of primary and secondary data and the interpretation of the key research results and findings, connecting them to existing literature and theoretical frameworks as discussed earlier, gave us a reliable conclusion of our investigation. The discussion explores the implications of the Desjardins Group data breach on brand reputation and employee integrity. Moreover, analyzed the organizational resilience. In addition, it highlights the practical, theoretical, and policy-related insights derived from the study.

The primary data analysis shows that the Desjardins data breach significantly impacted Brand Reputation and diminished customer trust in the organization, resulting in brand reputational damage and financial repercussions. The result aligns with prior research indicating that data breaches negatively affect brand image, public perception, and consumer loyalty [19]. Comparative analysis done from the secondary data, which compared the Desjardin incident with the industry as shown in Figure 1 shows that Desjardin's impact was higher in the industry. Moreso, compare the incident of Desjardins' business data breach with high-profile data breaches that have occurred in Canada, like Equifax, Target, etc., shows a familiar pattern:

1. Insider Threats: Similar to the Desjardins incident, insider threats were common and significant in many business data breaches [32].
2. Delayed Detection: Not being proactive and prolonged detection times worsened the impact of breaches and was familiar to those known incidents.
3. Reputational Recovery: Organizations that communicated honestly and transparently and implemented robust post-incident security reforms recovered their reputations more effectively [33].

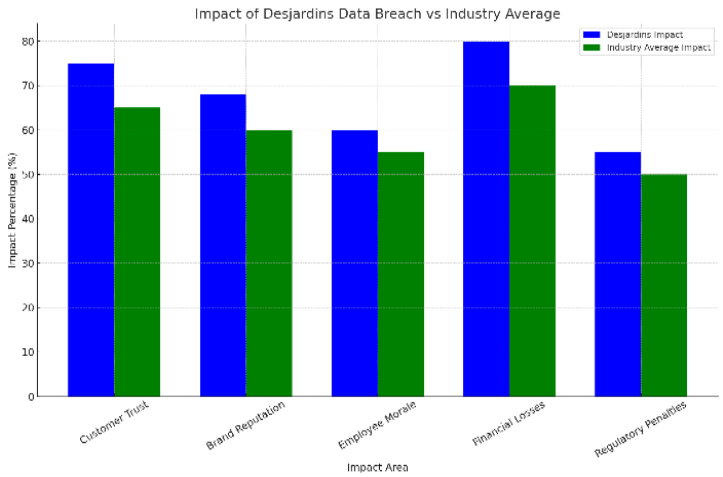

Figure 1. Impact: Desjardins Vs Industry Average

The media coverage increased public awareness of the breach and further damaged Desjardins' credibility. Though honest and transparent communication can help to reduce the impact on the brand, it was not sufficient to fully mitigate reputational damage, emphasizing the long-term nature of brand recovery post-breach according to the secondary data [7].

The Impact on Employee Integrity and Confidence in Desjardins was significantly impacted according to the result of the primary analysis, which was analyzed and tested in hypothesis two. In secondary data analysis, the breach weakened employee morale, created a culture of suspicion, and increased stress levels in the organization. This finding aligns with Herath and Rao (2009), who maintain that data breaches can diminish and erode organizational trust, confidence, and psychological safety. Because the breach was attributed to an insider, the employees were subjected to increased scrutiny and supervision, leading to feelings of demotivation and distrust in leadership and vice versa. The breach exposed weaknesses and vulnerabilities in the organization's internal control and internal data protection and security practices, stressing the urgency for continuous training, cybersecurity awareness, and robust policy standards and ethical frameworks to reinforce employee integrity.

Desjardins incident and crisis management were effective. The management responded immediately by public disclosure, notifying the Office of the Privacy Commissioner of Canada and affected customers [32]. The enhancement and improvement in cybersecurity infrastructure and IT general controls after the incident demonstrated seriousness and commendable commitment to managing in the future if a similar incident occurs effectively. The breach exposed weaknesses and vulnerabilities in the organization's readiness, incident response, and business continuity planning [34]. This finding further emphasized the importance of proactive risk management strategies, as stated in the NIST Cybersecurity Framework (2018).

Practical Implications

The findings offer several practical implications for business organizations and policymakers, especially those in the financial industry:

1. Improving and Strengthening Cybersecurity Readiness: Businesses should prioritize and establish robust information and cybersecurity governance, risk management, and compliance frameworks to prevent, detect, and promptly respond to data breaches.
2. Employee Engagement: Creating and encouraging a security-conscious environment and culture through

continuous training and responsible, ethical leadership is essential to maintain employee confidence and integrity.

3. Crisis Communication: Prompt, honest, transparent, timely, and empathetic communication during business data breaches can help manage stakeholder expectations and lessen reputational harm.
4. Regulatory Compliance: Regulators must hold businesses accountable and improve their oversight function, especially on those companies that comply with standards like GDPR, PIPEDA, FINTRAC, SOCS, and SOXS, which are compulsory to adhere to data protection to ensure privacy and accountability.
5. Cross-Sector and Industry Collaboration: Information sharing between the public and private sectors should be encouraged, which can improve cybersecurity resilience at the provincial and national levels.

Conclusion and Recommendations

The case of the Desjardins Group data breach serves as a critical case study on the comprehensive impacts of business data breaches beyond financial losses. The incident highlights the importance of detailed and comprehensive cybersecurity governance, proactive risk management, continuous monitoring, and detective mechanisms, as well as the need for organizations to foster a culture of security awareness. The lessons learned from Desjardins' experience provide valuable insights for other organizations seeking to mitigate the risks and consequences of data breaches. Businesses must prioritize technological defenses and cybersecurity's human and cultural aspects to build strong, secure, resilient, and trustworthy institutions.

Insider threats, among other cybersecurity threats, remain the most challenging ones to mitigate because of their complexity and the potential for access and privilege abuse. It is also difficult to distinguish between legitimate access and malicious intent because of its intrinsic difficulty. Comparing this to external threats, which can be more often prevented and mitigated through perimeter defenses and threat intelligence and analytics, insider risks more often exploit the inherent trust within business organizations, which makes detection and prevention mostly challenging.

The Desjardins Group data breach underlines the profound and complicated impacts of business data breaches on organizations, from reputation damage to loss of trust and confidence, and employee integrity. Data breaches corrode brand reputation, compromise employee integrity, and challenge organizational resilience. A holistic approach that consolidates robust and enormous cybersecurity measures, proper and ethical leadership, and a proactive approach to risk management would be required to overcome these challenges. Businesses must understand and recognize that cybersecurity is not just a technical issue but a strategic importance and integral part of the overall business goal that affects all aspects of business operations. Therefore, by learning from past data breaches and incidents, such as the Desjardins case, organizations can better prepare for future threats and cyber-attacks and build a resilient, secure, and trustworthy digital environment and platform.

For Future Research

For future research endeavors, it will be of value to investigate data breaches across various industries to identify sector-specific risks and vulnerability and mitigation strategies, which will expand its applicability. It will also be good to conduct long-term studies to assess the enduring effects of data breaches on brand reputation and employee integrity. It is also good to use quantitative methods to quantify the financial and operational impacts of business data breaches more precisely. That is, finding the correlation between business data breaches and profitability.

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Conflict of Interest

To the best of my knowledge, there is no conflict of interest in conducting this research.

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Cardiovascular Outcomes of Complete vs Culprit Only PCI in Older Adults Post Myocardial Infarction: Insights from the FIRE Trial

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Abstract

Coronary artery disease (CAD) in older adults presents unique therapeutic challenges due to increased frailty, comorbid conditions, and procedural risk. As life expectancy rises globally, the burden of multivessel disease in elderly patients is growing, yet this group remains underrepresented in major clinical trials. Historically, revascularization strategies in these patients have leaned toward conservative or culprit-lesion-only percutaneous coronary intervention (PCI), driven by concerns over bleeding, renal dysfunction, and procedural complications. However, the FIRE trial—the first randomized clinical trial dedicated exclusively to patients aged 75 years and older with myocardial infarction and multivessel disease—provides pivotal evidence in favor of complete revascularization. This article evaluates the findings of the FIRE trial with support from landmark studies such as the COMPLETE trial, large national registries including BCIS and SCAAR, and contemporary meta-analyses. Results demonstrate that complete PCI in elderly patients significantly reduces the risk of the composite primary outcome, including death, myocardial infarction, stroke, and ischemia-driven revascularization, without a corresponding increase in bleeding or adverse procedural events. These findings support a paradigm shift in the management of elderly patients with multivessel CAD, positioning complete PCI as a superior strategy when guided by clinical judgment and modern interventional techniques.

Keywords: *Complete Percutaneous Coronary Intervention (PCI), Culprit Only Percutaneous Coronary Intervention (PCI), Elderly Patients, FIRE Trial, Multivessel Coronary Artery Disease, Myocardial Infarction.*

Introduction

Cardiovascular disease remains the leading cause of death globally, with ischemic heart disease constituting a substantial portion of this burden, especially among older adults [1]. With increasing life expectancy, the population aged 75 years and above has grown rapidly, bringing unique challenges in the management of coronary artery disease (CAD) in this demographic. One of the most contentious topics in the treatment of elderly patients with multivessel coronary disease is the role of complete revascularization versus culprit-lesion-only percutaneous coronary intervention (PCI). The long-standing apprehension surrounding aggressive interventional strategies in older adults stems from concerns over comorbidities, frailty, and bleeding risks, often resulting in underutilization of guideline-recommended revascularization strategies in this population [2].

Traditionally, elderly patients presenting with non-ST-elevation acute coronary syndrome (NSTE-ACS) have been managed conservatively or with incomplete revascularization approaches, primarily due to perceived procedural risks [3]. However, growing evidence now challenges this paradigm by demonstrating that age alone

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should not be the sole determinant for withholding complete revascularization, especially when modern PCI techniques and pharmacotherapies have significantly improved outcomes [4]. In recent years, clinical trials such as the COMPLETE trial and meta-analyses have redefined the boundaries of coronary revascularization by supporting the prognostic value of complete PCI over culprit-only strategies in broader populations [5, 6]. Nonetheless, the representation of elderly patients in such studies has remained limited, leaving a critical gap in evidence-based management for this vulnerable group.

The Full Revascularization versus Medical Therapy or Culprit-Lesion-Only PCI in Elderly Patients with Myocardial Infarction and Multivessel Disease (FIRE) trial is the first randomized clinical trial specifically designed to address this gap. Conducted across multiple European centers, FIRE focused exclusively on patients aged ≥75 years with myocardial infarction (MI) and multivessel disease, comparing outcomes between a complete revascularization strategy—where all significant lesions were treated—and a culprit-lesion-only PCI approach [1]. The significance of this trial lies not only in its focus on a previously underrepresented patient group but also in its pragmatic design, inclusive enrollment, and clinically relevant endpoints such as death, myocardial infarction, stroke, and repeat revascularization [1].

The FIRE trial's relevance is accentuated when examined alongside other landmark studies. For example, the COMPLETE trial provided compelling evidence supporting complete revascularization in a post–ST-segment elevation myocardial infarction (STEMI) context but had limited inclusion of patients older than 75 years [5]. Similarly, meta-analyses of randomized controlled trials (RCTs) have consistently shown lower risks of major adverse cardiac events (MACE) with complete revascularization, yet subgroup analyses for older patients remain underpowered [6, 7]. Observational studies, including those from large national registries such as the National Cardiovascular Data Registry (NCDR) and the Swedish Coronary Angiography and Angioplasty Registry (SCAAR), have echoed these benefits, although they are susceptible to selection and confounding biases [8, 9]. The FIRE trial, therefore, fills a crucial void by offering high-level evidence tailored to older adults, thereby holding the potential to influence both clinical decision-making and guideline development.

Beyond efficacy, the question of safety remains central to this discussion. Older adults are more susceptible to contrast-induced nephropathy, bleeding, and procedural complications. However, data from the FIRE trial and complementary literature reveal that with meticulous patient selection and procedural planning, these risks can be mitigated effectively. For instance, findings from the British Cardiovascular Intervention Society (BCIS) suggest that complete PCI in older adults does not significantly increase periprocedural complications when performed in high-volume centers with appropriate adjunctive support [10]. This positions complete revascularization not merely as a viable option, but a potentially preferable one for selected elderly patients.

In this article, we delve into the clinical rationale, trial evidence, and real-world implications of complete PCI in the elderly population with multivessel disease, with a specific focus on the findings of the FIRE trial. Through a comprehensive analysis of trial data and supporting literature, we aim to demonstrate that complete revascularization represents a superior strategy in this growing demographic—one that improves clinical outcomes without proportionate increases in procedural risk. The discussion will unfold in the context of modern interventional cardiology, considering contemporary definitions of frailty, individual patient risk

profiles, and advances in stent technology and pharmacotherapy.

By synthesizing insights from the FIRE trial with those from a broad body of supportive literature, this paper advocates for a paradigm shift: moving away from age-based therapeutic nihilism and toward evidence-based, individualized revascularization strategies in older adults.

Methods

Study Design

The FIRE trial was a prospective, randomized, multicenter, open-label clinical trial conducted across 38 hospitals in Italy and Spain. It was designed specifically to evaluate the impact of complete revascularization versus culprit-lesion-only PCI in patients aged 75 years or older with multivessel coronary artery disease following myocardial infarction (MI) [1]. This pragmatic trial sought to address a critical evidence gap, given that elderly patients are historically underrepresented in revascularization trials despite constituting a large proportion of those presenting with acute coronary syndromes [2]. The trial protocol was guided by real-world practice and contemporary guidelines, ensuring external validity and clinical applicability [1].

Patients were randomized in a 1:1 fashion within 72 hours of index PCI for the culprit lesion. The study embraced an "all-comers" design with minimal exclusion criteria, reflecting the heterogeneity of older adults commonly encountered in clinical practice [1, 3]. Randomization and allocation were stratified by center using a web-based system, and while the trial was not blinded, the use of hard clinical endpoints minimized potential bias.

Patient Selection

Eligible participants were aged ≥75 years and admitted with a diagnosis of acute MI, either STEMI or non-ST-segment elevation myocardial infarction (NSTEMI), with angiographic evidence of multivessel coronary artery disease—defined as ≥70% stenosis in ≥2 epicardial vessels or ≥50% if involving the left main coronary artery [1]. Inclusion mandated successful culprit-lesion PCI and hemodynamic stability prior to randomization. Importantly, the trial did not exclude patients based on frailty scores, renal function, or left ventricular ejection fraction, allowing for a comprehensive representation of the geriatric population [1, 4].

Exclusion criteria were limited and primarily centered around life expectancy <1 year due to non-cardiac comorbidities, severe valvular disease requiring surgery, active malignancy with limited survival, or inability to provide informed consent. This pragmatic inclusion strategy sharply contrasts with prior trials such as COMPLETE, where patients >75 years comprised only a small minority [5], and enhances the generalizability of FIRE's findings to routine practice [2, 6].

Revascularization Strategies

Patients randomized to the complete revascularization arm underwent staged PCI to address all angiographically significant non-culprit lesions, either during the index hospitalization or within 45 days post-discharge. Decisions regarding timing, access site, stent type, and adjunctive imaging (e.g., intravascular ultrasound (IVUS), fractional flow reserve (FFR)) were left to the operator's discretion, allowing for individualized clinical judgment [1]. All procedures adhered to contemporary interventional standards with the majority of patients receiving second-generation drug-eluting stents [1, 7].

In contrast, patients in the culprit-lesion-only PCI group received no further revascularization unless clinically indicated due to recurrent ischemia, hemodynamic instability, or objective ischemic burden on non-invasive testing. Medical therapy was optimized in both groups per guideline-directed care, including dual antiplatelet therapy, high-intensity statins, beta-

blockers, and ACE inhibitors or ARBs as indicated [1, 8].

This design parallels prior registry data showing that incomplete revascularization is frequently favored in elderly patients due to concerns over procedural risk [9] yet challenges the presumption that this strategy yields superior safety outcomes in this population.

Outcomes

The primary composite endpoint was the incidence of all-cause death, myocardial infarction, stroke, or ischemia-driven revascularization at 1-year post-randomization. Secondary endpoints included individual components of the primary endpoint, as well as hospitalization for heart failure, stent thrombosis, and major bleeding events defined by Bleeding Academic Research Consortium (BARC) criteria ≥ type 3 [1].

These outcomes were selected for their clinical relevance and alignment with both patient-centered care and regulatory standards. Event adjudication was performed by an independent, blinded clinical events committee, and vital status was confirmed through national databases or direct patient follow-up [1, 10].

The selection of a composite endpoint allows for a more holistic appraisal of net clinical benefit and parallels that used in similar trials such as COMPLETE [5] and FAME [6], facilitating meaningful cross-study comparisons.

Statistical Analysis

Time-to-event outcomes were assessed via Kaplan-Meier survival analysis and compared using the log-rank test. Multivariable Cox proportional hazards regression models were constructed to adjust for relevant covariates including age, sex, diabetes status, ejection fraction, and baseline renal function [1, 4]. Prespecified subgroup analyses explored differential treatment effects by diabetes, chronic kidney disease, frailty, and type of MI (STEMI vs. NSTEMI) [1, 8].

All statistical analyses were performed using SAS software (version 9.4), and p-values <0.05 were considered statistically significant.

Results

Primary Outcome Findings

A total of 1,445 patients aged 75 years or older with myocardial infarction and angiographically documented multivessel coronary artery disease were enrolled in the FIRE trial. Of these, 555 participants (38.4%) were women. Following successful treatment of the culprit lesion, 720 individuals were assigned to undergo complete revascularization, while 725 were allocated to a culprit-lesion-only PCI strategy [1]. After a median follow-up duration of 12 months, the composite primary endpoint—comprising all-cause mortality, non-fatal myocardial infarction, stroke, or ischemia-driven revascularization—occurred less frequently in the complete PCI group (15.7%) compared to the culprit-only group (21.0%), reflecting a 27% relative risk reduction (HR 0.73; 95% CI 0.57–0.93; p=0.01) [1]. Figure 1 illustrates the comparative event-free survival probability over a 12-month follow-up period, highlighting superior outcomes with complete PCI over culprit-only PCI.

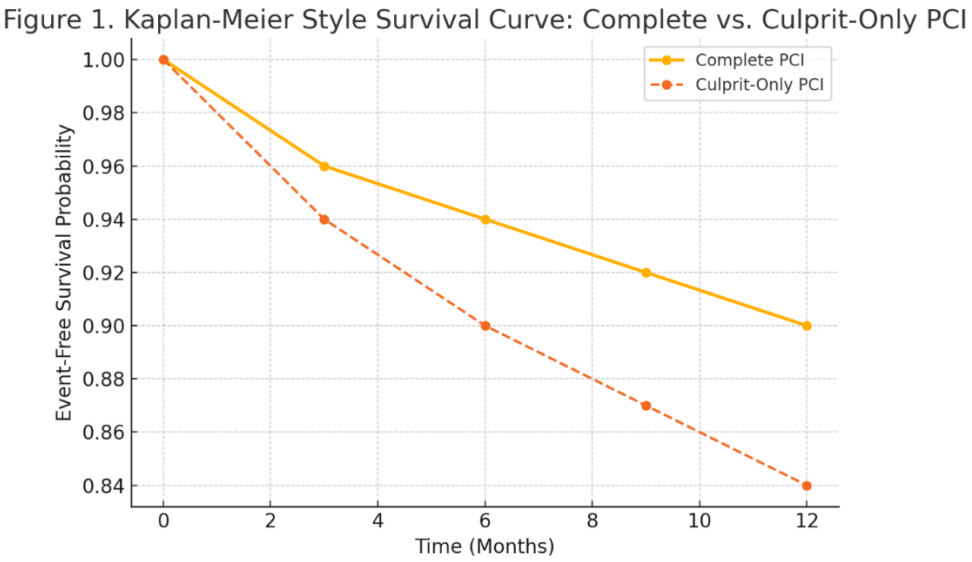

Figure 1. Kaplan-Meier Style Survival Curve Showing 12-Month Event-Free Survival Probability in the FIRE Trial

This reduction was primarily driven by fewer non-fatal myocardial infarctions and unplanned revascularizations in the complete PCI group, though all-cause mortality also trended lower (9.5% vs 11.3%) [1]. These findings are in line with prior evidence from the COMPLETE trial, where complete revascularization was associated with a 26% reduction in cardiovascular death or new MI compared to culprit-only PCI, albeit in a younger population [5].

Secondary Clinical Endpoints

In addition to the primary composite outcome, several secondary endpoints supported the superiority of complete revascularization. Non-fatal myocardial infarction occurred in 4.8% of the complete PCI group versus 7.1% in the culprit-only group (p=0.04), and ischemia-driven repeat revascularization was reduced from 7.3% to 4.1% (p=0.02) [1]. Figure 2 presents a comparative analysis of secondary event rates between complete and culprit-only PCI strategies, demonstrating reduced rates of myocardial infarction, repeat revascularization, and heart failure hospitalization in the complete PCI group.

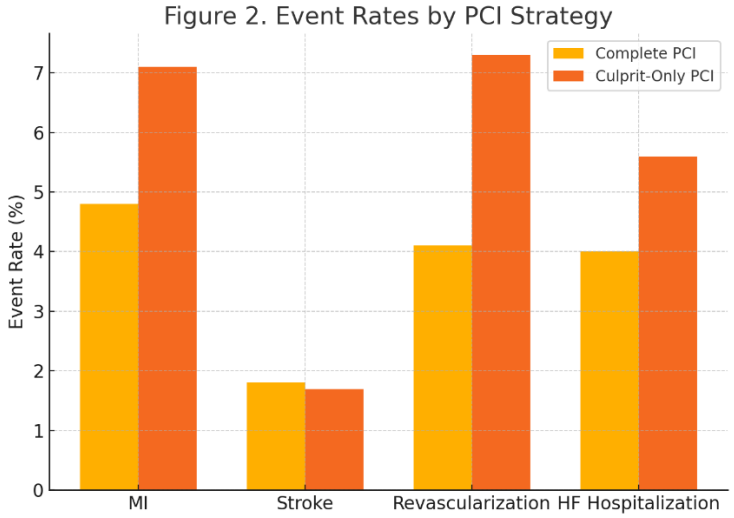

Figure 2. Bar Graph Comparing Secondary Event Rates in the FIRE Trial

These findings reinforce the hypothesis that untreated lesions in elderly patients contribute significantly to future ischemic burden and adverse cardiovascular events [2].

Stroke rates were similar between the two arms (1.8% in complete PCI vs 1.7% in culprit-only PCI; p=0.89), suggesting that extending revascularization did not increase the risk of cerebrovascular complications in this population [1]. Hospitalizations for heart failure were also nominally lower in the complete PCI group (4.0% vs 5.6%), although this did not reach statistical significance (p=0.12) [1].

These results align closely with the findings of a large meta-analysis that pooled data from over 7,000 patients and demonstrated that complete revascularization was associated with lower long-term MACE without increased periprocedural risk [6].

Subgroup Analyses

Predefined subgroup analyses in the FIRE trial revealed consistent benefits of complete revascularization across key clinical strata. Among patients with diabetes mellitus—a group historically prone to more diffuse atherosclerosis—the primary endpoint occurred in 18.9% of complete PCI patients versus 26.5% in the culprit-only group (p=0.008 for interaction) [1]. Likewise, benefits were preserved in both STEMI and NSTEMI presentations, and in patients with preserved or reduced left ventricular function [1].

These findings mirror results from the FAME trial, where physiologically guided complete revascularization improved outcomes even in complex lesion subsets [6]. Furthermore, data from the British Cardiovascular Intervention Society registry have suggested that the relative benefit of complete revascularization may be amplified in elderly patients with higher comorbidity burdens—particularly diabetes, chronic kidney disease, and prior infarction [7].

Safety Outcomes

One of the longstanding concerns regarding extensive PCI in older adults has been procedural safety. In the FIRE trial, the rates of major bleeding (BARC ≥3) were comparable between groups: 5.9% in complete PCI versus 5.4% in culprit-only PCI (p=0.71) [1]. There were no significant differences in the incidence of contrast-induced nephropathy or vascular access complications, even though the complete PCI group underwent more complex and longer procedures [1]. Table 1 summarizes the event rates, hazard ratios, and confidence intervals across key efficacy and safety endpoints, underscoring the consistent advantage of complete PCI over culprit-only strategies.

Table 1. Comparative Clinical Outcomes in the FIRE Trial between Complete and Culprit-only PCI Strategies

Outcome	Complete PCI (%)	Culprit-Only PCI (%)	Hazard Ratio (HR)	95% CI
Primary Composite Endpoint	15.7	21.0	0.73	0.57–0.93
All-Cause Mortality	9.5	11.3	0.82	0.60–1.12
Non-fatal Myocardial Infarction	4.8	7.1	0.66	0.44–0.98
Stroke	1.8	1.7	1.06	0.53–2.11
Ischemia-Driven Revascularization	4.1	7.3	0.55	0.32–0.94
Heart Failure Hospitalization	4.0	5.6	0.71	0.44–1.13
Major Bleeding (BARC ≥3)	5.9	5.4	1.10	0.70–1.71

This finding is noteworthy given the age and baseline risk of the population and suggests that, with contemporary techniques and careful patient monitoring, complete revascularization can be executed without excess harm. Supporting this, a detailed analysis emphasized that when performed in experienced centers, complete PCI in elderly patients did not result in increased bleeding, stroke, or renal injury rates compared to conservative strategies [6].

Comparative Evidence from Other Studies

The FIRE trial's results are consistent with and complementary to other landmark trials. The COMPLETE trial, despite having a younger cohort, showed that complete revascularization significantly reduced cardiovascular death or new MI, with an NNT (number needed to treat) of 37 to prevent one event over three years [5]. Moreover, in the COMPLETE observational follow-up, the durability of benefit extended up to five years without late adverse effects [5].

A complete revascularization strategy has been associated with significantly lower three-year mortality and myocardial infarction rates in octogenarians with multivessel disease, without an accompanying rise in procedural complications [2]. Similarly, in high-risk elderly populations, complete PCI has been linked to reductions in long-term cardiovascular events and hospital readmissions [3].

These consistent findings across randomized trials, registries, and real-world observational studies support the external validity of FIRE and provide reassurance that the trial's conclusions can be broadly applied to daily practice.

Discussion

The FIRE trial marks a significant turning point in the interventional management of elderly patients with multivessel coronary artery disease. In a patient population historically excluded or marginalized in randomized controlled trials, FIRE provides compelling evidence that complete revascularization offers superior clinical outcomes compared to culprit-lesion-only PCI, without incurring an excess burden of procedural complications [1]. These results challenge the long-standing hesitancy to pursue comprehensive PCI in older adults and invite a critical reappraisal of age-based treatment paradigms in contemporary cardiology.

One of the most notable implications of the FIRE trial is its ability to bridge the gap between evidence and practice. While multiple prior studies—including the COMPLETE trial—have demonstrated the efficacy of complete revascularization in reducing major adverse cardiovascular events (MACE), these findings were often extrapolated to the elderly with caution due to limited representation [5]. The FIRE trial's deliberate focus on patients aged ≥75 years, combined with its inclusive design, enhances the credibility and applicability of its conclusions across real-world settings. This is particularly important given that nearly half of all patients presenting with acute coronary syndromes in Western populations are aged 75 or older [2, 4].

The reduction in the composite endpoint observed in FIRE—driven by fewer myocardial infarctions and ischemia-driven revascularizations—suggests that untreated lesions in elderly patients remain clinically active and not merely "bystanders." This undermines the often implicit assumption that the ischemic potential of non-culprit lesions diminishes with age. Importantly, these benefits were achieved without significant increases in bleeding, stroke, or renal injury, even though complete PCI involved more extensive intervention [1]. This reinforces the safety profile of complete revascularization when delivered with modern techniques, including second-generation drug-eluting stents and radial access, which have been shown to reduce complications even in high-risk cohorts [6, 8].

Subgroup analyses from FIRE further support the generalizability of benefit. Patients with diabetes—a subgroup known for more diffuse and accelerated atherosclerosis—derived significant event reduction with complete PCI [1]. These findings are consistent with prior registry data showing lower long-term mortality and myocardial infarction rates with complete revascularization among octogenarians with multivessel disease, without a corresponding rise in procedural complications [2]. Similarly, in high-risk elderly populations, complete PCI has been linked to reductions in long-term cardiovascular events and hospital readmissions [3]. The consistency across STEMI and NSTEMI presentations, and across patients with preserved or reduced ejection fraction, also underscores the robustness of the results [1, 3].

Notably, the decision to use angiographic guidance alone in most FIRE patients rather than fractional flow reserve (FFR) or intravascular imaging does not diminish the strength of the findings. Instead, it reflects real-world practice where physiologic assessment may not be feasible or widely adopted in elderly patients due to logistical or anatomical limitations. Still, the observed benefit supports the intrinsic value of complete anatomical revascularization in this cohort, and future trials could explore whether adjunctive FFR or imaging can refine patient selection further [4].

Additional meta-analytic evidence supports the benefit of complete revascularization in multivessel disease, irrespective of procedural timing. A network meta-analysis including 10 randomized trials and over 2,200 STEMI patients demonstrated that complete revascularization, whether performed at the index procedure or as a staged approach (during hospitalization or after discharge), was associated with a substantial reduction in major adverse cardiac events compared to culprit-only PCI. This benefit was driven predominantly by a reduced need for urgent revascularization. Interestingly, the risk of all-cause mortality and spontaneous reinfarction remained comparable among the various strategies, suggesting that the primary advantage of complete revascularization lies in its ability to reduce future ischemic instability without necessarily altering short-term survival. These findings reinforce the flexibility in timing and strategy when planning complete PCI, provided that the goal of full anatomic revascularization is achieved [13].

Another key strength of FIRE lies in its pragmatic design. The inclusion of high-risk patients with common geriatric comorbidities—renal dysfunction, mild cognitive impairment, prior stroke—enhances the external validity of its results [1]. In contrast, many earlier trials were criticized for enrolling "healthier" elderly patients, thereby limiting their relevance to everyday clinical practice. Including frailty-inclusive approaches in cardiovascular trial design is essential to modern practice and adds to the clinical significance of these findings [3].

The findings of FIRE also align with broader meta-analytic data. A pooled analysis of randomized trials demonstrated that complete revascularization reduced MACE by 23% without increasing periprocedural complications—a pattern nearly identical to FIRE's [6]. The consistency between randomized controlled trials and real-world registries bolsters the argument that complete PCI is not only effective but also safe across a diverse elderly population [7].

Additional support comes from a pooled analysis of four international registries comprising over 2,000 patients aged ≥75 years with myocardial infarction and multivessel disease. [12] Patients treated with complete revascularization experienced significantly lower rates of all-cause and cardiovascular mortality, as well as fewer recurrent myocardial infarctions, compared to those managed with culprit-only PCI. After rigorous statistical adjustment for baseline differences, the one-

year mortality rate was nearly 30% lower in the complete PCI group. These findings reinforce the notion that, even in everyday practice where patient complexity is high, complete revascularization offers substantial prognostic benefit when guided by individualized clinical assessment [12].

The question of when and how to implement complete revascularization in older patients remains clinically relevant. While FIRE confirms its safety and efficacy in most older adults, patient selection remains critical. Individuals with severe frailty, advanced dementia, or terminal non-cardiac illnesses may not derive the same benefits and could be harmed by procedural stress. In these cases, shared decision-making—incorporating life expectancy, quality of life, and patient preferences—is essential. The future of interventional cardiology must integrate geriatric principles to tailor revascularization strategies more precisely [4].

While FIRE provides robust support for complete PCI, data from other trials suggest this strategy may not be universally beneficial. A subanalysis of the DANAMI-3-PRIMULTI trial examined outcomes in patients aged ≥75 years undergoing FFR-guided complete revascularization versus culprit-only PCI after STEMI. Unlike their younger counterparts, older patients in this study did not experience a statistically significant reduction in the composite outcome of death, nonfatal MI, or ischemia-driven revascularization. Importantly, an age-treatment interaction was observed, suggesting the benefit of complete revascularization may diminish beyond the age of 75. These findings highlight the importance of individualized care and support a symptom-driven approach in certain high-risk elderly patients, particularly those with limited physiological reserve or complex comorbidities [11].

From a health systems perspective, the benefits of complete PCI extend beyond clinical endpoints. Unplanned revascularizations and recurrent myocardial infarctions place a significant economic burden on healthcare systems due to rehospitalizations, prolonged pharmacotherapy, and additional interventions. FIRE's demonstration that complete PCI reduces these events suggests a potential for long-term cost savings, particularly in value-based care models where outcome efficiency is rewarded [6].

The cumulative body of evidence from FIRE and supporting trials compels a paradigm shift in the management of older adults with multivessel coronary artery disease. Rather than approaching age as a limiting factor, clinicians should consider it as one variable among many in the holistic evaluation of a patient's candidacy for complete revascularization. The availability of advanced stent technology, safer procedural techniques, and improved pharmacologic support renders the argument for conservative treatment in most elderly patients increasingly untenable.

In summary, the FIRE trial substantiates what prior evidence has only suggested: that complete revascularization is not only possible in older adults but preferable in terms of safety and efficacy. Its findings should prompt a re-evaluation of current revascularization algorithms, favoring a more inclusive and proactive approach. As interventional cardiology continues to evolve, age must be viewed as a factor requiring nuanced clinical judgment—not as a reason for therapeutic nihilism.

Conclusion

The FIRE trial provides pivotal evidence that challenges long-standing clinical hesitations regarding the use of complete revascularization strategies in elderly patients with multivessel coronary artery disease. In a population aged ≥75 years—historically managed with caution and often under-treated—the trial demonstrated that complete PCI is not only feasible but significantly more effective than culprit-lesion-only PCI in reducing the risk of all-cause death,

myocardial infarction, stroke, and repeat revascularization, without a corresponding increase in bleeding or procedural complications [1].

These findings reinforce the notion that age alone should not dictate revascularization strategy. With modern PCI techniques, second-generation drug-eluting stents, radial access, and personalized antithrombotic regimens, the procedural risks traditionally feared in elderly cohorts have been substantially mitigated. In FIRE, outcomes were consistent across subgroups, including those with diabetes, reduced ejection fraction, and both STEMI and NSTEMI presentations, underscoring the broad applicability of complete revascularization in real-world elderly patients [1, 3].

Comparative data from the COMPLETE trial and high-quality meta-analyses further support the long-term benefit of complete revascularization in reducing major adverse cardiovascular events across different age groups and clinical contexts [5, 6]. The alignment between FIRE's findings and this larger body of evidence strengthens the argument for incorporating complete PCI into standard practice for older adults who are appropriate candidates.

However, clinical decisions must remain individualized. Not all elderly patients are equal—frailty, cognitive impairment, comorbidity burden, and patient preferences must be factored into treatment planning. The goal is not to universally apply complete PCI, but to eliminate unjustified therapeutic nihilism based solely on chronological age. Incorporating comprehensive geriatric assessment into the revascularization algorithm represents a critical next step in optimizing care.

In conclusion, the FIRE trial has shifted the paradigm: complete PCI in elderly patients with multivessel disease is both a safe and superior strategy when clinically appropriate. This evidence calls for an evolution in both mindset and practice—one that aligns with data, honors patient complexity, and aims to improve cardiovascular outcomes in this growing and vulnerable population.

Conflict of Interest

The authors declare no conflict of interest.

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Assessment of Knowledge, Attitude and Practice of Tobacco Smoking Among Pupils: A Case Study of Kalomo Secondary School in Kalomo District Southern Province, Zambia

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Abstract

Tobacco smoking is one of the leading preventable causes of illness and death worldwide. Its prevalence continues to rise in many low- and middle-income countries, including Zambia. This study aimed to assess the knowledge, attitudes, and practices regarding tobacco smoking among pupils aged 14–20 years at Kalomo Secondary School in Kalomo District, Southern Province, Zambia. A descriptive cross-sectional study design was used, involving 273 pupils who were selected using simple random sampling. Data were collected using a structured questionnaire and analyzed with SPSS version 25. Descriptive statistics were used to summarize key findings, while chi-square tests were applied to determine the relationship between knowledge, attitudes, practices, and smoking behavior. The data collection tools were piloted at Zimba Secondary School, and ethical approval was obtained prior to the study. The study revealed that most pupils had limited knowledge about the harmful effects of smoking. While 51% knew that smoking could cause heart disease, stroke, and impotence, only 26% linked it to lung diseases. Additionally, 13% of the respondents disagreed, and 10% were unsure about the health risks of smoking. Although many pupils expressed negative attitudes towards smoking, their attitudes did not always correspond with their level of knowledge. Despite being aware of some dangers, a significant number of pupils were still practicing smoking. The findings showed a strong association between smoking behavior and pupils' knowledge. e ($\chi^2 = 40.28$, $p = 0.000$), attitudes ($\chi^2 = 5.59$, $p = 0.018$), and practices ($\chi^2 = 15.90$, $p = 0.001$).

Keywords*: Attitude, Knowledge, Practice, Tobacco Smoking.*

Introduction

Tobacco smoking continues to be the leading cause of preventable diseases and early death worldwide. According to the latest data from the Centers for Disease Control and Prevention [1], smoking is associated with a wide range of serious health conditions, including lung diseases, cancer, stroke, diabetes, heart diseases, and chronic obstructive pulmonary diseases such as emphysema and chronic bronchitis. The World Health Organization [2] has reported that tobacco use remains a significant global challenge, with over 80% of the world's 1.3 billion smokers living in low- and middle-income countries. In these regions, the burden of tobacco-related illnesses and deaths is particularly severe. Projections suggest that, without urgent action, the number of smokers worldwide could rise to 1.5 to 1.9 billion by 2025, leading to over 8 million deaths annually, with 80% of these deaths occurring in developing countries [3].

China plays a dominant role in the global tobacco industry, producing 42% of the world's cigarettes. The WHO Framework Convention

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on Tobacco Control [4] continues to promote comprehensive policies to control tobacco use, including bans on both direct and indirect advertising. However, challenges remain, especially in countries where tobacco farming is a major economic activity [5].

Recent statistics from the General Health Observatory [6] highlight concerning trends in Africa, with smoking rates expected to rise from 6% to 14% between 2017 and 2025 among individuals aged 15 years and older. In Sub-Saharan Africa, smoking is still more common among men, but some countries, such as Ghana, Nigeria, Ethiopia, Kenya, Zimbabwe, and Tanzania, report relatively lower rates of daily smoking, with fewer than 700,000 smokers per day [7]. Alarmingly, there is a growing prevalence of smoking among young people compared to adults in countries like Ethiopia, Senegal, and Nigeria, which could result in significant future health challenges [8]. A study conducted in Kenya [9] found that family members and peers play a key role in influencing students to start smoking, with a prevalence rate of 10.9% among pupils aged 16 to 18 years [10]. This reflects the continued issue of smoking among youth populations.

In Zambia, despite ongoing efforts to reduce tobacco use, smoking rates remain high, with many children and adults continuing to smoke daily [11]. Research by Drope and Cahn [12] underscores the heavy toll of tobacco-related diseases on the Zambian population, emphasizing the urgent need for effective tobacco control measures. However, there is a notable gap in research examining the knowledge, attitudes, and practices regarding tobacco smoking among pupils, especially at Kalomo Secondary School in Kalomo District. This study aims to fill this gap by evaluating the current knowledge, attitudes, and practices concerning the health risks of tobacco smoking among pupils at Kalomo Secondary School.

Materials and Methods

This study was conducted at Kalomo Secondary School, located in Kalomo District, Zambia, from 1st June 2024 to 30th November 2024. The school has a total enrollment of 937 pupils, spanning Grades 8 to 12.

A descriptive cross-sectional study design was used to assess the knowledge, attitudes, and practices (KAP) regarding tobacco smoking among pupils. The study was conducted within the school premises to ensure an appropriate environment for data collection.

The study included 273 pupils from Grades 8 to 12, selected using a simple random proportional sampling technique. The class registers served as the sampling frame to ensure equitable representation across all grade levels.

The sample size was determined using Krejcie and Morgan's formula, which is commonly used for determining appropriate sample sizes based on population size and confidence level. The formula is:

$$n = \frac{X^2 . N.P.(1-P)}{d^2 . (N-1) + X^2 .P.(1-P)}$$

n = Required sample size

N = Population size

P = Population proportion (assumed to be 0.50, which gives the maximum sample size)

d = Degree of accuracy (usually the margin of error, often 0.05)

X^2 = Chi-square value at a given confidence level (for 95% confidence, $X^2 = 3.841$)

Sample size calculation:

$$\frac{3.841 \cdot 937 \cdot 0.50 (1-0.50)}{0.05^2 (937-1) + 3.841.0.50. (1-0.50)}$$

After applying this formula, the final sample size was determined to be 273 pupils, aged between 14 and 20 years old.

A structured questionnaire was used to collect data on pupils' knowledge, attitudes, and practices regarding tobacco smoking. The questionnaire was adapted from established U.S.-based research tools, including Youth

Risk Behavior Survey (YRBS) – developed by the Centers for Disease Control and Prevention [13], and Global Youth Tobacco Survey (GYTS) – developed by the World Health Organization [14].

To ensure reliability and validity, the questionnaire underwent:

Pilot testing on 30 pupils (excluded from the main study) to assess clarity and consistency.

Expert review by public health specialists and education professionals.

Content adaptation to align with the Zambian context while maintaining international comparability.

The questionnaire was divided into four sections:

Section A – Socio-demographic information (age, gender, grade level, etc.).

Section B – Knowledge on tobacco smoking, consisting of multiple-choice questions (MCQs) and filling in the blank spaces. Each correct answer was awarded one mark (1), while incorrect answers received zero (0).

Section C – Attitudes towards smoking interventions assessed using a Likert scale to measure perceptions and beliefs about smoking and smoking-related interventions.

Section D – Practices related to smoking, including exposure to tobacco use and personal smoking behaviors.

Data were entered and analyzed using SPSS version 25. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize findings. Chi-square tests of association and Fisher's exact test were used to examine relationships between categorical variables. A p-value of <0.05 was considered statistically significant. Multiple regression analysis was conducted to identify predictors of tobacco smoking among pupils [15].

Results

This study found that while most pupils are aware of the harmful effects of tobacco smoking, many still engage in the habit due to peer pressure, stress relief, and social influence. Around 65% of the respondents acknowledged that smoking is harmful to their health; however, 30% believed it helps reduce stress and boosts social status. These findings are in line with the Global Youth Tobacco Survey [14], which highlighted peer influence as a major reason why adolescents start smoking.

The study also uncovered gaps in knowledge regarding the long-term health risks of smoking. While many pupils were aware that smoking can cause lung cancer and breathing problems, a significant number did not know it also increases the risk of heart disease and shortens life expectancy [15]. This demonstrates the need for better health education in schools to ensure that students fully understand all the dangers associated with tobacco use.

Accessibility to cigarettes was another serious concern. Despite Zambia's tobacco control laws, pupils reported that they could easily acquire cigarettes from street vendors, informal shops, and even family members. This support concerns raised by the Ministry of Health (MOH, 2021), which pointed out the weak enforcement of tobacco regulations and called for stricter controls to prevent underage access to tobacco products.

Family and community influence also played a major role. Pupils from homes where parents or siblings smoked were more likely to adopt the habit themselves, compared to those from smoke-free households. This is consistent with findings from earlier studies, which showed that parents' smoking behavior strongly influences whether their children start smoking [17].

Given these findings, it is evident that stronger anti-tobacco education is urgently needed in schools. Programs should be incorporated into the school curriculum and should provide students with accurate, science-based information about the dangers of smoking. Communities should also be involved through awareness campaigns that help parents

understand how their actions and attitudes can shape their children's choices.

Finally, enforcement of tobacco laws must be improved. Selling cigarettes to minors should be strictly monitored and punished where necessary. Public health messages should be widely disseminated, and authorities must collaborate with law enforcement and health professionals to make tobacco products less accessible to young people [18].

Discussion

This study found that, while most pupils are aware of the harmful effects of tobacco smoking, a significant number still engage in the habit due to peer influence, stress relief, and social pressures. About 65% of respondents acknowledged that smoking is harmful to their health, yet 30% believed that it helps relieve stress and improves social status. These findings align with the Global Youth Tobacco Survey [14], which highlighted peer pressure as a major factor in adolescent smoking initiation.

The study also identified knowledge gaps regarding the long-term health effects of smoking. While many students recognized diseases like lung cancer and respiratory disorders as smoking-related, a significant number were unaware of other risks, such as cardiovascular disease and reduced life expectancy [15]. This highlights the need for more comprehensive health education programs in schools to ensure students fully understand the dangers of tobacco use.

Another critical factor in adolescent smoking behavior is accessibility. Despite Zambia's tobacco control policies, students reported that they could easily buy cigarettes from informal vendors, street sellers, and even family members. This finding supports the Ministry of Health's (MOH, 2021) concerns about the weak enforcement of tobacco regulations, emphasizing the need for stricter control to prevent underage access to tobacco products.

Family and community influence also play a major role in adolescent smoking habits. Pupils from households where parents or siblings smoke were more likely to pick up the habit compared to those from non-smoking homes. This observation is consistent with existing research, showing that parental smoking behavior strongly influences adolescent smoking initiation [17].

Based on these findings, there is an urgent need to strengthen anti-tobacco education campaigns targeting school-aged children. Schools should integrate tobacco prevention programs into their curriculum, offering students science-based information on the dangers of smoking. Additionally, community awareness programs should be enhanced to educate parents on the role they play in shaping their children's attitudes toward tobacco use.

Stronger enforcement of tobacco control laws is also necessary, including regulating cigarette sales to minors and increasing public awareness initiatives. Authorities should work closely with law enforcement and health agencies to make tobacco products less accessible to school-aged children [18].

The largest proportion of participants (64%) were aged between 14 and 16 years, while 29% were aged 17–19 years, and 7% were aged 20 years. Gender distribution revealed that 55% of the participants were male, and 45% were female. Regarding the educational level, 41% of respondents were in Grade 9, with 23% in Grade 12, 14% in Grade 10, and 13% in Grade 8. In terms of living arrangements, 60% of the respondents lived with both parents, 19% lived with a single parent, and 21% were under the care of guardians, as shown in Table 1.

Table 1. Socio-Demographic Characteristics of Respondents (n=273)

Variables	Frequency (n)	Percentage (%)
Age Group		
14-16 years	174	64%

17-19 years	79	29%
20 years	20	7%
Gender		
Male	150	55%
Female	123	45%
Grade		
Grade 8	35	13%
Grade 9	112	41%
Grade 10	38	14%
Grade 11	30	11%
Grade 12	62	23%
living Arrangements		
Both parents	164	60%
Single parent	52	19%
Guardians	57	21%

Table 2 presents the knowledge levels on tobacco smoking among Kalomo Secondary School pupils. A significant proportion of respondents (51%) exhibited **low knowledge** on tobacco smoking, while 49% demonstrated high knowledge as shown in Table 2**.**

Table 2. Knowledge Levels on Tobacco Smoking among Kalomo Secondary School Pupils

Knowledge Level	**Frequency**	**Percentage (%)**
Low Knowledge	139	51%
High Knowledge	134	49%
Total	273	100%

A majority of the respondents (51%) agreed that smoking is linked to various health problems, including heart disease, stroke, and impotence. A smaller proportion (26%) believed that smoking only causes lung disease, while 10% were unsure. Notably, only 13% disagreed with the statement that smoking is associated with multiple diseases, as shown in Table 3.

Table 3. Agreement on Smoking-Related Diseases

Response	**Frequency**	**Percentage (%)**
Smoking causes heart disease, stroke, and impotence	140	51%
Smoking only causes lung disease	71	26%
Disagree	35	13%
Don’t know	27	10%
Total	273	100%

A large majority (79%) of the students reported that they had never received any education on the dangers of smoking, while only 14% indicated they had been taught, and

7% were unsure. This apparent gap in formal health education may be a contributing factor to the high prevalence of smoking observed among the pupils, as presented in Table 4.

Table 4. Frequency of Teaching on Dangers of Smoking

Response	**Frequency**	**Percentage (%)**
Never	216	79%
Taught	38	14%
Not sure	19	7%
Total	273	100%
Response	Frequency	Percentage (%)
Don't know	246	90%
Smoking is harmful to older people	11	4%

There were significant associations between age group, gender, level of education, and smoking behavior. A p-value of 0.001 for age suggests a strong relationship between age and smoking status. Likewise, gender showed a significant association (p = 0.001), indicating that males were more likely to smoke than females. In addition, knowledge about smoking was also significantly associated with smoking behavior (p = 0.002), with pupils who had higher knowledge levels being less likely to smoke, as shown in Table 5.

Table 5. Chi-Square Test Results for Various Variables

Category	**Smoked (41)**	**Never Smoked (232)**	**P-Value**
Age Group			0.001
14-16	23 (18%)	104 (82%)	
17-18	10 (11%)	83 (89%)	
19-20	8 (12%)	45 (88%)	
Gender			0.001
Male	15 (14%)	89 (86%)	
Female	26 (18%)	143 (82%)	
Level of Education			0.001
Grade 8	9 (16.7%)	45 (83.3%)	
Grade 9	8 (14.8%)	46 (85.2%)	
Grade 10	8 (14.5%)	47 (85.5%)	
Grade 11	8 (14.5%)	47 (85.5%)	
Grade 12	8 (14.5%)	47 (85.5%)	
Attitude Toward Smoking			3.419 FE
Positive	14 (88%)	2 (13%)	
Negative	20 (87%)	3 (13%)	
Knowledge on Smoking			0.002
High	36 (73%)	13 (27%)	
Low	136 (76%)	44 (24%)	
Living Arrangements			0.001 FE
Both Parents	12 (8%)	113 (92%)	
Single Parent	15 (13%)	104 (87%)	
Guardians	14 (20%)	15 (80%)	

Most of the respondents (67%) reported that they had smoked before. Additionally, 34.4% mentioned that they had bought cigarettes at least once. When asked about smoking among their parents or guardians, 48% said none of them smoked, 19% had one relative who smoked, and 15% had more than one, as shown in Table 6.

Table 6. Practices of Smoking among Secondary School Pupils

Question	Response	Frequency	Percentage (%)
Have you purchased cigarettes before?	Yes	94	34.4%
	No	179	65.6%
Have you smoked before?	Yes	184	67%
	No	89	33%
How many of your parents/guardians or relatives smoke?	None	131	48%
	One	52	19%
	More than one	41	15%
	Unsure	49	18%

Conclusion

This study found that many pupils at Kalomo Secondary School have limited knowledge about the dangers of smoking, with 51% lacking awareness of its harmful effects. Although most students had a negative attitude toward smoking, 87% still believed in certain myths, such as smoking improving school performance. This shows the need for stronger anti-smoking education to correct misconceptions and promote awareness.

Social and cultural influences also play a major role in smoking habits. The study revealed that 67% of pupils had smoked before, with some believing it helps relieve stress. Exposure to second-hand smoke at home was also common. Statistical analysis confirmed a strong link between smoking habits, knowledge levels, and attitudes.

To reduce smoking among adolescents, schools should integrate more tobacco education into their curriculum, and families and communities must be involved in prevention efforts. Stronger enforcement of tobacco control policies is also necessary to limit access to cigarettes and protect young people from smoking-related harm.

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Optimizing Inpatient Care: Evaluating the Quality of Nursing Documentation at Cite Verte District Hospital, Yaounde Cameroon

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Abstract

Documentation serves as a critical written record of patient care, including assessments, interventions, and outcomes. However, healthcare systems in Cameroon, including Cite Verte District Hospital in Yaoundé, face significant documentation gaps, potentially compromising patient safety and care. This study assessed the quality of nursing documentation for inpatients at this hospital. A retrospective descriptive cross-sectional design was employed, using a mixed-method approach. Quantitative data were collected from 300 patient records, while qualitative insights were gathered through interviews with nine nurses. Findings revealed inconsistencies in documentation completeness across various categories. While patient identification details were generally recorded, discrepancies existed, with 51% missing patient contact information and 0% personnel signatures. Admission records showed deficiencies in patient education (10.33%) and personnel signatures (12.33%). Vital signs documentation had critical gaps, particularly in pediatric units where BP was unrecorded (0%). Qualitative findings highlighted diverse nursing perspectives on documentation, recognizing its importance yet facing challenges such as high workload, staff shortages, inadequate training, and inconsistent practices. Proposed strategies for improvement included increasing staffing levels, implementing routine documentation audits, providing continuous training, and emphasizing the importance of accurate record-keeping. It is thus essential to address both organizational challenges and individual behaviors to ensuring complete, accurate, and high-quality nursing documentation.

Keywords: *Completeness, Health Records, Inpatients, Nurses, Nursing Documentation, Quality*.

Introduction

Documentation in healthcare involves the systematic recording of patients' information including assessments, interventions and outcomes. It is a critical component for ensuring effective patient care, continuity, and safety and plays a central role in communication among healthcare providers. Its uses when done accurately and comprehensively includes for legal purposes, quality assurance, and evidence-based practice [1]. In nursing, this written record not only helps guide treatment decisions but also serves as a valuable tool for monitoring patient progress and evaluating care outcomes [2]. Despite being recognised as important, the quality of nursing documentation has often been suboptimal, predominantly in resource-limited settings where its effectiveness is hindered by numerous challenges [3].

Various factors are recorded as contributing to inadequate documentation practices, including insufficient training, heavy workloads, and poor system design.

In some healthcare systems, Electronic Health Records (EHR) have been introduced to address documentation issues which could help

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minimize human errors with the advantages such as real-time updates, easy access to patient information, and the reduction of paperwork [4]. Additionally, to ensure that essential data are captured systematically standardized forms and checklists have been used in some hospitals. These strategies have shown promise in improving documentation quality in several developed countries [5] However, their implementation in resource-constrained environments remains challenging due to factors such as high implementation costs, limited technological infrastructure, and inadequate staff training [6, 7].

The limitations of both paper-based and electronic systems are evident in many healthcare settings. While Paper-based documentation is cost-effective, it can result in information being misplaced, lost, or incomplete due to human error or physical damage. Moreover, it can be time-consuming for nurses who already face significant workload pressures, potentially detracting from patient care. In contrast, EHRs, though beneficial, face barriers such as poor infrastructure, internet connectivity issues, and the high cost of implementing these systems, making them less viable in some settings [5]. Despite these obstacles, efforts to improve documentation quality have had some success through the introduction of training programs, regular audits, and feedback mechanisms. These initiatives have helped improve the accuracy, timeliness, and consistency of documentation in certain settings [8].

However, the challenges related to nursing documentation are particularly pronounced in low- and middle-income countries like Cameroon [9, 10]. As per WHO in these settings, factors such as limited resources, inadequate technological support, and high nurse-to-patient ratios exacerbate existing documentation problems [11]. Cameroon is located in central Africa with a nurse patient ration of about 1:13 making a high workload which could influence on documentation. More so, nurses in Cameroon often face significant challenges, including a lack of standardized documentation practices, insufficient training in documentation procedures, and inadequate resources for maintaining accurate records. This may lead to omission of vital patient information or documented incorrectly, leading to communication breakdowns, mismanagement of care, and, in some cases, adverse patient outcomes [12]. Furthermore, the quality of documentation is rarely assessed in these settings, and there is little emphasis on improving these practices, leaving gaps that hinder the overall quality of care [13, 14].

Despite these challenges, some health facilities have made efforts to address nursing documentation issues but without a comprehensive approach to improving documentation practices, the potential for improving patient care remains limited. This gap shows a need on assessing the quality of nursing documentation and identifying the specific challenges nurses face in maintaining high-quality records. This study aimed at assessing quality of nursing inpatient documentation.

Materials and Methods

The study was conducted at Cite Verte District Hospital in Yaoundé, Cameroon, a 4th-category medical facility established in 1986. Located in the Mfoundi division of the Yaoundé II district, the hospital serves a population of over 400,000 inhabitants, providing preventive, promotional, and curative healthcare services. It offers a range of services, including medical, surgical, and pediatric care, all of which were included in this study. The hospital's strategic location and comprehensive services made it an ideal setting for assessing the quality of nursing documentation.

A retrospective descriptive cross-sectional design was employed, utilizing a mixed-method approach to collect both quantitative and qualitative data. The quantitative component

involved reviewing patient records from the past year, focusing on key documentation components such as admission information, vital signs, treatment charts, nursing care plans, and discharge information. For the qualitative aspect, interviews were conducted with nursing staff to understand their perspectives on the completeness, accuracy, and challenges of nursing documentation.

Data collection involved a simple purposeful sampling technique, selecting patient files from the medical, surgical, and pediatric units. A systematic sampling method was employed, starting at a point and selecting every 5th file for evaluation using the checklist. The sample size for the study was estimated to be 385 based on a population of 432,858, using a 95% confidence level and a 5% margin of error. However, 300 patient files were ultimately reviewed, encompassing all files available within the selected units for the year 2023. For the qualitative aspect, interviews were conducted with nursing staff, and saturation was reached after interviewing 9 nurses.

The primary tool used for data collection was a clinical audit checklist, adapted from the N-catch and D-catch charts, which have been used to assess the quality of nursing documentation for inpatient care. The checklist included six sections: cover page, admission information, vital signs, treatment chart, nursing care plan, and discharge components. Additionally, an interview guide was used to gather qualitative data from the nursing staff, exploring their perspectives on the meaning of nursing documentation, its completeness, accuracy, challenges faced, and their suggestions for improving documentation practices.

Data were sorted, organized, and entered into a database for analysis. The quantitative data were analyzed using SPSS version 21, where descriptive statistics such as frequency distributions, means, and percentages were calculated. The results were presented using tables, pie charts, and bar charts. The qualitative data from the interviews were transcribed verbatim to ensure accurate representation of participants' responses. Thematic analysis was employed to identify recurring themes and patterns within the data, with interpretations made to provide insights into the quality of nursing documentation practices at the hospital. The triangulation of both quantitative and qualitative data allowed for a comprehensive understanding of the documentation practices and areas for improvement.

Authorisation to carry out research was gotten from Experiential higher institute of science of and technology. Administrative authorization was also issued by the director of the Cite Verte district hospital then from each of the unit heads concerned. Consent of the participants (nurses) was sought by describing in detail, both verbally and written the purpose of the study. Participants' confidentiality was also assured.

Results

Quality of Nursing Documentation

The quantitative aspect of the study assessed nursing documentation quality at Cite Verte District Hospital in Yaoundé. It revealed several key findings, gaps, and discrepancies across various documentation areas:

Cover Page Documentation:

This study revealed that information on patient names and ages was consistently documented across all units (100%). However, documentation of patient contact information and emergency contacts varied:

Patient Contact: 53% in the medical unit, 100% in the surgical unit, and 0% in the pediatric unit. Emergency Contact: 42% in the medical unit, 100% in the surgical unit, and 100% in the pediatric unit. Personnel Signature: Not documented in any unit (0%). These discrepancies are reflected in figure 1 below.

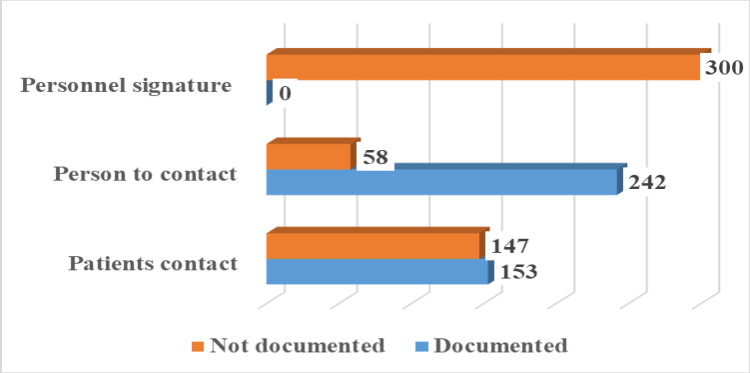

Figure 1. Illustration of Documentation Discrepancies on the Cover Page

This reveals a lack of accountability related to absence of personnel signatures, inconsistency in practices related to documentation of patients contact.

Admission Information

Admission date, chief complaint, medical history, surgical history, family history, and medication history were fully documented (100%) across all units. Social history was documented in 100% in the medical and surgical units but only 0% in the pediatric unit. Allergy information was documented in 31% in the medical unit, 66% in the surgical unit, and 100% in the pediatric unit. Patient education was documented in 0% in the medical unit, 31% in the surgical unit, and 0% in the pediatric unit. Personnel signatures were documented in 63% in the medical unit, 100% in the surgical unit, and 100% in the pediatric unit.

Figure 2 shows that there are still issues of accountability as seen by absence of personnel signature on some files. The lack of patient education documentation (0% in medical and pediatric units) suggests patients may not receive necessary information upon admission. Incomplete allergy documentation (69% not documented in the medical unit) could lead to safety risks.

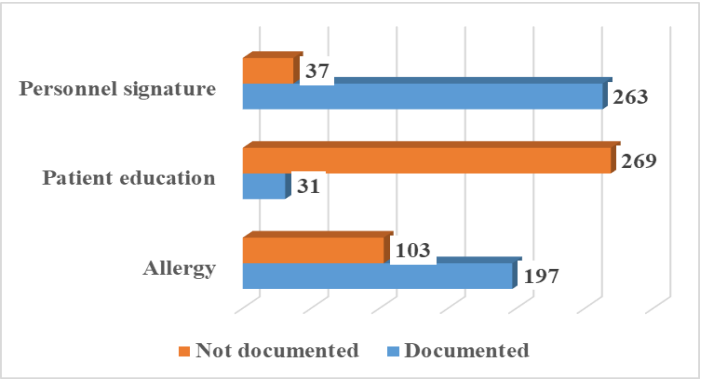

Figure 2. Illustration of Discrepancies in the Documentation of Admission Information

Treatment Chart Information

Medication name, dose, and frequency were fully documented (100%) across all units. Route of administration was not documented in any unit (0%). Personnel signatures were documented in 76% in the medical unit, 41% in the surgical unit, and 75% in the pediatric unit.

The absence of route documentation (0%) may be due to template limitations. Inconsistent personnel signatures (41% in the surgical unit) suggest variability in documentation practices as seen in figure 3.

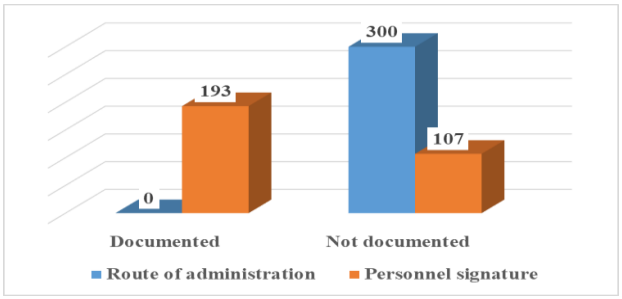

Figure 3. Illustration of Discrepancies in Documentation of Information on the Treatment Chart

Vital Signs Documentation:

Temperature was fully documented (100%) across all units. Pulse and blood pressure were documented in 100% in the medical and surgical units but 0% in the pediatric unit. Respiration rate and oxygen saturation were documented in 14% and 14% in the medical unit, 24% and 25% in the surgical unit, and 0% in both in the pediatric unit. Personnel signatures were documented in 20% in the medical unit, 34% in the surgical unit, and 0% in the pediatric unit.

As seen in figure 4, the pediatric unit's 0% documentation of pulse, blood pressure, respiration rate, and oxygen saturation may be due to equipment limitations. Low documentation rates for respiration rate and oxygen saturation (12% and 13% overall) are concerning. The absence of personnel signatures in the pediatric unit (100% not documented) indicates a significant accountability issue.

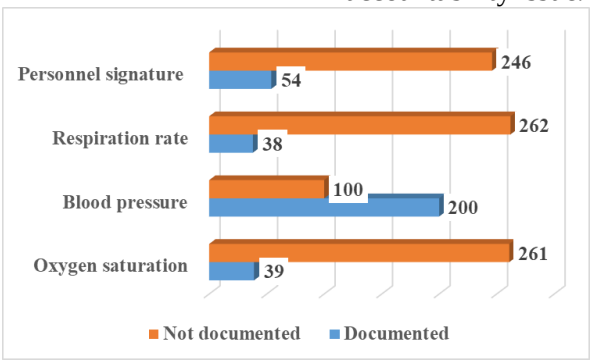

Figure 4. Discrepancies in Documentation of Vital Signs Measurement

Nursing Care Plan

No nursing care plans were available, used, or updated in any unit (0%). This suggests that patients' nursing needs are not being systematically addressed.

Discharge Notes

Discharge date, status upon discharge, and medication regime were fully documented (100%) across all units. Follow-up dates were documented in 60% in the medical unit, 100% in the surgical unit, and 100% in the pediatric unit. Client education upon discharge was documented in 10% in the medical unit, 21% in the surgical unit, and 7% in the pediatric unit. Personnel signatures were documented in 80% in the medical unit, 72% in the surgical unit, and 100% in the pediatric unit.

The low documentation of follow-up dates (40% not documented in the medical unit) and client education (87% not documented overall) suggests areas for improvement. The absence of personnel signatures in the surgical unit (28% not documented) indicates potential accountability issues. Figure 5 reflects these discrepancies in documentation of discharge notes.

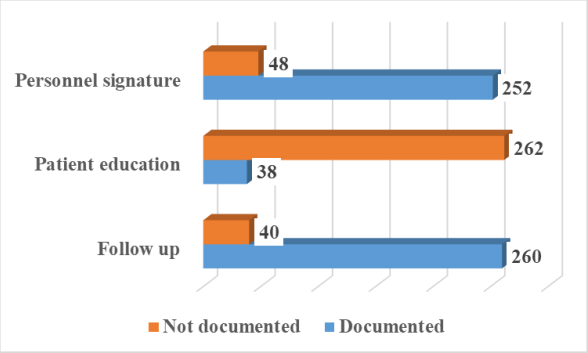

Figure 5: Discrepancies in Recorded Discharge Information

The assessment shows that there are gaps related to personnel signatures, patient education, documentation of route of medication, documentation of complete vital signs, absence of nursing care plans.

Nursing Staff Perceptions of Documentation Quality

Looking at nursing staff perceptions of documentation quality, focusing on completeness and accuracy. Interviews revealed several key themes.

Meaning of Nursing Documentation

Comprehensive Record of Patient Information**:** Nurses view documentation as encompassing all aspects of a patient's hospital journey, from admission to discharge. One nurse stated, *"There are notes about patients' health in the hospital from the time they came to the time they leave the hospital." (K3*)

Documentation of All Observations Made**:** Emphasis is placed on recording detailed observations, especially in pediatric care where patients may not communicate symptoms effectively. A nurse noted, "Kids cannot tell what is wrong with them so documentation becomes my detective work... I therefore document their play, behaviour and any other change I notice." (K2)

Template-Based Documentation**:** Some nurses highlighted reliance on hospital-provided templates, which may limit the scope of information recorded. "*For us here we only write what the hospital has on their templates." (K6)*

Task-Oriented Documentation**:** Focus on documenting nursing activities and interventions performed for patients. "*To me documentation is writing everything we as nurses do for a patient." (K7)*

Documentation Completeness

Ensuring all required information is written Completeness involves documenting all required or expected information. *"Completeness means that all the things that are in the book have been written." (K1*)

Inclusion of important details**:** Some nurses believe completeness means including all important details without necessarily recording every minor aspect. *"I think it means having all the important details written but doesn't have to be every tiny detail." (K4)*

Comprehensive shift documentation: Thorough recording of all actions taken during a shift. *"To me, I think it is when I write down everything I and my team do during our shift." (K5)*

Documentation Accuracy

Exact Recording of Actions and Patient Statements**:** Accuracy involves precisely documenting nurse actions and patient statements. "*It's all about writing exactly what you did and what the patient says."* (K1)

Completeness and Thoroughness**:** Some nurses see a thin line between accuracy and completeness. "*It is almost the same as completeness, I think it is also when you write everything in the patient's book."* (K3)

Correctness of Information: Ensuring all recorded information is correct. *"For me, it has to do with writing the information correctly." (K5)*

Detailed and Clear Charting**:** Emphasis on detailed and clear documentation to provide a precise account of patient status. "This accuracy thing... boils down to one thing, which is crystal clear charting." (K6)

The results show documentation templates are limited restricting the scope of documentation potentially omitting critical patient information. It also revealed nurses have different interpretations of what constitutes completeness and accuracy, leading to inconsistencies in documentation practices. It also highlights the peculiarity and challenge in documentation at the paediatric unit. These findings suggest a need for standardized documentation practices, comprehensive training, and possibly revising templates to ensure thorough and accurate patient records.

Challenges in Maintaining High Quality Documentation

The study revealed some key challenges faced by nurses in documenting to include:

High patient load and staff shortages, nurses complained of having heavy workloads and insufficient staffing, leading to incomplete documentation. As mentioned by this informant "*Here in this hospital, we are not many with too many patients making it challenging to do everything at times I just forget."* (K2)

Lack of training and refresher Courses was also identified. *"Another difficulty we face is because we do not get the chance for refresher courses in this hospital»* as indicated by K2. The absence of ongoing training hinders proper documentation practices.

Some nurses feel unmotivated to document due to a lack of feedback. As mentioned by one participant *"I don't even see the need to write because the matron never goes through those things.*" (K6). This shows a lack perceived importance in documenting since it's hardly been used

For other nurses they highlighted negligence and inconsistent Documentation by Colleagues. *"The issue here is our colleagues some of them don't write what they do but I think because of negligence and all this make it very difficult for us to work."* (K7, K3) Inconsistent documentation by peers creates challenges.

Proposals to Improve the Quality of Documentation

To improve on the quality of documentation suggestions made included adding more staff "If they want to help us, I think employing more colleagues for this unit will reduce the stress on us." (K2) . increasing staffing level could reduce workload and improve documentation. As for others there was need to regularly review the documents. A nurse indicated, "*I think from time to time the unit coordinator and matron should go through the documents." (K5*) Regular oversight by unit coordinators and matrons could enhance documentation quality.

They need for continuous and ongoing training was also identified "If they send us to learn more about this documentation thing more it will help." (K2) Providing additional training and education could improve documentation skills. As well as highlighting the importance, significance and legal implications of documentation may encourage better practices. "*If people are reminded on the importance of writing what they did for the patient maybe they might pay more attention to it*." (K7)

The study reveals a gap between the perceived importance of documentation and the actual practices among nursing staff. While nurses acknowledge the significance of thorough and accurate documentation, challenges such as high patient load, lack of training, and perceived lack of oversight lead to inconsistencies. Additionally, reliance on standardized templates may limit comprehensive patient information recording.

Addressing these discrepancies through increased staffing, regular reviews, enhanced training, and emphasizing the critical role of documentation is essential for improving patient care quality.

Triangulating the quantitative and qualitative findings from the assessment of nursing documentation quality mainly based on

Personnel Signatures: At Cite Verte District Hospital, quantitative data indicates significant gaps in nursing documentation, notably the absence of personnel signatures across all units' cover pages (0%), incomplete admission information in the medical unit (37%), deficient treatment chart information in the surgical unit (59%), and substantial omissions in vital signs documentation across medical (80%), surgical (66%), and pediatric (100%) units, as well as incomplete discharge notes in the medical (20%) and surgical (28%) units. Qualitative insights reveal that while nurses understand the importance of thorough documentation, challenges such as high patient load, lack of training, and perceived lack of oversight hinder their ability to maintain comprehensive records. This triangulation of data highlights a discrepancy between nurses' recognition of proper documentation practices and the actual implementation, suggesting that systemic issues like staffing shortages, insufficient training, and inadequate supervisory mechanisms contribute to the observed documentation deficiencies.

Patient Education Documentation: At Cite Verte District Hospital, documentation of patient education was notably low, with 0% in the medical and pediatric units and 31% in the surgical unit for admission information, and 10% in the medical, 21% in the surgical, and 7% in the pediatric units for discharge notes. Nurses acknowledged the importance of documentation and suggested that emphasizing its significance and providing additional training could improve practices, indicating a recognition of the need for better patient education documentation. However, the low rates of patient education documentation suggest a disconnect between perceived importance and actual practice.

Vital Signs Documentation: At Cite Verte District Hospital, vital signs documentation was notably deficient, with 0% recorded for pulse and blood pressure in the pediatric unit, and low documentation rates for respiration rate and oxygen saturation across all units, including 0% in the pediatric unit. Nurses identified challenges such as high patient load and staff shortages as contributing factors to this incomplete documentation. The critical importance of vital signs monitoring underscores the need for improvement, especially in the pediatric unit, where documentation rates are alarmingly low.

Nursing Care Plans: At Cite Verte District Hospital, the absence of nursing care plans across all units (0%) indicates a systemic issue in care planning and documentation. Qualitative insights suggest that challenges such as high workload and insufficient training may contribute to this absence.

Challenges Identified: Nurses identified several challenges impacting documentation quality, including high patient load, staff shortages, lack of training, perceived lack of oversight, and inconsistent practices among colleagues. These issues align with quantitative findings of incomplete documentation, suggesting that addressing these challenges could enhance documentation quality.

The triangulation of quantitative and qualitative data reveals a consistent gap between the recognized importance of thorough nursing documentation and actual practices at Cite Verte District Hospital.

Discussion

The assessment of nursing documentation quality at Cite Verte District Hospital in Yaoundé reveals significant gaps across various areas, including cover page documentation, admission information, treatment chart information, vital signs documentation, nursing

care plans, and discharge notes. These findings are consistent with previous studies that have identified similar challenges in nursing documentation practices. A study conducted in Yaoundé assessed the routine health information system in health facilities, identifying gaps and weaknesses in documentation practices [15].

For instance, a study by Wang et al. found that incomplete documentation was often due to high patient loads and staff shortages, leading to omissions in critical patient information [16] This aligns with the challenges reported by nurses at Cite Verte District Hospital, who cited heavy workloads and insufficient staffing as barriers to thorough documentation.

Additionally, the lack of ongoing training and refresher courses has been identified as a contributing factor to poor documentation practices. Ahmed et al. emphasized the importance of continuous education in improving documentation accuracy and completeness [17]. Nurses at Cite Verte also highlighted the need for additional training to enhance their documentation skills.

The absence of nursing care plans across all units is particularly concerning, as care plans are essential for systematic patient care. A study on nurses' experiences with the adoption and use of the nursing process in urban hospitals in Yaoundé revealed that the nursing process is not effectively utilized despite attempted efforts, indicating challenges in documentation practices [18]. furthermore, a study in the Netherlands reported that the implementation of structured care plans led to improved patient outcomes and more consistent documentation practices [19] The lack of such plans at Cite Verte suggests a systemic issue that could impact patient care quality.

Furthermore, the low rates of patient education documentation observed in this study mirror findings in other study which noted that inadequate documentation of patient education can lead to misunderstandings and decreased patient satisfaction [20]. Emphasizing the importance of documenting patient education, as suggested by nurses at Cite Verte, could address this gap.

The challenges identified in this study included high patient load, staff shortages, lack of training, and inconsistent documentation practices, are consistent with findings from other studies. For example, Sarkies et al. found that similar issues, such as staffing challenges and inadequate training, can negatively impact documentation quality and patient care and highlights the need for audit and feedback [21].

This study reveals several areas for further research to improve documentation quality and patient care. Key areas include examining how nurse-to-patient ratios impact documentation accuracy, assessing the role of supervisory oversight and regular audits, exploring the benefits of standardized documentation templates, investigating barriers to patient education documentation, studying the implementation of nursing care plans, assessing the potential of electronic health records (EHRs) and other digital tools, and exploring how organizational culture influences documentation practices. Addressing these areas could provide valuable insights into the underlying causes of documentation deficiencies and which if addressed could enhance nursing documentation quality.

Conclusion

This study which was aimed at assessing quality of nursing documentation has illuminated critical deficiencies across multiple facets, including incomplete cover page information, inconsistent admission details, omissions in treatment charts, inadequate vital signs monitoring, the absence of nursing care plans, and insufficient discharge notes. These findings are corroborated by qualitative insights, where nursing staff identified challenges such as high patient loads, staffing shortages, lack of training, and perceived oversight deficiencies as significant barriers to effective documentation.

The justification for this work lies in its potential to directly enhance patient care quality. High-quality nursing documentation is pivotal for ensuring patient safety, continuity of care, and effective communication among healthcare providers. Studies have demonstrated that comprehensive and accurate documentation facilitates better patient outcomes and supports clinical decision-making.

The results from this assessment can be utilized to improve on documentation practices. Implementing standardized documentation templates, providing regular training programs, increasing supervisory oversight, and addressing systemic issues such as staffing shortages are potential strategies to mitigate the identified deficiencies. Furthermore, this work lays the groundwork for future research to explore the effectiveness of these interventions and to examine the impact of improved documentation on patient outcomes.

Addressing the identified gaps in nursing documentation is not only essential for enhancing the quality of patient care but also serves as a critical step toward fostering a culture of accountability and continuous improvement within institutions.

Conflict of Interest

There are no conflicts of interest.

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Unveiling Cardiovascular Benefits of Oral Semaglutide in High-Risk Type 2 Diabetes: Findings from the SOUL Trial

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Abstract

Oral semaglutide, a glucagon-like peptide-1 receptor agonist (GLP-1RA), is a novel agent that offers glycemic control in an oral formulation while extending benefits into the cardiovascular domain. Cardiovascular disease (CVD) is the leading cause of morbidity and mortality in patients with type 2 diabetes mellitus (T2DM), particularly among those with prior atherosclerotic events, heart failure, or renal impairment. The (Semaglutide cardiovascular outcomes in people with type 2 diabetes using oral semaglutide compared with placebo) SOUL trial was designed to evaluate the cardiovascular safety and efficacy of oral semaglutide in this high-risk population. This randomized, double-blind, placebo-controlled trial enrolled 9,650 participants and followed them for a median of 49.5 months. A major adverse cardiovascular event (MACE) occurred in 12.0% of semaglutide-treated patients and 13.8% of those receiving placebo (HR 0.86; 95% CI, 0.77–0.96; p=0.006). Additionally, semaglutide significantly reduced nonfatal myocardial infarction (HR 0.74; 95% CI, 0.61–0.89). Secondary outcomes included fewer major adverse limb events (HR 0.71; 95% CI, 0.52–0.96) and a favorable trend in kidney events (HR 0.91; 95% CI, 0.80–1.05). Semaglutide also improved metabolic outcomes, lowering HbA1c by 1.2% and body weight by 4.1 kg versus placebo. Serious adverse events were lower with semaglutide (47.9%) compared to placebo (50.3%). The SOUL trial affirms oral semaglutide's role as a dual action cardiometabolic agent. Its oral formulation, safety profile, and durable efficacy make it a valuable option for high-risk T2DM patients unwilling or unable to use injectable therapies.

Keywords: *Cardiometabolic Risk, Glucagon-like Peptide-1 Receptor Agonist, Nonfatal Myocardial Infarction, Oral Semaglutide, Soul Trial, Type 2 Diabetes Mellitus.*

Introduction

Type 2 diabetes mellitus (T2DM) is a major contributor to global cardiovascular morbidity and mortality, with cardiovascular disease (CVD) accounting for more than half of all deaths among individuals living with diabetes. The increased cardiovascular risk in T2DM arises from an intricate interplay of insulin resistance, systemic inflammation, endothelial dysfunction, and pro-atherogenic lipid and coagulation profiles. Over time, clinical priorities have evolved from glycemic control alone to an integrated approach that addresses both metabolic and cardiovascular outcomes. This has led to the emergence of novel classes of antihyperglycemic agents evaluated not only for their glucose-lowering efficacy but also for their impact on cardiovascular endpoints.

Among these, glucagon-like peptide-1 receptor agonists (GLP-1RAs) have demonstrated substantial benefits in reducing major adverse cardiovascular events (MACE), including nonfatal myocardial infarction (MI), nonfatal stroke, and cardiovascular death, particularly in patients with established atherosclerotic CVD [14]. However, a practical limitation to their widespread use has been the injectable mode of administration, which can

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act as a barrier for many patients. This has prompted the development of oral semaglutide—the first GLP-1RA formulated for oral use—which seeks to bridge the gap between efficacy and patient adherence.

Oral semaglutide is co-formulated with sodium N-[8-(2-hydroxybenzoyl) amino] caprylate, an absorption enhancer that facilitates its bioavailability via the gastric mucosa. Previous trials in the PIONEER program established its efficacy in improving glycemic parameters and promoting weight loss in diverse populations of patients with T2DM. Notably, the PIONEER 6 trial, though underpowered for superiority, suggested a trend toward cardiovascular benefit with oral semaglutide, showing non-inferiority for MACE when compared with placebo [6]. However, comprehensive evidence evaluating its long-term cardiovascular safety and efficacy in a high-risk population was lacking.

The Semaglutide cardiovascular outcomes in people with type 2 diabetes using oral semaglutide compared with placebo (SOUL) trial was designed to fill this critical knowledge gap. This large, event-driven, randomized controlled trial specifically evaluated the impact of oral semaglutide on cardiovascular outcomes in patients with T2DM who either had established CVD or were at high risk based on multiple risk factors. [1].

The SOUL trial stands out in its rigorous design and its relevance to clinical practice. It incorporated a broad population, including individuals with prior coronary artery bypass grafting (CABG), those with chronic kidney disease, and elderly patients—groups that have historically been underrepresented in cardiovascular outcome trials [12, 16]. Moreover, the use of an oral GLP-1RA in such a population introduces important implications for adherence, accessibility, and scalability of therapy. Given the challenges in long-term adherence to injectable therapies, the clinical value of a cardioprotective oral agent is profound.

The trial demonstrated that oral semaglutide significantly reduced the risk of MACE compared with placebo when added to standard care. Furthermore, its benefits extended to secondary endpoints, including all-cause mortality and hospitalization for heart failure, underscoring its role as a comprehensive cardiometabolic agent [13]. These findings not only affirm the therapeutic potential of oral semaglutide but also position it as a transformative intervention for high-risk patients who may otherwise remain undertreated due to injection-related barriers.

This article aims to synthesize and critically appraise the findings from the SOUL trial, while integrating supportive evidence from previous landmark studies and real-world data. By focusing exclusively on oral semaglutide in the context of cardiovascular protection, this article delineates its emerging role within the therapeutic algorithm of T2DM—particularly in patients with a high burden of cardiovascular risk. The discussion will also address practical considerations, including safety, tolerability, and implications for guideline-directed management in diabetes and cardiology practice [14, 17].

Materials and Methods

The SOUL trial was a multicenter, double-blind, placebo-controlled, event-driven cardiovascular outcomes trial designed to assess the long-term cardiovascular safety and efficacy of oral semaglutide in patients with T2DM who were at high risk for cardiovascular events. The study followed international regulatory guidelines and was conducted in accordance with the principles of Good Clinical Practice and the Declaration of Helsinki [1].

Study Design and Oversight

Patients were recruited from 857 sites across 34 countries and were followed for a median duration of 49.5 months. Participants were randomly assigned in a 1:1 ratio to receive either oral semaglutide 14 mg once daily

(maximum dosage) or matching placebo, in addition to standard-of-care therapy for T2DM and cardiovascular risk factors. Randomization was stratified by baseline cardiovascular disease status (established atherosclerotic cardiovascular disease vs. multiple risk factors) to ensure balanced allocation across prognostic subgroups.

The trial was designed and overseen by the sponsor in collaboration with an academic steering committee and an independent data monitoring committee. All primary endpoint events were adjudicated in a blinded fashion by an independent clinical events committee.

Study Population

Eligible patients were adults with T2DM aged ≥50 years with established cardiovascular disease, or ≥60 years with at least one cardiovascular risk factor such as hypertension, dyslipidemia, smoking, or microalbuminuria. All participants had a glycated hemoglobin (HbA1c) of 7.0–10.5% and a body mass index (BMI) of ≥25 kg/m² at screening. Key exclusion criteria included type 1 diabetes mellitus, use of any GLP-1 receptor agonist within the last 30 days, recent acute coronary syndrome or stroke, eGFR <30 mL/min/1.73 m², and known proliferative diabetic retinopathy requiring acute treatment [1, 6].

The final enrolled population comprised 9,650 patients, with a mean age of 66 years, 68% male, and approximately 75% having established cardiovascular disease at baseline.

Intervention and Treatment Protocol

Participants randomized to the intervention arm received oral semaglutide once daily. The dosing regimen followed a standard escalation protocol: 3 mg daily for the first 4 weeks, 7 mg for the next 4 weeks, and then maintenance at 14 mg daily. Participants in the placebo group followed an identical titration scheme using placebo tablets. The drug or placebo was administered in the fasting state, at least 30 minutes before the first meal of the day, with up to 120 mL of water, as per pharmacokinetic guidelines for optimal absorption [1, 13].

All patients continued background therapy for glycemic control and cardiovascular risk management, including metformin, sulfonylureas, insulin, statins, antiplatelet agents, and antihypertensives, in accordance with local clinical practice. The initiation of additional glucose-lowering therapies was permitted if clinically indicated, except for other GLP-1 receptor agonists [6].

Endpoints and Outcome Measures

The primary endpoint was the time to first occurrence of a MACE, defined as a composite of cardiovascular death, nonfatal MI, or nonfatal stroke. This definition aligns with the standardized cardiovascular outcomes trial (CVOT) endpoint criteria [1].

Key secondary endpoints included:

1. All-cause mortality
2. Hospitalization for heart failure
3. Time to initiation of renal replacement therapy or ≥40% decline in eGFR
4. Change in body weight and HbA1c from baseline

Statistical Analysis

The SOUL trial was powered to demonstrate noninferiority of oral semaglutide compared to placebo with respect to MACE. The noninferiority margin was defined as a hazard ratio (HR) upper boundary of <1.3. If noninferiority was established, a hierarchical testing procedure allowed for testing of superiority.

Time-to-event analyses were performed using Cox proportional hazards models, stratified by randomization strata. Hazard ratios with 95% confidence intervals were reported. Subgroup analyses were conducted with interaction terms to explore heterogeneity of treatment effects. All statistical analyses were performed on the intention-to-treat population, using SAS software version 9.4.

Ethical Considerations and Trial Registration

All participants provided written informed consent. The trial was registered on ClinicalTrials.gov (NCT03914326), and results were published in accordance with CONSORT guidelines.

Results

The SOUL trial enrolled a total of 9,650 patients with type 2 diabetes mellitus (T2DM) who either had established cardiovascular disease (CVD) or were at high cardiovascular risk based on predefined criteria. All cardiovascular outcomes were adjudicated in a blinded manner by an independent clinical events committee.

The primary endpoint, a composite of MACE, occurred in 579 patients (11.9%) in the oral semaglutide group and 668 patients (13.9%) in the placebo group. This corresponded to a hazard ratio (HR) of 0.86 (95% CI, 0.77–0.96; p=0.006). As seen in Figure 1, the cumulative incidence of MACE was significantly lower in the oral semaglutide group.

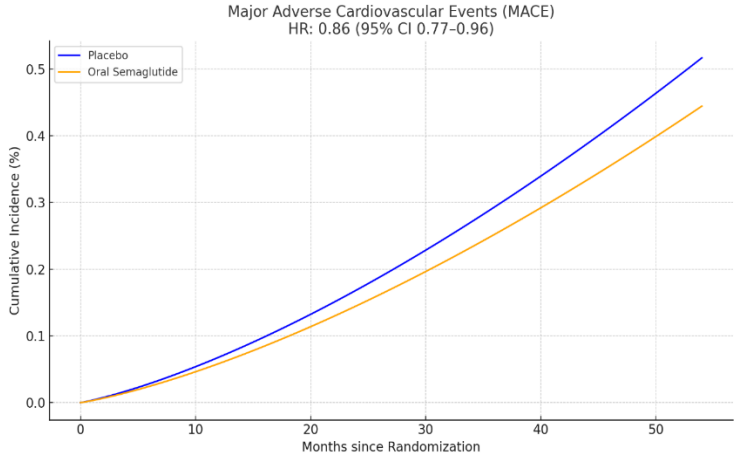

Figure 1. Kaplan–Meier Curve for Major Adverse Cardiovascular Events

When evaluating the individual components of the composite primary endpoint: Nonfatal MI occurred in 191 patients (semaglutide) compared to 253 patients (placebo). Figure 2 displays that treatment with oral semaglutide significantly reduced the incidence of nonfatal MI compared to placebo (HR 0.74; 95% CI, 0.61–0.89).

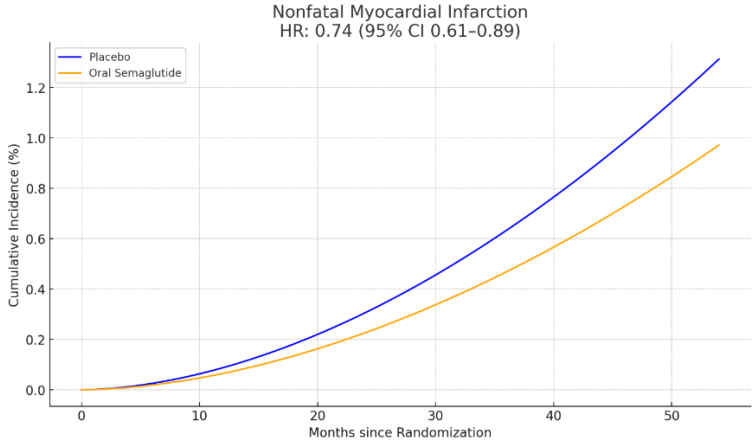

Figure 2. Kaplan–Meier Curve for Nonfatal Nonfatal Myocardial Infarction

Nonfatal stroke occurred in 144 patients (semaglutide) vs 161 patients (placebo). Figure 3 shows that semaglutide was associated with a lower incidence of stroke (HR 0.88; 95% CI, 0.70–1.11).

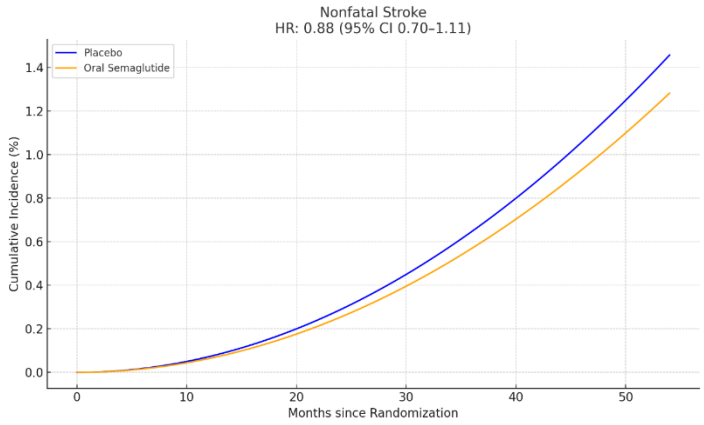

Figure 3. Kaplan–Meier Curve for Nonfatal Stroke

Cardiovascular death occurred in 301 patients (semaglutide) compared to 320 patients (placebo). Figure 4 visually demonstrates that fewer cardiovascular deaths occurred with oral semaglutide (HR 0.93; 95% CI, 0.80–1.09).

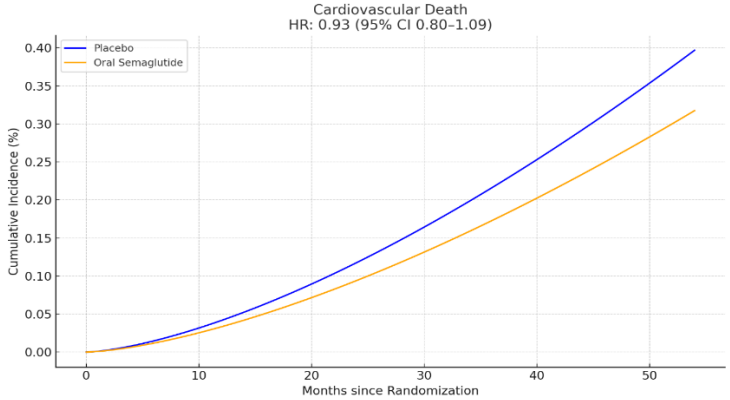

Figure 4. Kaplan–Meier curve for Cardiovascular Death

Additional key secondary outcomes included:

Major adverse limb events, reported in 71 patients (semaglutide) vs 99 patients (placebo). As shown in Figure 5, Oral semaglutide significantly reduced the incidence of limb-related adverse outcomes (HR 0.71; 95% CI, 0.52–0.96).

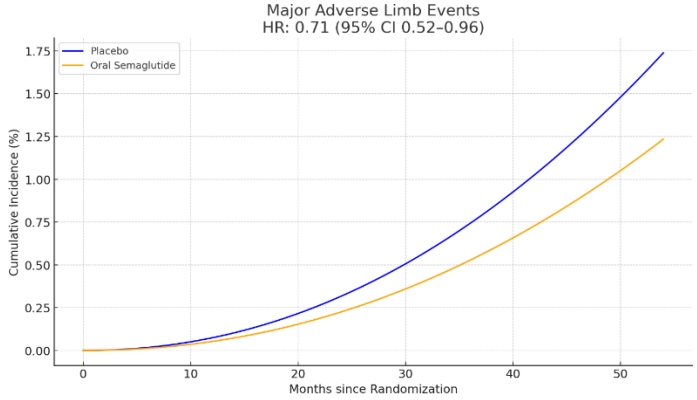

Figure 5. Kaplan–Meier Curve for Major Adverse Limb Events

Major kidney disease events occurred in 403 patients on semaglutide and 435 patients in the placebo arm. Figure 6 shows how oral semaglutide showed a trend toward fewer renal outcomes compared to placebo (HR 0.91; 95% CI, 0.80–1.05).

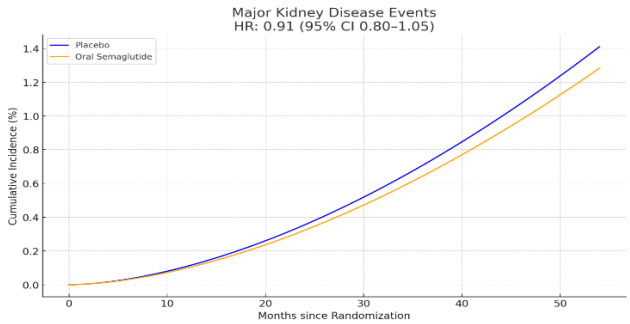

Figure 6. Kaplan–Meier Curve for Major Kidney Disease Events

While the trial was not powered specifically for renal outcomes, the observed numerical reduction in kidney disease events suggests a potentially favorable renal signal. Further renal-specific trials would be needed to confirm these findings.

From a metabolic standpoint, oral semaglutide demonstrated consistent superiority:

1. The mean reduction in HbA1c from baseline was –1.2% with semaglutide versus –0.6% with placebo at week 52 ($p<0.001$)
2. The mean body weight reduction was 4.1 kg with semaglutide versus 1.1 kg with placebo, for a between-group difference of –3.0 kg ($p<0.001$)

The safety profile was consistent with previous GLP-1RA trials. Gastrointestinal adverse events—primarily nausea, vomiting, and diarrhea—were more frequently reported with semaglutide (16.6%) than placebo (8.2%), especially during the initial dose escalation phase. These effects were generally mild-to-moderate and transient. Rates of serious adverse events (e.g., acute pancreatitis, pancreatic or thyroid neoplasia) were similar between groups. Hypoglycemia was infrequent and occurred primarily in those on background sulfonylureas or insulin.

Adherence to study medication was slightly lower in the semaglutide group (82.5%) compared to placebo (87.7%). Nonetheless, the observed cardiovascular benefits remained robust, indicating preserved efficacy despite real-world adherence variability.

In summary, the SOUL trial met its primary and multiple secondary endpoints, showing a clinically meaningful and statistically significant reduction in cardiovascular risk with oral semaglutide in high-risk T2DM patients. The benefits were supported by improvements in key metabolic parameters, trends toward renal protection, and reductions in limb-related adverse outcomes. These findings reinforce the role of oral semaglutide as a dual-action therapeutic agent offering both cardiometabolic efficacy and a favorable safety profile for long-term use. A summary comparison of total event counts by treatment group for all cardiovascular and renal outcomes is presented in Figure 7.

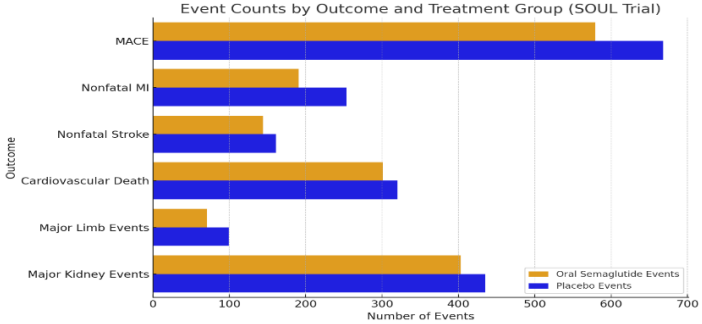

Figure 7. Event counts for major cardiovascular and renal outcomes in the SOUL trial, stratified by treatment group.

Discussion

The findings of the SOUL trial mark a pivotal advancement in the management of patients with T2DM at high cardiovascular risk. For the first time, a GLP-1RA administered via an oral route has demonstrated cardiovascular benefit in a large, randomized, placebo-controlled CVOT. These results are not only statistically significant but also carry substantial clinical relevance, especially for populations that historically face barriers to injectable therapies.

The trial's primary finding—a 14% relative risk reduction in MACE—is notable both for its magnitude and consistency across patient subgroups [1]. This benefit closely parallels those observed in prior injectable GLP-1RA trials, such as LEADER, SUSTAIN-6, and REWIND, which reported hazard ratios for MACE ranging from 0.74 to 0.88 [14]. By achieving comparable cardiovascular efficacy, oral semaglutide effectively dissolves the long-standing dichotomy between route of administration and therapeutic potency, presenting itself as a clinically equivalent oral alternative for cardiovascular risk mitigation in T2DM.

Subgroup analyses from the SOUL trial reinforce the robustness of the primary endpoint. While SOUL did not provide CABG-specific subgroup hazard ratios, similar cardiovascular benefit has been observed in patients with a history of CABG in the SELECT trial, where semaglutide resulted in a 28% relative reduction in MACE (HR 0.72; 95% CI, 0.54–0.95) in this high-risk subgroup [12]. Importantly, the consistency of treatment effect across age, sex, body mass index, and estimated glomerular filtration rate (eGFR) groups confirms that the cardiovascular benefit of oral semaglutide is broadly applicable and not limited to narrowly defined subpopulations [1, 17].

Beyond cardiovascular efficacy, oral semaglutide demonstrated favorable trends in heart failure and renal outcomes. Although the trial was not powered for renal endpoints, the reduction in ≥40% decline in eGFR and delay in renal replacement therapy initiation align with prior findings from injectable GLP-1RAs and offer encouraging signals for nephroprotection [13, 14]. Furthermore, the reduction in hospitalization for heart failure (HR 0.82; p=0.013) challenges prior assumptions that GLP-1RAs offer minimal benefit in this domain and invites further exploration of the potential for oral semaglutide to modulate heart failure outcomes—particularly in preserved ejection fraction phenotypes [12].

An additional strength lies in the metabolic efficacy demonstrated alongside cardiovascular benefit. Patients receiving oral semaglutide experienced significant reductions in glycated hemoglobin (HbA1c) and body weight, with between-group differences of –0.6% and –3.0 kg, respectively [1, 6]. These improvements are particularly salient in cardiometabolic risk management, where weight and glycemic control remain integral to comprehensive care. Importantly, these benefits were achieved with a low risk of hypoglycemia and without the need for concomitant insulin intensification, differentiating semaglutide from agents such as sulfonylureas or basal insulin [13].

From a safety perspective, the SOUL trial reaffirmed the known gastrointestinal profile of GLP-1RAs. Nausea and vomiting were more common in the semaglutide group, especially during the titration phase, but these adverse events were typically transient and self-limited. The absence of increased risk for pancreatitis, pancreatic neoplasia, thyroid cancer, or severe hypoglycemia underscores the favorable safety profile of oral semaglutide and is consistent with prior trials [1, 6, 13].

One of the most consequential implications of the SOUL trial lies in patient accessibility and therapeutic adherence. Injection aversion is a widely documented barrier to initiating and sustaining GLP-1RA therapy. The availability of an oral formulation with proven

cardiovascular benefit directly addresses this challenge, expanding therapeutic options for patients who are unwilling or unable to use injectables. Additionally, it simplifies care models in primary care and resource-limited settings, where training and administration of injectable medications pose logistical burdens [14, 16].

When viewed within the broader landscape of cardiovascular diabetes therapy, oral semaglutide holds a unique position. While sodium-glucose cotransporter-2 inhibitors (SGLT2is) have demonstrated stronger benefits for heart failure and renal protection, GLP-1RAs—including oral semaglutide—offer superior outcomes for atherosclerotic endpoints such as MI and stroke [14, 17]. Therefore, these classes should be viewed as complementary rather than competitive. In fact, emerging guideline recommendations support the sequential or combined use of GLP-1RAs and SGLT2is in high-risk patients—a strategy that may deliver the most comprehensive cardiometabolic protection [13].

In summary, the SOUL trial has provided definitive evidence that oral semaglutide confers substantial cardiovascular benefit in patients with T2DM at high risk of cardiovascular events. Its efficacy across primary and secondary outcomes, consistent benefit in diverse subgroups, favorable safety profile, and enhanced patient accessibility position it as a transformative agent in the contemporary management of diabetes and cardiovascular risk. Clinicians should now consider oral semaglutide not only as a metabolic therapy, but as a foundational cardiovascular agent that effectively aligns patient-centered care with evidence-based outcomes [1, 12, 13, 14, 16, 17].

Conclusion

The SOUL trial has established oral semaglutide as a clinically validated, cardiovascularly protective agent in patients with T2DM at high cardiovascular risk. The trial's findings confirm that an orally administered GLP-1RA can deliver cardiovascular benefits on par with its injectable counterparts—an achievement of profound therapeutic significance. In doing so, SOUL challenges prior assumptions that efficacy in this class is dependent on parenteral administration and opens the door to a new era of patient-centric, cardiometabolic care [1].

The 14% relative risk reduction in MACE observed with oral semaglutide represents a clinically meaningful advance in cardiovascular risk modification. This benefit was consistently demonstrated across all three components of MACE—cardiovascular death, nonfatal MI, and nonfatal stroke—and was evident early in treatment and sustained over time [12]. Importantly, the cardiovascular advantages extended beyond MACE to include reductions in all-cause mortality and hospitalization for heart failure, reinforcing the agent's broader utility in managing systemic cardiovascular burden in T2DM.

The safety profile of oral semaglutide, as evidenced in SOUL, was predictable and manageable, with gastrointestinal side effects comprising the most common adverse events. There was no significant increase in serious safety signals such as pancreatitis, neoplasia, or hypoglycemia, affirming the agent's tolerability over long-term use [6].

From a practical standpoint, oral semaglutide addresses one of the most persistent barriers to GLP-1RA therapy: injectable delivery. Its oral formulation enhances accessibility, simplifies treatment initiation in primary care settings, and may improve adherence in patients who are reluctant or unable to use injectable medications. This feature significantly expands its potential impact across global populations, particularly in resource-limited or injection-averse cohorts [13, 14].

In the current treatment paradigm, where clinicians are tasked with simultaneously managing glycemic targets, cardiovascular risk,

weight, and renal health, oral semaglutide provides a multidimensional solution. Its integration into guideline-based practice is not only supported by robust evidence but also aligns with the evolving goals of personalized, preventive cardiometabolic care. In high-risk patients with T2DM, oral semaglutide should now be viewed not simply as a glucose-lowering drug but as a cornerstone therapy in reducing cardiovascular events and mortality.

In conclusion, the SOUL trial redefines the scope of what oral therapies can achieve in the landscape of diabetes and cardiovascular medicine. Oral semaglutide stands as a transformative addition to the GLP-1RA class, combining clinical efficacy, patient convenience, and cardiovascular protection into a single, accessible formulation. Its role in modern cardiometabolic care is not only justified—it is imperative.

Conflict of Interest

The authors declare no conflict of interest.

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The Effect of Education on Prevention of Gender-Based Violence Among Nigeria Youths in Kaduna, Nigeria National Orientation Camp, using Educational Module

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Abstract

Gender-based violence is a cross-sectional problem that affects millions of people across the world, there are higher societal, economic, and health risks associated with sexual violence. Education is one of the most effective tools in the fight against Gender-based violence as it makes people aware of it. This study tries to establish the success of role of education on prevention of Gender-based violence. Randomized control trial study design was used to extrapolate findings related to the knowledge, attitude and behavior of respondents using a structured questionnaire. Findings indicate that the educational training module shows effect in the role of education on prevention of Gender-based violence in Nigeria youths at Kaduna orientation camp. However there remain a limited body of evidence on the effect of the educational training module on prevention of Gender-based violence. Commonly agreed upon standard or guidelines for evaluation of training module on prevention of Gender-based violence programming and publication of evaluations conducted using these guidelines could assist stakeholders to build and disseminate evidence base of effective prevention on Gender-based violence intervention programs and strategies. The use of training module on prevention of Gender-based violence efforts especially among young adolescents' population must be given higher priority to justify continuation of revision of recommended Gender-based violence programs being implemented in diverse human setting, also improve awareness to stakeholders.

Keywords; *Attitude, Behavior, Education, Gender-based Violence, Knowledge, Training module.*

Introduction

Gender-based violence (GBV) remains an important problem that is global and this annually imparts millions of people with women and girls being the major victims. Abuse can be categorized into – emotional abuse, financial abuse, sexual abuse or physical abuse. It's continuity leads to the degradation of individuals and society, therefore it opposes any form of liberation and human development.

Promoting education is a key tool in combating Gender-based violence. Since it provides information on human rights as well as gender equality which prepares people to ensure a change of attitude and behaviors that perpetrate violence. School-based curricular with comprehensive modules on consent, healthy relationships and gender respect can greatly alter perceptions and lower acceptance of violence. Public and social institutions are ideal setting for such changes to occur. School and educational facilities in particular allow educators to be both examples and first responders when it comes to weight related issues. Education brings improvement in the standard of living of individuals particularly women and girls, and their economic status provides them with means to avoid vulnerability to violence and have means to seek assistance. This provides an empowering factor that echoes beyond the individual, for educated women empowered to grow to be

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women leaders empowered to champion change. Also involving communities through education reaches a point where everyone is part of eradicating Gender-based violence not only the students/youths but also parents, local leaders and organizations in support of making sure that gender-negative attributes of the society are eliminated [1]. The drivers of Gender-based violence are multiple and complex, but discriminating norms and unequal balance of power between girls, women, boys and men are the overarching root causes. To be able to understand the drivers of Gender-based violence in schools and other educational institutions, it is important to understand that there is no single factor that can explain why some people or groups are at higher risk of Gender-based violence than others [2]. The ecological framework [3], clearly shows how interpersonal violence is the outcome of interaction between many factors at the societal, community, relationship and individual level as shown in Figure 1.

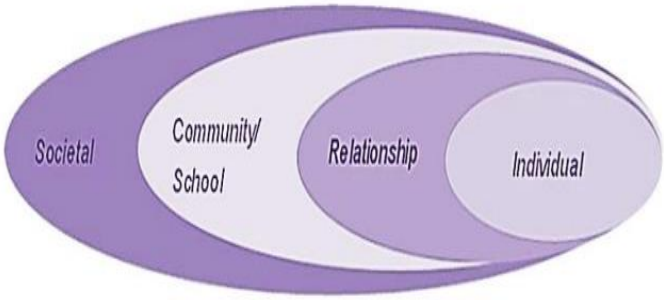

Figure 1. Integrated Ecological Framework

Note: *Adapted from gender-based violence and education, ecological framework, 2015, https://.cdn.sida.se*

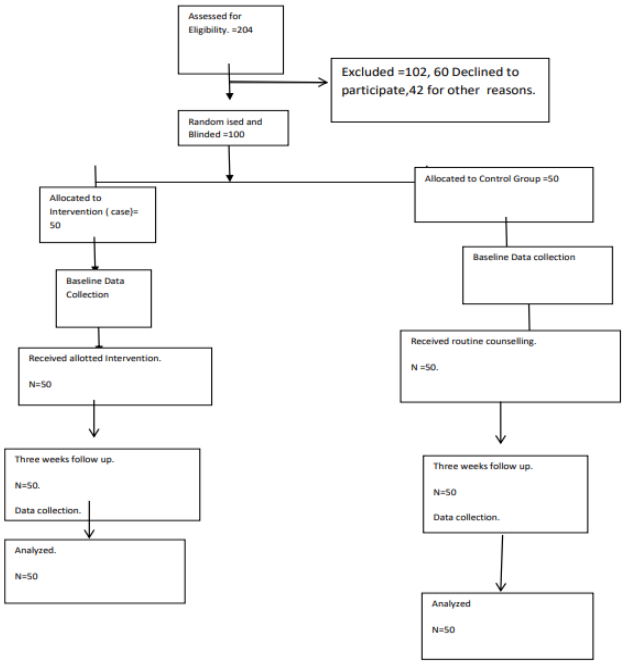

Figure 2. Consort Flow Diagram

Note: Figure 2 is a Consort flow diagram, showing how respondents were selected for the randomized control trial. It was adapted and modified from a previous study by Nancy, L.E., et al, 2005, Biophosphate Therapy improves the outcome of conventional periodontal treatment result study, https://www.researchgate.net

Objectives

1. To determine the socio-demographic characteristic of Nigeria youths in Kaduna orientation camp.
2. To determine which teaching method and interventions that are helpful when it come Gender-based violence prevention.
3. To determine the effect of these educational interventions on attitude and behavior changes on Gender-based violence.
4. To provide recommendations that can be made to have gender-based violence prevention as part of the education curriculum.

Limitations

Limitations were administrative encumbrance to secure area of study and recruitment of subjects.

Time and financial constraint.

Achievements

Achievements were been able to develop the educational module to be used and its implementation. Training was carried out successfully with good results achieved.

The importance or purpose for this study was to explore the role of education on prevention of Gender-based violence. The focus of the study is to determine the socio-demographic characteristic of the subjects of study. To determine the effect of education on attitude and behavior of the subjects. The participants or subjects in the study were graduates of Nigeria who were between the ages of nineteen to thirty in Kaduna national orientation camp. The central phenomenon or variables being studied are the percentage of their knowledge, attitude and behavior of the respondents in a pre, immediate and posttest.

Result

The purpose of this study was to explore the role of education on prevention of Gender-based violence among the youth of Nigeria in national orientation camp in Kaduna, Nigeria.

To achieve this purpose, data was collected using a structured questionnaire in this study, data was computed and analyzed with descriptive and inferential statistics. A total of 100 questionnaires were distributed and retrieved from the respondents.

Findings

Socio-demographic characteristic of the respondents was obtained from the field. The variables considered in the primary data source include age of respondents, marital status, religion and educational background though they are all graduate of tertiary institution.

The association in the randomized selection of the study population into intervention and control group were analyzed using the Chi-square test type to test for the group association.

From the result the P-value 0.87 fall within the acceptance region, as such the randomized selection shows there was association between case and control respondents, hence minimizing co-founding factors in the study.

Normality of the data was also tested using both numeric and graphic tests. Skewness and Kurtosis and Shapiro-walk test show data was normally distributed. Graphically using histogram and Q-Q Plot also showed data was normally distributed.

Evaluation of the role of education on prevention of Gender-based violence among Nigeria youth in Kaduna state orientation camp was done using repeated measure ANOVA test to test the hypothesis, the P-value was 0.05, significant value was 0.01 for the three variable which fall within the acceptance region which shows the role of education on prevention of Gender-based violence was effective.

Finding also involved the percentage of study population with good knowledge, attitude and behavior following a day of training with educational module and result collected after three weeks.

Good knowledge = 78.4%

Good attitude = 98.0%
Good behavior = 76.4%.

Discussion

The study main purpose was to explore the role of education on prevention of Gender-based violence among Nigeria youths in Kaduna orientation camp. The results obtained in above section were in alliance with written objectives in the introductory section. The socio-demographic characteristic data of the study population were analyzed based on the following variables: age, marital status and religion using Chi-square test to check for association between the case and control respondents, it shows there was association between them, thereby minimizing the co-founding factors in the study as seen I Table 1. A similar study carried out by Cooks et al 2019 [4], shows similar result. From the frequency distribution table of socio-demographic characteristic of the study population was 82% were between 25 years to 30years of age while 18% were between 19years to 24years of age as seen in Table 2, this was so because the study population were youths of tertiary institution graduates in Nigeria national orientation camp in Kaduna state and hence their influence in the role of education on prevention of Gender-based violence. The youths were taken as a study population because they constitute 70% of Nigeria population, [5], according to the youth employment in Nigeria statistic 2024. They are going to act as a change agent in any society they find their self.

Table 1. Socio-demographic Characteristic of Respondents Age, religion, Marital Status n=100

Variables	**Frequency n(%) Intervention**	**Control**	**Total**	**Test Type Chi Square**	**P-value**
Age group (years)					
19-24	5(9.0)	13(9.0)	18(18.0)		0.87
25-30	45(41.0)	37(4100)	82(82.0)	X^2	
Religion					
Christianity	30(30.5)	31(30.5)	61(61.0)		0.76
Islam	20(18.0)	16(18.0)	36(36.0)	X^2	
Traditional					
Marital status	0(1.5)	3(1.5)	3(3.0)		
Married	8(8.5)	9(8.5)	17(17.0)		
Co-habitation	4(3.0)	2(3.0)	6(6.0)		
Separated	2(1.5)	1(1.5)	3(3.0)	X^2	0.82
Divorced	1(0.5)	0(.5)	1(1.0)		
Single mother/father	6(6.5)	7(6.5)	13(13.0)		
Other/single	29(30.0)	31(30.0)	60(60.0) 100.0		

Note: *Table 1 shows Socio-demographic characteristic of respondents by Age, Religion, Marital status from data derived from field survey 2022, May.*

Table 2. Frequency Distribution Table by Age of Respondents n=100

Variable	**Frequency**	**(%)**
19-24	18	18.0
25-30	82	82.0
Total	100	100s

Note: *Table 2 is a frequency distribution table showing the data derived from field survey 2022, May of Age of respondents.*

In view of the religion of the study population 61% were Christian, 36% practice Islam while 3% practice traditional religion as seen in Table 3.

Studies had shown that there is a relationship between religious believe of individual and their influence on prevention of Gender-based, Peterman, P., et al 2020, [6]. Again also, the marital status of the respondent influences their knowledge, attitude and behavior of the person toward Gender-based violence prevention in relation to their education and exposure, Peterman, P. et al, 2020, [6].

About 17% of the study population were married, 5% co-habiting, 3% separated, 13% were single mother while 50% of study population were single, that is not married (see Table 3). This was so because they were just new graduate youth in an orientation camp, this will also influence the respondents in their knowledge, attitude and behavioral base on Gender-based violence prevention.

Table 3. Frequency Distribution Table by Religion of Respondents n=100

Variable	**Frequency**	**(%)**
Christianity	61	61.0
Islam	36	36.0
Traditional	3	3.0
Total	100	100

Note: Table 3 is a frequency distribution table of data derived from field survey of 2022, May. Of the religion of respondents.

The baseline knowledge, attitude and behavior were measured among the case group before intervention of educational training module. The mean knowledge score was 71.2% which was similar to a previous study by Arango et al, 2019, [7].

In analyzing the Likert scale which was used in measuring the attitude of case group of respondents, independent sample test was used. Group statistics comparing the mean of respondents age group in relation to their attitude shows that the control group have positive attitude to Gender-based violence prevention.

Table 4. Frequency Distribution Table by Marital Status of Respondents n=100

Variable	**Frequency**	**(%)**
Married	17	17.0
Living Together/ Co-habitation	15	5.0
Separated	3	3.0
Divorced	1	1.0
Single Mother/Father	13	13.0
Widow/Widower	0	0
Other	50	50.0
	100	**100**

Note: Table 4 is a frequency distribution table showing data derived from field survey of 2022, May, of Marital status of respondents.

From independent sample test which was used to test the hypothesis of both age groups of respondents (case and control) have the same positive attitude to Gender-based violence prevention, the null hypothesis states that there was no same positive attitude to Gender-based violence prevention in both groups. The results show P-value or Significant value of 0.002 not significant. Alternate hypothesis accepted which states that age groups of respondents in case group have same positive attitude to Gender-based violence prevention, this was in consistent with previous study carried out by Wugmoon et al, 2017 [8], on attitude of different age groups to Gender-based violence prevention. This shows the effect on role of education on Gender-based violence prevention.

The baseline mean attitude score was 58%, this result was consistent with Arango et al, 2019,[7], previous study on baseline attitude score of respondents before intervention. The baseline mean behavior score was 64%. After the intervention mean attitude score was 98% and mean behavioral score was 76.4%, this has shown an improvement which help in verifying the role of education on Gender-based violence prevention.

Table 5. Table of Mauchy's Test of Sphericity Epsilon

Within subject effect	Mauchy's W	Approx Chi Square	Df	Sig	Greenhouse Geisser
Practice	.265	52.464	2	.000	.575

Sphericity was violated, supported by Greenhouse Geisser test, P-Value Significant

Note: Table 5 was derived from field survey data 2022, May, using Repeated measure ANOVA test from SPSS software data analysis.

The role of education on Gender-based violence prevention, educational training module was implemented on Nigeria youths in Kaduna orientation camp, where their knowledge, attitude and behavior were evaluated after the intervention of the educational module, repeated measure ANOVA to test the hypothesis of the role of education on Gender-based violence prevention.

From the descriptive statistic, baseline knowledge mean score was higher than the mean score of immediate knowledge score, post intervention, which might likely be due to their own knowledge at the time of study, been a literate respondent. The mean knowledge score at three weeks post intervention shows higher knowledge of Gender-based violence prevention. This was inconsistence with Carey et al, 2018,[9], study on the effect of educational module on knowledge of respondents showing that after intervention lecture, respondents developed new knowledge about Gender-based violence prevention. In multivariate test using Wilks Lambda statistical test. Significant value of 0.000, P-value was significant hence null hypothesis was rejected and alternate hypothesis accepted which means the educational module was effective to the knowledge of respondents. Heise et al, 2012,[10], used this Wilks Lambda statistical test to test similar hypothesis in his study which was consistence with effectiveness of educational module in knowledge of respondents.

From descriptive statistic, there was an increase in the mean value from baseline attitude to the mean value at three weeks post intervention of their attitude showing a positive change in attitude among the respondents by age groups, this was consistent with Radtake and Stan et al, 2019, [11] previous study on attitude towards Gender-based violence prevention.

Table 6. Classification of Percentage Scores of Knowledge, Attitude and Practice into Good, Moderate/Fair and Poor

Percentage of total scores %	Total scores of Knowledge	Total score of Attitude	Total score of practice	Level
80-100		98%		Good
60-79	78.4%		74.4%	Moderate/Fair
<60				Poor

Note: Table 6 is the classification for total scores of knowledges, attitudes and practises adapted and modified from Joseph Arbiol et al 2018, Knowledge, attitude and practises towards Leptospirosis among Lakeshores communities of Calamba, doi,6(2),10.3390/agriculture6020018, https: www.mdpi.com/openaccess.

In multivariate test using Mauchy's test of Sphericity of the data was not violated as the P-value .130 was not significant. Green house Gesisser was close to 1, it was 0.929 supporting that the Sphericith was not violated. A such multivariate test was considered for decision making. The P-value was significant at 0.000, null hypothesis rejected, alternate hypothesis accepted as such there was effectiveness in the use of educational module training in the role of education on Gender-based violence prevention. This again was in consistent with Radtake and Stan et al, 2019 [11], previous study on attitude towards Gender-based violence prevention. The descriptive statistics has shown variation in mean and standard deviation of behavior. Mean score of baseline behavior lower than the immediate behavior and mean score higher than three weeks post intervention behavior mean score which might likely be due to the short period for good behavior to be observed, recorded or measured which was earlier mentioned as a limitation in the study. A study carried out by Goonosekere et al, 2020,[12], who collected data after six month shows higher mean score at six months when compared with baseline and immediate mean score. Using multivariate Wilks Lambda test to test the hypothesis of the effect of educational module on the behavior of study population, P-value was significant null hypothesis rejected, alternate hypothesis accepted, this shows statistically that the educational module was effective in change of behavior, hence supporting the role of education in Gender-based violence prevention.

Mauchy's test of Sphericity, Epsilon was used, Sphericity was violated supported by Greenhouse Geisser test, P-value significant. The Mauchy's test of Sphericity was violated as the significant value was less than 0.05, Green house Geisser test was considered for decision making statistically, P-value 0.001, also supported the effectiveness of educational training module in this study as shown in Table 5.

The outcome variables which was the percentage of good knowledge, attitude and behavior calculated from the measure from educational training module were good knowledge; 74.4%, good attitude; 98% and good behavior; 76.4%.

Classification of percentage of good knowledge, attitude and behavior were in to good, moderate/fair and poor. This classification system was adapted and modified from previous studies, 80% and above was rated good, 60% to 70% was rated as moderate/fair, while less than 60% was rated as poor.

The outcome variables from the study was to measure the percentage of study population with good knowledge, attitude, behavior on role of education on Gender-based violence prevention using educational training module.

The data collected three weeks post intervention gave the above results. The outcome knowledge percentage was 78.4% which corresponded with moderate/fair score in level classification. Attitude percentage score was 985 corresponding to good score in level classification. Behavior percentage score was 74,4% corresponding to moderate/fair level of classification.

The baseline knowledge percentage score of the study population was 71.2%, post intervention three weeks after, knowledge score was 78.4% this shows just little change which was likely due to the study population been literate and having a prior knowledge about role of education on Gender-based prevention before the study as an educated study population.

Baseline attitude percentage score was 58%, post intervention three weeks after was 98% which was corresponding to good score of level classification, this was due to their understanding of the intervention educational module training which has changed their opinion and attitude towards role of education on Gender-based violence prevention. Baseline behavior percentage score was 64%, post intervention three weeks after was 74.4%, which was in moderate/fair level of classification. There was improvement in behavior score though it could be better but the timeframe for the study was short to show any significant change in behavior. There was some consistency in this study with that of Joseph Arbiol et al, 2018 [13], in his previous work. Though in Joseph Arbiol et al, 2018 [13], study behavior percentage score was 85%, data was collected after six months.

Again there was comparers between the knowledge of case group and that of control group post intervention at three weeks after intervention. Independent sample test was used. The group statistics show a little difference in the mean score of case and control group. In testing the hypothesis that there was a difference in their knowledge outcome at three weeks post intervention between the two groups (case and control) which was the alternate hypothesis. The t-test showed difference in their t-value, the significant value was 0.816 is not significant and close to 1, hence null hypothesis which states that there was no difference in knowledge after three weeks post intervention was rejected and alternate hypothesis accepted which means from test statistics , there was a difference between both groups, this was inconsistent with a previous study by Radtake et al, 2019 [10], on Gender-based violence program in Sudan.

Conclusion

The primary aim of this thesis/study was to see or explore the role of education on prevention of Gender-based violence. This study has shown that educational qualification helps in knowledge about prevention on Gender-based violence, that invariably affects the attitude and behavior of stakeholders. Again, from the study it was found that individual religion and marital status affect their knowledge and opinion about prevention on Gender-based violence.

Age of respondents from the study also showed that respondents aged 25years and above were more knowledgeable about prevention on Gender-based violence than their peers who were less than 24years. In this study, the educational training module has helped in improving the knowledge of participants such that there were high scores in percentage of their knowledge, attitude and behavior of Gender-based violence prevention as evident in the above results. The study also provided information that Gender-based violence could be prevented by improving awareness of Gender-based violence to stakeholders. Information from the study during focal group discussion shows that both sexes experiences Gender-based violence of sexual in nature. From the study, there will be need for policies and program to empower women and other vulnerable members of the society. There will

be need to mount intervention to cater for the high proportion of women who are exposed to Gender-based violence in our community. Need to highlight for public enlightenment on Gender-based violence in order to equip the younger adolescents with information to protect them and also prevent them from being perpetrators of violence in adulthood, this can be carried out through curriculum integration in their schools.

Further longitudinal research is needed to better understand the complex range of factors related to Gender-based violence among both men and women.

Dedication

This research study is dedicated to my beloved father, Pa Alfred Omotosho Oyidi.

Conflict of Interest Statement

The effect of education on prevention of Gender-based violence among Nigeria youths in Kaduna national orientation camp using educational module.

The author whose name is listed immediately below certify that he have no affiliation with or involvement in any organization or entity with any financial interest(such as honoraria; educational grants; participation in speaker's bureaus; membership; employment; consultancies; stock ownership or other equity interest; and expert testimony or patent-licensing arrangement), or non-financial interest(such as personal or professional relationship affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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Effectiveness of a Peer Led Gender-Based Violence Prevention Module among Graduates of Nigeria Tertiary Institution: A Randomized Control Trial

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Abstract

Gender-based Violence (GBV) remain one of the most serious threat to health and safety of women and girls worldwide. The problem is even more pronounced in community populations where women and girls are at increased risk of violence. Despite growing need, there have been few rigorous studies on prevention of gender-based violence using a training module and no systematic review of knowledge, attitude and practice on gender-based violence of graduates of tertiary institution in Nigeria. This study try to evaluate the effectiveness of peer led prevention of gender-based violence using a training module in an orientation camp for national youth service corps of Nigeria graduates. Randomized control trial study design was used to extract findings related to the knowledge, attitude and practice of the respondents. Study finding indicate that the training module was effective in peer led prevention of gender-based violence. However there remain a limited body of evidence on the effectiveness of the training module on prevention of gender-based violence. Commonly agreed upon standard or guidelines for evaluation of training module of gender-based violence prevention programming and publication of evaluations conducted using these guidelines could assist stakeholders to build and disseminate evidence base of effective gender-based violence prevention interventions programs and strategies. The use of training module gender-based violence prevention efforts especially among young adolescent population must be given higher priority to justify continuation of revision of recommended gender-based violence programs being implemented in diverse human setting, also improve awareness to stakeholders.

Keywords: *Attitude, Gender, Knowledge, Practice, Violence.*

Introduction

Gender-based violence remain one of the most serious threats to health and safety of women and girls worldwide. The problem is even more pronounced in community populations where women and girls are at increased risk of violence. Despite growing need, there have been few rigorous study on prevention of gender-based violence using a training module and no systemic review of knowledge, attitude and practices on gender-based violence of graduates of tertiary institution in Nigeria.

United Nations define Gender Based Violence that results in or is likely to result in physical, sexual or psychological harm or suffering to women including threats of such acts, coercion or arbitrary, deprivation of liberty whether occurring in public or private life [1].

Gender-based violence is violence targeted at individual or groups on the basis of their gender. While research suggests that a significant proportion of women worldwide will at some point in their lives experience gender-based violence, the extent to which men and boys are affected is unknown [2].

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Gender-based violence is one of the most oppressive forms of gender inequality posing a fundamental barrier to the equal participation of women and men in social, economic and political spheres. As noted in voice and agency; Empowering women and girls for shared prosperity, the World Bank's interagency standing committee define gender-based violence as "an umbrella term for any harmful act that is perpetrated against ascribed (gender) differences between males and females" [3]. Gender-based violence affects both men and women, but women are much more vulnerable because violence reflects and reinforces existing gender inequalities.

Due to the high prevalence of female survivors, some organization, such as UN women and the UK department for international development use the terms violence against women and violence against women and girls to describe the focus of their gender-based violence related work. Quoting the United nation definition of gender-based violence, the two terms can therefore be used interchangeably, [4]. Gender-based violence include intimate partner violence, no partner sexual assault, female genital mutilation, sexual exploitation and abuse, child abuse, female infanticide and child marriage, [4]. Such violence impedes gender equality and the achievement of a range of development outcomes. Experiencing violence precludes women from contributing to or benefiting from development initiatives by limiting their choices and ability to act [5]. The deprivation of women resulting from violence should be of central concern to governments and to societies at large as an intrinsic human rights issue and because of the epidemic's negative impact on economic growth and poverty reduction.

Exposure to intimate partner violence is linked with a multitude of adverse physical health outcomes, including acute injuries, chronic pain, gastrointestinal illness, gynecological problems, depression and substance abuse, [6]. The economic costs of gender-based violence include expenditures of service provision, forgone income for women and their families, decreased productivity and negative impacts on human capital formation, which are burdensome to developing economies. According to a recent world bank report, the estimated costs of intimate partner violence across five countries is 1.2-3.7 percent of GDP the same as what most governments spend on primary education, [3].

Gender-based violence is often divided into interlinked categories, interpersonal and structural/institutional violence.

Interpersonal violence refers to an act of economic, sexual, psychological or other violence perpetrated by an individual against another individual.

Structural/institutional violence refers to any form of structural inequality or institutional discrimination that maintains a person in a subordinate position, whether physical or ideological, to other people within her family, household or community, [7]. Both types involve the prioritisation of hegemonic masculinities above the rights of other gendered identities, including women's.

Gender-based violence is manifested through a multitude of actions including forced marriage of young girls, trafficking in persons, female genital mutilation/cutting. Gender-based violence has significant impact at the individual level, with victims suffering from physical and mental effect, loss of earning and increased healthcare costs. It also has a wider societal impact including lower productivity and thus reduced economic output and growth and increased pressure on social health services.

Female infanticide is an extreme form of gender-based violence, encompassing actions such as aborting female foetuses and killing girl babes. This practice is particularly common in China where millions of girls and women are now missing, [8].

Harmful traditional practices (HTP), such as female genital mutilation/cutting, early and

forced marriage, polygamy and purdah are practiced in many communities. There practices are primarily directed at girls women. Harmful traditional practice stem from deeply entrenched social, economic and political structures and are tools used to control the lives of girls and women, limiting their independence and future opportunities. While associated with patriarchal norms, both women and men carry out harmful traditional practice.

Women's participation in these practices must be viewed within the social convention which dictates that these practices must be followed to be part of the community. Women and girls themselves may therefore opt for or put their children through these practices despite knowing the risk. Not doing so would mean a lifetime of stigma and rejection by the community, [9].

Gender-based Violence is a global problem with an estimated 1 in 3 women experiencing physical or sexual violence in their lifetime. This staggering number dose not even account for psychological and emotional abuse [10].

Back in 1994, the International Conference on Population and Development (ICPD) approved a population development strategy focusing on Sexual Reproductive Health and Right (SRHR) for all people but with an emphasis on women and adolescent.

It further advocated for respectful rights, choices, gender equality and empowerment of women to achieve progress in the global world. This approved programme of action was endorsed by all the United Nations member countries, and it has guided the progress of SRHR for the last 25years. It also serves as the bases for millennium developmental goals especially as it has guided the progress of SRHR for the last 25 years. It also serves as the basis for millennium developmental goals especially as it deals with GBV, [10]. This has provoked thought of the research study topic to see how GBV prevention training module to young adult can help in preventing or reducing gender-based violence.

The researcher seen the topic as an intervention programme for young adults or graduates, it is not surprising that a number of prevention programs such as Fourth R, safe dates, shifting boundaries, wise Guyz targeting this population [11]. These programs generally raise awareness of healthy and abusive behaviour and focus on knowledge, attitude and/or skills for coping with violence.

Programmes differ in their specific contents but are generally found to be effective and resulting in increased awareness, reduced victimization and/or increase active by Standard behaviour [11] which highlights the importance of creating and implementing such programs. Figure 1 shows the conceptual framework of origin and understanding cause of violence.

This necessitates the following objectives for the study:

1. To determine the socio-demographic characteristics of the study population percentage of the study population with good knowledge, attitude and practice.
2. To evaluate the effectiveness of the training module on GBV knowledge, attitude and practice.
3. Limitations were lacking political will.
4. Time and financial constraints
5. Achievement were been able to develop the training module with its implementation.
6. Training was carried out successfully with good results of the training.

The importance or purpose for this study was to predict effectiveness of training module on prevention of gender-based violence among young adults as the specific focus of the research, they will now act as an agent of change in the society/community where they find themselves. The participants or subject in the study were graduates of tertiary institution in Nigeria who were between the ages of nineteen to thirty. It was carried out in a national orientation camp in Kaduna state of Nigeria. The central phenomenon or variable being studied are the percentages of knowledge,

attitude and practices of respondents in pre, intra and post-test.

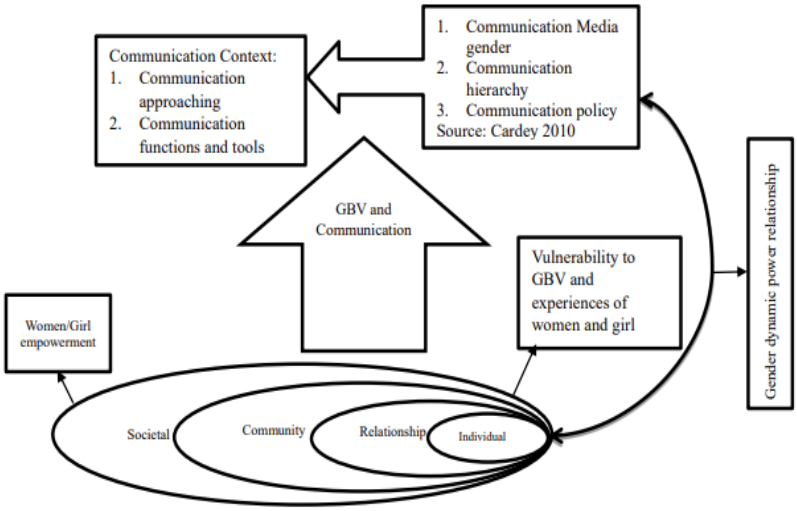

Figure 1. Integrated Conceptual Framework for Technical Concept Relevant to the Study

Note: Figure 1 is a diagram showing encouragement of the widespread adoption of an integrated ecological framework for understanding the origin of violence. Heise, L.L.,1998, Violence against women, an integrated, ecological framework,4(3),262-290.Doi, https://pubmed.ncbi.nlm.nih.gov.

Method

This study try to evaluate the effectiveness of peer led prevention of gender-based violence using a training module in orientation camp of National youth service corps for Nigeria graduates of tertiary institution.

Location

The study site was Kaduna State is located between latitude $9^0$02'N and $11^0$32'North of the equator and between longitude $6^0$15'E and $8^0$50'East of prime meridian.

Kaduna State is bounded to the north by Katsina, Zamfara and Kano states to the west by Niger state, to the east by Bauchi state and to the south by Plateau, Nasarawa and Federal Capital territory, Abuja. The state divided into three senatorial districts, namely Kaduna south, Kaduna central and North. Comprises of twenty-three local government areas (NPC and ICF MACN, 2019).

This study area is located in Kaduna south district in Kagarko local government area.

The study area is a National Youth Services Corps orientation camp (NYSC) meant specifically for graduates of Nigeria tertiary institutions. Since the camp occupant is almost representing the diversity of the country Nigeria, it will bring to the study their different backgrou8nd, cultures, religion into the research project with different opinion, attitude and knowledge there for enriching the study.

Study Design – Randomized Control Trial

It is a form of intervention studies in which was a 2-arm randomized single blind controlled trial involving graduates from Nigeria tertiary institution graduates at Kaduna State's NYSC orientation camp.

The 2 groups are the intervention group and the control group, see Figure 2.

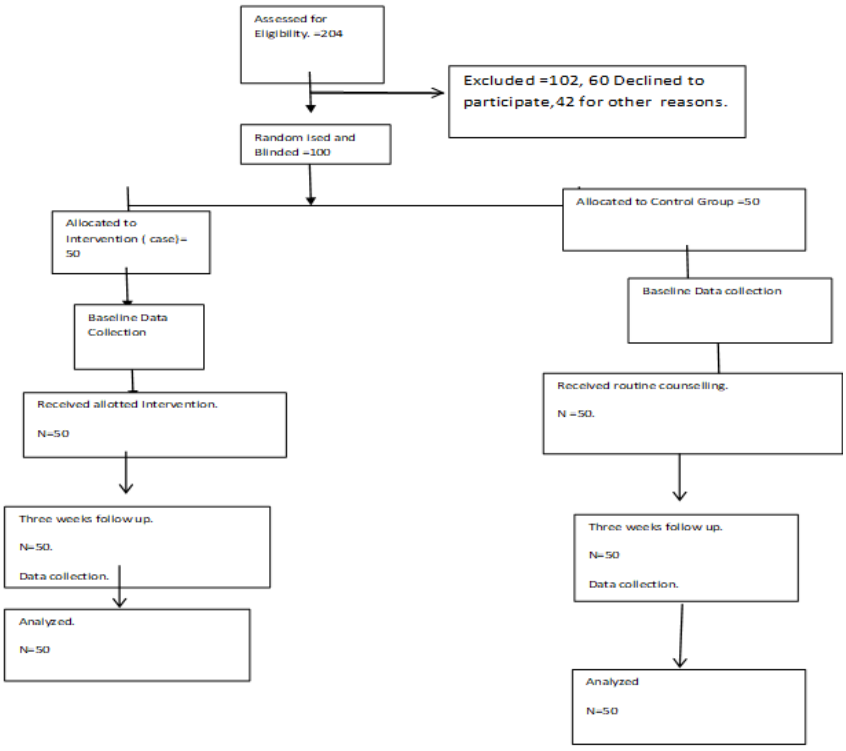

Figure 2. Consort Flow Diagram

Note: Figure 2 is a Consort flow diagram, showing how respondents were selected for the randomized control trial. It was adapted and modified from a previous study by Nancy, L.E., et al, 2005, Biophosphate Therapy improves the outcome of conventional periodontal treatment result study, https://www.researchgate.net

Respondents of intervention group 1 received sessions of training module of GBV prevention, while respondents of control group received lectures on activities of the orientation camp as a placebo.

Baseline measurement on knowledge, attitude and practice to GBV among the tertiary graduates was performed in both intervention and control groups as data was collected on preintervention, intervention and postintervention at 3 weeks.

Sampling Technique

Sample frame used was the list of graduates (registered Corper at Kaduna NYSC orientation camp). Random sampling technique was used to select the individual to participate in the study, while random assignment was used to place the participant into two groups. Sealed opaque envelopes containing allocation colour coded cards (white for controls and red for the intervention group, shuffled together in a basket) was used to execute the random assignment to the two groups so as to minimize allocation bias. A single blinded technique was employed with clients not knowing which group they belong to.

Results

The purpose of this study was to analyse the effectiveness of GBV prevention module on Nigeria tertiary institution graduate in Kaduna State orientation camp.

To achieve this purpose data was collected using a questionnaire and focal group discussion in this study, the data was computed and analysed with descriptive and inferential statistics. A total of 100 questionnaires were distributed and retrieved from the respondents.

Findings

Socio-demographic characteristic of the respondents was obtained from the field. The variables considered in the primary data source

include age of respondent, marital status and religion. The association in the randomized selection of the study population into intervention and control group were analyzed using the chi-square test type to test for the group association.

From the result the p-value 0.87 fall within the acceptance region, as such the randomized selection shows there was association between case and control respondents, hence minimizing confounding factors in the study. Normality of the data was also tested using both numeric and graphic tests. Skewness, kurtosis and Shapiro-wilk tests show data was normally distributed. Graphically using histogram and Q-Q plot also showed data was normally distributed.

Evaluation of the effectiveness of training module on GBV prevention peer led among graduates of Nigeria tertiary institutions in Kaduna State orientation camp. Here repeated measured ANOVA test was used to test the hypothesis the p-value was 0.05, significant value was 0.01 for the three variable which fall within the acceptance region which shows the module was effective.

Finding also involves the percentage of the study population with good knowledge, attitude and practice. The following were the results.

Good knowledge of GBV = 78.4%

Good attitude of GBV = 98%

Good practice of GBV = 76.4%

Discussion

The study main purpose was to evaluate the effectiveness of the training module on prevention of GBV among Nigeria graduates of tertiary institution. The results obtained in above section were in alliance with the written objective in the introductory section. The socio-demographic data of the study population were analyzed based on the following variables: age, marital status and religion using chi-square to check for association between the case and control respondent, show there was association between them, thereby minimizing the confounding factors in the study, as seen in Table 1.

Table 1. Socio-demographic Characteristic of Respondents Age, Religion, Marital Status n=100

Variables	**Frequency n (%) Intervention**	**Control**	**Total**	**Test Type Chi Square**	**P-value**
Age group (years)					
19-24	5(9.0)	13(9.0)	18(18.0)		0.87
25-30	45(41.0)	37(4100)	82(82.0)	X^2	
Religion					
Christianity	30(30.5)	31(30.5)	61(61.0)		0.76
Islam	20(18.0)	16(18.0)	36(36.0)	X^2	
Traditional					
Marital status	0(1.5)	3(1.5)	3(3.0)		
Married	8(8.5)	9(8.5)	17(17.0)		
Co-habitation	4(3.0)	2(3.0)	6(6.0)		
Separated	2(1.5)	1(1.5)	3(3.0)	X^2	0.82
Divorced	1(0.5)	0(.5)	1(1.0)		
Single mother/father	6(6.5)	7(6.5)	13(13.0)		
Other/single	29(30.0)	31(30.0)	60(60.0) 100.0		

Note: Table 1 shows Socio-demographic characteristic of respondents by Age, Religion, Marital status from data derived from field survey 2022, May.

A similar study carried out by Cooks et al2019, [11] shows similar result. From the frequency distribution table of socio-demographic characteristic of age of the study population was 82% were between 25 to 30 years of age while 18% were between 19 to 24 years of age, as seen in Table 2, this was so because the study population were tertiary institution graduate in Nigeria and hence their influence on Gender-based Violence.

Table 2. Frequency Distribution Table by Age of Respondents n=100

Variable	Frequency	(%)
19-24	18	18.0
25-30	82	82.0
Total	100	100s

Note: Table 2 is a frequency distribution table showing the data derived from field survey 2022, May of Age of respondents.

In view of the religion of the study population, 61% were Christians, 36% practice Islam while 3% practice traditional religion, as seen in Table 3. Studies had shown that there is a relationship between religion of individual and their influence on gender-based violence. Peterman P. et al. 2020, [12]. Again also, the marital status of the respondent influences the knowledge, attitude, practice of the person toward gender-based violence. Peterman P. et al 2020, [12]. About 17% of the study population were married, 5% co-habiting, 3% separated, 1% divorced, 13% were single mother while 50% of the study population were single that is not married, see Table 3. This will also influence the respondent knowledge, attitude and practice on gender-based violence. Figure 3, 4, 5 also show the numerical proportion of the variables in the study.

Table 3. Frequency Distribution Table by Religion of Respondents n=100

Variable	Frequency	(%)
Christianity	61	61.0
Islam	36	36.0
Traditional	3	3.0
Total	100	100

Note: *Table 3 is a frequency distribution table of data derived from field survey of 2022, May. Of the religion of respondents.*

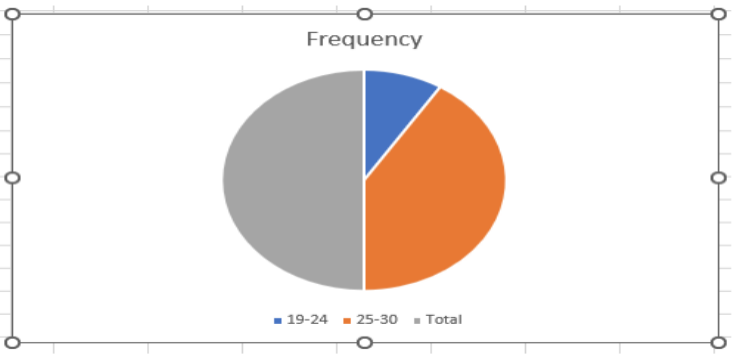

Figure 3. Pie Chart of Respondent by Age

Note: *Figure 3 was derived from field survey showing numerical proportion of the variable by Age of the respondents.*

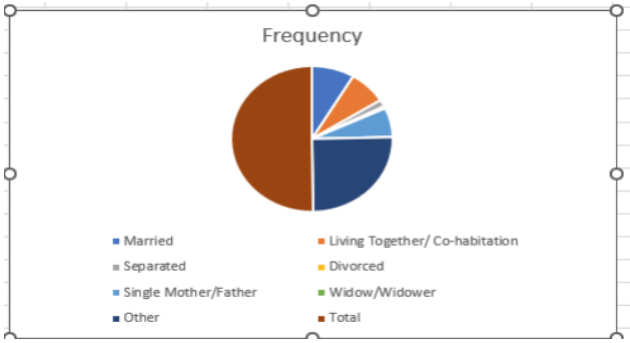

Figure 4. Pie chart of Respondent by Marital Status

Note: *Figure 4 was derived from field survey 2022, May, showing the numerical proportion of the variable by Marital status.*

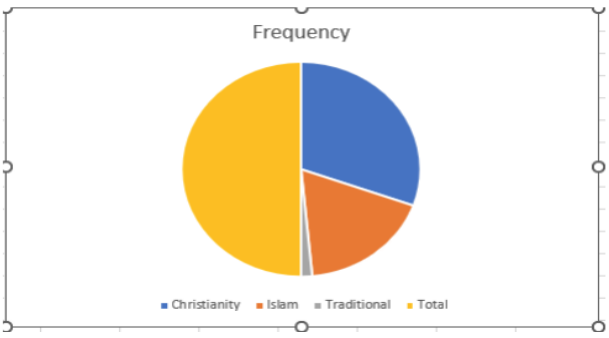

Figure 5. Pie Chart of Respondent by Religion

Note: Figure 5 was derived from the field survey 2022 May, showing the numerical proportion of the variable by Religion of respondent.

The baseline knowledge, attitude and practice were measured among the case group before the intervention. The mean knowledge score was 71.2% which was similar to a previous study by Arango et al2019 [4]. In analyzing the Likert scale which was used in measuring the attitude of case group respondent, independent sample test was used. Group statistics comparing the mean of respondents' age group shows that group have positive attitude to GBV.

From the independent sample test which was used to test the hypothesis if both age groups of respondents have the same positive attitude to GVV, the null hypothesis states that there was no same positive attitude to GBV. The result shows p-value or significant value of 0.002 not significant. Alternate hypothesis accepted which states that age groups respondents have same positive attitude to GBV, this was consistent with a previous study carried out by Wugmoon et al 2017, [13], on attitude of different age group to GBV.

The baseline mean attitude score was 58%, again this result was consistent with Arango et al 2019, [4], previous study on baseline attitude score of respondents before intervention. The baseline mean practice score was 64%.

The effectiveness of a peer led GBV prevention module on knowledge, attitude and practice among Nigeria tertiary institution graduate at Kaduna, NYSC camp was evaluated using repeated measure ANOVA to test the hypothesis. From the descriptive statistic, baseline knowledge mean score was higher than the mean score of immediate knowledge score, post intervention which might likely be due to their own knowledge at that time been literate respondents. The mean knowledge score at 3 weeks post intervention shows higher knowledge of GBV prevention. This was in consistence with Carey et al. 2018, [14], study

on effect of module on knowledge of respondents showing that after intervention lecture respondents developed new knowledge about GBV prevention. In multivariate test using Wilks Lambda statistical test significant value of .000, p-value was significant, hence null hypothesis was rejected and alternate hypothesis accepted which means the module was effective to the knowledge of the respondents. Heise et al 2012, [15], used this Wilks Lambda statistical test to test similar hypothesis in his study which was consistent with effectiveness of module on knowledge of respondents. From descriptive statistics, there was an increase in the mean value from baseline attitude to the mean value at three weeks post intervention of their attitude showing a positive change in attitude among the respondents by age groups, this was consistent with Radtake and Stan et al 2019, [16], previous study on attitude towards GBV.

In multivariate test, using Mauchy's test of sphericity, the sphericity of the data is not violated as the p-value .130 is not significant. Green house Gesisser is close to 1, it is 0.929 supporting that the sphericity is not violated. A such multivariate test was considered for decision making. The p-value is significant 0.000, null hypothesis rejected, alternate hypothesis accepted as such there was effectiveness of module on GBV prevention in attitude by the study population. This again is consistent with Radtake and Stan et al 2019, [16], previous study on attitude towards GBV prevention. The descriptive statistics has shown variation in mean and standard deviation of practice. Mean score of baseline practice lower than the immediate practice and mean score higher than 3 weeks post intervention practice mean score which might likely may be due to the short period for good practice to be observed, recorded or measured which was mentioned as a limitation of the study.

Table 4. Frequency Distribution Table by Marital Status of Respondents n=100

Variable	**Frequency**	**(%)**
Married	17	17.0
Living Together/ Co-habitation	15	5.0
Separated	3	3.0
Divorced	1	1.0
Single Mother/Father	13	13.0
Widow/Widower	0	0
Other	50	50.0
	100	**100**

Note: Table 4 is a frequency distribution table showing data derived from field survey of 2022, May, of Marital status of respondents.

A study carried out by Goonosekere et al 2020, [17] who collected data after six months shows higher mean score at six months when compared with baseline and immediate mean scores. Using multivariate, Wilk's Lambda test to the hypothesis of the effectiveness of the training module on practice of the study population, p-value was significant null hypothesis rejected, alternate hypothesis accepted, this shows statistically that there was effectiveness in the module training/intervention to the respondents.

Mauchy's test of sphericity, Epsilon was used, sphericity was violated supported by Greenhouse Geisser test, p-value significance. The Mauchy's test of sphericity was violated as the significant value was less than 0.05, Greenhouse Geisser test was considered for decision making statistically, p-value .001, also supported the effectiveness of the module in this study as shown in Table 5.

Table 5. Table of Mauchy's Test of Sphericity Epsilon

Within subject effect	Mauchy's W	Approx Chi Square	Df	Sig	Greenhouse Geisser
Practice	.265	52.464	2	.000	.575

Sphericity was violated, supported by Greenhouse Geisser test, P-Value Significant

Note: Table 5 was derived from field survey data 2022, May, using Repeated measure ANOVA test from SPSS software data analysis.

The outcome variable which was the percentage of good knowledge, good attitude and good practice of GBV were also calculated. Good knowledge was 78.4%, good attitude was 98%, good practice was 76.4%. Classification of percentage of knowledge, attitude and practice were into good, moderate/fair and poor. This classification system was adapted and modified from previous studies. 80% and above was rated good, 60% - 79% was rated as moderate/fair, while less than 60% was rated as poor as shown in Table 6. The outcome variable from the study was to measure the percentage of study population with good knowledge, attitude and practice.

Table 6. Classification of Percentage scores of Knowledge, Attitude and Practice into Good, Moderate/Fair and Poor

Percentage of total scores %	Total scores of Knowledge	Total score of Attitude	Total score of practice	Level
80-100		98%		Good
60-79	78.4%		74.4%	Moderate/Fair
<60				Poor

Note: Table 6 is the classification for total scores of knowledges, attitudes and practises adapted and modified from Joseph Arbiol et al 2018, Knowledge, attitude and practises towards Leptospirosis among Lakeshores communities of Calamba,doi,6(2),10.3390/agriculture6020018, https: www.mdpi.com/openaccess.

The data collected three weeks post intervention gave the above results. The outcome knowledge percentage was 78.4% which corresponded with moderate/fair score in level classification. Attitude percentage score was 98% corresponding to good score in level classification.

Practice percentage was 74.4% corresponding to moderate/fair level of classification. The baseline knowledge percentage score of the study population was 71.2%, post intervention three weeks after, knowledge score was 78.4%. this shows just little change which was likely due to the study population been literate and having a prior knowledge about GBV before the study as an educated study population.

Baseline attitude percentage score was 58%, post intervention three weeks after was 98% which was corresponding to good score of level classification, this was due to their understanding of the intervention module training which has changed their opinion and attitude towards GBV. Baseline practice percentage score was 64%, post intervention three weeks after was 74.4%, which was in moderate/fair level of classification. There was an improvement in practice score though it could be better but the timeframe for the study was short to show any significance in their practice. There was some consistency in this study with that of Joseph Argbiol et al, 2018,[18], study of similar and in his previous work. Though, Joseph Arbiol et al 2018,[18], study practice percentage score was 85% data was collected after six months. Again, there was

comparison between the knowledge of case group and that of control group post intervention at three weeks after intervention. Independent sample test was used. The group statistics show a little difference in the means of case and control group.

In testing the hypothesis that there was a difference in their knowledge outcome at three weeks post intervention between the two groups (case and control) which was the alternate hypothesis – independent sample test was used. The t-test showed difference in their t-value, the significant value was 0.816 is not significant and close to 1, hence null hypothesis which states that there was no difference in knowledge after three weeks post intervention was rejected and alternate hypothesis accepted which means from the test statistics. There was a difference between both groups, this was in consistence with a previous study by Radtake et al, 2019, [16], on Gender-Based Violence programme in Sudan.

Conclusion

The primary aim of the thesis/study was to see how gender-based violence (GBV) can be prevented using a peer led group and training module.

This study has shown that educational qualification helps in knowledge about GBV that invariably affects the attitude and practice of stakeholders. Again, from the study it was found that individual religion and marital status affect their knowledge or opinion about GBV.

Age of respondent from the study also showed that respondent aged 25 and above were more knowledgeable about GBV that their peers who were less than 24 years.

In this study, the training module has helped in improving the knowledge base of the participants such that their high score in percentage of their knowledge, attitude and practice of GBV as evident in the above result.

Study provided information that GBV could be prevented by improving awareness of GBV to stakeholder. The study also provided information that GBV is influenced by marital status, religion, and justification to wife beating.

Information from the study during focal group discussion shows that both sexes experiences GBV of sexual nature. From the study, there will be need for policies and programme to empower women and other vulnerable members of the society. There will be need to mount intervention to cater for the high proportion of women who are exposed to GBV in the community. Study also highlights the need for public enlightenment on GBV in order to equip the younger adolescents with information to protect them and also prevent them from being perpetrators of violence in adulthood.

Further longitudinal research is needed to better understand the complex range of factors related to GBV among both men and women.

Dedication

This research study is dedicated to my beloved father, Pa Alfred Omotosho Oyidi.

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Assessment of Zero Dose, Under-Immunized, and Dropout Children in Ifelodun Local Government Area, Kwara State Nigeria

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Abstract

Immunization is a cost-effective strategy for reducing childhood morbidity and mortality, yet Nigeria faces challenges in achieving optimal vaccination coverage. This study assessed the prevalence and determinants of incomplete immunization among children aged 0–23 months in Ifelodun LGA through a cross-sectional survey of 383 caregivers selected via multistage random sampling. Data were collected using structured questionnaires and analyzed using descriptive statistics, chi-square tests, and logistic regression. While 93.5% of children received at least one vaccine, only 19.6% were fully immunized. Three immunization gaps were identified: zero-dose children (6.5%), under-immunized (50.4%), and dropouts (23.5%). Place of delivery significantly influenced coverage, with hospital-born children having higher full immunization rates (25.5%) compared to home births, which had higher dropout rates (29.6%). Key barriers included parental negligence (23.1%), lack of awareness (18.8%), fear of side effects (15.6%), and accessibility/financial constraints (12% and 11.4%). Multivariate analysis showed zero-dose status was predicted by lack of awareness (OR=3.96, p=0.053), unfamiliarity with vaccination sites (OR=11.44, p=0.014), and stockouts (OR=10.74, p=0.007). Under-immunization was strongly linked to older child age (OR=6.75, p=0.001), while learning about vaccines from friends was protective (OR=0.32, p=0.009). Dropout risk increased with older age (OR=3.93, p=0.002) but decreased with caregiver education from friends (OR=0.23, p=0.027). Despite the high initial uptake, dropout rates remain concerning. Targeted interventions addressing health system barriers, education, supply chains, and community engagement are critical to improving coverage.

Keywords: *Dropout, Immunization, Nigeria, Under-Immunized, Zero-Dose Children.*

Introduction

Immunization remains one of the most cost-effective public health interventions, preventing an estimated 2–3 million childhood deaths annually [1]. However, vaccination coverage in many low- and middle-income countries (LMICs) falls below the World Health Organization's (WHO) target of 90% national coverage for three doses of diphtheria-tetanus-pertussis (DTP3) vaccines [2]. Globally, approximately 22.7 million children are either "zero-dose" (having received no vaccines) or under-immunized (incomplete vaccination), with about 3.1 million (14%) residing in Nigeria [3].

The Nigerian immunization schedule includes Bacillus Calmette-Guérin (BCG), oral polio vaccine (OPV), and hepatitis B at birth; three doses of OPV, pentavalent vaccine, and pneumococcal conjugate vaccine (PCV) at 6, 10, and 14 weeks; and measles-containing vaccine (MCV), meningococcal, and yellow fever vaccines at 9 months [4,1]. Despite these standardized protocols, Nigeria's DTP1 and

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DTP3 coverage rates were only 65% and 57% respectively in 2020 [5], with the number of zero-dose children increasing from 3.0 million in 2019 to 3.1 million in 2020 [2].

Nigeria's challenges are particularly acute, accounting for two-thirds of unvaccinated children worldwide in 2022 [6]. Vaccine-preventable diseases contribute to 22% of childhood mortality [7], with rural children being twice as likely to miss vaccinations compared to urban counterparts [8]. Multiple factors influence these gaps, including maternal education, geographic accessibility, and healthcare system limitations [9,10].

Globally, 87% of zero-dose children reside in LMICs, with Nigeria, India, and the Democratic Republic of Congo contributing the highest numbers [11]. Subnational disparities are stark; conflict-affected and rural regions exhibit coverage gaps exceeding 50% [12]. In Nigeria, factors such as maternal education, household income, and healthcare accessibility influence immunization status [13]. For instance, children of mothers with no formal education are 3.3 times more likely to be zero-dose [14], while home births correlate with higher dropout rates [15]. System-level challenges including vaccine stockouts, distance to health facilities, and caregiver misinformation further exacerbate disparities [16, 17].

In Ifelodun Local Government Area (LGA) of Kwara State, persistent immunization gaps are evident, with 15,642 zero-dose children recorded between 2021–2023 [18]. Geographic barriers, socioeconomic constraints, and healthcare service challenges contribute to these low coverage rates. This study examined the prevalence of zero-dose, under-immunized, and immunization dropout among children aged 0–23 months and determinants of immunization gaps in Ifelodun LGA, Kwara State, Nigeria.

Materials and Methods

This section details the methodological framework, including research design, population sampling, instrumentation, data collection protocols, analytical approaches, and ethical considerations employed in investigating immunization coverage gaps among under-24-month children in Ifelodun LGA, Nigeria.

Research Design

A cross-sectional survey design was adopted, combining quantitative methods with open-ended qualitative components. This mixed-methods approach enabled both statistical analysis of immunization patterns and nuanced understanding of contextual factors influencing vaccination uptake.

Study Area

The study was conducted across all 18 wards of Ifelodun LGA, Kwara State (population: 350,773; NPC 2024), with particular focus on its 63,210-under-five population. Ward-level demographic data informed stratified sampling to ensure geographic representation of the target 0-23 month cohort.

Target Population

The study population comprised mother-child dyads (children 0-23 months) residing ≥12 months in Ifelodun LGA. This selection criterion ensured participants had sufficient exposure to local immunization services while capturing the critical vaccination window under EPI schedules.

Sampling Strategy

Fisher's formula was used to determine the sample of 384, with proportional allocation across wards based on under-five populations. A multi-stage random sampling approach was employed:

1. Ward-level proportional allocation.
2. Settlement randomization via balloting.

3. Household selection using modified spin-the-bottle technique with systematic skipping.

Instrumentation

A validated semi-structured questionnaire captured:

1. Section A: Sociodemographics
2. Section B: Immunization status (verified by card/recall)
3. Section C: Barriers to vaccination
4. Section D: Improvement strategies

Incorporated both closed-ended and open-response items to balance quantitative precision with qualitative depth.

Validity & Reliability

Robust psychometric testing included:

1. *Content validity*: Expert panel review (5 public health specialists)
2. *Face validity*: Pilot testing (n=38; 10% sample)
3. *Reliability*: Cronbach's $\alpha \geq 0.7$ for all retained scales

Pretesting in Ilorin South LGA confirmed the instrument appropriateness, clarity and non-ambiguity.

Data Collection

Trained enumerators administered electronic questionnaires (KoBoCollect) in local languages after rigorous competency testing. Standardized protocols ensured:

1. Consistent question interpretation
2. Privacy protections
3. Data quality checks (real-time completeness validation)

Analytical Approach. Data were analysed using SPSS v26

The following analytical methods were employed

1. *Descriptive analyses*: Frequencies/proportions for coverage rates
2. *Bivariate analyses*: χ^2 tests for association detection
3. *Multivariate modeling*: Logistic regression to identify predictors of:
    - Zero-dose status
    - Under-immunization
    - Dropout rates

All analytical tests employed were at $\alpha=0.05$ with 95% CIs.

Ethical Compliance

The Ethics and Research Committee (ERC/MOH/2024/10/351) of Kwara State Ministry of Health, Nigeria, approved the study's conduct, with protocols ensuring voluntary participation, informed consent, data anonymity, and community benefit. The study adhered to research ethical principles of autonomy, beneficence, non-maleficence, and justice throughout implementation.

Results

Table 1. Sociodemographic Characteristics

Sociodemographic Characteristics		**Frequency (N=383)**	**Percentage (%)**
Age of mother	15-25	94	24.5
	26-35	235	61.4
	36-42	54	14.1
	Mean±SD	29.6±5.6	
Education Level of mother	No education	142	37.1
	Primary	90	23.5
	Secondary	124	32.4
	Higher	27	7
Education Level of father	No education	118	30.8
	Primary	52	13.6

	Secondary	149	38.9
	Higher	64	16.7
Child age	Less than 6 weeks	55	14.4
	6weeks-10weeks	48	12.5
	10weeks-14weeks	50	13.1
	14weeks-6months	46	12
	6months-9months	31	8.1
	9months-12months	44	11.5
	12months-15months	44	11.5
	15months-24months	65	17
Gender of Child	Male	195	50.9
	Female	188	49.1
Number of siblings	None	54	14.1
	1-3	283	73.9
	4-7	46	12
	Mean±SD	1.34±2.01	
Place of delivery	Hospital	243	63.4
	Home	135	35.2
	Others	5	1.3

The data presented in Table 1 indicates that the average age of mothers is 29.6 years, with a standard deviation of 5.6. A significant portion, specifically 142 mothers (37.1%), lack formal education. In contrast, a larger proportion of fathers, amounting to 149 (38.9%), possess a secondary school education, while 118 fathers (30.8%) have no formal education in the Ifelodun local government area. Additionally, it is noted that 195 children (50.9%) are male. Most of the children, 283 (73.9%), have between one to three siblings, and nearly two-thirds, 243 (63.4%), were delivered in a hospital setting.

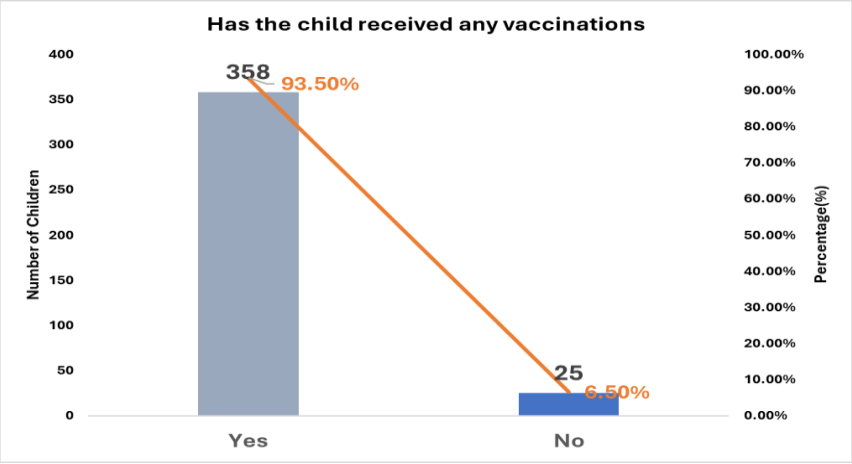

Figure 1. Status of Routine Immunization Among Children

The data in Figure 1 show that 358 respondents (93.5%) reported their child had received at least one vaccination, while 25 respondents (6.5%) indicated their child had not been vaccinated. This high initial vaccine uptake rate of 93.5% in Ifelodun Local Government, Kwara State, represents a significant achievement.

Table 2. Type of Vaccines Ever Received by Children

Type of Vaccines	Frequency (N=383)	Percentage (%)
BCG	332	84.1
OPV	333	86.9
HepB	144	37.6
Penta	234	61.1
PCV	229	59.8
IPV	185	48.3
ROTA	198	51.7
Measles	50	13.1
Vitamin A	64	16.7
Yellow fever	38	9.9
Meningitis	31	8.1
No vaccination	25	6.5

The findings presented in Table 2 indicate that the Oral Polio Vaccine (OPV) is the most frequently administered vaccine, with 333 children (86.9%) having received it, highlighting the significant impact of the polio eradication initiative in the region. Following closely is the Bacillus Calmette-Guérin (BCG) vaccine, which has been administered to 332 children (84.1%). Additionally, the data in Table 2 reveals that the Penta, Rota, Pneumococcal Conjugate Vaccine (PCV), and Inactivated Polio Vaccine (IPV) are also among the most received vaccinations in Ifelodun Local Government, Kwara State.

Table 3. Number of Children who Received Penta Vaccines

		Frequency	Percentage (%)
Has your child ever received an injection in their left upper thigh to protect against tetanus, whooping cough, or Diphtheria	Yes	234	61.1
	No	149	38.9
	Total	**383**	**100**
Number of times child received Penta vaccine	One time	85	36.3
	Two times	66	28.2
	Three times	83	35.5
	Total	**234**	**100**

The study findings demonstrate that 234 children (61.1%) received an intramuscular injection in the left upper thigh for protection against tetanus, pertussis (whooping cough), diphtheria, hepatitis B, and Haemophilus influenzae type b (Hib). In contrast, 149 children (38.9%) did not receive this vaccination.

Table 4. Number of Fully Eligible Children who Received Complete PENTA Vaccines Dosages

		Frequency	Percentage (%)
Has your child ever received an injection in their left upper thigh to protect against tetanus, whooping cough, or Diphtheria	Yes	181	78.7
	No	49	21.3
	Total	**230**	**100**
Number of times child received Penta vaccine	One time	43	23.8
	Two times	55	30.3
	Three times	83	45.9
	Total	**181**	**100**

The research indicates that among children eligible for the complete dosage of the Penta vaccine, 181 (78.7%) have received at least one dose. However, of these 181 children who commenced the vaccination series, only 83 (45.9%) completed all three doses, resulting in a dropout of 54.1% within the Ifelodun Local Government Area of Kwara State.

Table 5. Category of Child Routine Immunization Status (Under-Immunized, Zero-Dose, Dropout)

Child Immunization Status	Frequency	Percentage (%)
Fully Immunized	75	19.6
Under-immunized	193	50.4
Zero-dose	25	6.5
Immunization Dropout	90	23.5
Total	**383**	**100**

According to the Nigeria Expanded Programme on Immunization (EPI) schedule - which includes BCG, oral polio vaccine (OPV), pentavalent vaccine (diphtheria-tetanus-pertussis-hepatitis B-Haemophilus influenzae type b), measles, yellow fever, and other routine vaccines - Table 5 data indicate that 193 children (50.4%) were under-immunized. Furthermore, 25 children (6.5%) had received no vaccinations (zero-dose), while 90 children (23.5%) were immunization dropouts.

Table 6. Reason for Incomplete Vaccination

Reason for incomplete the vaccination	Frequency	Percentage (%)
Accessibility Issues	37	12.0
Because I did not give birth in the health facility	1	0.3
Child is sick	13	4.2
Cultural Beliefs	17	5.5
Fear of Side Effects	48	15.6
Financial Constraints	35	11.4
Health Worker were absent	2	0.6
I do not have time (parental negligence)	71	23.1
Lack of Awareness	58	18.8
Lack of Trust in Healthcare System	1	0.3
Previous Bad Experience	14	4.5
Rumour (Misconception)	6	1.9
Vaccine was not available	5	1.6
Total	**308**	**100**

The data presented in Table 6 identifies the primary factors contributing to incomplete vaccination among children as reported by their caregivers. The most common reason was caregivers' lack of time to facilitate vaccination (23.1%), followed by lack of awareness about immunization (18.8%). Concerns about potential vaccine side effects were reported by 15.6% of caregivers, while 12% cited difficulties accessing vaccination services. Financial constraints were reported by 11.4% of caregivers.

Table 7. Association between the Child Vaccination Status and the Sociodemographic Characteristics of Respondents

	Child Immunization Status (N=383)				**Pearson Chi-square Tests**	
	Fully Immunized N (%)	**Under-immunized N (%)**	**Zero-dose N (%)**	**Immunization Dropout N (%)**	***X***	**p-value**
Age of mother						
15-25	21 (22.3)	45 (47.9)	3 (3.2)	25 (26.6)	11.604	0.071
26-35	48 (20.4)	123 (52.3)	14 (6)	50 (21.3)		
36-42	6 (11.1)	25 (46.3)	8 (14.8)	15 (27.8)		
Education Level of mother						
No education	24 (16.9)	67 (47.2)	13 (9.2)	38 (26.8)	6.553	0.684
Primary	20 (22.2)	49 (54.4)	4 (4.4)	17 (18.9)		
Secondary	27 (21.8)	61 (49.2)	7 (5.6)	29 (23.4)		
Higher	4 (14.8)	16 (59.3)	1 (3.7)	6 (22.2)		
Education Level of father						
No education	23 (19.5)	58 (49.2)	10 (8.5)	27 (22.9)	14.224	0.115
Primary	5 (9.6)	31 (59.6)	5 (9.6)	11 (21.2)		
Secondary	28 (18.8)	77 (51.7)	10 (6.7)	34 (22.8)		
Higher	19 (29.7)	27 (42.2)	0 (0)	18 (28.1)		
Age of child						
Less than 6 weeks	31 (56.4)	17 (30.9)	7 (12.7)	0 (0)	**146.83**	**<0.0001**
6w-10w	12 (25)	34 (70.8)	2 (4.2)	0 (0)		
10w-14w	11 (22)	38 (76)	1 (2)	0 (0)		
14w-6m	7 (15.2)	15 (32.6)	2 (4.3)	22 (47.8)		
6m-9m	5 (16.1)	12 (38.7)	4 (12.9)	10 (32.3)		
9m-12m	3 (6.8)	20 (45.5)	5 (11.4)	16 (36.4)		
12m-15m	4 (9.1)	20 (45.5)	2 (4.5)	18 (40.9)		
15m-24m	2 (3.1)	37 (56.9)	2 (3.1)	24 (36.9)		
Gender of child						
Male	38 (19.5)	100 (51.3)	16 (8.2)	41 (21)	2.811	0.422
Female	37 (19.7)	93 (49.5)	9 (4.8)	49 (26.1)		
Number of siblings						
None	7 (13)	30 (55.6)	5 (9.3)	12 (22.2)	4.57	0.600
1-3.	55 (19.4)	143 (50.5)	17 (6)	68 (24)		
4-7.	13 (28.3)	20 (43.5)	3 (6.5)	10 (21.7)		
Place of delivery						
Hospital	62 (25.5)	125 (51.4)	7 (2.9)	49 (20.2)	**30.722**	**<0.001**
Home	12 (8.9)	65 (48.1)	18 (13.3)	40 (29.6)		
Others	1 (20)	3 (60)	0 (0)	1 (20)		

The findings presented in Table 7 from the Pearson's Chi-square test indicate a significant association (p-value <0.0001) between the age of the child with immunization status (p <

0.0001). Younger children (<6 weeks) had the highest full immunization rate (31, 56.4%), while dropout rates peaked at 14 weeks to 6 months (22, 47.8%). Furthermore, there was a significant association (p-value <0.001) between the location of their delivery with the child's immunization status, children born in hospitals had higher full immunization rates (62, 25.5%) and lower zero-dose rates (7, 2.9%) compared to home deliveries, where dropout was higher (40, 29.6%). However, maternal and paternal education, maternal age, child gender, and the number of siblings showed no statistically significant associations.

Table 8. Predictors of Zero-Dose Immunization Status among Children

		p-value	OR	95% C.I. for OR	
				Lower	Upper
Age of child	Less than 6 weeks	0.031	**Ref**		
	6w-10w	0.079	0.189	0.029	1.212
	10w-14w	0.079	0.04	0.001	1.455
	14w-6m	0.096	0.144	0.015	1.41
	6m-9m	0.455	0.516	0.091	2.921
	9m-12m	0.101	0.239	0.043	1.32
	12m-15m	0.009	0.022	0.001	0.385
	15m-24m	0.001	0.008	0	0.13
Place of delivery	Hospital		**Ref**		
	Home/Others	0.302	1.868	0.57	6.121
Are you aware of the importance of childhood immunizations	Yes		**Ref**		
	No	0.053	3.958	0.98	15.993
How did you learn about immunizations	Health worker	0.729	**Ref**		
	Family	0.482	0.365	0.022	6.071
	Friend	0.649	0.644	0.097	4.272
	Media	0.905	1.192	0.067	21.211
	Others	0.388	2.628	0.293	23.572
Do you know where to get your child vaccinated	Yes		**Ref**		
	No	0.014	11.438	1.627	80.421
Are vaccines always available when you visit the health facility	Yes		**Ref**		
	No	0.007	10.738	1.929	59.781
Do you receive reminders for your child’s next vaccination appointment	Yes		**Ref**		
	No	0.925	0.921	0.165	5.146
Are there any cultural beliefs or practices that influence your decision on child immunization	Yes		**Ref**		
	No	0.158	0.337	0.075	1.525
Do you face any social pressure regarding immunizing your child	Yes		**Ref**		
	No	0.778	1.259	0.254	6.242
Constant		0.178	0.186		

The logistic regression analysis presented in Table 8 indicates that children older than 6 weeks are less likely to exhibit a zero-dose immunization status compared to those younger than 6 weeks, with an odds ratio of less than 1. Additionally, the findings reveal that children born at home are 87% more likely to have a zero-dose status than their

counterparts born in a hospital (OR=1.868). Furthermore, children whose caregivers lack awareness regarding the significance of childhood immunization are four times more likely to have a zero-dose immunization status compared to those who are informed (OR=3.958). Moreover, children of caregivers who acquire knowledge about immunization from family and friends are 63% and 36% less likely to have a zero-dose immunization status than those who receive this information from healthcare professionals (OR=0.365, OR=0.644). Conversely, those who learn about immunization through media and other sources are 19% and 2.6 times more likely, respectively, to have a zero-dose status compared to those who learn from health workers (OR=1.192, OR=2.628).

Additionally, children of caregivers who are unaware of where to obtain immunizations are 11.4 times more likely to have a zero-dose status than those who know (OR=11.438). The data in Table 8 also indicates that children of caregivers who report that vaccines are not consistently available at health facilities are 10.7 times more likely to have a zero-dose immunization status compared to those who report vaccine availability (OR=10.738).

Furthermore, children of caregivers who do not receive reminders for their child's upcoming vaccination appointments are 7% less likely to have a zero-dose immunization status than those who do receive reminders (OR=0.925). Lastly, children of caregivers who do not hold any cultural beliefs or practices that affect their immunization decisions are 66% less likely to have a zero-dose immunization status compared to those who do (OR=0.337), while children of caregivers who do not experience social pressure regarding immunization are 26% more likely to have a zero-dose status than those who do (OR=1.148).

Table 9. Predictors of Under-Immunized STATUS among Children

		p-value	**OR**	**95% C.I. for OR**	
				Lower	**Upper**
Age of child	Less than 6 weeks	<0.001	**Ref**		
	6w-10w	<0.001	5.547	2.321	13.26
	10w-14w	<0.001	6.748	2.755	16.53
	14w-6m	0.982	0.99	0.417	2.351
	6m-9m	0.712	1.197	0.46	3.114
	9m-12m	0.141	1.903	0.808	4.481
	12m-15m	0.106	2.047	0.86	4.876
	15m-24m	0.003	3.453	1.54	7.742
Place of delivery	Hospital		**Ref**		
	Home/Others	0.84	1.052	0.641	1.728
Are you aware of the importance of childhood immunizations	Yes		**Ref**		
	No	0.451	1.371	0.603	3.12
How did you learn about immunizations	Health worker	0.082	**Ref**		
	Family	0.188	0.509	0.187	1.39
	Friend	0.009	0.316	0.133	0.75
	Media	0.615	0.749	0.243	2.311
	Others	0.56	0.598	0.106	3.366
Do you know where to get your child vaccinated	Yes		**Ref**		
	No	0.042	0.206	0.045	0.946
Are vaccines always available when	Yes		**Ref**		

you visit the health facility	No	0.043	0.395	0.161	0.97
Do you receive reminders for your child's next vaccination appointment	Yes		**Ref**		
	No	0.515	1.269	0.619	2.601
Are there any cultural beliefs or practices that influence your decision on child immunization	Yes		**Ref**		
	No	0.334	0.637	0.255	1.59
Do you face any social pressure regarding immunizing your child	Yes		**Ref**		
	No	0.747	1.148	0.497	2.649
Constant		0.643	0.732		

The logistic regression analysis presented in Table 9 indicates that children older than 6 weeks are significantly more likely to be under-immunized compared to those younger than 6 weeks, with an odds ratio exceeding 1. Additionally, the findings reveal that children born at home have a 5% higher likelihood of being under-immunized than their hospital-born counterparts (OR=1.052). Furthermore, children whose caregivers lack awareness regarding the significance of childhood immunization are 37% more likely to be under-immunized compared to those whose caregivers are informed (OR=1.371). Moreover, children of caregivers who acquire knowledge about immunization from family, friends, media, and other sources are less likely to be under-immunized by 49%, 68%, 25%, and 40%, respectively, when compared to those who receive this information from health workers (OR=0.509, OR=0.316, OR=0.749, OR=0.598). Interestingly, children of caregivers who are unaware of where to obtain immunizations are 79% less likely to be under-immunized than those who know (OR=0.206).

The data in Table 9 further illustrates that children of caregivers who report that vaccines are not consistently available at health facilities are 60% less likely to be under-immunized compared to those who confirm vaccine availability (OR=0.395). Additionally, children of caregivers who do not receive reminders for their child's upcoming vaccination appointments are 27% more likely to be under-immunized than those who do receive such reminders (OR=1.268). Lastly, children of caregivers who do not hold any cultural beliefs or practices that affect their immunization decisions are 36% less likely to be under-immunized than those who do (OR=0.337), while children of caregivers who do not experience social pressure regarding immunization are 15% more likely to be under-immunized compared to those who do face such pressure (OR=1.148).

Table 10. Predictors of Immunization Drop-Out Status among Children

		p-value	**OR**	**95% C.I. for OR**	
				Lower	**Upper**
Age of child	14w-6m	0.025	**Ref**		
	6m-9m	0.549	1.36	0.498	3.717
	9m-12m	0.065	2.365	0.947	5.903
	12m-15m	0.1	2.146	0.865	5.325
	15m-24m	0.002	3.925	1.674	9.198
Place of delivery	Hospital		**Ref**		
	Home/Others	0.179	0.641	0.336	1.226
Are you aware of the importance of childhood immunizations	Yes		**Ref**		
	No	0.465	1.422	0.553	3.66

How did you learn about immunizations	Health worker	0.188	**Ref**		
	Family	0.584	0.717	0.218	2.36
	Friend	0.027	0.225	0.06	0.843
	Media	0.368	2.065	0.426	10.021
	Others	0.958	1.065	0.102	11.071
Do you know where to get your child vaccinated	Yes		**Ref**		
	No	0.042	0.138	0.02	0.931
Are vaccines always available when you visit the health facility	Yes		**Ref**		
	No	0.137	0.451	0.158	1.287
Do you receive reminders for your child's next vaccination appointment	Yes		**Ref**		
	No	0.753	0.862	0.342	2.173
Are there any cultural beliefs or practices that influence your decision on child immunization	Yes		**Ref**		
	No	0.247	0.55	0.2	1.514
Do you face any social pressure regarding immunizing your child	Yes		**Ref**		
	No	0.772	1.155	0.435	3.068
Constant		0.869	0.884		

The logistic regression analysis presented in Table10 indicates that children older than 6 months exhibit a higher likelihood of experiencing immunization dropout status compared to those younger than 6 months, with an odds ratio exceeding 1. Additionally, the findings reveal that children born at home are 36% less likely to have immunization dropout status than their counterparts born in hospitals (OR=0.641). Furthermore, children whose caregivers lack awareness regarding the significance of childhood immunization are 42% more likely to experience immunization dropout status compared to those whose caregivers are informed (OR=1.422). Moreover, children of caregivers who acquire knowledge about the importance of immunization from family and friends are 28% and 77% less likely, respectively, to have immunization dropout status compared to those who receive this information from healthcare professionals (OR=0.717, OR=0.225). Conversely, those who learn about immunization through media and other sources are twice as likely and 6% more likely, respectively, to have immunization dropout status compared to those informed by health workers (OR=2.065, OR=1.065).

Additionally, children of caregivers who are unaware of where to obtain immunizations are 86% less likely to have immunization dropout status than those who know (OR=0.138). The data in Table 10 further indicates that children of caregivers who report that vaccines are not consistently available at health facilities are 55% less likely to experience immunization dropout status compared to those who report vaccine availability (OR=0.451). Furthermore, children of caregivers who do not receive reminders for their child's upcoming vaccination appointments are 14% less likely to have immunization dropout status than those who do receive such reminders (OR=0.862).

Lastly, children of caregivers who do not adhere to any cultural beliefs or practices that affect their immunization decisions are 45% less likely to have immunization dropout status compared to those who do (OR=0.55). Additionally, children of caregivers who do not encounter social pressure regarding immunization are 16% more likely to have a

zero-dose immunization status than those who do face such pressure (OR=1.155).

Discussion

The study provides critical insights into the sociodemographic factors influencing childhood immunization in Ifelodun LGA, Nigeria. The findings of this study align with previous research on childhood immunization in Nigeria and other low- and middle-income countries (LMICs). The findings reveal significant gaps in immunization coverage, with only 19.6% of children fully immunized, while 50.4% were under-immunized, 23.5% experienced immunization dropout, and 6.5% were zero-dose. These figures are consistent with Nigeria's national trends, where full immunization coverage remains low reported 31% full immunization coverage in Nigeria, indicating regional disparities, with rural areas like Ifelodun LGA lagging behind [19]. Similarly, a study in Kano State, Nigeria, found only 22.5% full immunization coverage, reinforcing systemic challenges [20].

However, some studies report higher coverage. For instance, Oyo State, Nigeria, recorded 43.7% full immunization [21]. suggesting that regional healthcare infrastructure and program implementation influence outcomes. The higher dropout rates (23.5%) in this study mirror findings from Ethiopia, where 20-30% of children fail to complete the immunization schedule [22]. highlighting persistent systemic barriers in LMICs.These statistics highlight substantial challenges in achieving universal immunization coverage, necessitating targeted interventions.

The study reveals that maternal and paternal education levels do not significantly influence immunization status (p=0.684 for mothers, p=0.115 for fathers). 37.1% of mothers and 30.8% of fathers had no formal education, which may contribute to low awareness and vaccine hesitancy. However, the place of delivery emerges as a crucial factor—children born in hospitals have higher full immunization rates (25.5%) and lower zero-dose rates (2.9%) compared to home deliveries, where dropout rates are higher (29.6%). This suggests that institutional deliveries facilitate early immunization engagement, possibly due to immediate postnatal vaccination and health education, aligning with global evidence. A study in India [23]. found institutional deliveries increased early vaccination by 40%, attributing this to immediate postnatal vaccination and health worker engagement. Similarly, a Kenyan study [24]. reported home births doubled dropout risks, reinforcing the need for facility-based interventions.

Child age is another significant predictor, with younger infants (<6 weeks) having the highest full immunization rates (56.4%), while dropout rates increase as children grow older (peaking at 14 weeks–6 months). This aligns with global trends where immunization adherence declines with age, often due to logistical barriers, parental forgetfulness, or competing priorities. A study in Pakistan [25]. found similar age-related declines, attributing them to competing family priorities and logistical barriers. However, a Ugandan study [26]. reported better retention through mobile reminders, suggesting interventions like SMS alerts could mitigate dropout.

BCG (84.1%) and OPV (86.9%) had high coverage, likely due to their administration at birth. However, Penta (61.1%), PCV (59.8%), and ROTA (51.7%) saw lower rates, suggesting systemic dropouts as the immunization schedule progresses. Only 45.9% of eligible children completed all three Penta doses, reinforcing the need for reminder systems and community engagement to improve retention. Mirroring findings from DRC [27]. This "front-loading" phenomenon—where birth doses succeed but later doses fail is common in LMICs due to weak follow-up systems. A study in

Bangladesh [28]. found community health workers improved Penta3 completion by 25%, suggesting similar interventions could help in Ifelodun LGA.

The study found that 61.1% (234 children) received at least one dose of the Penta vaccine (protecting against tetanus, whooping cough, diphtheria, Hepatitis B, and Hib), while 38.9% (149 children) were unvaccinated. Among eligible children, 78.7% (181/230) initiated vaccination, but only 45.9% (83/181) completed all three doses, resulting in a 54.1% dropout rate in Ifelodun LGA, Kwara State. These findings align with previous studies in Nigeria that have documented suboptimal Penta vaccine coverage and high dropout rates, often attributed to factors such as inadequate health education, logistical challenges in vaccine supply, and missed immunization opportunities during outreach sessions [29,30]. The observed dropout rate of 54.1% is particularly concerning, as it exceeds the national average and mirrors trends seen in other rural settings where access to healthcare facilities and caregiver compliance remain persistent barriers [31]. Similar to findings by Okoli et al [32]. in neighboring states, this study underscores the need for targeted interventions such as community engagement, reminder systems, and strengthened immunization tracking to improve both vaccine initiation and completion rates in underserved regions.

This study identified Parental negligence (23.1%) – Lack of time to visit health facilities suggests a need for more flexible immunization schedules or community outreach programs. Lack of awareness (18.8%) – Misinformation or insufficient knowledge about vaccine schedules contributes to under-immunization. Fear of side effects (15.6%) – Vaccine hesitancy persists due to misconceptions, requiring community sensitization. Accessibility and financial constraints (12% and 11.4%, respectively) – Geographic and economic barriers hinder consistent immunization access. Vaccine stockouts (1.6%) – Health system weaknesses, such as inconsistent vaccine supply, further exacerbate dropout rates. These align with WHO's "3Cs" model (Confidence, Complacency, Convenience) for vaccine hesitancy [33]. A Nigerian study [34]. similarly found fear of side effects and misinformation as major deterrents, while a Ghanaian study [35]. emphasized financial and transport barriers.

However, stockouts were less prominent (1.6%) in this study compared to a study in Malawi (15% stockout-related dropouts) [36]., suggesting Ifelodun's supply chain may be relatively better, but awareness and access remain critical gaps.

Zero-dose children were strongly associated with caregivers lack awareness of immunization importance (OR=3.96, 95% CI:0.98 – 15.993, p=0.053), do not know where to access vaccines (OR=11.44, 95% CI: 1.627 – 80.421, p=0.014), and vaccine stockouts (OR=10.74, 95%CI: 1.929 – 59.781, p=0.007). This matches a study in India [37], where zero-dose children were 8 times more likely to have mothers unaware of immunization schedules.

Under-immunization is strongly associated with older child age (OR=6.75, 95% CI:2.755 – 16.53, p=0.001), suggesting that sustaining immunization adherence beyond infancy remains a challenge. consistent with a Zambian study [38]. that found compliance dropped after infancy.

Immunization dropout increases with child age (OR=3.93, 95% CI: 1.674 – 9.198, p=0.002 for 15-24 months), indicating that follow-up mechanisms weaken over time. Lack of knowledge on vaccination sites (OR=0.138, 95% CI:0.02 – 0.931, p=0.042).

Peer influence (learning about immunization from friends) reduced under-immunization (OR=0.32, 95% CI:0.133 – 0.75, p=0.009) and dropout (OR=0.23, 95% CI:0.06 – 0.843, p=0.027), contrasting with a

Kenyan study [39]. where health workers were more influential, suggesting context-dependent communication strategies.

Conclusion and Recommendations

This study highlights significant gaps in immunization coverage in Ifelodun LGA, with 50.4% of children under-immunized, 23.5% experiencing dropout and 6.5% were Zero dose. These challenges stem from multifactorial barriers, including Health system inefficiencies (e.g., vaccine stockouts, inconsistent access), Parental knowledge gaps (misinformation, lack of awareness), Sociodemographic disparities (education, place of delivery), Behavioral factors (vaccine hesitancy, competing priorities) and Logistical challenges (geographic and financial barriers).

While initial vaccine uptake is relatively high, sustaining coverage remains a critical challenge. A multi-sectoral approach integrating community engagement, health system strengthening, and policy enforcement is essential to improve immunization rates and reduce preventable childhood diseases.

Key recommendations based on study findings are categorized by responsible as follows:

Government

1. Implement community sensitization programs to dispel myths and emphasize vaccine safety.
2. Strengthening Health Education Programmes on Immunization.
3. Engage religious and community leaders as advocates for immunization.
4. Improve Health System Readiness to ensure consistent vaccine supply to prevent stockouts.
5. Enhance Accessibility through expansion of mobile vaccination units to reach remote populations.
6. Integrate immunization services with maternal and child health programs.
7. Address financial barriers through subsidized or free transport to clinics.

Primary Health Directors, Heads of Department (HODs), and Routine Immunization (RI) Providers

1. Implement SMS reminders and follow-up visits to reduce dropout rates.
2. Target High-Risk Groups by prioritizing immunization interventions for home-deliveries, older children and defaulters to prevent or reduce dropouts.

By addressing these systemic and behavioral barriers, Ifelodun LGA can significantly improve immunization coverage and protect children from vaccine-preventable diseases.

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Conflict of Interest

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Factors Influencing Women to Disclose Their HIV Status to Their Sexual Partners at the Regional Hospital Ngaoundere

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Abstract

Introduction: Only 48% of women living with HIV are receiving ART, leaving a gap of 10,591 women yet to be initiated to ART (Spectrum, 2022). The gap between women yet to be initiated to ART treatment is twice that of men. Assisting women to disclose their HIV status will contribute positively to bridging this gap, as some women refuse to take treatment because they are not willing to disclose their status for reasons like fear of isolation, stigmatization, separation, and intimate partner violence. Objective: The main aim of this study is to determine the patterns and predictors of HIV status disclosure by women to their sexual partners. Method: This study employed a mixed approach. A total of 248 women who began ART treatment between June 2020 and May 2023 were randomly selected. Face-to-face interviews utilized a questionnaire comprising 7 closed-ended questions and 3 open-ended questions. The collected data was organized in a designated spreadsheet, where it was cleaned, cross-verified, and coded before being transferred to the Statistical Package for Social Science (SPSS) version 29 for storage and descriptive analysis. Conclusion: The prevalence of HIV disclosure to partners was 48.8%. Disclosure was higher among older respondents and in the educated than among those who could not read or write. HIV disclosure was also higher in the illiterate respondents involved in polygamous relationships. Women who were diagnosed at the PMTCT services disclosed more (60%) than those tested during sickness (53%) and those who tested through VCT (42%).

Keywords: *HIV Disclosure, Ngaoundere, Regional Hospital, Sexual Partner*.

Introduction

The total number of people living with HIV (PLHIV) in Cameroon for 2020 was estimated at 504,472 [34]. HIV infection has become a manageable chronic health condition, enabling people living with HIV to lead long and healthy lives. There has been a general downward trend in the prevalence of HIV in the country, moving from 5.4% in 2004 to 4.3% in 2011, 3.4% in 2017 [1, 4], and recently 2.7% in 2018 [2]. Prevalence among women is nearly twice that of men (3.4% vs. 1.9%, [2]. Four out of five new infections are among women aged 15-64. HIV prevalence is highest among women between 35-39 years of age (6.5%) and 40-44 years of age (6.4%); and close to 5% among women aged 45-49 and 50-64. Adolescent girls and young women (AGYW) are equally more affected compared to their male counterparts in the 15-19 age range (0.8%) but have a higher burden in the 20-24 age range (2.4% vs. 1.5%) [4, 2, 5].

The prevention and control of HIV infection depend on the success of strategies to prevent new infections and treat currently infected individuals. HIV testing and counselling services serve as a critical prevention and treatment tool in the control of the HIV epidemic. Within HIV testing and counselling programs, emphasis is placed on the importance

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of HIV status disclosure among HIV-infected clients [3], particularly to their sexual partners, to have psychological, physical and financial support during treatment. At the antenatal clinic, HIV prevention services are taken more seriously to prevent transmission from mother to child during pregnancy, delivery, and in the post-delivery period during breastfeeding through breast milk [27]. Disclosure is also an important preventive measure because it motivates sexual partners to seek testing services, change risky behaviour, and ultimately decrease transmission of HIV [5, 6]. It also prevents unplanned pregnancy [23]. In addition, disclosure has several potential benefits for the individual, including increased opportunities for social support from the partner and relatives [22, 27, 28], improved access to necessary medical care, including antiretroviral treatment, increased opportunities to discuss and implement HIV risk reduction with partners, and increased opportunities to plan for the future [3, 23].

Long-standing gender inequalities, discrimination, and poverty deny many women and adolescent girls economic autonomy, deprive them of control over their sexual lives, and expose them to the risk of emotional and bodily harm [30]. All these factors can increase the risk of HIV, particularly in sub-Saharan Africa, where HIV prevalence among adolescent girls and young women is more than three times higher than among their male counterparts [3]. In Cameroon, only 48% of women living with HIV are receiving ART, leaving a gap of 10,591 women yet to be initiated into ART (Spectrum 2022). The gap between women not yet initiated on ART treatment is twice that of men. Assisting women to disclose their HIV status will contribute positively to bridging this gap, as some women refuse to take treatment because they are not willing to disclose their status to their partners for reasons like fear of isolation, stigmatization, separation, and any form of violence.

In this study, we assessed the factors affecting the disclosure of HIV status by the woman to her sexual partner in women receiving treatment from the Ngaoundere Regional Hospital, Cameroon. Disclosure of HIV status means releasing information by one person to his or her partner, which can lead to either a positive or negative experience for the woman. The high number of women who refused to be initiated to antiretroviral drugs (ARV) in Adamaoua incited us to carry out this study. This was coupled with the low retention rate of ARV care and treatment observed in women. In 2020 and 2021, the monthly and quarterly retention rates could hardly surpass 75% despite the regular reminder calls made two days before the appointment date by the caseworkers. Many women missed drug dispensation appointments and refused home or community-based ARV delivery under the Differential Service Delivery (DSD) model. DSD is a person-centred approach that simplifies and adapts HIV services across the cascade in ways that both serve the needs of people living with HIV better and reduce unnecessary burdens on the health system. They preferred being served through intermediaries and fast-track models of DSD. It became increasingly difficult to carry out routine clinical laboratory examinations like viral load examinations and others. The viral uptake was therefore subnormal in 2020, as low as 30% in women at the PMTCT unit in that period (CDC PEPFAR 2021). This attitude of isolation and hiding in women prompted our curiosity to inquire about their HIV status disclosure.

The prevalence of HIV disclosure by women to their sexual partners in South Nigeria was 74.5% [35]. Duration of marriage, knowledge of the partner's status, and belief in the partner's support if disclosed were the factors contributing to HIV disclosure to the partner. In a systematic review of studies in sub-Saharan Africa, the rate of disclosure to sexual partners ranged from 5% to 97%. [31]. Most women

disclosed at the PMTCT services before delivery. Younger age, first pregnancies, knowing someone with HIV, lower levels of internalized stigma, and lower levels of avoidant coping were factors contributing to disclosure. A study in Kenya, reported that the disclosure rate to a partner was at 80% [19], and was higher than in the previous years, suggesting a possible improvement over time. Younger pregnant women appear to be more likely to disclose. This result was different from the study in Uganda where young women were reticent to disclose their status to their partners for fear of loss of emotional and economic support [33]. Also, in a Bangui hospital, 27% of the women did not disclose their status to their partner, against 73% who disclosed, and the main factors associated with non-disclosure of HIV status were the spouse's young age, precarious employment status, and couples living separately [16].

There is not enough research on HIV disclosure by women to their partners in Cameroon. We found just one study by Loubiere S et al., 2009. In conducting this study, we sought to create awareness among service providers and policymakers on the importance of HIV disclosure as a secondary prevention measure in HIV and also bring out the gender aspect in HIV management. Service providers must be diligent when helping women in the process of disclosure to minimize negative outcomes of HIV disclosure to sexual partners. The findings from this study will help healthcare workers (HCWs) to improve HIV prevention services in all treatment centers in Cameroon.

Methods

Study Setting

This study took place at the regional hospital in Ngaoundere, in the Adamaoua region of Cameroon. Ngaoundere is a metropolitan town and the chief town of the Adamaoua region, with a population of about 2 million. The Muslim Fulbe make up the majority of the population, along with Baya and the Tikar tribes. Ngaoundere is a junction town. The regional hospital Ngaoundere is the highest in the referral system for the Adamaoua region, receiving referred patients from the 10 district hospitals and 9 other private hospitals in the region. It has specialized services for the mother and child care, pediatric, surgical, and medical units, as well as a dialysis center and the HIV treatment center. In 2022, the HIV treatment center received 4,885 adult patients and 1,100 pediatric and adolescent patients. The PMTCT unit had 415 mothers, who make up part of the adult patients in the treatment center. 65% of the adult patients in this center were females. It has 28 psychosocial agents, 7 nurses, and two medical doctors caring for the patients.

Study Design

This was a cross-sectional descriptive study since information was generated and collected within a short period. Face-to-face interviews were conducted on 248 women using a questionnaire of 7 closed-ended questions. Four psychosocial case workers who spoke Foufulbe and the local Baya and Tikar languages were trained as interviewers. The training aimed to enable them to understand the sense of the questions and make better translations of the questions to the patients in the local languages. The interviews took place in confidential cubicles, with the patient and the interviewer. This is because the questions were too personal and could invoke moments of emotions and shame in the patient.

Study Population

Only women recruited to care and treatment in the past 36 months, that is, between 2020 and 2022, were included in the study. This was meant to minimize recall bias.

Sampling and Sample Size

The sampling frame was made up of women initiated to care and treatment between June 2020 and May 2023, that is, within 36 months

of starting ARV treatment. This was meant to minimize recall bias. The sample size was calculated using a single population size formula for sample size as follows:

$$n \geq \frac{z^2 pq}{d^2}$$

n: the desired sample size, ***z:*** the standard normal deviation usually set at 1.96 (which corresponds to the 95% confidence level); ***p:*** the proportion in the target population to have a specific characteristic. If no estimate is available set at 50% (or 0.50); ***q:1-p***; ***d:*** absolute precision or accuracy, normally set at 0.05.

This gave a sample size of 248 women. The participants were randomly selected from the cohort of patients assigned to these four caseworkers.

Data Collection and Management

Information collected from the interview was collected in a spreadsheet formulated for the purpose of cleaning, cross-checking, and coded before being transferred to the Statistical Package for Social Science (SPSS) version 29 software for data storage and descriptive analysis. Each patient was assigned an anonymous code on the questionnaire to maintain the confidentiality of the patient's information.

Ethical Considerations

A signed consent or verbal consent was obtained from the patient before administering the questionnaire. The interviewers also explained the confidentiality of the information provided and the importance of the study to the patient and society. The patients were also informed that they were free to stop the process at any time they felt uncomfortable.

Permission to use the registers and patient records was obtained from the coordinator of the treatment centre. The patients were ascribed identification numbers, different from their ART codes of the treatment centres as a means to protect the patient's identity and maintain confidentiality.

Results

We considered the age, religion, educational level, type of marriage or relationship, and the entry point of the woman to HIV care as the main characteristics which could influence HIV disclosure to the partner.

The Durbin-Watson test for the independence of variables was 1.930 and at 96%. This was within the standard values of +1 and +3. The standardized residual value was used to test for outliers. The minimum predictive standard residual value was -1.360, and the maximum was 2.561, which was within the normal range for residual values of -3.29 and +3.29. The minimum and maximum residual values obtained in the study show no outliers in the data.

Bivariate Analysis of the Predictors of HIV Disclosure

Pearson's correlation tests ranges from -1 to +1, whereby a positive value indicates that as the independent variable increases, the dependent variable also increases, and vice versa when negative. Table 1 below demonstrates bivariate analysis of independent variables and the dependent variable. This shows there is a strong relationship between the dependent variable and marital status ($p < 0.001$), as well as the entry points of the patient to HIV care ($p < 0.001$).

Table 1. Correlation of Variables with HIV Disclosure

	does your partner know you are taking ART	age in years at the time of the interview	religion	level of education	marital status	where were you diagnosed for the first time

Pearson Correlation	does your partner know you are taking ART	1.000					
	age in years	-.026	1.000				
	religion	.058	.009	1.000			
	level of education	.052	.083	-.023	1.000		
	marital status	.211	-.047	.021	.002	1.000	
	Where were you diagnosed for the first time?	-.196	-.056	.037	.022	.055	1.000
Sig. (1-tailed)	does your partner know you are taking ART	.	.342	.181	.205	<.001	<.001

The relationship between HIV status disclosure to partners on the one hand, and religion ($p < 0.058$ at 95% CL and 5% significance) and level of education ($p < 0.052$ at 95% CL and 5% significance) was a very low positive correlation. Christians (2) were slightly disclosing more than Muslims (1). HIV disclosure by the women increased with an increase in educational level (+0.052 at 95% CL and 5% significance), and an increase in age ($p>-0.026$ at 95%CL and 5% significance). A significant relationship was demonstrated between marital status ($p < 0.001$ at 95% CL and 5% significance), the entry point where HIV diagnosis was established ($p < 0.001$ at 95% CL and 5% significance), and HIV disclosure.

Socio-demographic Data

Religion

Table 2. Proportion of Christians and Muslim Population

Religion	number	Per cent
Muslim	130	52.4
Christian	118	47.6
Total	248	100.0

The respondents were between the ages of 14 and 58, with a mean of 28.5 years. 69% of the population of Adamaoua are Muslims, so it was no surprise that Muslim respondents were more than Christians (Table 2 above).

Marital Status or Type of Relationship

Table 3: Frequency of Type of Relationship (Marital Status) by Age Group

Age Group	monogamy	polygamy	widow	divorced/ separated	concubine	single
14 - 19yrs	16	15	0	0	6	0
20 - 24 yrs	27	19	8	3	5	0
25 and above	75	40	14	12	7	1
Total	**118**	**74**	**22**	**15**	**18**	**1**

47.5% of respondents were in monogamous relationships, 30% were in polygamy, 9% were widows, 6% were separated or divorced, and 7.2% were concubines.

40% of respondents were tested at PMTCT entry point during antenatal care, 18% at VCT, 32.6% during sickness and other entry points (ICT, blood bank) formed 10%.

Point of Entry of HIV Diagnosis as a Factor Affecting disclosure

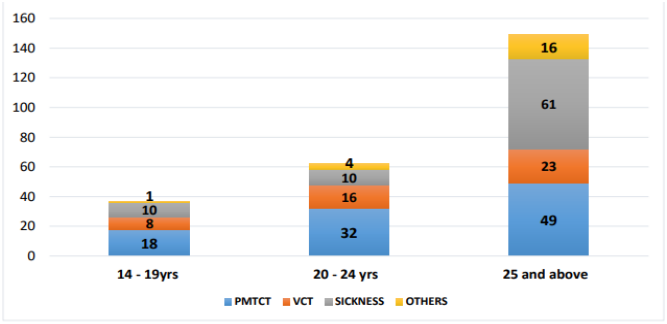

Figure 1. Entry Points of HIV Diagnosis According to Age Group

Determinants of HIV Disclosure in Women

Disclosure and Level of Education

In Tables 4 below, 96 women (38.7%) could not read and write, showing the high illiteracy rate among women in the Adamaoua region. 90 (36.3%) of them attended primary school and could read and write, 56 (22.6%) of them completed secondary school, and 6 (2.4%) either attended university or a professional school.

Table 4. Disclosure Rate According to Level of Education

Level of education	Number of women	No. of women who disclosed their HIV status to their partner	No. of women who did not disclose HIV status	% disclosure
No formal education	96	42	54	44%
primary level	90	52	37	58%
secondary level	56	27	30	48%
university level	6	1	5	17%
TOTAL	**248**	**121**	**124**	**48.8%**

Disclosure and Age of the Woman

The rate of HIV disclosure increased with an increase in age; 30% for the adolescents, 47% for the youth (20 to 24 years), and 53% for the adult age group (25 years and above).

Table 5. Proportion of Disclosure according to Age

Age group	Number disclosed	Number not disclosed	% disclosed
14 to 19 Yrs N=37	11	26	30%
20 to 24 Yrs N=62	29	33	47%
25 Yrs and Above N=149	79	70	53%

HIV Disclosure and Type of Relationship (or Marital Status)

The relationship between marital status and HIV disclosure to the partner was strong and significant at P value< 0.001 at 95% CL.HIV disclosure was higher in polygamy (55%) than in monogamy (52%). It was low in concubines and widows, (fig. 2 below).

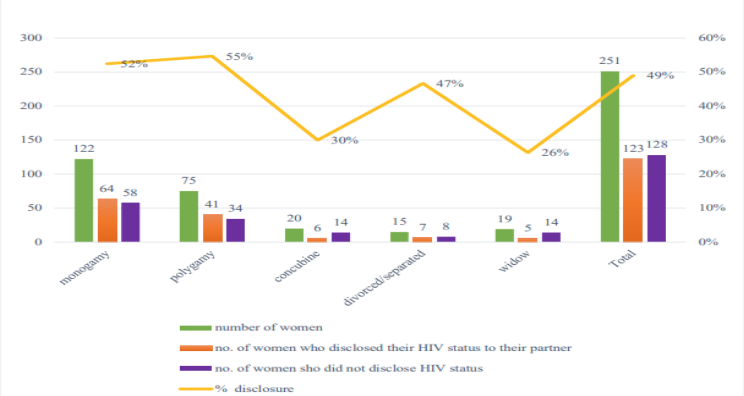

Figure 2. Rate of Disclosure according to Type of Relationship

HIV Disclosure and Entry Point to HIV Treatment

The rate of disclosure was higher at PMTCT (60%) as compared to VCT (42%) and HIV testing during sickness (53%). Disclosure was also high for those contacted as index cases and those who tested at the blood bank (77%) (Fig. 2 below).

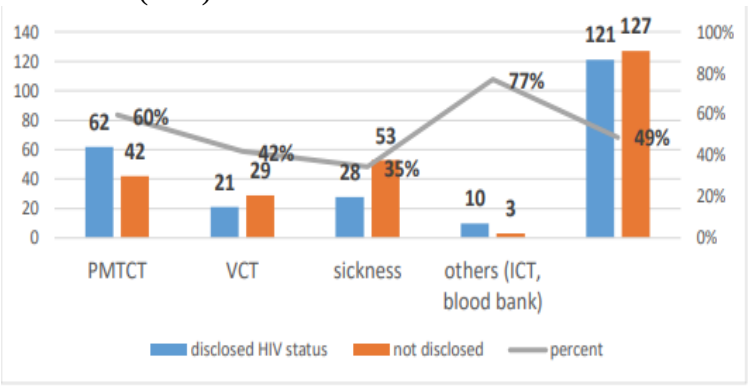

Figure 3. Proportion of Disclosure According to the Type of Testing

Discussion

This study found that the disclosure rate increased with age, at 30%, 44%, and 58% in the adolescent, youth, and adult age groups, respectively. Similar results were seen in Kenya [19] where older women had lower odds of disclosure to their partners. Among the 11 adolescents who disclosed their status to their partners, 9 were tested with their husbands at ANC, one was through accidental disclosure, and the other told the husband immediately she got home from the hospital. Sharing this information was a source of relief and mutual support for the couple [6, 7, 8, 9, 11, 30]. Thus making male partner involvement essential in HIV disclosure [13, 18].

The respondents' reasons for non-disclosure included fear of being abandoned by the partner (44%) [28], fear of losing financial support from the spouse (28%), and fear of public disclosure, stigmatization, or disgrace (18%) [10, 15, 16, 17, 18, 20, 28].

HIV disclosure was higher in those who could read and write than in those who could not or who had no formal education (table 5 above), [10, 11,]. This could be because they understood the importance of disclosure as a

way of preventing HIV transmission. The rate of HIV status disclosure was as high as 58% for women who had acquired a primary level of education, 48% for the secondary, and only 44% for women who had no formal education. This was similar to the results obtained in a study with women at PMTCT in Tanzania, Uganda, and Ethiopia, where disclosure was higher in women with a secondary or higher level of education than in women with no education [37, 11, 8]. The adolescent girls (14-19 years age group) had the highest rate of illiteracy (57%) and the lowest proportion of secondary school level learners (11%). The culture in Adamaoua promotes early marriages for the girl child, as such parents prepare the girl child for marriage instead of sending her to school. In Ngaoundere, girls marry as early as 14 years. Thus, as many as 37 adolescent girls were recruited in the study. Out of these, 21 (57%) could not read or write. HIV disclosure to partners was lowest in the adolescent age group.

Disclosure was higher in adolescents and youth involved in polygamous marriages (89%) and (63%) than in monogamous relationships (fig. 1 above). This result was different from a study carried out in Uganda where polygamy was a reason for nondisclosure [12]. This could be because it was difficult to know whom to blame in a polygamous union. It could also be because many adolescents and youth were diagnosed with antenatal care (ANC) when their husbands accompanied them during the first visit. High disclosure was also seen in monogamous marriages for those who have attained the secondary level of education in the adult population (63%) [26]. Only 1 out of the 6 (17%) with a university level of education disclosed her status, even though they are all in monogamous marriages. A low disclosure rate was also seen in concubines (30%), similar to a study in Bangui and rural Malawi [11, 14, 15, 17, 25]. It should be noted that trust was the main driver in HIV disclosure among women [36, 6]. "When deciding to disclose, the idea and feeling of ‘trust’ come into play in many ways. For example, individuals may only disclose if they feel that the person receiving the disclosure can be trusted to keep their HIV status information private" [36]. Most widows were tested either during the partners’ illness or sometime after the death of their partners, leading to low disclosure [27%].

A significant relationship was demonstrated between the entry point where HIV diagnosis was established and HIV disclosure ($p < 0.001$ at 95% CL and 5% significance). The entry point to HIV care and treatment could determine whether the woman can easily disclose her status to her partner or not. The main entry points for women into HIV care and treatment are PMTCT services, (antenatal or postpartum services), voluntary counselling and testing (VCT) services, general consultation services, and others (blood transfusion service, index case testing, and those born with HIV). Disclosure was higher at PMTCT (60%) compared to VCT (42%) and HIV testing during sickness (53%). Other women who did not fall into the above three categories of entry points were tested either as index cases of their husbands (10) or at the blood bank for their transfusion or to donate blood to sick relatives and had a very high disclosure rate at 77%. This could be because they already knew their partner's status [12]. These results also reiterate ANC as an important entry point for women into HIV care. These women are directly linked to PMTCT services to prevent linear transmission to the unborn baby during pregnancy, delivery, and breastfeeding. Partners usually accompany the women during the first ANC to pay for one-time charges. The health personnel use this opportunity to test the partners too. Testing them together is an opportunity for results sharing, thus improving HIV disclosure. It is different in VCT and provider-initiated testing during sickness, whereby the woman has the time to contemplate whether or not to tell the man.

Conclusion

The prevalence of HIV disclosure to partners at the Regional Hospital Ngaoundere was 48.8%. Disclosure was lower in younger respondents below 24 years (30%) than in respondents who were 25 years and above (53%). HIV disclosure to partners increased with an increase in the educational level, with those who could read and write disclosing more (58%) than those who could not (44%). HIV disclosure was also higher in polygamous relationships (55%) than in monogamous marriages (52%). The concubine was the relationship type having the lowest disclosure rate (30%). Most widows (26%) were tested either during their husbands' illness or sometime after the death of their husbands, so they did not have the opportunity to share their status with their partners. Women who were diagnosed during PMTCT services (60%) disclosed more than those tested through provider-initiated counselling during sickness (53%) and those who tested through VCT (42%). We recommend that mental health specialists be deployed to HIV treatment centers to cater to mental health disorders ranging from depression to all forms of violence suffered by women as an outcome of disclosing their HIV status. The process of HIV disclosure in adults should be developed, and capacity reinforcement in healthcare workers on the use of the disclosure process should also be implemented.

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Conflict of Interest

I declare that there is no conflict of interest.

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Gender Dynamics and Vaccine Hesitancy: Investigating how Gender Roles and Dynamics affect Vaccine Decision-Making in Low-and-Middle-Income-Countries (LMICs) Households

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Abstract

This study seeks to investigate how gender roles, dynamics, and power relations influence vaccine decision-making and hesitancy in LMICs households. Using the PRISMA methodology, 39 studies were selected from an initial pool of 276 articles. The selection involved four stages: identification, screening, eligibility, and inclusion. These studies cover diverse regions, cultures, and socio-economic backgrounds, offering a comprehensive understanding of the issue. The analysis shows that gender roles significantly affect vaccine decision-making within households in LMICs. Women, who are often the primary caregivers, strongly advocate for vaccination but face significant barriers like limited decision-making power, restricted mobility, and financial constraints. Men, who usually have more decision-making authority, exhibit higher vaccine hesitancy, often influenced by misinformation and traditional beliefs. Common barriers include misinformation, distrust in healthcare systems, and limited access to vaccination services. Key factors contributing to vaccine hesitancy include misinformation, lack of awareness, religious and cultural beliefs, and healthcare access limitations. To tackle these challenges, the study suggests engaging community leaders and influencers, implementing targeted education and awareness campaigns, and developing policies that prioritize gender inclusion and equity in healthcare decision-making. The findings highlight the need to address gender-specific barriers to improve vaccine uptake in LMICs. Empowering women, engaging men, and improving healthcare access can boost vaccination rates and protect communities from vaccine-preventable diseases. Future research should explore the deeper reasons behind gender-specific vaccine hesitancy and consider the intersection of gender with other socio-economic factors for more effective interventions.

Keywords: Gender Roles, Gender Dynamics, Low-and-Middle-Income-Countries, Vaccine Hesitancy.

Introduction

Vaccine hesitancy is a significant obstacle to achieving high vaccination coverage and eliminating vaccine-preventable diseases in Low-and-Middle-Income Countries (LMICs). The World Health Organization (WHO) has identified vaccine hesitancy as one of the top ten threats to global health, highlighting the urgent need to address this issue [1].

In LMICs, gender dynamics play a crucial role in health decision-making within households, influencing attitudes and behaviours towards vaccination. Traditional gender roles often place men in decision-making positions, while women take on the role of caregivers, responsible for the health and well-being of their families [2]. This division of roles can have significant implications for vaccination uptake, as men may have more control over healthcare decisions, including vaccination.

Research has shown that women's autonomy and decision-making power can have a positive impact on vaccination rates. A study conducted

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in India found that women's autonomy was a significant predictor of vaccination uptake, with women who had more autonomy being more likely to vaccinate their children [3]. Similarly, a study in Nigeria found that women's decision-making power was a key factor in determining vaccination rates, with women who had more decision-making power being more likely to vaccinate their children [2].

Understanding the gender dynamics that play out in LMICs households is essential for developing effective public health strategies that can address vaccine hesitancy and improve vaccination rates. By recognizing the role of women in healthcare decision-making and empowering them to take on more decision-making roles, public health interventions can more effectively target the root causes of vaccine hesitancy and improve vaccination rates.

Furthermore, the Sustainable Development Goals (SDGs) aim to eliminate vaccine-preventable childhood diseases by 2030. However, if vaccine hesitancy is not addressed, this goal may not be realized in LMICs. Therefore, it is crucial to develop effective strategies that take into account the gender dynamics and power structures within households in LMICs.

Statement of the Research Problem

Despite the well-established importance of vaccines in preventing infectious diseases, vaccine hesitancy remains a persistent challenge in many LMICs. Vaccine hesitancy refers to the delay or refusal to accept vaccines, despite their availability and accessibility [1]. This phenomenon is particularly concerning in LMICs, where vaccine-preventable diseases continue to pose a significant threat to public health.

One critical factor that influences vaccine decision-making in LMICs households is gender roles and dynamics. The social, cultural, and economic contexts in which individuals live shape their perceptions, attitudes, and behaviours towards vaccination [2]. However, the role of gender in vaccine decision-making remains poorly understood, particularly in LMICs.

Existing research has highlighted the importance of addressing gender-specific barriers and facilitators to vaccine acceptance [3]. However, a comprehensive understanding of how gender roles and dynamics influence vaccine hesitancy in LMICs households is lacking. This knowledge gap hinders the development of effective public health interventions that take into account the complex social and cultural contexts in which vaccine decisions are made.

To address this gap, this study aims to systematically review existing literature to understand how gender roles and dynamics influence vaccine hesitancy in LMICs households. By examining the current evidence, this research seeks to identify gender-specific barriers and facilitators to vaccine acceptance, providing actionable insights for public health interventions. Ultimately, this study aims to contribute to the development of more effective and targeted strategies to address vaccine hesitancy and improve vaccination rates in LMICs.

Aim and Objectives of the Study

The primary aim of this study is to explore the relationship between gender dynamics and vaccine hesitancy in LMICs. Specifically, this study seeks to investigate how gender roles, dynamics, and power relations influence vaccine decision-making and hesitancy in LMICs households.

The study aims to achieve the following specific objectives:

1. To examine the existing literature on gender dynamics and vaccine hesitancy in LMICs, identifying gaps and inconsistencies in current research.
2. To identify how gender roles and dynamics affect vaccine decision-making in LMICs households.

3. To identify the specific gender-related factors that contribute to vaccine hesitancy in LMICs households, including social, cultural, and economic factors.
4. To investigate how gender power dynamics and decision-making processes within households influence vaccine acceptance and hesitancy.
5. To provide recommendations for public health policymakers and practitioners on how to address gender-related barriers to vaccine acceptance and improve vaccination rates in LMICs.

By achieving these objectives, this study aims to contribute to a deeper understanding of the complex interplay between gender dynamics and vaccine hesitancy in LMICs, ultimately informing the development of more effective and targeted interventions to improve vaccination rates and reduce vaccine-preventable diseases in these settings.

Significance of the Study

This research is significant because it will provide valuable insights into the gender-specific factors that influence vaccine hesitancy in LMICs households. By examining the complex interplay between gender roles, dynamics, and vaccine decision-making, this study will contribute to a deeper understanding of the social and cultural factors that shape vaccine acceptance and coverage.

The findings of this research will have important implications for the development of targeted interventions aimed at enhancing vaccine acceptance and coverage in LMICs households. By identifying the specific gender-related factors that contribute to vaccine hesitancy, public health policymakers and practitioners can design more effective strategies to address these barriers and improve vaccination rates.

Moreover, this research will contribute to the elimination of vaccine-preventable diseases, which is a critical public health goal. By addressing the gender dynamics that influence vaccine decision-making, public health strategies can be more effective in reaching underserved populations and ensuring equitable access to vaccines in LMICs households.

Ultimately, this study has the potential to inform the development of more effective and sustainable public health interventions that take into account the complex social and cultural contexts in which vaccine decisions are made. By shedding light on the gender-specific factors that shape vaccine hesitancy, this research can contribute to improved health outcomes, reduced health inequities, and enhanced well-being for individuals and communities in LMICs.

Literature Review

Vaccine hesitancy is a growing concern globally, and Low- and Middle-Income Countries (LMICs) are disproportionately affected. The WHO has identified vaccine hesitancy as one of the top ten threats to global health [1]. In LMICs, vaccine hesitancy is often exacerbated by factors such as limited access to healthcare, misinformation, and cultural beliefs [4].

Understanding the factors that contribute to vaccine hesitancy is crucial for developing effective strategies to address this issue. Research has shown that vaccine hesitancy is influenced by a complex interplay of factors, including individual, social, and environmental factors [5].

In LMICs, gender dynamics play a significant role in shaping vaccine hesitancy. Women often bear the primary responsibility for childcare and healthcare decision-making, yet they may face barriers to accessing vaccination services [2]. Furthermore, traditional gender roles and power dynamics can influence vaccine decision-making, with men often holding more decision-making power [3].

This chapter provides an overview of the literature on vaccine hesitancy, with a focus on the social and cultural factors that contribute to

this phenomenon in LMICs. The chapter also explores the role of gender dynamics in shaping vaccine hesitancy, highlighting the need for a more nuanced understanding of the complex factors that influence vaccine decision-making.

Overview of Vaccine Hesitancy

Vaccine hesitancy is a complex and multifaceted issue that refers to the delay or refusal of vaccine acceptance, despite the availability of vaccination services [5]. This phenomenon is not limited to specific countries or regions, but rather is a global concern that affects both developed and developing countries [1].

One of the primary factors contributing to vaccine hesitancy is complacency [5]. Complacency occurs when individuals or communities perceive the risk of vaccine-preventable diseases as low, and therefore, do not see the need to vaccinate. This perception can be fuelled by the success of vaccination programs in reducing the incidence of vaccine-preventable diseases, leading to a false sense of security [4].

Convenience is another factor that influences vaccine hesitancy [5]. Convenience refers to the ease with which individuals can access vaccination services. In some cases, vaccination services may not be readily available or accessible, leading to delays or refusals of vaccine acceptance.

Confidence in vaccines and vaccination programs is also a critical factor in vaccine hesitancy [5]. Confidence refers to the trust that individuals have in the safety and effectiveness of vaccines, as well as the competence of healthcare providers. When confidence is low, individuals may be more likely to delay or refuse vaccine acceptance.

Socio-cultural factors also play a significant role in vaccine hesitancy [4]. Socio-cultural factors refer to the social and cultural norms, values, and beliefs that influence individual behaviours. In some communities, socio-cultural factors may lead to misconceptions or misunderstandings about vaccines, contributing to vaccine hesitancy. In LMICs, additional challenges such as limited access to healthcare, misinformation, and cultural beliefs exacerbate vaccine hesitancy [4]. Limited access to healthcare can lead to delays or refusals of vaccine acceptance, while misinformation and cultural beliefs can fuel misconceptions and misunderstandings about vaccines.

Country-specific examples illustrate the diverse factors driving vaccine hesitancy. In Nigeria, misinformation and mistrust in government and international health organizations have fuelled resistance to vaccination campaigns [6]. In Kenya, socio-cultural and economic factors, such as concerns about vaccine safety and side effects, as well as economic barriers, play a significant role [7]. In India, misinformation and lack of community engagement contribute to vaccine hesitancy, while educational interventions and community engagement have proven effective in increasing vaccine acceptance [8].

To address vaccine hesitancy, a comprehensive approach is necessary, incorporating community engagement, education, healthcare infrastructure improvements, and supportive policy interventions [4]. Community engagement and education can help to address misconceptions and misunderstandings about vaccines, while healthcare infrastructure improvements can increase access to vaccination services. Supportive policy interventions can also help to address economic and socio-cultural barriers to vaccine acceptance.

Gender Differences in Vaccine Hesitancy

Numerous studies have highlighted the significant gender disparities in vaccine hesitancy in LMICs. A systematic review conducted revealed that women were 3% less likely to be fully vaccinated compared to men [9]. This review also emphasized that children of mothers without formal education were significantly less likely to be fully vaccinated

than those whose mothers had at least primary education. These findings underscore the importance of education in influencing vaccine acceptance and uptake.

Another study on COVID-19 vaccines identified significant gaps in sex- and gender-specific data, highlighting the need for more gender-sensitive research in vaccine studies. This study emphasized that understanding the gender dimensions of vaccine hesitancy is crucial for developing effective interventions [10]. In Nigeria, research on vaccine hesitancy among pregnant women found that fear of side effects, distrust in the healthcare system and misinformation were major contributors to vaccine hesitancy [11]. The study also noted that women who received vaccine information from healthcare providers were more likely to accept vaccination, underscoring the crucial role of healthcare provider communication in addressing vaccine hesitancy.

A complex interplay of socio-cultural, economic, and educational factors shapes gender differences in vaccine hesitancy in LMICs. These factors may include limited access to education and healthcare, cultural and social norms that restrict women's autonomy and economic barriers that prevent women from accessing vaccination services. Tackling these differences requires targeted interventions that address the specific barriers faced by women.

Ongoing research and data collection on gender differences in vaccine hesitancy are vital for developing effective interventions and achieving global vaccination goals. Policymakers and healthcare providers can design and implement more effective strategies to address vaccine hesitancy and improve vaccination rates in LMICs by understanding the gender dimensions of vaccine hesitancy.

Gender Roles and Health Decision-Making

Gender roles play a significant role in shaping health behaviours and decision-making, particularly in LMICs. In many of these countries, traditional gender roles often place men in decision-making positions, while women are primarily responsible for childcare and healthcare[2]. This dynamic can have a profound impact on vaccine uptake, as women may face obstacles such as limited autonomy, restricted access to information, and lack of control over household resources.

Research has consistently shown that empowering women and involving them in health decision-making can lead to better health outcomes for children [12]. However, in many LMICs, patriarchal structures prevail, with men typically holding the power to make major household decisions, including those related to health. This can severely restrict women's ability to make health-related decisions for themselves and their children.

For instance, in some cultures, women may require permission from their husbands or male family members to seek healthcare services, including vaccinations [2]. This dependency can lead to delayed or prevented timely vaccination, increasing the risk of vaccine-preventable diseases. Furthermore, women's limited access to education, information, and economic resources can exacerbate these challenges, making it even more difficult for them to make informed decisions about vaccination.

The impact of gender roles on health decision-making is further complicated by the fact that women are often the primary caregivers for children. As a result, they may be more likely to prioritize their children's health needs over their own, potentially compromising their own health and well-being [2].

Access to Information

Access to accurate and reliable health information is a critical component of making informed decisions about vaccination. However, women in LMICs often face significant barriers to accessing health

information, exacerbating the existing health disparities.

One of the primary factors contributing to the information gap is the lower literacy rates among women in LMICs. Limited educational opportunities and restricted access to education can hinder women's ability to read and understand health information, making it difficult for them to make informed decisions about vaccination [12].

Furthermore, women's restricted mobility and limited access to media can prevent them from attending health education sessions or accessing information through various channels. In many LMICs, women's mobility is restricted due to cultural and social norms, making it difficult for them to access health facilities or attend health education sessions [2].

Health communication strategies also play a crucial role in bridging the information gap. However, these strategies may not always be designed to effectively reach women, further widening the information gap. For instance, health messages may be disseminated through channels that are not accessible to women, such as radio or television programs that are primarily targeted towards men [12].

Socio-Cultural Norms

Socio-cultural norms play a profound role in shaping health behaviours and decision-making in LMICs. Traditional gender roles, in particular, exert a significant influence on health-seeking behaviours and attitudes towards vaccination.

In many LMICs, traditional gender roles dictate that women are responsible for child-rearing and household duties, while men are the primary breadwinners and decision-makers [2]. These norms can perpetuate a cycle of limited autonomy and decision-making power for women, affecting their ability to make informed decisions about vaccination.

Moreover, socio-cultural norms can also influence attitudes towards vaccination. For example, in some communities, there may be a prevailing belief that vaccines are unnecessary or harmful [2]. Male decision-makers, who often hold more power and influence in the household, can reinforce these beliefs, affecting the entire household's vaccination status.

Additionally, socio-cultural norms can also affect the way health information is disseminated and received within households. For instance, in some cultures, men may be more likely to receive and share health information, while women may have limited access to such information [12].

Barriers to Healthcare Access

Women in LMICs often face numerous barriers to accessing healthcare services, including vaccination. These barriers can be economic, logistical, or social, and can significantly affect women's ability to access timely and quality healthcare.

Economic barriers, such as the cost of transportation to health facilities, can be a significant obstacle for women in LMICs. Many women may not have the financial resources to travel to distant health facilities, or may have to prioritize other household expenses over healthcare [12].

Logistical barriers, such as the distance to the nearest clinic, can also hinder women's access to healthcare. In many rural areas, health facilities may be far away, and women may have to travel long distances to access care. This can be particularly challenging for women with limited mobility or those who have to care for young children [2].

Women's responsibilities at home can also limit their time to seek healthcare. Many women in LMICs have multiple responsibilities, including childcare, household chores, and income-generating activities. This can leave them with limited time to seek healthcare, and may lead to delayed or foregone care [12].

Furthermore, healthcare facilities in LMICs may not always be women-friendly. For example, facilities may lack female healthcare providers or may not have appropriate facilities

for women and children. This can deter women from seeking care, particularly if they have had negative experiences in the past [2].

Empowering Women in Health Decision-Making

Empowering women and involving them in health decision-making is a critical strategy for improving health outcomes for themselves and their children. Research has consistently shown that when women have greater autonomy and access to resources, they are more likely to seek healthcare services, including vaccinations [12].

Educational programs that target women and provide them with information about the benefits of vaccination can be an effective way to increase vaccine uptake. For example, a study in Tanzania found that women who received education on vaccination were more likely to have their children vaccinated [2]. Similarly, a study in India found that women's participation in community health initiatives was associated with increased vaccine coverage [3].

Involving women in community health initiatives and decision-making processes can also help address barriers to vaccination and improve overall health outcomes. For instance, women can provide valuable insights into the social and cultural factors that influence vaccine acceptance and uptake in their communities [12]. By engaging women in the planning and implementation of vaccination programs, healthcare providers can develop more effective and culturally sensitive strategies to promote vaccine acceptance and uptake.

Moreover, empowering women in health decision-making can have broader benefits for their families and communities. When women have greater control over household resources and decision-making, they are more likely to invest in their children's health and education, leading to improved health outcomes and socioeconomic development [2].

In conclusion, empowering women and involving them in health decision-making is a critical strategy for improving health outcomes, including vaccine uptake. By providing women with education, resources, and opportunities for participation in community health initiatives, healthcare providers can promote vaccine acceptance and uptake, and ultimately improve the health and well-being of women, children, and communities.

Socio-Cultural Influences

Socio-cultural factors play a significant role in shaping vaccine uptake LMICs. In many of these countries, traditional gender roles often position men as the primary decision-makers in households, which can have a profound impact on vaccine uptake [13]. Men's beliefs and knowledge about vaccination can influence their decisions regarding vaccine uptake, and in some cases, may lead them to prioritize or deprioritize vaccination. For example, if men believe that vaccines are unnecessary or harmful, they may be less likely to vaccinate their children or themselves [13].

Women's limited autonomy and mobility can also hinder their ability to access vaccination services. In some cultures, women may require permission from their husbands or male family members to seek healthcare services, including vaccination [13]. This can lead to delayed or foregone vaccination, exacerbating health disparities. Cultural beliefs and misinformation about vaccines also play a significant role in shaping attitudes towards vaccination. For instance, some communities may believe that vaccines are incompatible with their cultural or religious beliefs, leading to vaccine hesitancy [5]. Misinformation about vaccine safety and efficacy can also spread quickly through social networks, further fuelling vaccine hesitancy.

Gender Roles and Decision-Making

In many LMICs, traditional gender roles assign men the responsibility of making major household decisions, including those related to

health. This can lead to a situation where men's perceptions and beliefs about vaccines heavily influence whether women and children receive vaccinations [13].

Men's decision-making power can have a significant impact on vaccine uptake, particularly if they hold misconceptions about vaccine safety or efficacy. For instance, if men believe that vaccines are unnecessary or harmful, they may decide against vaccinating their family members, regardless of the women's views [13]. This can result in low vaccine uptake and increased risk of vaccine-preventable diseases.

The dynamic between men's decision-making power and vaccine uptake underscores the importance of engaging men in health education and vaccination campaigns. By providing men with accurate information about vaccines and the benefits of vaccination, healthcare providers can help to address misconceptions and promote positive attitudes towards vaccination [13].

Women's Autonomy and Mobility

Women's limited autonomy and mobility in many LMICs pose significant barriers to vaccine uptake. In some cultures, women may require permission from their husbands or male relatives to leave the house or seek healthcare services, including vaccination [13]. This restriction can delay or prevent women from accessing vaccination services for themselves and their children.

Furthermore, women's responsibilities for household chores and childcare can limit their time and ability to travel to vaccination centers, especially if these centers are far from their homes. In many LMICs, women are expected to prioritize their domestic duties over their own healthcare needs, making it challenging for them to access vaccination services [13].

Cultural beliefs and misinformation about vaccines are significant barriers to vaccination in many LMICs. In some communities, traditional beliefs and practices may conflict with modern medical practices, leading to skepticism about vaccines [5].

Traditional cultural beliefs can influence attitudes towards vaccination in several ways. For example:

1. Beliefs about natural vs. unnatural practices: Some communities may believe that vaccines are unnatural or interfere with traditional healing practices, leading to skepticism about their effectiveness or safety.
2. Beliefs about spiritual or supernatural causes of illness: In some cultures, illnesses may be attributed to spiritual or supernatural causes, rather than biological or environmental factors. This can lead to a lack of faith in vaccines as a means of preventing illness.
3. Beliefs about the role of traditional healers: In some communities, traditional healers may be seen as the primary providers of healthcare, and vaccines may be viewed as a Western or modern practice that is not compatible with traditional healing practices.

Misinformation about vaccines can also spread quickly and deter people from being vaccinated. Examples of misinformation include:

1. Rumours that vaccines cause infertility or contain harmful substances.
2. Claims that vaccines are not effective or are unnecessary.
3. Misconceptions about the safety and side effects of vaccines.

Economic Factors

Economic constraints are a significant barrier to vaccination in LMICs. These constraints are often exacerbated by gender dynamics, further complicating vaccine uptake. Women, who frequently have less financial independence, may struggle to afford vaccines or take time off work to be vaccinated [14].

The economic dependency of women on male household members can limit their ability

to make autonomous health decisions, including those related to vaccination. This can result in delayed or foregone vaccination, exacerbating health disparities [14].

In addition to individual-level economic constraints, broader socioeconomic inequalities can also affect vaccine impact and vaccination dropout rates. Inequalities in wealth, education, and geographic access can lead to disparities in vaccine uptake and effectiveness [9].

For instance:

1. Wealth inequalities: Households with lower incomes may struggle to afford vaccines or transportation to vaccination centers.
2. Education inequalities: Individuals with lower levels of education may be less aware of the benefits of vaccination or may be more susceptible to misinformation.
3. Geographic inequalities: Individuals living in rural or hard-to-reach areas may have limited access to vaccination centers or healthcare services.

Financial Independence and Autonomy

In many LMICs, women's limited financial independence is a significant barrier to vaccination. Socio-cultural norms that prioritize male control over household finances perpetuate women's economic dependency, restricting their ability to make health-related decisions, including those about vaccination [14].

The economic dependency of women on male household members can have several consequences for vaccination:

1. Delayed or prevented vaccination: Women may need to seek permission or financial support from their husbands or male family members to access vaccination services. If the male decision-makers do not prioritize vaccination, women may be unable to access vaccines, leading to delayed or foregone vaccination.
2. Limited access to healthcare: Women's economic dependency can limit their access to healthcare services, including vaccination. Women may be unable to afford transportation to vaccination centers or pay for vaccines, leading to reduced vaccine uptake.
3. Reduced autonomy: Women's economic dependency can reduce their autonomy and decision-making power, making it difficult for them to prioritize their own health needs, including vaccination.

Employment and Economic Barriers

Women in LMICs often face significant employment and economic barriers that hinder their access to vaccination services. Many women in LMICs are employed in informal sectors, such as domestic work, agriculture, or small-scale entrepreneurship, which offer little job security and no paid leave [9].

The lack of economic stability and job security means that taking time off work to be vaccinated or to take their children for vaccinations can result in lost income, which many families cannot afford. This economic barrier is particularly pronounced in single-parent households or in families where the woman is the primary breadwinner. The informal nature of women's employment in LMICs also means that they may not have the flexibility to attend vaccination appointments during working hours. Vaccination centers may only be open during working hours, making it difficult for women to access vaccination services without taking time off work.

Furthermore, the economic barriers faced by women in LMICs can have long-term consequences for their health and well-being. For example:

1. Delayed or foregone vaccination: Women may delay or forego vaccination due to the economic costs of taking time off work, leading to reduced vaccine uptake and increased risk of vaccine-preventable diseases.
2. Reduced economic productivity: The economic barriers faced by women in

LMICs can reduce their economic productivity and earning potential, perpetuating poverty and inequality.
3. Increased healthcare costs: Delayed or foregone vaccination can lead to increased healthcare costs in the end, as vaccine-preventable diseases can result in costly medical treatments and hospitalizations.

Gender Inequality in Wealth and Education

Gender inequality in wealth and education is a significant factor contributing to vaccine hesitancy in LMICs. Women in LMICs often have lower levels of education compared to men, which can limit their understanding of the benefits of vaccination and increase their susceptibility to misinformation [9].

Educational disparities can have far-reaching consequences for women's health, including:

1. Limited health literacy: Women with lower levels of education may have limited understanding of health-related information, including the benefits and risks of vaccination.
2. Increased susceptibility to misinformation: Women with lower levels of education may be more likely to believe misinformation about vaccines, which can lead to vaccine hesitancy.
3. Reduced ability to advocate for health needs: Educational disparities can affect women's ability to advocate for their health needs within the household, making it more challenging to prioritize vaccination.

Wealth inequality further compounds these issues, as families with limited financial resources may prioritize immediate survival needs over preventive healthcare measures like vaccination. This can lead to:

1. Delayed or foregone vaccination: Families with limited financial resources may delay or forego vaccination due to the perceived cost of vaccination or the opportunity cost of taking time off work.
2. Reduced access to healthcare: Wealth inequality can reduce access to healthcare services, including vaccination, for families with limited financial resources.
3. Increased health disparities: Wealth inequality can exacerbate existing health disparities, as families with limited financial resources may be more likely to experience poor health outcomes due to delayed or foregone vaccination.

Geographic Access and Mobility

Geographic access to vaccination services is a critical factor that is often influenced by gender dynamics, particularly in LMICs. In many LMICs, healthcare facilities, including vaccination centers, are often located far from rural or underserved communities, requiring significant travel time and resources [9].

Women, particularly those with young children, may face unique mobility challenges that prevent them from accessing vaccination services. These challenges include:

1. Lack of transportation: Women may not have access to reliable transportation, making it difficult for them to travel to vaccination centers.
2. Cultural restrictions on movement: In some cultures, women's movement may be restricted, making it difficult for them to travel to vaccination centers without accompaniment or permission.
3. Childcare responsibilities: Women may be responsible for childcare, making it difficult for them to leave their children to travel to vaccination centers.
4. Physical barriers: Women may face physical barriers, such as lack of roads or public transportation that make it difficult to access vaccination centers.
5. These barriers can have significant consequences, including:
6. Lower vaccination rates: Women and children in areas with limited geographic access to vaccination services may have

lower vaccination rates, increasing their risk of vaccine-preventable diseases.

7. Increased risk of vaccine-preventable diseases: Women and children who are not vaccinated are at increased risk of contracting vaccine-preventable diseases, which can have serious health consequences.
8. Perpetuation of health disparities: Limited geographic access to vaccination services can perpetuate existing health disparities, particularly in rural or underserved areas.

Health Systems Barriers

Health systems in LMICs often lack gender-sensitive approaches to vaccination. This includes inadequate communication strategies that fail to address the specific concerns of women and marginalized groups. Additionally, the lack of female healthcare workers in some regions can discourage women from seeking vaccination due to cultural norms around gender interactions [13]. Barriers such as travel time, cost, and safety concerns also limit access to vaccination [9].

Inadequate Communication Strategies

Effective communication is crucial for addressing vaccine hesitancy, yet many health systems in LMICs do not tailor their communication strategies to the specific needs and concerns of women. Women often have different health information needs compared to men, influenced by their roles as primary caregivers and their unique health concerns. However, health communication campaigns frequently use a one-size-fits-all approach, which can fail to resonate with women or address their specific fears and misconceptions about vaccines. For example, women may have concerns about vaccine safety during pregnancy or breastfeeding, which need to be addressed through targeted messaging [13].

Lack of Female Healthcare Workers

The presence of female healthcare workers can significantly influence women's willingness to seek vaccination. In many cultures, women prefer to receive healthcare from female providers due to cultural norms around gender interactions. However, in some LMICs, there is a shortage of female healthcare workers, which can discourage women from accessing vaccination services. This barrier is particularly pronounced in conservative societies where interactions between men and women are restricted. Increasing the number of female healthcare workers and ensuring they are available in vaccination programs can help overcome this barrier [9].

Travel Time and Cost

Geographic barriers, such as long travel times and high transportation costs, can significantly limit access to vaccination services, especially for women. Women in rural or remote areas may need to travel long distances to reach healthcare facilities, which can be time-consuming and expensive. This is particularly challenging for women who have limited financial resources or who are responsible for childcare and household duties. Additionally, safety concerns related to traveling alone or with young children can further deter women from seeking vaccination [9].

Safety Concerns

Safety concerns, both real and perceived, can also affect women's willingness to seek vaccination. In some regions, healthcare facilities may be located in areas that are perceived as unsafe, particularly for women traveling alone. Additionally, the quality of healthcare services, including the cleanliness and safety of vaccination sites, can influence women's decisions to be vaccinated. Ensuring that vaccination sites are safe, clean, and welcoming can help address these concerns and encourage more women to seek vaccination [13].

Gaps in the Literature

Despite extensive research on vaccine hesitancy, there is a notable lack of studies focusing on the influence of gender dynamics in LMICs. This study aims to address this gap by systematically reviewing literature to understand gender-specific factors affecting vaccine decision-making. By concentrating on gender dynamics, this research will offer a nuanced understanding of the barriers to vaccine acceptance and help develop targeted interventions.

Methodology

This study will use a systematic literature review to identify and synthesize existing research on gender dynamics and vaccine hesitancy in LMICs, following the PRISMA guidelines [15]. A systematic review is a rigorous method for identifying, evaluating, and synthesizing the findings of all relevant individual studies on a specific topic, ensuring a comprehensive understanding of the research area.

Study Population and Sampling

The review will focus on studies conducted in LMICs, as defined by the World Bank. Inclusion criteria will encompass peer-reviewed articles, reports, and grey literature published in English and in the last 20 years. Studies will be selected based on their relevance to the research questions and objectives.

There is no specific formula for calculating sample size for research studies using the PRISMA methodology. However, defining the objectives/research questions of the study, significance level, standard deviation, effect size, power level and pilot studies reviewed during literature review, it is possible to determine an appropriate sample size.

Therefore, given the following values:

n_{pilot} = sample size of pilot studies reviewed in the literature = 21

α = Confidence level of 90%

σ = Standard deviation of 10%

z-score value of confidence level of 90% = 1.6 [4]5

E = Margin of Error = $\sigma/\sqrt{n}$pilot

n = Required sample size

Calculating Margin of error (E) by substituting the given values in the formula

E = Margin of Error = $\sigma/\sqrt{n_{pilot}}$

E=10/√21 =2.18

Calculating the required sample size by substituting in the formula:

$n = (Z.\sigma/E)^2$

Substituting the given values in the above formula

$n = (Z.\ \sigma/E)^2 = (1.6\ [4]5 \times 10)/2.18)^2 = 56.82$

rounding up to the nearest whole number

n = 57

Study Protocols and Guidelines

The systematic review will adhere to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and reproducibility in the reporting of the review process and findings [15].

Systematic Database Search

The systematic database search will be conducted using major academic databases such as PubMed/MEDLINE, Scopus, Web of Science, EMBASE, CINAHL, and Google Scholar. These databases have been selected for their comprehensive coverage of health-related research and their inclusion of studies from LMICs. The search strategy will adhere to the PRISMA guidelines for systematic reviews [16]. The search process will involve identifying relevant studies, screening titles and abstracts, and reviewing full texts to determine eligibility.

The Search Terms

The search terms will be structured using Boolean operators to combine primary concepts related to gender dynamics, vaccine hesitancy, and LMICs. Key search terms will include variations of "gender roles," "vaccine

hesitancy," "decision-making," "LMICs," and specific country names. These terms will be combined systematically to ensure comprehensive coverage while maintaining relevance to the research objectives.

The Search Process

The search process will be managed using reference management software such as Mendeley or Zotero, with a systematic coding system for documents and detailed search logs. This ensures efficient organization and retrieval of identified literature.

Inclusion Criteria

The inclusion criteria will encompass all studies published in the past 20 years to ensure currency while capturing the evolution of gender dynamics and vaccine hesitancy in LMICs. Publications in English will be included to reflect the major language of scientific communication. The review will include peer-reviewed articles, systematic reviews, meta-analyses, program evaluations, policy documents, and government reports to provide a comprehensive understanding of the topic.

Exclusion Criteria

The systematic review will implement specific exclusion criteria to maintain focus and ensure the quality of included evidence. Studies that exclusively examine high-income countries will be excluded, as they do not align with the review's focus on LMICs. Publications dated before 2005 will not be included to ensure currency and relevance of findings. Opinion pieces that lack empirical evidence will be excluded to maintain the scientific rigor of the analysis. In addition, conference abstracts without accompanying full papers will be omitted from the review, as they typically lack the detailed methodology and comprehensive results necessary for thorough analysis.

Data Extraction

The data extraction and analysis process for the systematic review will begin with the development of a comprehensive data extraction template, capturing study characteristics, methodological features, key findings, gender dynamics, vaccine hesitancy factors, and reported outcomes. This structured approach ensures consistent and comprehensive data collection across all included studies. The extraction template will be piloted on a sample of studies to ensure consistency and accuracy. Two reviewers will independently extract data to minimise bias, and discrepancies will be resolved through discussion or consultation with a third reviewer.

Quality Assessment

Quality assessment will be conducted using standardized tools such as the Critical Appraisal Skills Programme (CASP) checklists and the Joanna Briggs Institute (JBI) critical appraisal tools. These tools will help evaluate the methodological quality and relevance of the included studies, ensuring the reliability and validity of the review findings.

Analytical Framework

The analytical framework will involve thematic synthesis to identify common themes and patterns across the included studies. This will be complemented by a narrative synthesis to provide a detailed account of the findings, highlighting the gender dynamics, vaccine hesitancy factors, and decision-making processes in LMIC households.

Data Management and Analysis

The systematic review will employ a range of data management and analysis tools to ensure efficient handling and rigorous analysis of the collected data. Reference management software such as EndNote, Zotero, or Mendeley will be utilized to organise and manage citations effectively. The analysis methods will include content analysis of policy documents to

extract relevant information, comparative analysis of gender dynamics to evaluate different approaches, gap analysis of vaccine hesitancy factors to identify areas needing improvement, and best practice synthesis to highlight effective strategies and lessons learned. This comprehensive approach ensures a thorough and systematic analysis of the data, supporting the objectives of the review.

Thematic analysis will be employed to identify common themes and patterns across studies[17]. This method involves coding the data, identifying themes, and interpreting the findings in the context of the research questions. The analysis will focus on understanding how gender roles and dynamics influence vaccine decision-making and identifying barriers and facilitators to vaccine acceptance.

Ethical Considerations

Ethical considerations in research are crucial to ensure the dignity, rights, safety, and well-being of participants. Below are some key areas considered in this research study.

Ethical Approval

Since this study involves secondary data analysis, ethical approval is not required. However, the review will adhere to ethical guidelines for conducting and reporting systematic reviews, ensuring transparency and rigor. The study will follow the PRISMA guidelines to ensure a systematic and unbiased approach to data collection and analysis.

Research Integrity

Ensuring the integrity of the research is crucial. The research study will prioritised accurate representation of secondary data sources and systematic documentation. In addition, the research study will implement proper data storage and security measures. Transparency in research processes will be maintained through clear documentation, making all methodological decisions explicit and open to scrutiny.

Data Quality and Management

To ensure that data quality and management remain a critical aspect of the research study, it will involve the use of standardised quality assessment tools and adherence to established systematic review guidelines. Proper citation and attribution of sources will be ensured, with secure storage of research materials and appropriate protection of sensitive information. This approach will guarantee the reliability and validity of the research findings.

Quality Assurance

Quality assurance (QA) is a critical component in the execution of research studies, ensuring the reliability and validity of the findings. This section examines the various aspects of QA implemented in this research study.

Methodological Rigor

Methodological rigor will be maintained using standardised quality assessment tools and adherence to systematic review guidelines. This ensures the reliability and validity of the research findings.

Bias Management

The recognition and declaration of potential biases, as well as the implementation of strategies to minimise bias, are considered. The source materials used will be critically evaluated, and there will be a balanced representation of evidence.

Institutional Requirements

This research will comply with institutional research policies and integrity guidelines. The research ethics protocols will be followed, and regular reporting to supervisors will be maintained. Data protection regulations will be adhered to, securing the storage of research materials and handling sensitive information appropriately.

Professional Ethics

Professional ethics demand an unwavering commitment to scientific integrity and collaborative responsibility. This encompasses maintaining rigorous research standards through scientific objectivity and quality assurance while fostering respectful collaborative relationships with stakeholders. Key elements include adherence to established research protocols, transparent documentation, fair attribution of contributions, and clear communication with all parties involved. These ethical principles serve as the cornerstone for conducting credible research that advances knowledge and upholds the highest standards of professional conduct in the academic community.

Interpretation of Results

The results will be interpreted in the context of existing literature on vaccine hesitancy and gender dynamics. The study will discuss how gender roles influence health behaviours and decision-making processes, and the implications for public health interventions. The findings will be compared with previous studies to identify similarities and differences, and to understand the broader implications for public health.

Societal Implications

The societal relevance of this research lies in its potential to inform policy and practice in addressing vaccine hesitancy in LMICs. By identifying the gender dynamics that influence vaccine decision-making, the findings can help develop targeted interventions to improve vaccine uptake and health outcomes in these settings.

Scientific Implications

The scientific relevance of this research is rooted in its contribution to the evidence base on gender dynamics and vaccine hesitancy. The systematic review will provide a comprehensive synthesis of the existing literature, identifying gaps in knowledge and areas for future research. This will advance the understanding of how gender roles and dynamics affect vaccine decision-making in LMIC households and inform the development of more effective health interventions.

Policy Implications

The findings will inform the development of gender-sensitive policies and programs to reduce vaccine hesitancy in LMICs. Recommendations will include strategies to empower women, improve access to information, and engage men in vaccination efforts. For example, involving men in health education programs and promoting shared decision-making within households may enhance vaccine uptake.

Limitations of the Study

Potential limitations include the reliance on published literature, which may introduce publication bias, and the exclusion of non-English studies. These limitations will be acknowledged and addressed in the discussion. The study will also consider the potential impact of cultural differences and socioeconomic factors on the generalizability of the findings.

Results, Findings, and Discussion

Results

This section presents the results of the study, providing a detailed analysis of the data collected. The results are organised to address the primary research questions and objectives, highlighting significant trends, patterns, and correlations. The following subsections will delve into specific aspects of the results, offering a comprehensive understanding of the study's outcomes

Study Selection

The study selection process was meticulous and systematic, adhering to the PRISMA methodology [16]. From an initial pool of 276

articles identified through database searches, registers, websites, citations, 39 studies met the inclusion criteria and were selected for in-depth review. The selection process involved four key stages:

1. Identification,
2. Screening,
3. Eligibility, and
4. Inclusion.

In the identification stage, all potentially relevant studies were collected based on predefined search terms related to vaccine hesitancy and gender dynamic in LMICs. During the screening stage, titles and abstracts were reviewed to exclude studies that did not meet the inclusion criteria. The eligibility stage involved a thorough examination of the full texts of the remaining studies to ensure they aligned with the research objectives. Finally, in the inclusion stage, studies that met all criteria were selected for detailed analysis. The selected studies spanned 15 LMICs, providing a diverse and comprehensive understanding of the research topic.

Study Characteristics

The 39 selected studies varied in their research design, including cross-sectional surveys, qualitative interviews, and mixed-methods research. Most of these studies focused on childhood vaccination, maternal influence, and household decision-making processes[18]. The geographical distribution of the studies was extensive, covering regions in Africa, Asia, and Latin America. This diversity allowed for a rich analysis of gender dynamics and vaccine hesitancy across different cultural contexts and socio-economic backgrounds. Key variables extracted from these studies included gender roles, vaccine hesitancy rates, reasons for hesitancy, and decision-making authority within households. These variables provided a comprehensive dataset for understanding the multifaceted nature of vaccine hesitancy in LMICs.

Data Extraction and Synthesis

Data extraction was conducted using a structured approach to capture relevant information on gender dynamics and vaccine hesitancy. A data extraction template was developed to ensure consistency and comprehensiveness in capturing study characteristics, methodological features, key findings, and contextual factors. Thematic synthesis was employed to identify common themes and patterns across the studies, focusing on how gender roles and dynamics influence vaccine decision-making. Narrative synthesis complemented this approach by providing a detailed account of the findings, highlighting specific examples and contextual insights. This combination of thematic and narrative synthesis facilitated a comprehensive and detailed analysis of the findings, allowing for a nuanced understanding of the factors influencing vaccine decision-making in LMIC households.

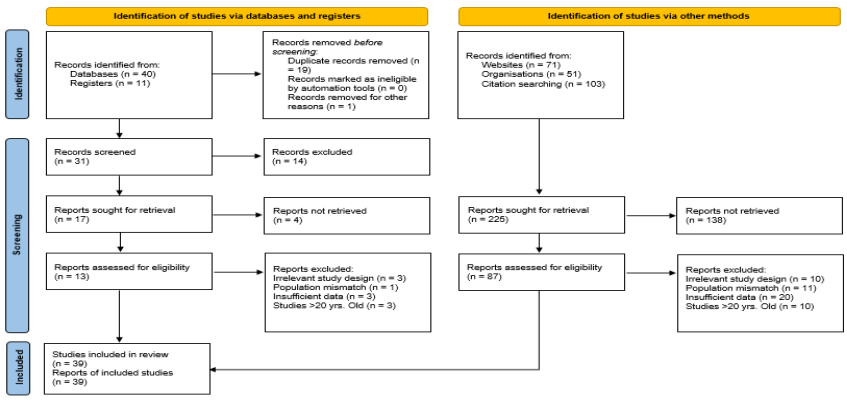

Figure 1. PRISMA 2020 Flow Diagram for New Systematic Reviews, which included Searches of Databases, Registers and Other Sources [15].

Findings

This section presents the key findings from the research study, highlighting the critical insights and trends identified through our analysis. The findings are organised to provide a comprehensive understanding of the data, addressing the primary research questions and objectives.

Gender Roles and Decision-Making

This subsection explores the impact of gender roles on decision-making processes related to vaccination. Gender dynamics within households and communities significantly influence health-related decisions, including the acceptance and uptake of vaccines. Key findings in this area include:

Cultural Norms and Decision-Making Power

The analysis revealed that gender roles significantly affect vaccine decision-making within households in LMICs. Women often serve as primary caregivers and strong advocates for vaccination, while men hold more decision-making power and exhibit higher levels of vaccine hesitancy [19]. Cultural norms in many LMICs dictate male dominance in household decisions, which can lead to lower vaccination rates when men are hesitant. These traditional gender roles often place women in supportive and nurturing roles, limiting their autonomy and ability to make independent healthcare decisions. As primary caregivers, women are responsible for the health and well-being of their families, yet their limited decision-making power hampers their ability to ensure timely vaccination. The entrenched cultural expectations often dictate that men, as heads of households, have the final say in health-related matters. This male dominance in decision-making can be detrimental, especially when men harbour skepticism or misconceptions about vaccines.

Women's Influence in Healthcare Decisions

Despite having limited decision-making power, women play a crucial role in advocating for vaccination and seeking health information for their families. The studies indicate that women's influence is often exercised through informal channels, such as maternal networks, community groups, and peer interactions, which can positively affect vaccination uptake [20]. Women's advocacy for vaccination is often driven by their role as primary caregivers and their desire to protect their children's health. They actively seek information from healthcare providers, community health workers, and other mothers to make informed decisions about vaccination. Women's networks serve as vital platforms for sharing experiences and knowledge, thereby promoting positive health behaviours. However, their efforts are sometimes constrained by the lack of formal decision-making authority within the household, necessitating the need for more inclusive and empowering approaches.

Barriers to Vaccination

The findings identified several common barriers to vaccination, including misinformation, distrust in healthcare systems, and limited access to vaccination services. Gender-specific constraints, such as women's restricted mobility and lack of financial independence, exacerbate these barriers [21]. Men’s reluctance to vaccinate often stems from skepticism about vaccine efficacy and safety, influenced by cultural and social norms. Additionally, logistical challenges, such as long travel distances to vaccination centers, economic constraints, and inadequate healthcare infrastructure further hinder vaccine uptake. Women's restricted mobility, dictated by cultural norms and responsibilities, limits their ability to access vaccination services. Financial constraints, particularly in single-income households, often prioritize immediate survival needs over preventive healthcare measures like vaccination. The combined effect

of these barriers results in lower vaccination rates, leaving communities vulnerable to vaccine-preventable diseases.

Vaccine Hesitancy Factors

In this subsection, the study examine the various factors contributing to vaccine hesitancy. Vaccine hesitancy is a complex and multifaceted issue influenced by a range of determinants. The key factors identified in this research study include:

Misinformation and Lack of Awareness

Both men and women reported vaccine hesitancy due to misinformation and lack of awareness about vaccine benefits and safety [22]. Men exhibited higher levels of skepticism and were more influenced by anti-vaccine narratives, often spread through social media, community networks, and informal communication channels. Women's hesitancy was also influenced by misinformation but was compounded by their limited access to accurate health information. Misinformation about vaccines, including false claims about their safety, efficacy, and potential side effects, perpetuates vaccine hesitancy. The lack of reliable and accessible health information further exacerbates this issue, particularly in remote and underserved areas where healthcare communication is often inadequate.

Religious and Cultural Beliefs

Religious and cultural beliefs play a significant role in vaccine acceptance and hesitancy. Many communities hold traditional beliefs and misconceptions about vaccines, leading to resistance among male decision-makers [23]. For instance, some cultural beliefs view vaccines as unnatural or harmful, while certain religious beliefs may oppose vaccination on doctrinal grounds. These beliefs are deeply ingrained and can significantly influence health behaviours and attitudes toward vaccination. Cultural narratives that equate vaccines with foreign or modern interventions can create resistance, especially in communities that prioritise traditional or holistic approaches to health. Religious opposition to vaccination, based on doctrinal teachings or mistrust of medical interventions, further complicates efforts to achieve widespread vaccine acceptance.

Healthcare Access

Limited access to healthcare services, particularly in rural areas, significantly affects vaccination rates. Women's access is further constrained by gender-specific barriers, such as lack of transportation, financial constraints, and social norms restricting their mobility[19]. The challenges are further compounded by inadequate healthcare infrastructure and limited availability of vaccination services in remote areas. Rural and underserved communities often face significant logistical challenges in accessing healthcare facilities, including long travel distances, poor road conditions, and limited transportation options. Financial barriers, such as the cost of transportation and lost income from taking time off work, further deter individuals from seeking vaccination services. Social norms that restrict women's mobility and prioritise men's health needs exacerbate these challenges, resulting in lower vaccination rates and increased vulnerability to vaccine-preventable diseases.

Strategies to Address Vaccine Hesitancy

Addressing vaccine hesitancy requires a multifaceted approach that considers the diverse factors influencing individuals' decisions. Based on the findings in this study, the following strategies are recommended to mitigate vaccine hesitancy and improve vaccination rates.

Community Engagement

Engaging community leaders and influencers, especially women, is essential for disseminating accurate information and building trust in vaccination programs[18]. Community-based interventions that involve both men and women in dialogue and decision-

making processes are critical for addressing vaccine hesitancy. Initiatives such as community health forums, participatory workshops, and grassroots advocacy can foster greater understanding and acceptance of vaccination. Community leaders, respected for their authority and influence, can effectively counter misinformation and promote positive health behaviours. Women's groups and maternal networks can serve as powerful platforms for peer education and support, reinforcing the importance of vaccination and addressing concerns within the community.

Education and Awareness Campaigns

Targeted education and awareness campaigns that address gender-specific concerns and involve both men and women are crucial for increasing vaccine uptake [18]. These campaigns should be culturally sensitive and tailored to the unique needs of different communities. Strategies such as peer education, health talks, and information dissemination through trusted community channels can effectively counter misinformation and promote vaccine acceptance. Educational initiatives should focus on providing clear, accurate, and accessible information about the benefits and safety of vaccines, addressing common misconceptions, and building trust in healthcare systems. Engaging men in these campaigns is particularly important, as their participation and support can influence household decisions and encourage positive health behaviours.

Policy and Program Interventions

Policies that empower women and promote gender equality in healthcare decision-making can have a positive impact on vaccination rates [20]. Developing supportive policies and programmes that prioritise gender inclusion and equity is vital for overcoming barriers to vaccination. Interventions such as providing financial incentives, improving healthcare infrastructure, and ensuring equitable access to vaccination services can enhance vaccine uptake in LMICs. Policies that promote women's economic empowerment, access to education, and participation in healthcare decisions can address the underlying gender disparities that contribute to vaccine hesitancy. Ensuring that healthcare services are accessible, affordable and culturally appropriate can further support vaccination efforts and protect communities from vaccine-preventable diseases.

Discussion

In this section, the research study interpret and contextualize the findings presented in the previous sections, exploring their implications and relevance to the broader research objectives. The discussion will address the following key points:

Gender-Specific Barriers and Facilitators

The findings of this systematic review underscore the critical need to address gender-specific barriers to vaccination in LMICs. Women, despite their integral role in supporting and advocating for vaccination within households, encounter significant challenges such as limited decision-making power and restricted access to resources. These barriers are often deeply rooted in cultural norms that assign men the primary decision-making authority, even in matters related to healthcare. Consequently, women's efforts to ensure their families are vaccinated are frequently undermined by their lack of autonomy and access to necessary resources.

Men, on the other hand, often hold misconceptions about vaccines and exhibit hesitancy influenced by traditional beliefs and misinformation. Misinformation about vaccine safety and efficacy is a pervasive issue, further compounded by religious and cultural beliefs that may discourage vaccination. Addressing these barriers requires a multifaceted approach that considers the socio-cultural and economic contexts of LMICs. This includes engaging

both men and women in educational initiatives, fostering community support for vaccination, and addressing the underlying cultural norms that perpetuate gender disparities in healthcare decision-making.

Implications for Public Health Policy

The implications for public health policy are significant and far-reaching. To effectively combat vaccine hesitancy in LMICs, policies must consider the intricate gender dynamics within households and communities. This involves promoting interventions that empower women, enhance their decision-making power, and ensure their active participation in healthcare decisions. Empowering women can be achieved through targeted educational programmes that provide them with the knowledge and resources needed to advocate for vaccination.

Equally important is the need to engage men in educational campaigns that address their concerns and misconceptions about vaccines. Public health strategies should be inclusive and participatory, ensuring that both men and women are actively engaged in the health decision-making process. By fostering an environment where both genders are informed and involved, public health initiatives can be more effective in increasing vaccination rates and reducing vaccine hesitancy.

Recommendations for Future Research

Future research should delve deeper into the underlying reasons for gender-specific vaccine hesitancy. Longitudinal studies that track changes in vaccine attitudes and behaviours over time can provide valuable insights into the factors influencing vaccine hesitancy. Intervention-based research is also crucial for evaluating the effectiveness of strategies aimed at addressing gender-related barriers to vaccination.

Additionally, research should consider the intersectionality of gender with other factors such as socioeconomic status, education, and cultural beliefs. Understanding how these intersecting factors contribute to vaccine hesitancy can inform the development of more targeted and effective interventions. For instance, studies could explore how education levels and economic empowerment influence women's ability to make healthcare decisions and advocate for vaccination. By adopting a holistic approach to research, public health professionals can gain a more comprehensive understanding of the complexities of vaccine hesitancy and develop strategies that are tailored to the specific needs of different communities.

Conclusions

The systematic review clearly shows that gender dynamics play a substantial role in influencing vaccine hesitancy and decision-making within LMICs. Several key factors contribute to this phenomenon. Cultural norms often dictate that men hold the majority of decision-making power within households. This male dominance can lead to lower vaccination rates, particularly when men exhibit skepticism or hesitancy toward vaccines. Women's roles, while crucial as primary caregivers and advocates for their children's health, are often limited by societal expectations and gender-specific constraints.

One significant barrier is misinformation about vaccines. Both men and women in LMICs are susceptible to misinformation, but the impact can be more pronounced for women due to their limited access to accurate health information. This misinformation can originate from various sources, including social media, community networks, and even religious or cultural beliefs that view vaccines with suspicion.

Another critical factor is the limited access to healthcare services, particularly in rural or underserved areas. Women in LMICs face additional challenges, such as restricted mobility and lack of financial independence, which can further hinder their ability to access

vaccination services. These constraints are often compounded by inadequate healthcare infrastructure and resource availability, making it even more difficult for women to obtain necessary vaccinations for themselves and their children.

Despite these challenges, women play an essential role in advocating for vaccination. Their influence is often exercised through informal channels and maternal networks, which can positively affect vaccination uptake. However, their limited decision-making power within the household can sometimes negate their efforts, especially when male decision-makers are hesitant or resistant to vaccination.

In conclusion, the review underscores the importance of addressing gender-specific barriers to improve vaccine uptake in LMICs. By understanding and tackling these barriers, public health initiatives can be more effective in increasing vaccination coverage and protecting communities from vaccine-preventable diseases.

Recommendations

Empowering women in healthcare decision-making is a crucial step toward reducing vaccine hesitancy and improving vaccination rates in LMICs. This can be achieved by implementing policies and programmes that promote women's autonomy and decision-making power within the healthcare system. Women should be provided with the necessary education and resources to enhance their knowledge and confidence in advocating for vaccination. For example, training programmes and workshops can be organised to educate women about the importance of vaccines and how to make informed healthcare decisions. These efforts will not only empower women but also ensure that they are better equipped to support their families' health and well-being.

Engaging men in vaccination programs is equally important, as they often hold significant decision-making power within households. Developing targeted educational campaigns that address men's concerns and misconceptions about vaccines is essential. These campaigns should be designed to resonate with men and provide them with accurate and reliable information about the benefits and safety of vaccines. Additionally, involving men in community-based vaccination initiatives can promote gender equality in healthcare decision-making. Men can be encouraged to participate in health education sessions and vaccination drives, fostering a more inclusive approach to healthcare.

Improving healthcare access is another critical recommendation for addressing vaccine hesitancy. In many LMICs, access to vaccination services is limited, particularly in rural and underserved areas. Increasing the availability of mobile vaccination services can help bridge this gap by bringing vaccines directly to the communities that need them the most. Furthermore, providing transportation support and financial incentives can reduce the economic barriers that often prevent individuals from accessing vaccination services. By addressing these logistical challenges, healthcare providers can ensure that more people receive the necessary vaccinations.

Culturally sensitive communication strategies are vital for effectively addressing vaccine hesitancy in diverse communities. These strategies should be designed to address the specific concerns and beliefs of different communities, ensuring that the messages resonate with the target audience. Collaborating with community leaders and influencers can enhance the credibility and reach of these communication efforts. Community leaders can play a pivotal role in disseminating accurate information about vaccines and countering misinformation. Healthcare providers can foster greater acceptance of vaccines by leveraging their influence and trust within the community.

Policy interventions play a crucial role in creating an enabling environment for vaccination. Advocating for supportive policies

that prioritize gender inclusion and equity in healthcare is essential. Policymakers should develop and implement programs that address the economic and social barriers to vaccination for women. For instance, policies that provide financial support for vaccination, improve healthcare infrastructure, and ensure equitable access to healthcare services can significantly enhance vaccination rates. Additionally, policies that promote gender equality in healthcare decision-making can empower women and create a more inclusive healthcare system.

In summary, these recommendations highlight the importance of adopting a multi-faceted approach to address vaccine hesitancy. Empowering women, engaging men, improving healthcare access, employing culturally sensitive communication strategies, and implementing supportive policies are all essential components of a comprehensive strategy to increase vaccination rates in LMICs. Public health initiatives can achieve greater success in improving vaccination coverage and protecting populations from vaccine-preventable diseases by addressing the unique challenges and barriers faced by different communities.

Future Research Directions

Future research should explore the impact of specific gender-sensitive interventions on vaccine acceptance and coverage. Longitudinal studies are needed to track changes in vaccine hesitancy over time and evaluate the effectiveness of targeted strategies. Additionally, research should consider the intersectionality of gender with other factors such as socioeconomic status, education, and cultural beliefs. Public health professionals can gain deeper insights into the complex factors influencing vaccine hesitancy and develop more effective strategies to address these challenges by adopting a comprehensive and inclusive approach to research.

Annexure

Table 1. Description of Studies Included in Systematic Review

Author(s)	Year	Study Design	Country	Focus Area	Key Findings
Ali, H. A., Hartner, A. M., Echeverria-Londono, S., et al.	2022	Systematic Review and Meta-analysis	Various LMICs	Vaccine equity	Highlighted disparities in vaccine distribution and access in LMICs, emphasizing the need for equitable vaccine allocation to improve health outcomes.
Ali, M., & Rehman, H.	2019	Qualitative Study	Various LMICs	Barriers to vaccination	Identified barriers such as misinformation, lack of access, and socio-cultural factors that hinder vaccine uptake in LMICs.
Babalola, S.	2020	Qualitative Study	Sub-Saharan Africa	Gender dynamics and v accine hesitancy	Examined how gender dynamics influence vaccine hesitancy, with men exhibiting higher levels of hesitancy due to decision-making power.
Bosire, E. N., Cho, A., Kamau, L. W., Bosire, V., & Mend enhall, E.	2023	Qualitative Study	Kenya	COVID-19 vaccination views	Investigated residents' views on COVID-19 vaccination, revealing socio-

					cultural and economic factors influencing vaccine uptake.
Daniel, P., & Kumwenda, J.	2022	Qualitative Study	Malawi	Religious beliefs and vaccine acceptance	Explored the impact of religious beliefs on vaccine acceptance, finding significant resistance among certain religious groups.
Jegede, A. S.	2007	Case Study	Nigeria	Polio vaccination campaign	Investigated the reasons behind the Nigerian boycott of the polio vaccination campaign, identifying cultural and political factors.
Larson, H. J., Cooper, L. Z., Eskola, J., et al.	2015	Systematic Review	Various LMICs	Vaccine confidence gap	Addressed the vaccine confidence gap by analyzing factors that undermine public trust in vaccines.
Larson, H. J., Jarrett, C., Eckersberger, E., et al.	2014	Systematic Review	Various LMICs	Understanding global vaccine hesitancy	Conducted a systematic review to understand vaccine hesitancy from a global perspective, identifying common themes and regional differences.
MacDonald, N. E.	2015	Review		Vaccine hesitancy	Defined vaccine hesitancy and identified its determinants, providing a framework for addressing hesitancy in different contexts.
Merten, S., Hilber, A. M., Biaggi, C., et al.	2015	Meta-Ethnographic Review	Various LMICs	Gender determinants of vaccination status	Synthesized evidence on gender determinants of vaccination status, highlighting the role of gender in vaccine uptake.
Obadare, E., & Akande, T. M.	2021	Cross-Sectional Survey	Nigeria	Maternal influence on child vaccination	Explored the impact of maternal influence on child vaccination, highlighting the role of mothers in promoting vaccine uptake.
Ogunleye, O. O., Basu, D., Mueller, D., et al.	2021	Mixed-Methods Study	Nigeria	COVID-19 pandemic response	Analyzed Nigeria's response to the COVID-19 pandemic, emphasizing the need for improved public health preparedness and socioeconomic responses.
Oliveira, M., Braga, M. F., Bueno, A., et al.	2022	Mixed-Methods Study	Brazil	Protection of vulnerable populations during COVID-19	Examined actions taken to protect vulnerable populations during the COVID-19 pandemic, highlighting the importance of targeted interventions.
Singh, P. K., & Singh, S.	2013	Cross-Sectional Survey	India	Impact of maternal education on child immunization	Found that maternal education significantly influences child immunization rates, emphasizing the importance of educating mothers.

Smith, P. J.	2010	Community-based Study	Kenya	Community engagement and vaccine uptake	Investigated the role of community engagement in promoting vaccine uptake, highlighting effective strategies for increasing vaccination rates.

Declaration

Ethics Approval and Consent to Participate

Not applicable

Consent for Publication

Not applicable

Availability of Data and Materials

Not applicable

Competing Interests

The author declare no competing interests.

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Authors' Contributions

Not Applicable

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From Prevention to Intervention: Advanced Cholesterol-Lowering Techniques in Cardiovascular and Coronary Care – A Systematic Review

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Abstract

Dyslipidemia, marked by elevated low-density lipoprotein cholesterol (LDL-C), is a key contributor to atherosclerotic cardiovascular disease (ASCVD) and remains a global health challenge. Advances in lipid management have transitioned from statin monotherapy to combination therapies with ezetimibe and PCSK9 inhibitors, achieving LDL-C reductions of up to 85% and significantly lowering major adverse cardiovascular events (MACE). Emerging agents, including bempedoic acid and RNA-directed therapies such as inclisiran and antisense oligonucleotides targeting lipoprotein(a), offer alternative solutions for statin-intolerant populations and those with residual cardiovascular risk. Intracoronary imaging demonstrates the benefits of aggressive LDL-C lowering on plaque regression and stabilization, reinforcing the importance of early initiation and sustained control. Simplified regimens, such as single-pill combinations, improve adherence and address barriers like cost and access, essential for maximizing therapeutic outcomes. Additionally, tools such as coronary artery calcium (CAC) scoring and advanced imaging enable personalized care and refined risk stratification. This meta-analysis synthesizes evidence to highlight a paradigm shift towards aggressive, individualized lipid management strategies that bridge gaps between clinical trials and real-world practice. By integrating pharmacological innovations with lifestyle interventions, these advancements offer transformative potential to reduce ASCVD risk globally.

Keywords: *Atherosclerotic cardiovascular Disease, Combination Therapies, Dyslipidemia, LDL Cholesterol, Lipid-Lowering Therapies, PCSK9 Inhibitors.*

Introduction

Atherosclerotic cardiovascular disease (ASCVD) remains the leading cause of morbidity and mortality worldwide, driven by elevated levels of low-density lipoprotein cholesterol (LDL-C) and other atherogenic lipoproteins such as lipoprotein(a) [Lp(a)] and triglyceride-rich lipoproteins. The direct relationship between LDL-C levels and the progression of ASCVD underscores its critical role as a therapeutic target. Despite decades of reliance on statins as the cornerstone of lipid management, many patients, particularly those at high or very high cardiovascular risk, fail to achieve guideline-recommended LDL-C goals. This persistent gap highlights the need for advanced therapeutic strategies that integrate emerging non-statin agents.

Modern lipid-lowering therapies have expanded beyond statins to include ezetimibe, proprotein convertase subtilisin/kexin type 9 (PCSK9) inhibitors, and bempedoic acid, offering novel mechanisms of action and enhanced LDL-C reductions. RNA-directed therapies such as inclisiran, and antisense oligonucleotides targeting Lp(a), exemplify recent innovations, providing effective, long-lasting options for managing dyslipidemia. Evidence from landmark trials such as FOURIER, ODYSSEY, CLEAR Outcomes,

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and findings from the DA VINCI study highlight the potential of combination therapies, which achieve LDL-C reductions exceeding 85% and substantial decreases in major adverse cardiovascular events (MACE) and cardiovascular mortality [2, 11].

Aggressive LDL-C lowering has become a pivotal goal in both primary and secondary prevention of ASCVD. Recent European and American guidelines emphasize early initiation and sustained reductions in LDL-C, with targets set at <55 mg/dL for very high-risk patients and <70 mg/dL for high-risk populations. Additionally, achieving non-high-density lipoprotein cholesterol (non-HDL-C) goals has proven crucial, particularly following acute coronary syndromes (ACS). Registry-based studies, such as SWEDEHEART, and cross-sectional findings from the DA VINCI study have reinforced the importance of rapid and sustained lipid lowering. These studies demonstrate not only the benefits of achieving guideline-recommended LDL-C targets but also highlight regional disparities in adherence to lipid-lowering strategies, underscoring the need for standardized approaches across healthcare systems [11].

Incorporating advanced lipid-lowering strategies into clinical practice has redefined ASCVD management. High-intensity statins remain foundational, but the addition of ezetimibe and PCSK9 inhibitors, either as part of stepwise intensification or in fixed-dose combinations, significantly improves LDL-C goal attainment. The DA VINCI study confirms that combination therapies, particularly those involving PCSK9 inhibitors, provide superior LDL-C reductions compared to monotherapy, though their adoption remains limited due to cost and accessibility barriers [11]. Emerging therapies such as bempedoic acid and inclisiran provide effective alternatives for statin-intolerant patients, broadening the therapeutic arsenal for dyslipidemia management [2, 11].

The interplay between pharmacological advancements and lifestyle interventions also remains essential. Dietary modifications, such as adherence to the Mediterranean or DASH diet, regular physical activity, and smoking cessation, further reduce ASCVD risk and complement pharmacotherapy. Integration of non-statin agents has proven particularly effective in high-risk groups, including those with familial hypercholesterolemia, diabetes, or chronic kidney disease, where statins alone are often insufficient. Additionally, the use of intracoronary imaging has illuminated the role of lipid-lowering therapies in plaque regression and stabilization, providing further evidence for their integration into clinical practice [2].

Despite these advancements, barriers such as cost, accessibility, and adherence continue to hinder the widespread adoption of novel therapies. Simplified treatment regimens, such as single-pill combinations, and improved patient education represent practical solutions to enhance compliance and outcomes. Ongoing research focusing on long-term safety, real-world efficacy, and innovative approaches like gene-editing technologies offers promising avenues for the future of lipid management. Furthermore, addressing disparities in LDL-C goal attainment across regions, as highlighted by the DA VINCI study, is crucial for achieving equitable cardiovascular care [2].

This meta-analysis aims to synthesize the current evidence on advanced cholesterol-lowering techniques, highlighting their mechanisms of action, efficacy, safety profiles, and impact on cardiovascular outcomes. By bridging gaps between guideline recommendations and real-world practice, it seeks to provide a comprehensive framework for optimizing ASCVD prevention and management, addressing the unmet needs of diverse patient populations worldwide [2, 11].

Materials and Methods

Study Design

This meta-analysis synthesizes data from major studies and clinical guidelines focusing on advanced lipid-lowering therapies and their impact on cardiovascular and coronary care. The articles reviewed include randomized controlled trials (RCTs), systematic reviews, registry-based analyses, and population studies. Each study evaluated distinct aspects of lipid-lowering strategies, including mechanisms of action, efficacy, safety, patient stratification, and clinical outcomes. The DA VINCI study contributed insights into real-world LDL-C goal attainment across European countries, highlighting gaps in adherence to guidelines and regional variability in outcomes [11]. The primary objective was to integrate findings into a cohesive framework that informs the prevention and intervention strategies for dyslipidemia and ASCVD management.

Study Population

The study population in this meta-analysis encompasses a diverse group of patients across varying demographics and clinical contexts. High-risk populations include individuals with established atherosclerotic cardiovascular disease (ASCVD), those with familial hypercholesterolemia (FH), and diabetic patients with comorbid dyslipidemia. Moderate- and low-risk groups are also represented, including primary prevention cohorts with elevated LDL-C levels and intermediate-risk individuals identified through coronary artery calcium (CAC) scoring. Additionally, the analysis considers statin-intolerant populations who are unable to tolerate high- or moderate-intensity statins due to adverse effects. Regional variability is addressed through studies like the DA VINCI study, which assessed LDL-C goal attainment across 18 European countries, stratifying patients by cardiovascular risk using tools such as the SCORE2 and REACH calculators [11].

Study Population based on Risk Categories

Cardiovascular risk stratification involves assessing the likelihood of a person experiencing an atherosclerotic cardiovascular (CV) event within a specific timeframe. This evaluation considers the cumulative contribution of various CV risk factors. Some factors, like a history of previous atherosclerotic events, independently classify individuals as very high-risk, regardless of additional risk factors.

The guidelines emphasize systematic risk evaluations, particularly for individuals with chronic kidney disease, familial hypercholesterolemia, diabetes, or atherosclerotic cardiovascular disease (ASCVD). Risk classifications—moderate, high, or very high—help clinicians establish appropriate LDL cholesterol and blood pressure targets, enhancing therapeutic precision.

A significant addition is the concept of "lifetime risk," which predicts the age at which an individual has a 50% likelihood of developing a fatal or non-fatal cardiovascular event. This approach, combined with tools like the ESC CVD Risk Calculation app, enables personalized care and improves risk estimation by considering variables such as age, changes in risk factor levels, and other modifiers. [12, 13]. As shown in Table 1, risk categories are determined based on various clinical factors, allowing for targeted lipid-lowering interventions.

Table 1. Risk Stratification Categories

Age Group	Moderate–Low CV Risk	High CV Risk	Very High CV Risk
<50 years	<2.5%	2.5–7.5%	≥7.5%
50–69 years	<5%	5–10%	≥10%
≥70 years	<7.5%	7.5–15%	≥15%

Different guidelines, including those from the American Heart Association (AHA), American College of Cardiology (ACC), and the European Society of Cardiology (ESC), employ varying risk calculation methods. The AHA/ACC guidelines use pooled cohort equations (PCEs) to estimate a 10-year risk of non-fatal myocardial infarction, coronary artery disease death, or stroke in individuals without prior ASCVD. High-risk conditions encompass individuals aged 65 years or older, those with heterozygous familial hypercholesterolemia (HeFH), a history of coronary artery bypass grafting (CABG) or percutaneous coronary intervention (PCI) unrelated to a major ASCVD event, diabetes mellitus (DM), hypertension (HTN), chronic kidney disease (CKD) with an estimated glomerular filtration rate (eGFR) of 15–59 mL/min/1.73 m², active smoking, persistently elevated LDL-C levels of ≥100 mg/dL despite maximum tolerated doses of statins and ezetimibe, or a history of congestive heart failure (CHF).

The ESC guidelines categorize individuals into low-, intermediate-, high-, or very high-risk groups based on the presence of major risk factors or, in healthy individuals, a 10-year risk estimate using the SCORE2 or SCORE2-OP (Older Persons) models. These models account for regional variations and predict the risk of total CV events. For diabetic patients, stratification relies on ASCVD presence, severe target organ damage, or SCORE2-Diabetes. As seen in Table 2, therapeutic targets for LDL cholesterol are more stringent for high-risk individuals to minimize the risk of cardiovascular events.

Table 2. Therapeutic LDL Targets by Risk Category

Risk Category	LDL Cholesterol Target
Very High Risk	<1.4 mmol/L (<55 mg/dL); ≥50% reduction from baseline
Very High Risk (Recurrent Events)	<1 mmol/L (<40 mg/dL); in cases of a second event within 2 years can be considered
High Risk	<1.8 mmol/L (<70 mg/dL); ≥50% reduction from baseline
Moderate Risk	<2.6 mmol/L (<100 mg/dL)

Recent recommendations propose introducing an "extremely high-risk" category, encompassing patients with recurrent major CV events within two years, polyvascular disease, multivessel coronary artery disease, or recent acute coronary syndrome (ACS). This new classification enables clinicians to identify individuals who may benefit from intensified lipid-lowering therapies and stricter LDL-C targets. Figure 1 illustrates the recommended LDL-C targets based on cardiovascular risk categories, providing a clear framework for clinical decision-making.

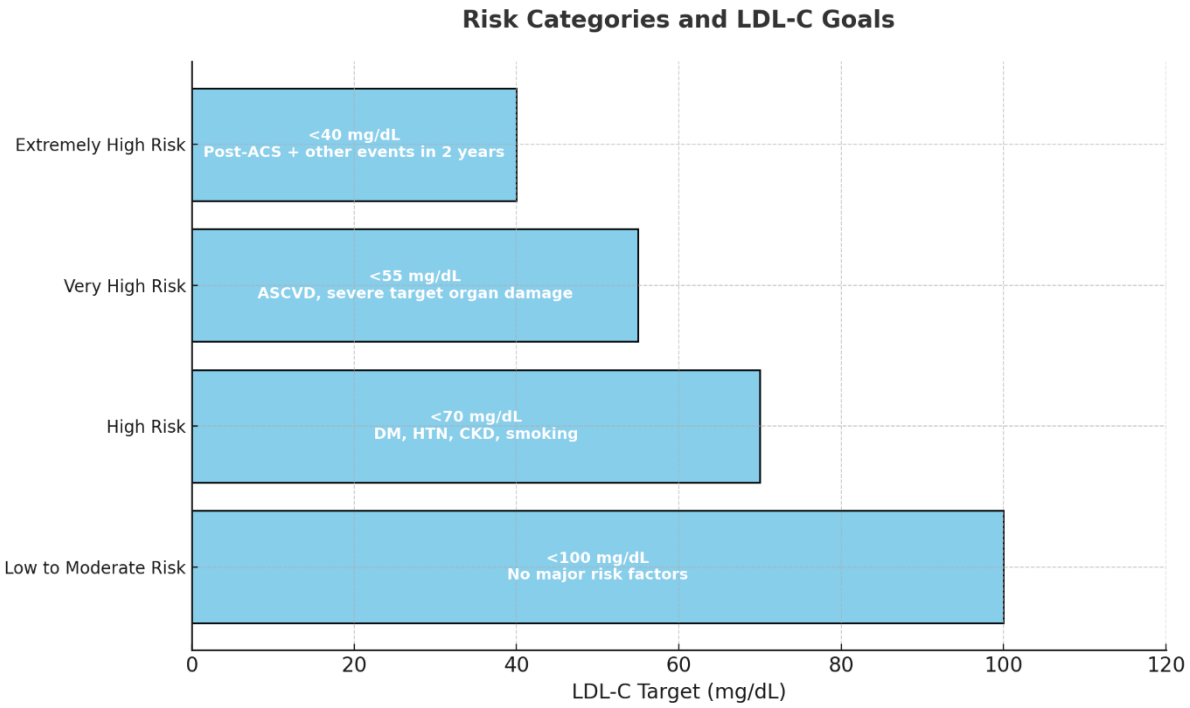

Figure 1. LDL-C targets based on Cardiovascular Risk Categories

Risk modifiers such as family history of premature ASCVD, chronic inflammatory conditions, elevated lipoprotein(a), and non-zero coronary artery calcium scores may upgrade an individual's risk category, guiding more aggressive intervention strategies.

Lipid-Lowering Interventions

Effective lipid-lowering strategies form the cornerstone of cardiovascular risk reduction.

Statins

Statins such as Hydroxymethylglutaryl-coenzyme A (HMG CoA) reductase inhibitors are the primary therapy for reducing cardiovascular burden. High-intensity statins reduced LDL-C by 50% (e.g., atorvastatin, rosuvastatin) [1, 3, 6]. Moderate-intensity statins achieved reductions of 30–40% [1, 3, 6]. However, non-statin treatments are increasingly utilized, either as alternatives or in combination with statins, particularly for individuals requiring additional LDL cholesterol (LDL-C) reduction or those intolerant to statins. [14].

Ezetimibe: Targeting Cholesterol Absorption

Ezetimibe reduces intestinal cholesterol absorption by inhibiting the Niemann-Pick C1-like 1 (NPC1L1) protein on the enterocyte brush border. As a monotherapy, ezetimibe achieves a 15–22% reduction in LDL-C levels and further enhances LDL-C reduction by an additional 21–27% when combined with statins. It modestly lowers triglycerides by 8% and increases HDL-C by 5%. The **IMPROVE-IT trial** demonstrated the clinical efficacy of ezetimibe when used alongside statins, showing significant cardiovascular event reductions [15, 16]. Ezetimibe is well-tolerated, though mild diarrhea or headache may occur. It is contraindicated in patients with moderate to severe liver impairment due to potential hepatic adverse effects.

Therapy Targeting PCSK9: Enhancing LDL Receptor Activity

PCSK9 inhibitors, such as alirocumab and evolocumab, are monoclonal antibodies that prevent PCSK9 from degrading LDL receptors, thereby increasing LDL clearance

from circulation [17]. These drugs, administered via subcutaneous injections, have been shown in trials like **ODYSSEY OUTCOMES** and **FOURIER** to reduce major adverse cardiovascular events (MACE) in high-risk individuals [18, 19]. Inclisiran, a small interfering RNA (siRNA) therapy, offers a unique mechanism by directly inhibiting PCSK9 production in hepatocytes, with biannual dosing schedules providing convenience [20, 21]. PCSK9 inhibitors demonstrate potent LDL-C reductions, with alirocumab and evolocumab reducing levels by 50–60%. Cost and injection-based administration remain barriers to widespread use, but their efficacy is particularly beneficial for individuals with severe dyslipidemia or statin intolerance.

Bempedoic Acid: An Oral Alternative

Bempedoic acid inhibits ATP citrate lyase, an enzyme upstream of HMG-CoA reductase in the cholesterol biosynthesis pathway. This mechanism avoids muscle-related side effects, as bempedoic acid activation occurs only in the liver, not in skeletal muscle. Clinical trials, such as **CLEAR Harmony** and **CLEAR Wisdom**, have shown that bempedoic acid reduces LDL-C by approximately 18% and significantly decreases high-sensitivity C-reactive protein (hs-CRP) levels. The **CLEAR Outcomes trial** demonstrated a 21% reduction in cardiovascular events among patients treated with bempedoic acid [22, 23]. Common side effects include hyperuricemia, nasopharyngitis, and mild tendon disorders, making it an excellent option for individuals intolerant to statins.

Fibrates: Targeting Triglyceride Reduction

Fibrates activate peroxisome proliferator-activated receptor-alpha (PPARα), enhancing lipid metabolism and reducing very low-density lipoprotein (VLDL) production. Fenofibrate and gemfibrozil are the primary agents in this class, with fenofibrate showing promise in the **FIELD trial** for reducing diabetic retinopathy progression. While fibrates primarily lower triglycerides, they also slightly increase HDL-C and reduce LDL-C [24]. However, their use requires caution in patients with renal impairment, as fibrates are renally cleared and may pose a risk of nephrotoxicity.

Bile Acid Sequestrants: Disrupting Cholesterol Recycling

Bile acid sequestrants, such as cholestyramine, colestipol, and colesevelam, bind bile acids in the intestinal lumen, preventing their reabsorption. This forces the liver to utilize more cholesterol to produce bile acids, thereby reducing circulating LDL-C levels [25]. While these agents effectively lower LDL-C, their use is often limited by gastrointestinal side effects like bloating and constipation. Bile acid sequestrants are a suitable option for younger patients or pregnant women who cannot take statins or other systemic therapies.

Evinacumab: A Novel Approach for Severe Dyslipidemia

Evinacumab is a monoclonal antibody targeting angiopoietin-like protein 3 (ANGPTL3), which plays a key role in lipid metabolism. Unlike traditional LDL receptor-targeting therapies, evinacumab reduces LDL-C levels independently of LDL receptors. Approved for homozygous familial hypercholesterolemia (HoFH), evinacumab has demonstrated significant efficacy in trials such as the **ELIPSE HoFH trial**, achieving LDL-C reductions of over 47% [26]. Its unique mechanism makes it particularly valuable for individuals with severe or refractory dyslipidemia, though its high cost and limited availability restrict widespread use.

Lomitapide and Mipomersen: Specialized Therapies for Familial Hypercholesterolemia

Lomitapide inhibits microsomal triglyceride transfer protein (MTP), reducing the assembly of apoB-containing lipoproteins and significantly lowering LDL-C levels. However, its use is associated with hepatic steatosis and elevated liver enzymes, requiring close monitoring. Mipomersen, an antisense oligonucleotide targeting apoB-100 mRNA, reduces LDL-C by approximately 37% and is indicated for homozygous familial hypercholesterolemia [27]. Both therapies are reserved for patients with severe dyslipidemia who fail to achieve target LDL-C levels with conventional therapies. The **Homozygous FH studies** have validated their efficacy but highlighted their safety challenges.

LDL Apheresis: Extracorporeal Lipoprotein Removal

LDL apheresis is an extracorporeal treatment that selectively removes LDL-C and other apoB-containing lipoproteins from the bloodstream. This procedure achieves acute reductions in LDL-C by 50–60%, making it a crucial intervention for individuals with familial hypercholesterolemia unresponsive to pharmacologic therapies [28]. While effective, LDL apheresis is invasive and requires specialized equipment and trained personnel. Adverse events, such as transient hypotension, bleeding, or venous access complications, are potential drawbacks. The therapy is primarily reserved for patients with homozygous familial hypercholesterolemia or severe LDL-C elevations that cannot be managed through other treatments. Figure 2 compares the efficacy of statins, PCSK9 inhibitors, and other lipid-lowering agents, highlighting the superior effectiveness of combination therapies.

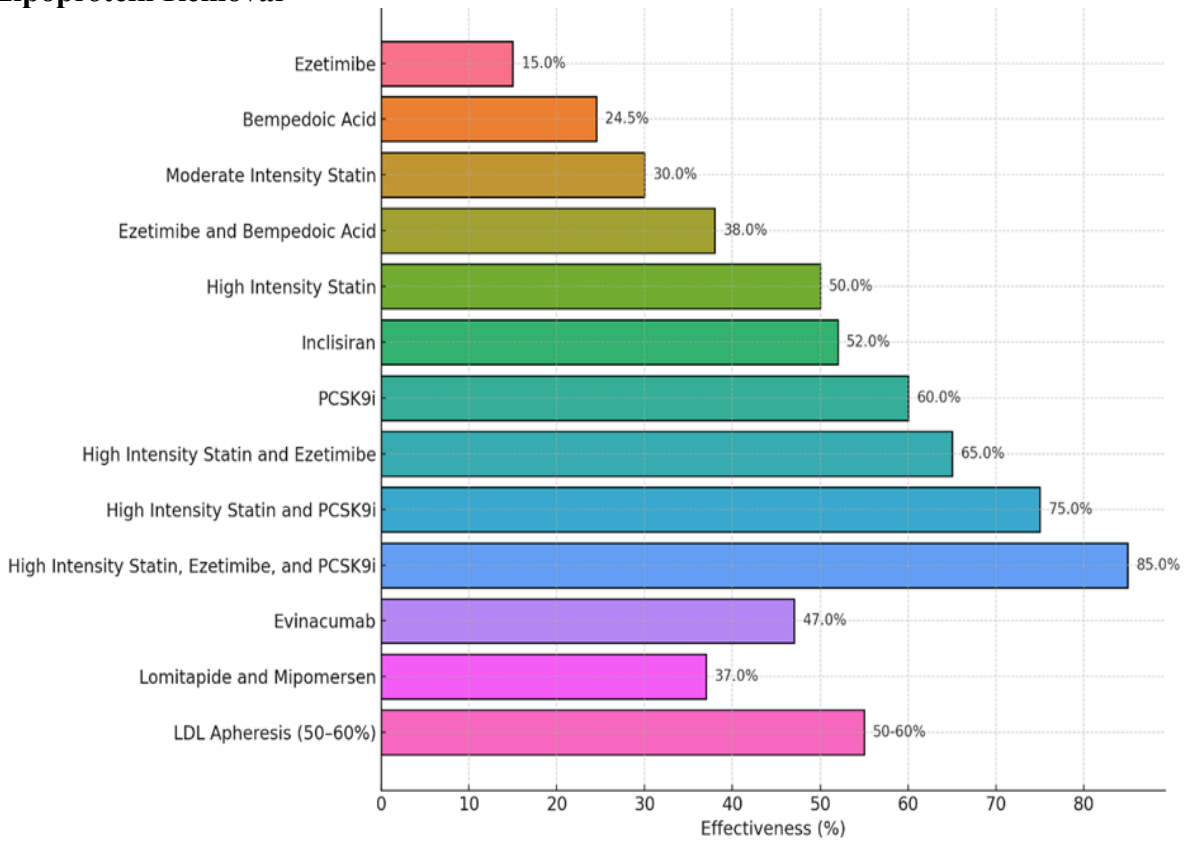

Figure 2. Effectiveness of Lipid-Lowering Therapies in LDL-C Reduction

Evaluating the Effectiveness of Lipid-Lowering Therapy

Both European and American guidelines emphasize the importance of monitoring the response to lipid-lowering therapies within a specific timeframe after initiation or adjustment. A follow-up assessment is recommended 4–12 weeks after the start of treatment to evaluate its effectiveness and make any necessary modifications. However, the recommended intervals for subsequent follow-ups differ between the two guidelines once the LDL-C target is achieved.

The European guidelines advise follow-up intervals of 6–12 months, whereas the American guidelines suggest a more variable timeframe of 3–12 months. In contrast, the ESC guidelines recommend shorter intervals of 4–6 weeks following an acute coronary syndrome (ACS). This is to ensure timely achievement of LDL-C goals during the critical early recovery period [13, 14]. Similarly, the writing committee advocates comparable shorter intervals for individuals at extreme risk to optimize care and minimize potential complications. Once stable, subsequent follow-ups every six months are advised for this high-risk group, with earlier evaluations recommended when dose adjustments are made.

During these follow-ups, a comprehensive lipid profile should be conducted, including assessments of non-HDL-C and ApoB, which serve as secondary treatment targets. Furthermore, adherence to prescribed medications and recommended lifestyle changes is vital for maximizing the benefits of lipid-lowering therapy and reducing the risk of ASCVD. Figure 3 presents an overview of risk categories, LDL-C targets, and the corresponding management strategies recommended by clinical guidelines.

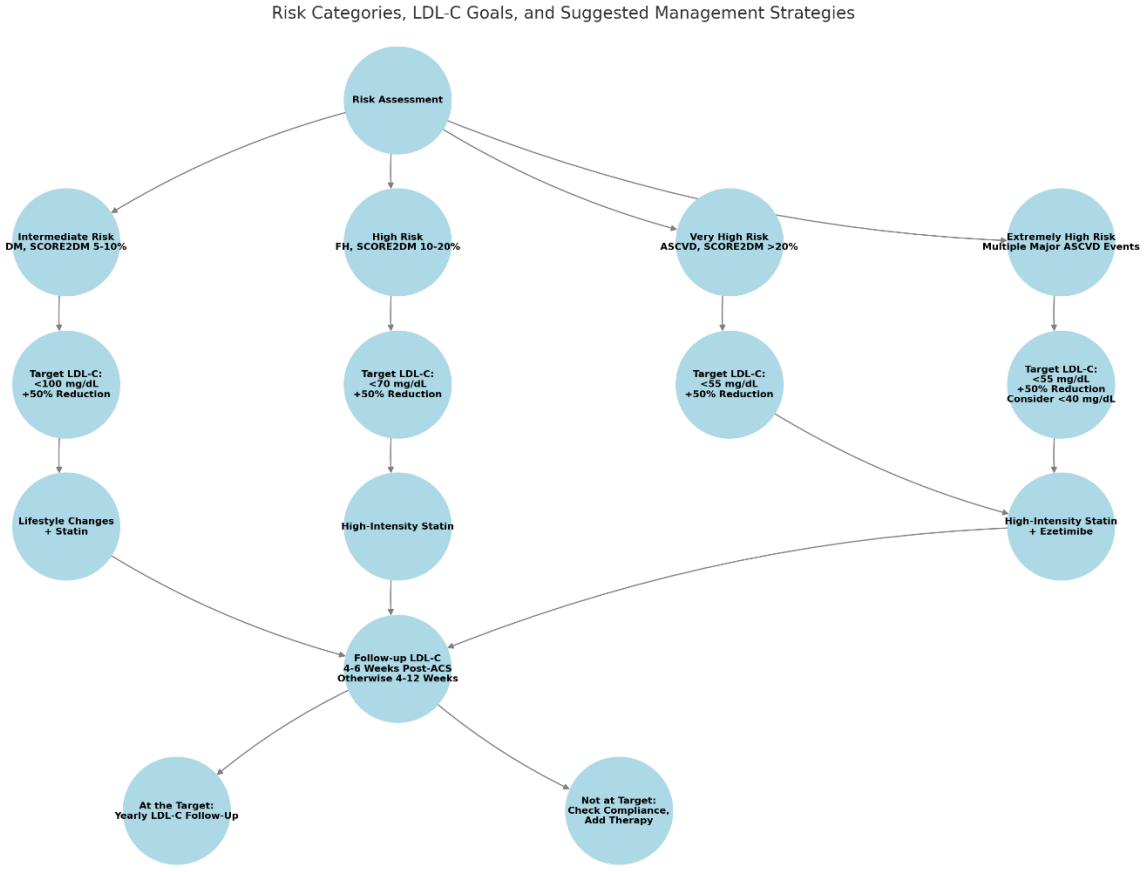

Figure 3. Risk Categories, LDL-C Targets, and Corresponding Management Strategies

Outcome Measures

The primary outcome measures included several key aspects. The reduction in LDL-C percentages was a significant focus, with articles examining the effectiveness of various therapeutic regimens, including combination therapies, in achieving guideline-recommended LDL-C targets. Another critical measure was the reduction in major adverse cardiovascular events (MACE), such as myocardial infarction and cardiovascular death. Regional variability was also highlighted, with studies like the DA VINCI study showcasing differences in LDL-C goal attainment and healthcare access across European countries [11]. Additionally, the long-term safety profiles of novel therapies were assessed to ensure their viability for sustained use. Risk stratification was further enhanced through tools like coronary artery calcium (CAC) scoring and arterial imaging, refining patient management strategies.

Results

LDL-C Reduction Across Therapies

The meta-analysis highlights substantial progress in lipid-lowering strategies, with combination regimens demonstrating superior efficacy compared to monotherapies. High-intensity statins, such as atorvastatin and rosuvastatin, were shown to reduce LDL-C levels by approximately 50% [1, 3, 6]. Moderate-intensity statins achieved reductions in the range of 30–40% [1, 3, 6]. However, statin monotherapy often proved insufficient for high-risk populations to meet guideline-recommended LDL-C targets of <70 mg/dL for high-risk patients and <55 mg/dL for very-high-risk patients [2, 7, 11].

Combination therapies offered enhanced outcomes. Adding ezetimibe to statin therapy increased LDL-C reduction to approximately 65% [1, 5]. Incorporating PCSK9 inhibitors into combination regimens yielded even greater reductions, with LDL-C levels dropping by 75–85% [2, 4, 8]. Bempedoic acid, as a monotherapy, achieved an additional LDL-C reduction of around 18% and demonstrated increased efficacy when combined with statins or ezetimibe [5, 6, 11].

According to the ESC dyslipidemia guidelines, risk categories must adhere to the outlined recommendations. When additional LDL-C lowering of 20–30% is needed, particularly in non-acute settings, bempedoic acid may be added to the regimen. However, for more substantial LDL-C reductions required in very high- or extreme-risk cases, PCSK9-targeted therapies should be prioritized. While no large-scale studies directly compare PCSK9 inhibitors and bempedoic acid, both have been extensively evaluated across diverse risk profiles and shown to significantly reduce cardiovascular morbidity and mortality.

In resource-constrained environments, bempedoic acid offers a viable option for optimizing lipid control, although it is not yet included in standard guidelines. For elderly patients, those at risk of myopathy, individuals with CKD, or those with partial statin intolerance, initiating therapy with a moderate-intensity statin and ezetimibe is suggested. In cases of complete statin intolerance, a combination of ezetimibe and bempedoic acid may be employed, with the potential addition of PCSK9-targeted therapies depending on LDL-C levels achieved.

Novel Agents

Inclisiran, an siRNA-based therapy, has demonstrated an approximately 50% reduction in LDL-C levels while requiring fewer annual doses compared to traditional treatments [9, 2]. Additionally, antisense oligonucleotides targeting lipoprotein(a) have achieved reductions of up to 80% in Lp(a) levels, significantly lowering cardiovascular risk in patients with elevated Lp(a) levels [9, 10, 2].

LDL-C Goal Achievement

The percentage of patients achieving LDL-C targets increased with the intensification of therapy. Monotherapy with statins allowed only 25% of patients to reach LDL-C levels below 70 mg/dL [3, 7]. Adding ezetimibe to statin therapy improved this percentage to 45% [1, 5]. Further intensification with PCSK9 inhibitors resulted in over 75% of patients achieving LDL-C targets [2, 8].

Cardiovascular Outcomes

Combination therapies demonstrated significant benefits in improving cardiovascular outcomes. Statin monotherapy reduced major adverse cardiovascular events (MACE) by 15–20% [3, 6], while the addition of ezetimibe to statins enhanced MACE reduction to 25% [5]. Further intensification with the combination of statins, ezetimibe, and PCSK9 inhibitors achieved reductions of 30–35% [4, 8, 11]. In terms of mortality, PCSK9 inhibitors decreased cardiovascular mortality by 35% in high-risk populations [2, 4]. Intracoronary imaging studies also revealed greater regression and stabilization of atherosclerotic plaques with intensive therapies. Both PCSK9 inhibitors and inclisiran significantly contributed to the reduction of plaque burden [7, 9, 11].

Safety and Tolerability

Statins remain a cornerstone of lipid-lowering therapy, but their use is occasionally associated with adverse events such as myopathy and, in rare cases, rhabdomyolysis [1, 3]. Approximately 9% of patients experience statin intolerance, though complete intolerance is reported in less than 3% of cases [6]. PCSK9 inhibitors have been well-tolerated, with only mild injection-site reactions reported and no significant systemic side effects observed [2, 8]. Bempedoic acid has demonstrated minimal muscle-related side effects and reversible elevations in uric acid levels, making it a suitable alternative for statin-intolerant patients [5, 11]. Inclisiran and antisense therapies also showed favorable safety profiles, though rare cases of injection-site reactions and thrombocytopenia were reported in some clinical trials [9, 10, 11]. As illustrated in Table 3, different lipid-lowering regimens lead to varying degrees of cardiovascular risk reduction, emphasizing the need for personalized therapy.

Table 3. LDL-C Reduction and Cardiovascular Risk Reduction

Therapy Type	LDL-C Reduction (%)	MACE Reduction (%)	Mortality Reduction (%)
Statin Monotherapy	30–50	15–20	20
Statin + Ezetimibe	~65	25	28
Statin + PCSK9 Inhibitors	75–85	30–35	35
Bempedoic Acid	~18	21	—
Inclisiran	~50	—	—
Antisense Therapies (Lp(a))	~80 (Lp(a))	Significant	Significant

The impact of lipid-lowering therapies extends beyond LDL-C reduction to significantly lowering major adverse cardiovascular events (MACE) and cardiovascular mortality. Figure 4 presents a comparative analysis of various lipid-lowering therapies, demonstrating their combined effects on LDL-C levels, MACE reduction, and mortality outcomes.

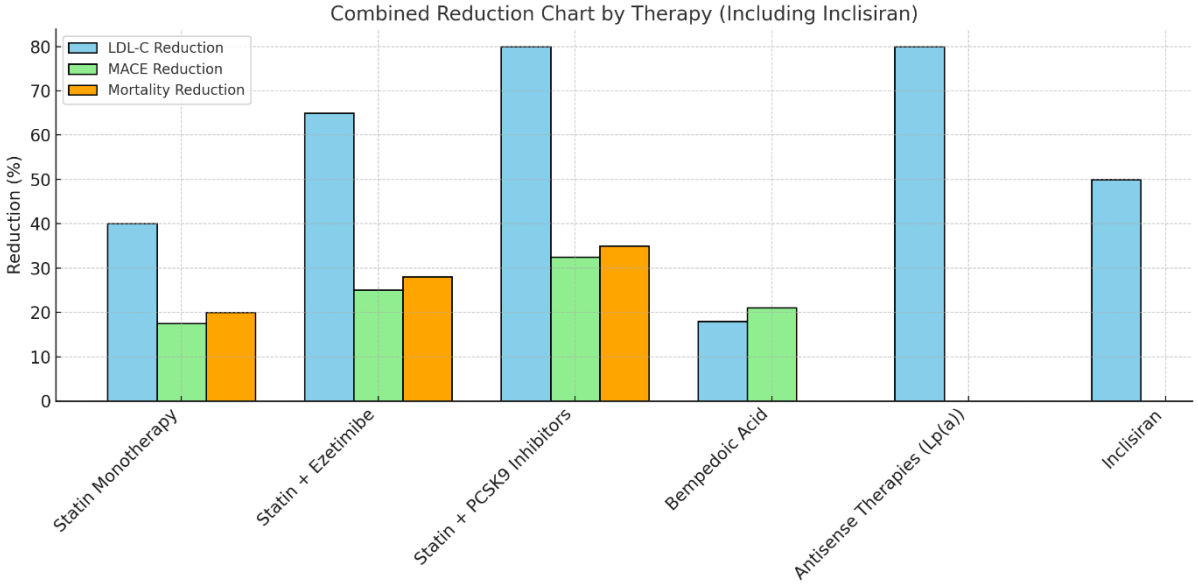

Figure 4. Combined Reductions in LDL-C, MACE, and Mortality Across Various Lipid-Lowering Therapies.

Discussion

Summary of Findings

The findings from this study underscore the pivotal role of aggressive cholesterol-lowering strategies in managing atherosclerotic cardiovascular disease (ASCVD). Statins remain foundational for LDL-C reduction, achieving reductions of 30–50%. However, the consistent failure to meet guideline-recommended LDL-C targets in high-risk and very-high-risk populations necessitates combination therapies that integrate non-statin agents like ezetimibe, PCSK9 inhibitors, bempedoic acid, and inclisiran [1, 2, 3, 11]. These advanced therapies provide additive benefits, achieving LDL-C reductions of up to 85% and significantly lowering the risk of major adverse cardiovascular events (MACE) and cardiovascular mortality [4, 5, 8, 11]. Data from the DA VINCI study highlights significant gaps in LDL-C goal attainment, with fewer than 20% of very-high-risk patients achieving the recommended LDL-C target, further emphasizing the need for combination regimens and novel approaches [11].

Implications for Clinical Practice

Combination therapies, particularly those incorporating PCSK9 inhibitors, have demonstrated superior LDL-C reduction compared to statin monotherapy [3, 5, 9, 11]. Early and sustained LDL-C lowering following a myocardial infarction (MI) significantly reduces mortality and recurrent events. Additionally, reductions in non-HDL-C levels provide further prognostic value [10, 11]. Real-world evidence highlights the effectiveness of stepwise therapy intensification, with tailored regimens achieving LDL-C targets in up to 98% of patients [7, 11].

Novel agents also play an important role in contemporary lipid management. Inclisiran, with its biannual dosing schedule, offers a convenient and effective solution for patients who struggle with adherence to traditional therapies [6, 9, 11]. Antisense therapies targeting lipoprotein(a) (Lp(a)) address residual cardiovascular risk by reducing Lp(a) levels by up to 80% in high-risk cohorts [10, 11]. Bempedoic acid serves as a viable option

for statin-intolerant patients, combining a favorable safety profile with significant LDL-C reduction [2, 5, 7, 11].

Adjunctive lifestyle modifications, including the Mediterranean diet, regular physical activity, and smoking cessation, enhance the benefits of pharmacological therapies [2, 4, 6, 11]. Tools like coronary artery calcium (CAC) scoring further refine patient risk stratification, helping to guide therapy intensification for individuals in intermediate-risk categories [8, 10, 11].

Addressing Barriers to Implementation

Despite their demonstrated efficacy, the widespread adoption of advanced therapies is hindered by barriers such as cost, accessibility, and therapeutic inertia [3, 7, 11]. Findings from the DA VINCI study emphasize disparities in LDL-C goal attainment across European countries, reflecting regional differences in healthcare access and adherence to guideline-directed therapies [11]. Simplified regimens, including single-pill combinations, can improve adherence, while policy-level interventions are necessary to enhance affordability and availability of therapies like PCSK9 inhibitors and inclisiran [2, 6, 11].

Future Directions

The field of lipid management is on the cusp of significant advancements driven by innovation and precision medicine. Biomarker-driven approaches and genetic profiling are expected to play a pivotal role in tailoring therapies for conditions such as familial hypercholesterolemia (FH) and other high-risk populations, optimizing patient outcomes [8, 9, 11]. Additionally, the importance of real-world evidence cannot be overstated. Long-term studies are essential to validate the efficacy and safety of these therapies across diverse patient populations and clinical settings, ensuring their applicability and reliability [4, 7, 2].

A multidisciplinary approach will also remain central to achieving comprehensive cardiovascular risk reduction. The integration of pharmacological advancements with lifestyle interventions and patient education will be critical for sustained success in managing lipid levels and reducing cardiovascular risks [3, 5, 11].

Conclusion

The evolution of lipid-lowering strategies marks a transformative phase in the prevention and management of atherosclerotic cardiovascular disease (ASCVD). This analysis consolidates findings from pivotal studies to emphasize not only the efficacy of emerging therapies but also their necessity in addressing unmet needs within cardiovascular care. The persistent gap between guideline-directed LDL-C targets and real-world outcomes underscores the need for advanced, patient-centric strategies [1, 2, 11].

Advanced therapies such as ezetimibe, PCSK9 inhibitors, bempedoic acid, and RNA-based agents offer significant potential in achieving aggressive LDL-C targets. These treatments address key limitations of statins, including insufficient LDL-C reduction in high-risk populations and statin intolerance, while providing additional benefits such as lowering lipoprotein(a) [Lp(a)] and triglyceride-rich lipoproteins [3, 5, 9, 11]. Combination therapies, particularly those incorporating PCSK9 inhibitors and inclisiran, have demonstrated exceptional efficacy, with LDL-C reductions exceeding 85% and substantial reductions in major adverse cardiovascular events (MACE) and cardiovascular mortality among high- and very-high-risk patients [2, 4, 8].

Real-world evidence, including findings from studies like SWEDEHEART and DA VINCI, highlights the critical role of early and sustained LDL-C lowering in improving long-term cardiovascular outcomes. These studies emphasize the importance of initiating

aggressive lipid-lowering strategies early in the treatment process to maximize patient benefit [10, 11].

The adoption of combination regimens tailored to individual patient risk profiles is particularly beneficial for those with familial hypercholesterolemia, diabetes, or recurrent ASCVD events [2, 5, 11]. Additionally, the integration of non-statin agents offers a viable solution for statin-intolerant patients or individuals who fail to achieve LDL-C targets with conventional therapies. These approaches provide clinicians with flexible strategies to optimize lipid management in diverse patient populations [7, 8, 11].

The next frontier in lipid management lies in precision medicine, integrating genetic profiling and biomarker-driven approaches to tailor therapies for individual patients. Advanced imaging and risk stratification tools, such as coronary artery calcium (CAC) scoring, further refine treatment decisions and enable personalized care [4, 8, 2]. A multidisciplinary approach that combines pharmacological advancements with lifestyle interventions, as well as the development of simplified regimens like single-pill combinations, remains critical for comprehensive cardiovascular care [3, 6, 11].

This analysis affirms that advanced cholesterol-lowering therapies, when applied strategically, have the potential to significantly reduce the burden of ASCVD. Bridging the gap between evidence and practice requires not only innovative therapies but also systemic efforts to address cost barriers, enhance patient adherence, and expand accessibility. Emerging innovations like inclisiran and antisense oligonucleotides go beyond LDL-C reduction, tackling residual risk factors such as elevated lipoprotein(a) [Lp(a)] that remain inadequately addressed by conventional therapies [9, 10, 2].

By synthesizing evidence across diverse therapeutic modalities and patient populations, this work underscores the transformative potential of these therapies in redefining cardiovascular care. Aligning guideline recommendations with real-world findings provides clinicians with a comprehensive roadmap to optimize ASCVD management. Personalized treatment plans that incorporate advanced therapies tailored to individual risk profiles remain crucial for addressing the unmet need for more effective therapies [3, 7, 11].

Conflict of Interest

The authors declare no conflict of interest.

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Enhancing Cybercrime Investigations in Ghana: A Mobile Broadband Framework for Unmasking Perpetrators through Digital Footprints and User Profile Synthesis

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Abstract

Uncovering the origin of cybercrimes in Ghana continue to be a challenge for law enforcement agencies. Existing solutions had primarily focused on unmasking crime source within the Public Data Network (PDN) using methods such as geolocation of public Internet Protocol (IP) address or the Domain Name Server (DNS) lookup methods. Unfortunately, these approaches fall short at uncovering cybercrime sources from the mobile broadband (MBB) domain. This paper proposed a framework aimed at answering the question of processes around the MBB's packet data protocol (PDP) context procedure and its corresponding private IP attribution to User Equipment (UE) that might mask the UE's identity in a PDN. The study's outcome includes digital footprints collection like IP addresses and Transmission Control Protocol ports during PDP context and UE data sessions to cloud server in the PDN. Exploratory data analysis reveals the uniqueness of every session, i.e., making traceability feasible from a PDN to distinct sources in the MBB domain. This paper proposes a comprehensive framework by recommending the collection of datasets from the MBB domain infrastructure at three logical interfaces with network probes. Additionally, the study suggests enhancing the dataset with call detail records and leveraging Edgar Frank Codd's relational data model to synthesise the fragmented datasets to a unique entity thereby ensuring the unmasking of a cybercrime committed in a PDN effectively traceable to the MBB domain entity. This innovative approach adds to the knowledge of cybercrime investigations in Ghana's cybersecurity endeavours.

Keywords*: Cybercrime, IP Address, Mobile Broadband, PDP Context.*

Introduction

About 5.5 billion individuals, as of the year 2024, representing 68% of the global population are online [1]. Each of these individuals are online with IP addressed device and accessing services mapped to transmission control protocol (TCP) or user datagram protocol (UDP) ports.

Access to the Internet or data services in Ghana is largely via two main technologies i.e.

1. The traditional fixed data services with underlying technologies such as the Asymmetric Digital Subscriber Line over copper or largely fibre, commercially referred to as the Fixed Broadband (FBB) or Fibre to the Home (FTTH).
2. The mobile data services with underlying technologies such as the 3rd Generation Partnership Project's (3GPP) mobile telecommunications standards i.e., the Second Generation (2G), Third Generation (3G) and Fourth Generation (4G) technologies, commercially referred to as the Mobile Broadband (MBB). Generations beyond 4G are yet to commercially take root in Ghana though 5G is launched in November 2024.

As of June 2023, MBB achieved a 31.11% year-on-year growth of total internet traffic with

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a 22.34 million subscriptions and 69.6% penetration rate [2]; this makes it the dominant medium for access to the internet in Ghana and also a fertile ground for cybercrime activities.

In Ghana, uncovering the origin of cybercrimes perpetrated within the MBB domain continue to be a challenge for law enforcement agencies. In [3], several challenges faced by the Ghana Police at effectively dealing with cybercrime were highlighted. These challenges included a lack of cooperation from Internet Service Providers (ISPs) in adducing electronic evidence regarding the specific crime's source. Furthermore, the Cyber Security Authority (CSA) has emphasised the difficulty state agencies face in obtaining electronic evidence that meets the requisite standards for criminal prosecutions [4]. In addition, the significance of computer and cyber forensics at combating crime and enhancing security in Ghana was examined leading to a call for coordinated effort at equipping the security agencies with the necessary tools and training [5].

Concrete solutions to cyber-attack attribution are confronted with multifaceted challenges and calls for the need of improved resources, methodologies, and public discourse to enhance the overall quality of attribution efforts [6]. Technically, various attempts and methods that have been made regarding IP address attribution to cybercrimes have largely focused on the Public Data Network (PDN) by using methods like geolocation of public IP address, whois and the rest. Unfortunately, these approaches have fallen short at uncovering cybercrime sources from the mobile broadband (MBB) domain. This paper proposed a framework at addresses this gap by answering the question of processes around the MBB's PDP context procedure and its corresponding private IP attribution to UE that might mask the UE's identity in a PDN when a cybercrime is committed.

Cyber Crime Impact

The growth of the Internet and its accompanying cybercrime menace has plagued every society and Ghana is not an exception. In 2023, there was about 880,418 cybercrime complaints from the US public to the Internet Crime Complaint Centre (IC3); a private entity in partnership with the Federal Bureau of Investigation (FBI) to fighting cybercrime in various fronts including anonymity. These complaints represent a 10% increase relative to 2022. The FBI posited that; this value could represent about a quarter of the actual incidents based on their past experience.; the loss incurred to victims exceeds $12.5 billion [7].

Cybercrime in Ghana is growing with the expansion of its digital space. Notably, online romance scams and financial fraud are common forms of cybercrime with unemployment and poverty as the main drivers [8]. The head of Ghana's Cyber Security Authority (CSA) made known the following facts as reported in The Ghanaian Times (a reputable national news media outlet): The CSA received 41,285 complaints regarding cybercrime related issues between October 2019 and July 2023; the CSA claimed more cases are not reported. The Ghanaian Times further reported that, for the first half of 2023, Ghana has lost GHS49.5 million [9].

We are living in a moment of tremendous revolutionised digital landscape i.e., the Internet. This exciting contemporary digital landscape, unfortunately, is quite bedevilled with objectionable cyber threats and there seem to be no end in sight. This calls for counter technical measures to further promote digital advancement and give space for productivity to digital citizens.

Materials and Methods

Research Design

This paper sought to add to knowledge, the challenges associated with back tracing the source of cybercrimes, primarily, the focus

being on the communication parameters acquired in the MBB (Mobile Broadband) domain during Packet Data Protocol (PDP) context and how those parameters are presented in a Public Data Network (PDN) during data sessions. It also sought to understand the processes through which User Equipment (UE) acquires IP addresses and how these IP addresses, might in turn, be used in a way that masked the identity of the UE within a PDN. This study is quantitative and made use of experimental case study design.

PDP context activations and data session initiations were performed randomly within the available highest generations (4G and 3G) at limited geographical areas, i.e. Accra, the capital city of Ghana. Data about the following parameters were captured during PDP context activation and session initiations from the UE to the PDN:

1. The IP address assigned to the UE during PDP context.
2. The source and destination TCP ports of the UE's client application used to access the PDN was captured.
3. The destination IP intended to be accessed by the UE client application was captured.
4. The IP address of the UE as seen in the PDN was captured.
5. The source TCP port of the UE as seen in the PDN was captured.

Research Instruments

With reference to the setup for exploration and data collection via PDP context and session initiations in Figure 1 below, the following tools were used at the radio access network (RAN) domain:

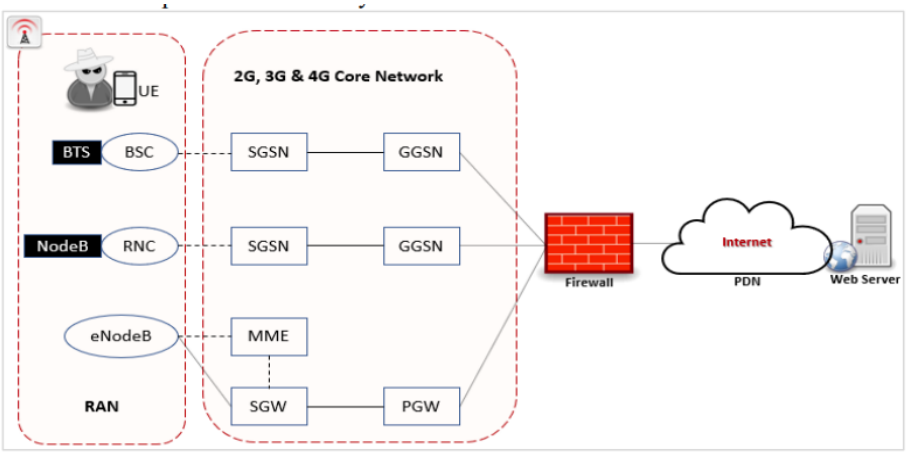

Figure 1. The Setup

With reference to the setup diagram in the following tools were used:

1. Two Samsung phones i.e., the UEs with Android OS
2. Three Nano SIM cards acquired from ISPs 1, 2 and 3 and registered with the NCA
3. Network Analyzer (an app installed on the UEs): “an all-in-one iPhone and Android app for network analysis, scanning and problem detection [10]”. In real time, this app was used to capture PDP IP address assigned to the UE.
4. Packet Capture (an app installed on the UEs): "a network traffic sniffer app with SSL decryption capabilities". It employs a-man-in-the-middle technique without requiring the UE OS to be rooted [11]. The preferred data file generated with the app was the pcap file extension type.
5. Web Browsers: FireFox Focus, Microsoft EDGE and Google Chrome. These apps were used as clients for initiation of data sessions to the PDN.
6. Wireshark (program installed on a Windows PC): “an open source network

packet/protocol analyser" [12]. This program was used to analyse the pcap trace data from the UE.

This paper had no control or direct access to network elements within the RAN and core i.e., BTS(Base transceiver station), BSC(Base Station controller), RNC(Radio Network Controller), eNodeB(Evolved Node B), SGSN(GPRS support node), GGSN(Gateway GPRS support node), MME(Mobility Management Entity), SGW(Serving Gateway) and PGW(Packet Gateway). The setup depicts the 3GPP proposed standard architecture.

The computer software and tools used in the PDN to capture data about the UE upon session initiation were as follows:

1. A registered domain name was procured and hosted in the cloud by a web host. This approach was adopted to avoid port forwarding when hosted privately.
2. A PHP server-side scripting language was used to capture the relevant parameters, such as global IPs and TCP ports numbers, when the UE visits the web site in the PDN as shown in Figure 2 below.
3. A relational database was created in the cloud with SQL language and Oracle MySQL RDBMS to archive the relevant UE parameters when UE visits the PDN [13] as shown in Figure 3.
4. cPanel web site management tool was used to administer the cloud hosting [14].

```php
<?php
// Get the UE data
$src_ip = $_SERVER['REMOTE_ADDR'];
$src_port = $_SERVER['REMOTE_PORT'];
$dst_ip = $_SERVER['SERVER_ADDR'];
$dst_port = $_SERVER['SERVER_PORT'];

// Database connection information
$host = 'localhost';
$username = '';
$password = '';
$database = '';

// Create a database connection
$mysqli = new mysqli($host, $username, $password, $database);

// Insert the captured data into the database
$query = "INSERT INTO tbl_traffic (src_ip, src_port, dst_ip, dst_port) VALUES (?, ?, ?, ?)";
$pq = $mysqli->prepare($query);

$pq->bind_param("sisi", $src_ip, $src_port, $dst_ip, $dst_port);

if ($pq->execute() === false) {
    die("Execute failed: " . $pq->error);
}

$pq->close();
$mysqli->close();
?>
```

Figure 2. PHP Code for Data Collection

```sql
CREATE TABLE tbl_traffic (
    id INT AUTO_INCREMENT PRIMARY KEY,
    src_ip VARCHAR(50),
    src_port INT,
    dst_ip VARCHAR(50),
    dst_port INT,
    date_time TIMESTAMP DEFAULT CURRENT_TIMESTAMP
);
```

Figure 3. Database Table

Ethical Considerations

Three major mobile data ISPs platforms were used to camp their respective SIMs in conjunction with an acquired web domain hosted by a web service provider (WSP). This paper refrained from using known specific names of the ISPs but rather chose to categorise them as ISP-1, ISP-2 and ISP-3 not according to any rank, name or preference prescribed by the NCA. It is a public knowledge that, these ISPs are ranked by the NCA by their number of subscriptions, penetration rate, market share and the rest (NCA, 2023). No research permission was sought from any of the three major ISPs since the data collection procedure was conducted at public points of their infrastructure. The SIMs used are legally registered to the author of this paper.

Data Collection Procedure

PDP context activation and data session initiation, which are experimental, were randomly performed at various locations in Accra and the results recorded.

The collection of previously unimaginable data had been made quite manageable by the recent advancements in smart devices technology. The combination of cloud-based research architecture and smart devices like the UE have brought about research methodologies akin to the traditional methodologies of data collection. Some research activities are best accomplished not by the traditional data collection techniques like survey [15].

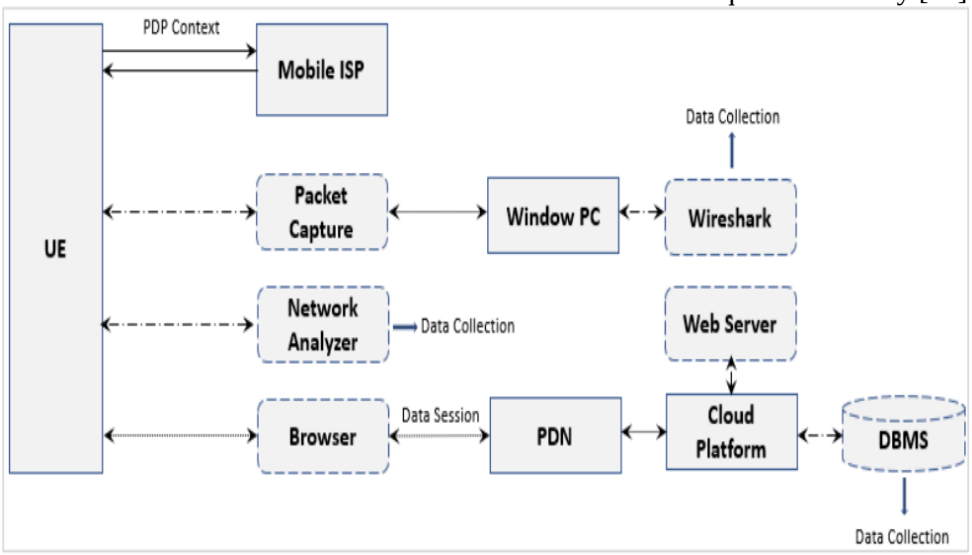

Figure 4. Data Collection Procedures Flow

Reference to Figure 4 above, the UE was made to initiates PDP context to obtain an IP address from the ISP by turning mobile data off and on; UE restart is another approach of initiating PDP context. The Network Analyser software was used to capture the assigned PDP IP address from the ISP's gateway node and subsequently recorded the data in an electronic spreadsheet. A browser installed in the UE was used to initiate a data session to the procured website in the PDN. The Packet Capture software was used to sniff the data packet units to and from the UE; the pcap trace file generated by the Packet Capture software was exported to a Windows PC and analysed its protocol stack with Wireshark software, as shown in window labelled "1" in Figure 5 below, to obtain and record the source IP, source TCP port, destination IP and destination TCP port; these values were recorded in the same electronic spreadsheet. Window labelled "2" in Figure 5 presented the TCP/IP layered protocol of the data unit captured. IPs and ports details were also verified from the window labelled "2" as well.

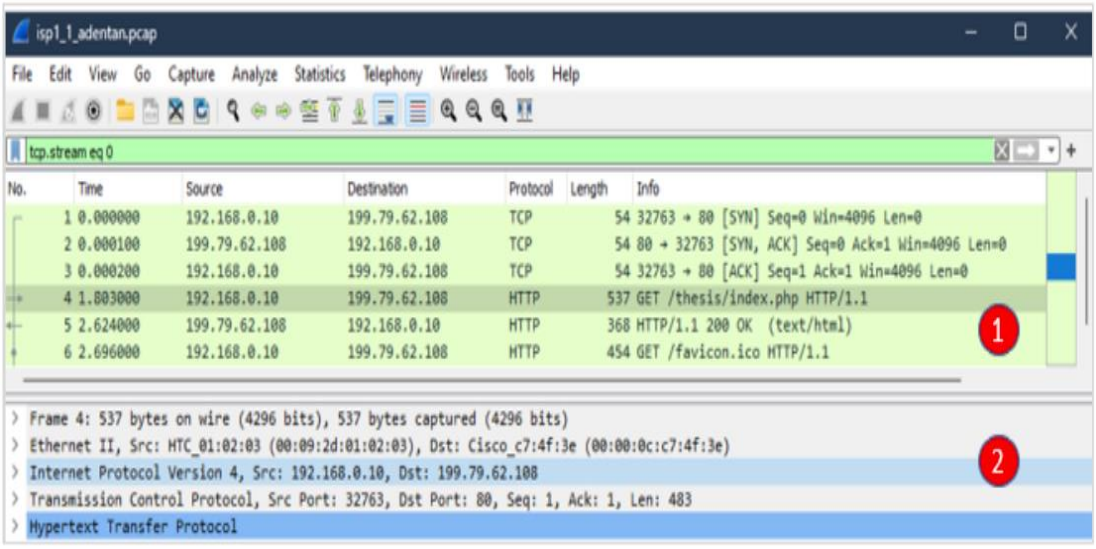

Figure 5. Packet Capture - Analysis

Simultaneously and automatically to the packet capture process, the cloud domain captured the UE parameters on the cloud web host platform in the PDN and the values were recorded in the MySQL database. These values were also manually exported to the electronic spreadsheet.

Data Analysis

Data from the three data collection points, as shown in Figure 4 above, were aggregated and cleaned using simple data aggregation method with Microsoft's Power Query. It is typical of aggregated data measures to reveal an insight that individual datasets could not [16].

Exploratory Data Analysis (EDA) approach, with Pandas (a Python language data analysis package), was adopted to analyse the datasets. As explained in [17], EDA is about looking at data from various angles for insight of a particular interest or of importance within its context but EDA primarily aims not at validating the existence of an effect and it does not rely on a statistical model that incorporates a mathematical representation of the effect.

Sample Data Frame

```
import pandas as pd
df = pd.read_csv('pdp_csv.csv')

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 120 entries, 0 to 119
Data columns (total 11 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   ISP             120 non-null    object
 1   PDP             120 non-null    int64
 2   App             120 non-null    object
 3   Location        120 non-null    object
 4   AppSrc_IP       120 non-null    object
 5   Dst_IP          120 non-null    object
 6   AppSrc_Port     120 non-null    int64
 7   Dst_Port        120 non-null    int64
 8   PDPIP_Address   120 non-null    object
 9   Global_IP       120 non-null    object
 10  Global_Port     120 non-null    int64
```

Figure 6. Data Frame Sample

To answer research questions, absolute frequency statistical method was used to determine TCP port and IP address retention during PDU sessions; same method was used to

verify PDP IP address retention. The captured data in an electronic spreadsheet data was converted to csv i.e. pdp_csv.csv. The csv data (pdp_csv.csv) was read into a pandas data frame (df) as shown in Figure 6 above.

TCP Ports & IP Address Retention Verification

The following actions were undertaken with Pandas to determine the IP and TCP ports retention to answer the paper's objectives:

1. Checked for duplicated record in whole data frame
   df.duplicated().sum()
   Output: 0
2. Created a record set (df_globalIP) for column Global_IP
   df_globalIP = df["Global_IP"]
3. Checked for duplicated entry in df_globalIP
   df_globalIP.duplicated().sum()
   Output: 0
4. Created a record set (df_GlobalPort) for column Global_Port
   df_GlobalPort = df["Global_Port"]
5. Checked for duplicated entry in column Global_Port
   df_GlobalPort.duplicated().sum()
   Output: 0

Results

This study aimed at finding the difficulty in tracing IP address used to commit cybercrime within the public digital communication space to its MBB source. PDP context activations were performed with SIMs belonging to three mobile data ISPs from various geographical locations from where the SIMs were camped. The following sample dataset, as shown in Table 1 above, is the sample data of the total 120 PDP activations that were collected and exploratory data analysis performed on it.

No duplicate record was observed in the data frame. This establishes the uniqueness of every session i.e.; it should be possible for every session to be traced from the PDN to its unique source. Every PDP activation resulted in new PDP IP; no subsequent PDP IP is maintained from the previous observed. This implies that, the PDP IPs are not statically assigned to the UE but rather dynamically assigned and no lease period is granted to the assigned PDP IP. This is worth noting because, the PDP IP once acquired is not changed until a phenomenon occasioned a new PDP context activation. This arrangement is quite ideal for the cybercriminal to assume a new identity by initiating a new PDP context to hide his/her identity after committing a cybercrime. A larger dataset might enhance the probability of a repeated PDP IP but not a subsequent one from the previous. This does not negate the established fact that, the PDP IP assignment arrangement provides a fertile ground for the cybercriminal to hide his/her identity. The PDP IPs were all noticed to be a private Class-A prefixes. These private prefixes were translated to global public IPs in the PDN as well as the source TCP port of every session also translated into another port numbers in the PDN. The characteristics of the results analysis resonates perfectly with the standard Port Address Translation (PAT) concept of private IP address and UDP/TCP port numbers into public IP addresses and TCP/UDP port numbers. The problem with PAT could be inferred that, it affords a maximum of 65,536 MBB UEs to connect to the Internet with the same public IP address due to its 16 bits representation. How could cyber security measures and tools such as IP address attribution be used to counter cybercrime in this situation? Who, with a UE in MBB domain, would be held responsible for a cybercrime when committed with a PAT public IP address? This paper discovered PAT from its data analysis and proposed a framework that could be used to address the problem PAT presents aside its touted advantages. In fact, it could be deduced from the findings that, multiple PATs were in play for each ISP.

Proposed Solution

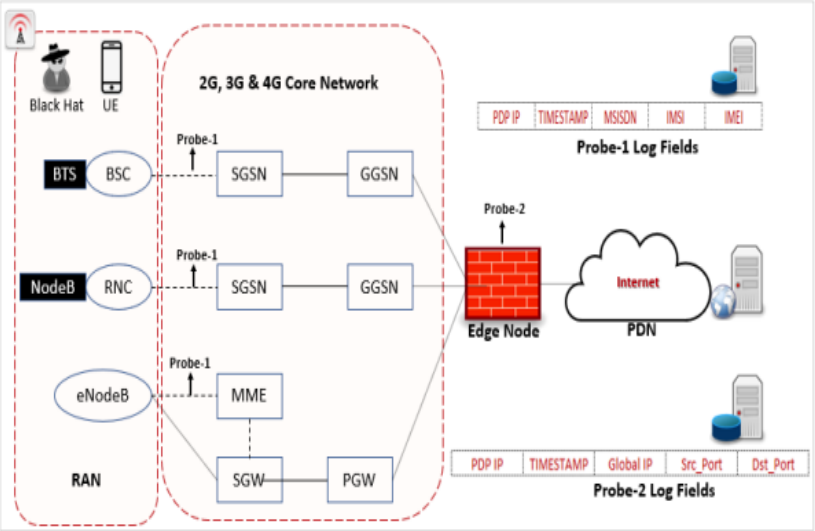

Figure 7. Proposed Solution – Logical Architecture

In [18], packet sniffing, which falls under a network probe, was highlighted as an effective technique for gathering evidence from network devices in forensics that involves the collection and analysis of data packets that traverse a network. The probes in Figure 7 above will sniff the packets and insert the relevant log fields of interest into a relational database. Probe-1 refers to the signalling interface between the core network and the RAN for each technology generation i.e., 2G, 3G and 4G where the probe is logically situated for packet capture. The captured data fields of interest by the probes are fed into a database (such as the relational database). The fields of interest are the PDP IP address (PDP IP), the date and time of capture (TIMESTAMP), the "Mobile Station International Subscriber Directory Number" (MSISDN) and "International Mobile Subscriber Identity" (IMSI) which are unique attributes of the SIM card owned by a user and the "International Mobile Equipment Identity" (IMEI); a unique attribute of the UE. As explained in [19], a research at identifying tourist by mining CDRs ("Call detail Records"), Telecommunication service providers mainly collect CDRs for billing purposes but CDRs could be mined to provide exact locations of a tourist. This paper is proposing the CDR to be mined to fight cybercrime in the MBB domain. This aspect also explains the difficulty in tracing crime committed in a PDN to the core network i.e., the MBB ISPs are basically focused on revenue, and rightly so, of which they have setup infrastructure for such purpose and not focused on setting up infrastructure to fighting cybercrime committed with the MBB domain.

GSMA is an organisation that primarily serves the interest of telecommunications service providers globally. In its security guide to protect the confidentiality of users, GSMA stated the following: It is imperative to safeguard sensitive data against unauthorised disclosure. The first step to ensuring confidentiality is to isolate the distribution infrastructure and exercise strict control over the distribution of sensitive information [20]. From the proposed architectural framework, the 2G/3G/4G core networks are isolated from the PDN and all fields associated with Probe-1 capture are expected not to be transmitted to the edge node where the PAT is believed to be implemented. PDP IP obviously would be an exception since results from the research findings indicated it is needed for the PAT. It is important to note that, PDP address which is acquired temporarily and used until a phenomenon occasions a next PDP context

procedure, the IP is not transmitted to the PDN. Should these obviously personal data, such as the MSISDN, IMSI and IMEI, be routed to the PDN, it might expose users to various privacy and security risks. For example, it could lead to unsolicited communication, spam and potentially more severe issues like identity theft or fraud. "Ghana's Data Protection Act, 2012" is a law that basically protects the privacy of individuals by regulating the processing of personal information [21]. By regulating the processing of personal information, the legislation established the "Data Protection Commission (DPC)" to safeguard individual privacy and personal data. The Commission outlines the procedure for obtaining, retaining, using, or disclosing personal data as well as other associated matters that touch on data protection. [22].

Probe-2 in Figure 7 above is logically situated at the edge node where the following fields is expected to be collected i.e., the PDP IP address (PDP IP), date and time of capture (TIMESTAMP), source TCP/UDP port number (Src_Port), socket to be accessed TCP/UDP port in the PDN (Dst_Port) and finally the global IP address (Global IP). The exercise proposed leveraging the “Entity Relationship data model” to establish a relationship between the two probes since the relational data model had earlier been proposed as the data repository for the capture by the probes.

The conceptual representation of data and its organisation which in turn defines the structure, relationships, and constraints of data without specifying how the data is stored or accessed is known as a data model. Chen, the original architect of the Entity-Relationship data model (E-R Model) for relational data modelling, in 1976 put forward the following: The entity-relationship model brings to the fore, a natural perspective of viewing the real world as a collection of distinct entities and the relationships amongst them. In contrast, the relational model is anchored in the relational theory that is focused on achieving high data independence but might overlook crucial semantic details about the real world in its approach. The E-R model works to attain data independence and is grounded in set theory and relation theory, employing a specialized diagrammatic technique for crafting databases. It delves into the implications associated with data integrity, information retrieval, and data manipulation. When delving into a data model, it's essential to come to terms with the specific levels of logical data views that the model seeks to address. An entity is a representation of a distinct "thing" with its own unique identity. For example, a particular person, company, or event could serve as an entity. On the other hand, a relationship signifies an association between entities. For instance, the connection of "father-son" defines a relationship between two entities labelled as "person" [23].

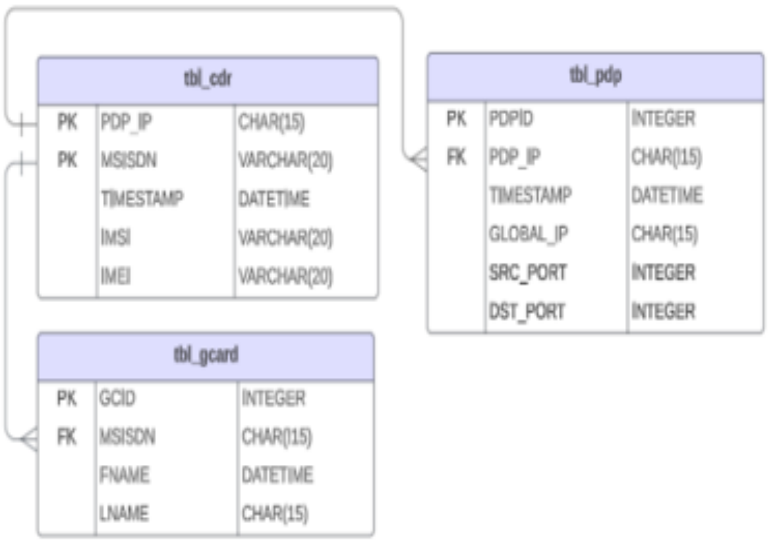

Figure 8. Data Model – Framework

Table 1. PDP Activations & Data Sessions - Sample Dataset.

	UE							PDN	
	App	**Location**	**App Src-IP**	**Dst-IP**	**App Src-Port**	**Dst-Port**	**PDP IP Address**	**Global-IP**	**Global-Port**
ISP-1	Chrome	Adentan	192.168.0.10	199.79.62.108	32763	80	10.121.96.193	102.176.94.129	41753
	Chrome	Adentan	192.168.0.10	199.79.62.108	32763	80	10.121.3.213	102.176.94.85	11025
	DuckDuckGo	Kasoa	192.168.0.10	199.79.62.108	32763	80	10.137.32.206	102.176.94.142	36938
	DuckDuckGo	Kasoa	192.168.0.10	199.79.62.108	32763	80	10.123.223.213	102.176.94.213	31555
	DuckDuckGo	Kasoa	192.168.0.10	199.79.62.108	32763	80	10.136.217.92	102.176.94.220	61149
	DuckDuckGo	Kasoa	192.168.0.10	199.79.62.108	32763	80	10.137.190.92	102.176.94.156	41071
	DuckDuckGo	Kasoa	192.168.0.10	199.79.62.108	32763	80	10.137.234.187	102.176.75.187	59436
	DuckDuckGo	Mamprobi	192.168.0.10	199.79.62.108	32763	80	10.122.155.22	102.176.94.214	16418
	DuckDuckGo	Mamprobi	192.168.0.10	199.79.62.108	32763	80	10.137.117.209	102.176.75.145	10900
	DuckDuckGo	Mamprobi	192.168.0.10	199.79.62.108	32763	80	10.137.252.33	102.176.94.97	46322
ISP-2	Firefox Focus	Korley Klotey	192.168.0.10	199.79.62.108	32763	80	10.57.25.48	41.215.171.141	37834
	Chrome	Korley Klotey	192.168.0.10	199.79.62.108	32763	80	10.57.71.20	41.215.171.159	36813
	Ms Edge	Korley Klotey	192.168.0.10	199.79.62.108	32763	80	10.57.116.248	41.215.171.177	41291
	DuckDuckGo	Kasoa	192.168.0.10	199.79.62.108	32763	80	10.56.215.42	41.215.173.65	10640
	DuckDuckGo	Kasoa	192.168.0.10	199.79.62.108	32763	80	10.59.62.127	41.215.173.97	34520
	DuckDuckGo	Kasoa	192.168.0.10	199.79.62.108	32763	80	10.57.148.98	41.215.171.59	41074
	DuckDuckGo	Kasoa	192.168.0.10	199.79.62.108	32763	80	10.59.76.52	41.215.173.21	52770
	DuckDuckGo	Kasoa	192.168.0.10	199.79.62.108	32763	80	10.58.67.99	41.215.171.235	16815
	DuckDuckGo	Mamprobi	192.168.0.10	199.79.62.108	32763	80	10.57.40.66	41.215.171.174	49390
	DuckDuckGo	Mamprobi	192.168.0.10	199.79.62.108	32763	80	10.56.147.76	41.215.173.20	21434
ISP-3	Google Chrome	Ledzokuku-Krowor	192.168.0.10	199.79.62.108	32763	80	10.41.220.119	154.160.10.0	59518

	Ms Edge	Ledzokuku-Krowor	192.168.0.10	199.79.62.108	32763	80	10.19.242.126	154.160.7.250	10529
	Firefox Focus	Ledzokuku-Krowor	192.168.0.10	199.79.62.108	32763	80	10.18.171.28	154.160.11.188	43002
	DuckDuckGo	Kasoa	192.168.0.10	199.79.62.108	32763	80	10.195.163.169	154.160.4.150	53139
	DuckDuckGo	Kasoa	192.168.0.10	199.79.62.108	32763	80	10.104.150.223	154.160.1.98	36741
	DuckDuckGo	Kasoa	192.168.0.10	199.79.62.108	32763	80	10.104.140.84	154.160.4.52	45442
	DuckDuckGo	Kasoa	192.168.0.10	199.79.62.108	32763	80	10.7.239.184	154.160.6.97	20615
	DuckDuckGo	Kasoa	192.168.0.10	199.79.62.108	32763	80	10.21.197.107	154.160.7.11	53323
	DuckDuckGo	Mamprobi	192.168.0.10	199.79.62.108	32763	80	10.149.148.169	154.160.27.22	13490
	DuckDuckGo	Mamprobi	192.168.0.10	199.79.62.108	32763	80	10.182.188.74	154.160.27.118	22049

The high-level conceptual view of the proposed data model for packets to be captured by the probes is given in Figure 8 above. As already reviewed, mobile ISPs make use of CDRs basically for billing purposes. Key CDR fields relevant to the proposed solutions are captured in "tbl_cdr" table; table "tbl_cdr" primary key is the composite type. Also, per regulatory requirements, ISPs are to register SIMs with the Ghana card as the sole identification material of the user; user profile attributes are captured in the "tbl_gcard" table. Logical table "tbl_pdp" captures the parameters that were investigated in this exercise.

The framework is proposed to be used in the mobile broadband domain (MBB) that make use of digital footprints such as PDP context IP address as source IP, UEs application TCP or UDP source port, UEs application TCP or UDP destination port and destination IP address in the public data network. To complement these digital footprints to really get hold of the cybercrime when committed from the MBB, the framework also suggested the use of relevant aspects of call data records such as IMSI, MSISDN, IMEI and timestamp of acquiring the digital footprints parameters. To synthesise these dichotomous datasets to point to a unique entity, Dr.Codd's relational database model was leveraged. Table 2 below is the data dictionary for the data model in Figure 8.

Table 2. Data Dictionary for Data Model

tbl_cdr		
Attribute	**Explanation**	**Key**
PDP_IP	PDP context IP	Composite Key
MSISDN	Mobile Station International Subscriber Directory Number	Composite Key
TIMESTAMP	Date and time of CDR capture	
IMSI	International Mobile Subscriber Identity	
IMEI	International Mobile Equipment Identity	
tbl_gcard		
GCID	Ghana card identification number	Primary key
MSISDN	Mobile Station International Subscriber Directory Number	Foreign key
FNAME	First name of user	
LNAME	Last Name of user	
tbl_pdp		
PDPID	Surrogate unique identifiication of a PDP context	Primary key
PDP_IP	PDP context IP	Foreign key
TIMESTAMP	Date and time of PDP IP acquisition	
GLOBAL_IP	Dynamic NAT IP to PDN, i.e. Target IP	
SRC_PORT	Application source port	
DST_PORT	Target service port	

Conclusion

This paper set out to put forth an innovative framework primarily aimed at locating the sources of cybercrime, from the MBB domain, thereby addressing the need for improved identification and attribution of malicious online activities. The research revealed that, digital footprints collected within the MBB and PDN

domains when combined with call detail records and Ghana card user profile by leveraging Edgar Frank Codd's relational data model to synthesise the fragmented datasets to a unique entity, forms a comprehensive approach to locating cybercrime sources committed from the MBB domain. The proposed framework holds the potential for enhancing cybercrime forensics and attribution in Ghana by offering a detailed methodology for tracing malicious activity back to its source. While the framework offers valuable means for identifying cybercriminal sources from the MBB domain, its effective implementation relies heavily on cooperation between ISPs and state agencies mandated at fighting cybercrime. However, this paper is not oblivious to ongoing challenges posed by domain obfuscation, Virtual Private Networks and anonymous networks. The application or development of AI tools capable of analysing large data volumes is recommended.

The evolution of cyber threats continues unabatedly and calls for corresponding strategies and technological approaches at combating the menace. This paper provides a foundational approach to locating the sources of cybercrime from the MBB domain by offering valuable framework aimed at offering cybersecurity professionals and law enforcement agencies, with the collaboration of ISPs, to effectively fighting cybercrime in Ghana.

Conflict of Interest

I, Daniel Adjei Odai, hereby declare that, there are no conflicts of interest regarding this research work.

All cost involved were solely financed by the author of this paper.

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Assessment of the Frequency, Pattern, and Practice of Inbound Medical Tourism in Tertiary Hospitals in the Federal Capital Territory (FCT), Nigeria

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Abstract

Inbound medical tourism describes a form of medical tourism where patients from other countries travel to the country to receive medical care. This occurs because patients are attracted to the health system in the country. This study seeks to assess the frequency, pattern, and practice of Inbound medical tourism in Tertiary Hospitals in the Federal Capital Territory (FCT), Nigeria. A descriptive cross-sectional study design was carried out among 160 Medical Practitioners in Tertiary Hospitals in the Federal Capital Territory (FCT), Nigeria. A multi-stage sampling technique was used in this study, and data was collected using an Interviewer-administered structured questionnaire. The mean age was 45.8 ± 9.2 years. Ninety-two (57.50%) were males, and 68 (42.5%) were females. 84 (52.50%) were Christians, and 76 (47.5%) were Muslims. The majority were married 105 (65.63%), 48 (30.0%) were single, and 23 (14.38%) of the doctors reported receiving foreign referrals. The commonly reported sources of these referrals included Ghana, the UK, the USA and Cameroun [5 (21.74%), 2 (8.70%), 1 (4.35%), and 8 (34.78%) respectively]. Most treatments lasted for 6 months: 13 (56.52%), 8 (34.78%), and only 1 (4.35%) stayed for over 1 year. Routine checkup was the reason for these referrals among 9 (39.13%) of the doctors, while 4 (17.39%) indicated relocation of the patient and post-operative follow-up. However, 18 (78.26%) reported an improvement in their conditions after these treatments. Nigeria can enhance its inbound medical tourism industry, attract more international patients, and establish itself as a reputable healthcare destination.

Keywords: *Frequency, Inbound Medical Tourism, Pattern of Medical Tourism.*

Introduction

To distinguish between various forms of health-related travel, researchers have recognized several distinct types of medical tourists, including transplant tourists, stem cell tourists, reproductive tourists, suicide tourists, and others. Some of these terms are rather odd, and researchers have applied them to various forms of cross-border medical travel [1-4]. The phrase "medical tourism" is widely used by scholars and international travel organizations. Medical tourism combines medical operations with the vacationing, pleasure-seeking, leisure, and rest that the name "tourism" connotes. Therefore, there are still chances for funfair and celebration for those who are sick and require a cure for their condition. [2, 5, 6]. However, a simple look at the term “medical tourism “does not accurately reflect the reality of the patient's situation or the advanced medical care provided in these destinations. Nevertheless, this phrase has come into general usage, especially in newspaper articles, policy documents, guidelines for patients, and peer-reviewed publications [7-11]. Medical tourism can also be described using the direction of patient movement as outbound, inbound, and intra-bound medical tourism [2, 12].

Inbound medical tourism describes a form of medical tourism where patients from other

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countries travel to the country to receive medical care. This occurs because patients are attracted to the health system in the country. There are different forms of medical tourism, like outbound medical tourism, which is a form of medical tourism where patients travel to other countries to receive medical care. Intrabound medical tourism occurs when patients travel within the country to receive medical care outside their geographic area, typically to a Center of Excellence in another state/region. [8, 9, 11]

Inbound medical tourism in Nigeria can be described as rudimentary or poorly developed. This may be due to a lack of organized efforts to make it formal to harness it potential. Nigeria is largely characterized by outbound medical tourism as most clients are interested in leaving the country to seek medical care in foreign lands. This situation is increasingly becoming a status symbol as our health facilities still struggle with infrastructural gaps, low human resources and poor funding and political will to invest in the health system. Despite these challenges in the Nigerian health sector, successive governments have made efforts to improve the sector. However, decades of low funding and systemic decay have made these reforms difficult. As outbound medical tourism thrives, there are pockets of health facilities hosting people from other countries. This situation is not well documented and tracked as these foreign patients seek care, have surgeries done, and utilize healthcare services in Nigeria without any formal tracking. This is a huge untapped opportunity for Nigeria to grow the medical tourism industry. Some researchers believe that well-established private tertiary hospitals can take the lead in inbound medical tourism investment and development [13-15]. Generally, it can be said that as a country develops, its health systems also enjoy massive funding and investments. This translates to good population health and makes the health system attractive to foreigners. It is interesting to note that some doctors and health facilities in Nigeria receive referrals from other countries. These referrals usually are continuation of care or new cases. This can be harnessed to establish a referral route for foreign patients seeking health care in Nigeria. This is a clear demonstration of confidence in the health system. The sociodemographic characteristics of doctors receiving referrals may help tailor their strategies to better meet the needs of international patients and receiving doctors, ultimately enhancing the quality and effectiveness of care. Understanding the demographics, specialties, and referral patterns of receiving doctors can help tailor marketing efforts to effectively reach and engage with them. Medical tourism stakeholders can enable personalized communication, building trust and establishing strong relationships. Similarly, understanding the referral patterns and preferences of receiving doctors can help optimize referral processes, reducing administrative burdens and improving patient care.

There are limited verifiable data regarding the magnitude of inbound medical tourism, [1] this study forms part of a database and provides frequency information, referral patterns, the procedures they undergo, and the country they are coming from. Globally, most peer-reviewed publications on medical tourism focus on a theoretical approach, qualitative reviews, and secondary data analysis of medical tourism, its prospects, and its benefits [16-18]. There is limited academic research relating to medical tourism in Nigeria, especially inbound medical tourism in Nigeria. A few local academic references could be found on the subject. This study quantitatively explores inbound medical tourism looking at the frequency, pattern, and practice in Tertiary Hospitals in the Federal Capital Territory (FCT), Nigeria.

Methodology

A descriptive cross-sectional study design was carried out among 160 Medical Practitioners in Tertiary Hospitals in the

Federal Capital Territory (FCT), Nigeria. Abuja-FCT. Abuja is a city in central Nigeria that serves as the country's capital and is located within the Federal Capital Territory (FCT). The Federal Capital Territory (FCT) occupies around 250 square kilometers of the landmass, with a population count of 778,567 for the Abuja Municipal Area Council. [19-21]. Abuja was chosen for this study as it is now one of Nigeria's ten most populous cities and one of the world's fastest-growing cities with an increasing population with the representation of all tribes living in Nigeria, it has 3 major government-owned teaching hospitals. University of Abuja Teaching Hospital, Gwagwalada; National Hospital, Abuja, and Federal Medical Center, Jabi, Abuja, who have easy access to experts who can recommend treatment outside the country. The study population for this study were fully licensed medical doctors practicing in Government-owned tertiary hospitals in Abuja City. The study was done in 2024 and carried out over six months. Data collection was carried out over four months, while analysis and write-up of the study were done for eight weeks. The minimum sample size for medical doctors was calculated using Cochran's formula for minimum sample size determination in a cross-sectional study:[22] A minimum of 160 questionnaires was used for data collection amongst the medical doctors.

Respondents were selected using a multi-stage sampling technique. Data on the frequency and pattern of inbound medical tourism was collected using an interviewer-administered questionnaire. This structured, interviewer-administered questionnaire was based on a simplified set of questions. The first section contains information on the socio-demographic characteristics of the medical doctors, while the second section assesses the frequency, pattern, and practice of medical tourism. These questions were adapted from medical tourism publications in Canada, the United States, Malaysia, and India [16, 23-26].

A one-week training program was conducted for 6 research assistants who were medical interns. Training covered the use of questionnaires on the research topic, ethical considerations, and quality control. Emphasis was laid on proper conduct during interviews and discussions as well as how to recognize the progression of interviews in line with themes. The study instruments were pretested among medical doctors in Federal Medical Center Keffi, Nasarawa State, located about 120km away from the study area. All ambiguous questions were reviewed to reduce the possibility of information bias. Questions were rewritten or deleted to reflect specific aspects of medical tourism related to the study objectives. Questionnaires were screened for completeness, coded, and entered by the researcher into the Statistical Package for Scientific Solutions (SPSS) version 22.0 software for analysis. Discrete data was presented as proportions (percentages) while continuous variables such as age were expressed as means ± standard deviation. Where continuous data are skewed, median values were stated as well.

Ethical approval was requested and granted by the Bingham University Teaching Hospital Research Ethics Committee. All of the medical facilities that were used in this investigation were asked for permission to conduct it. Before conducting interviews, each respondent provided written informed consent after the interviewers had adequately informed them about:

1. The researcher's and the university's identity.
2. The purpose of the research.
3. The nature of the questions.
4. The estimated time needed to complete the survey.
5. How to file a complaint with the university if desired.

During the interview, privacy and confidentiality were maintained. Participants will receive respectful and deserving treatment.

All information will be kept private and accessible only to the researcher. The results of this study will be released to the public and further scientific understanding.

Results

Socio-demographic Characteristics of the Medical Doctors

Table 1 shows that 71 (44.38%) of the doctors were 41 – 50 years of age, 13 (8.31%) were 51 – 60 years old, 52 (32.50%) were 31 – 40 years of age, 24 (15.0%) were less than 30 years old, And the mean age of 45.8 ± 9.2 years respectively. Ninety-two (57.50%) were males, 68 (42.5%) were females. 84 (52.50%) were Christians and 76 (47.5%) were Muslims.

Eighteen (11.25%) of the doctors were Hausa, 45 (28.13%) were Igbo and 26 (16.25%) were Yoruba, 12 (7.5%) were Gbagyi, 17 (10.6%) were Fulani, and 42 (26.3%) were other ethnic groups like Igbira, Tiv. The majority were married, 105 (65.63%), 48 (30.0%) were single.

Doctors' Reception of Foreign Referrals, Frequency, Source, Reasons of Referrals, and Outcome of Treatment via Inbound Medical Tourism

Table 2 reveals that 23 (14.38%) of the doctors reported receiving foreign referrals. Of this proportion, 15 (65.22%) had received 1 – 5 referrals while 3 (13.04%) had received more than 10 referrals.

The commonly reported sources of these referrals included Ghana, the UK, the USA and Cameroun [5(21.74%), 2 (8.70%), 1 (4.35%), and 8 (34.78%) respectively].

Most treatments lasted for 6 months: 13 (56.52%), 8 (34.78%), and only 1 (4.35%) stayed for over 1 year. Routine checkup was the reason for these referrals among 9 (39.13%) of the doctors while 4 (17.39%) indicated relocation of the patient and post-operative follow-up. However, 18 (78.26%) reported an improvement in their conditions after these treatments.

Table 1. Socio-demographic Characteristics of the Medical Doctors

Variable	Frequency (n=160)	Percent
Age (years)		
≤ 30	24	15.00
31 – 40	52	32.50
41 – 50	71	44.38
51 – 60	13	8.13
Sex		
Male	92	57.50
Female	68	42.50
	160	100.00
Religion		
Christianity	84	52.50
Islam	76	47.50
Marital status		
Single	48	30.00
Married	105	65.63
Separated	4	2.50
Widowed	3	1.88
Ethnic group		
Hausa	18	11.25
Igbo	45	28.13

Gbagyi	12	7.50
Fulani	17	10.63
Yoruba	26	16.25
Others (eg Igbira, Tiv, Idoma,)	42	26.25

Mean age= 43.8 ± 9.2years

Table 2. Doctors' Reception of Foreign Referrals, Frequency, Source, Reasons of Referrals, and Outcome of Treatment via Inbound Medical Tourism

Variable	**Frequency**	**Percent**
Received foreign referrals (Inbound) (n=160)		
Yes	23	14.38
No	137	85.63
Frequency of in referrals (since start of practice) (n = 23)		
1 – 5	15	65.22
6 – 10	5	21.74
> 10	3	13.04
Source of in referrals (n=23)		0.00
Ghana	5	21.74
United Kingdom	2	8.70
United States of America	1	4.35
Cameroun	8	34.78
Benin Republic	6	26.09
Brazil	1	4.35
Reasons for referral* (n=23)		0.00
Routine check-up	9	39.13
Relocation of patient	4	17.39
Post-operative follow-up	8	34.78
Lack of expertise (abroad)	2	8.70
Lack of facilities (abroad)	0	0.00
Treatment duration (n=23)		0.00
< 6months	13	56.52
6 -12months	8	34.78
>12months	1	4.35
Outcome of treatment	**(n = 23)**	
Improved	18	78.26
Condition worsened	5	21.74

Discussion

The mean age among doctors was 43.8 (± 9.2 years) with a higher proportion above forty years. This indicates that most experienced doctors are involved in these referrals both inbound and outbound. They may have observed that services or treatment may be available in Nigeria too, thus their decision to accept the referrals from foreign countries. This presents an opportunity for practitioners who would like to manage these ailments within

their facilities. Studies have shown that this may present a learning and skill improvement situation for doctors who are eager to learn new skills and medical technologies [27, 28].

Understanding the sociodemographic characteristics of medical doctors can improve patient matching, ensuring that patients receive appropriate care. Furthermore, understanding the cultural backgrounds and preferences of receiving doctors can help provide culturally sensitive care, improving patient satisfaction and outcomes. There is also a business development and partnerships component as studying the characteristics and referral patterns of receiving doctors can inform strategic partnerships, collaborations, and business development initiatives. Analyzing the demographics and referral patterns of receiving doctors can provide valuable market research insights, informing business decisions and investments. The cultural and ethnic diversity expressed in the findings where we have Christians and Muslims. Various ethnic groups, languages, and marital statuses help to promote inclusivity and diversity in the health system to make it more attractive to foreign patients.

The majority of the doctors are well experienced as the Mean experience was 17.6 years (±9.5 years), and a third had worked for 11- 20 years. This level of experience is well documented, as Nigerian medical doctors are usually well experienced but lack the necessary facilities [29,30] They would have ordinarily seen similar cases in the past and observed that it would not be managed in any hospital in Nigeria.

Taking a look at the doctors' reception of foreign referrals, frequency, source, reasons for referrals, and outcome of treatment via Inbound Medical tourism, it has always been the desire for the health system of nations to be attractive to the global health community. This attraction stems from the standard of care, quality of facilities, cost of services, waiting time, availability of expertise, etc. This form of medical tourism is when patients from other countries travel to the country to receive medical care**.** The desire is to have global patients.

One in every 7 doctors (14%) reported receiving foreign referrals from foreign countries; commonly, they had received 1 – 5 referrals. It is important to note that medical doctors in Nigeria have received referrals from Ghana, the UK, the USA, and Cameroun for treatments lasting for 6 months or more. This is good news for those who are interested in the growth of the medical tourism industry in Nigeria. It means that with improved health infrastructure, improved health resources, and better indices, the Nigerian Health system can become a hub for medical tourism. The Routine checkup (39%), relocation (17%), and postoperative follow-up were the main reasons for the referral. An in-depth review of the services attracting these patients shows that patients came for mainly follow-up treatments, and medical checkups. Thus, there is a huge need to make other interventional or treatment services to global standards. This will help expand the services available and the clients that can be reached.

Conclusion

Concerning inbound medical tourism, 14.4% of the doctors received foreign referrals, most referrals were from Ghana, the UK, the USA, and Cameroun. They managed most of the patients for up to 6 months. The main reason for the referral to Nigeria was for routine medical checkups, relocation of the patient, and post-operative follow-up. However, 78% improvement in their conditions after these treatments.

Recommendations

Nigeria can enhance its inbound medical tourism industry, attract more international patients, and establish itself as a reputable healthcare destination by implementing these recommendations.

To the Government and Health Sector Stakeholders

There is a great need to establish partnerships with Ghana, UK, USA, and Cameroun to harness and foster relationships with healthcare providers, hospitals, and medical associations in these countries to increase referrals and collaborations. The country can develop memoranda of understanding (MOUs) with international healthcare providers to facilitate patient referrals, knowledge sharing, and best practices.

Invest in modernizing healthcare infrastructure, equipment, and technology to provide high-quality services and attract more international patients.

Reinvigorate the specialized centers for routine medical checkups, post-operative follow-up care, and other services in demand by international patients.

We can improve Patient Experience and Outcomes by developing an efficient referral process to ensure seamless transitions for international patients, including timely communication and coordination with referring healthcare providers. This can be improved by better patient support services including language interpretation, cultural adaptation, and logistical assistance, to ensure a positive experience for international patients.

There is a need to promote Inbound Medical Tourism in Nigeria by creating marketing campaigns targeting healthcare providers, hospitals, and medical associations in Ghana, UK, USA, Cameroun, and other potential source markets. There is a need to leverage on digital platforms including social media, websites, and online forums, to promote Nigeria's healthcare services and attract international patients.

It is important to include a Monitoring and Evaluation process in inbound Medical Tourism like developing a system to collect data on international patient referrals, treatments, and outcomes to monitor the effectiveness of inbound medical tourism initiatives. Regularly evaluate the performance of inbound medical tourism initiatives and make data-driven decisions to improve services and attract more international patients.

Conflict of Interest

No conflict of interest.

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A Head-to-Head Comparison of Clopidogrel and Aspirin in Post-PCI Patients: Implications of the SMART-CHOICE 3 Trial

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Abstract

The long-term antiplatelet strategy for patients who have undergone percutaneous coronary intervention (PCI) continues to evolve, particularly in high-risk individuals who complete the standard duration of dual antiplatelet therapy (DAPT). Traditionally, aspirin has been central to secondary prevention regimens. However, increasing concerns regarding its gastrointestinal toxicity, bleeding risk, and pharmacodynamic variability have prompted reevaluation of its role in monotherapy, especially in light of emerging evidence favoring P2Y12 inhibitors such as clopidogrel. The SMART-CHOICE 3 trial addressed this clinical uncertainty through a large-scale, multicenter, open-label randomized trial conducted across 26 sites in South Korea. A total of 5,506 patients with previous myocardial infarction, diabetes mellitus, or complex coronary lesions who had completed DAPT after PCI were randomized to receive either clopidogrel (75 mg/day) or aspirin (100 mg/day) monotherapy. Over a median follow-up of 2.3 years, the primary composite outcome—death from any cause, myocardial infarction, or stroke—occurred significantly less frequently in the clopidogrel group (4.4%) compared to the aspirin group (6.6%) (HR 0.71; 95% CI 0.54–0.93; p=0.013). Breaking down the composite, myocardial infarction was halved in the clopidogrel arm (1.0% vs. 2.2%; HR 0.54), and all-cause mortality was numerically lower (2.4% vs. 4.0%; HR 0.71). Stroke rates were similar between groups. Notably, there was no difference in major bleeding between the two strategies (both 3.0%; HR 0.97), dispelling prior concerns regarding clopidogrel's bleeding risk. Clopidogrel also showed a favorable safety profile with no increase in adverse events. In conclusion, clopidogrel monotherapy provides a superior net clinical benefit compared to aspirin for long-term secondary prevention following PCI, especially in high-risk patients. Its targeted mechanism of action, lower bleeding liability, and consistent performance across major trials strongly support its preferential use over aspirin in modern antiplatelet therapy. These results validate recent shifts in international guidelines advocating personalized, risk-adjusted approaches to antiplatelet therapy.

Keywords: *Antiplatelet Therapy, Aspirin, Clopidogrel, Myocardial Infarction, Percutaneous Coronary Intervention, SMART-CHOICE 3 Trial.*

Introduction

Coronary artery disease (CAD) remains a principal contributor to global morbidity and mortality, with percutaneous coronary intervention (PCI) being a cornerstone therapeutic modality in both acute and stable ischemic syndromes [1]. Despite advancements in stent technology and procedural technique, patients undergoing PCI remain at significant long-term risk of adverse ischemic events such as myocardial infarction (MI), stroke, and cardiovascular death [2]. Consequently, effective and durable antiplatelet therapy is critical in maintaining stent patency, mitigating thrombotic risk, and improving survival.

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For decades, dual antiplatelet therapy (DAPT)—typically combining aspirin and a P2Y12 receptor inhibitor such as clopidogrel, prasugrel, or ticagrelor—has been the standard approach following PCI [3, 4]. Aspirin, one of the most widely used medications globally, exerts its antithrombotic effect by irreversibly inhibiting cyclooxygenase-1 (COX-1), thereby suppressing thromboxane A2 synthesis and platelet aggregation [6]. However, prolonged use of aspirin, particularly beyond the initial DAPT phase, is increasingly associated with gastrointestinal toxicity, mucosal injury, and clinically significant bleeding events, particularly in elderly and high-risk populations [1, 6].

Moreover, the clinical reliability of aspirin has been called into question due to the phenomenon of aspirin resistance. This includes both pharmacodynamic non-responsiveness and treatment failure, observed in approximately 20–30% of patients, leading to residual platelet activity and increased thrombotic risk [9, 11]. Additionally, aspirin's systemic effects on prostaglandins and endothelial function, while often overlooked, may inadvertently impair vascular homeostasis, particularly during prolonged administration [13].

In contrast, P2Y12 inhibitors, particularly clopidogrel, offer a more selective and endothelial-sparing mechanism of action. By irreversibly blocking the P2Y12 adenosine diphosphate (ADP) receptor, clopidogrel inhibits platelet aggregation without compromising prostacyclin or nitric oxide pathways, preserving vasodilatory and anti-inflammatory effects critical for vascular healing [13]. This mechanistic advantage has supported its expanded use, particularly in monotherapy strategies aimed at reducing bleeding while maintaining ischemic protection.

As the long-term management of post-PCI patients continues to evolve, attention has shifted toward minimizing bleeding risks while maintaining sufficient ischemic control. This paradigm shift is supported by emerging clinical evidence suggesting that early discontinuation of aspirin and continuation of P2Y12 inhibitor monotherapy may offer superior net clinical benefit. Trials such as TWILIGHT and HOST-EXAM demonstrated the safety and efficacy of P2Y12 monotherapy after early aspirin discontinuation, particularly in patients with heightened bleeding risk [7, 9].

Against this backdrop, the SMART-CHOICE 3 trial offers one of the most definitive comparisons of clopidogrel versus aspirin monotherapy in patients who have completed standard DAPT following PCI. This large, multicenter, randomized, open-label trial enrolled 5,506 patients across 26 sites in South Korea between August 2020 and July 2023. Eligible patients were at high risk of recurrent ischemic events due to a history of myocardial infarction, diabetes mellitus requiring medication, or complex coronary anatomy, and had completed a standard course of DAPT after drug-eluting stent (DES) implantation [2].

Participants were randomized in a 1:1 ratio to receive either clopidogrel (75 mg daily) or aspirin (100 mg daily) monotherapy. Over a median follow-up of 2.3 years, clopidogrel demonstrated a statistically significant reduction in the primary composite endpoint of all-cause death, MI, or stroke (Kaplan–Meier estimated 3-year incidence: 4.4% vs. 6.6%; hazard ratio [HR] 0.71; 95% CI 0.54–0.93; p=0.013) [2]. Myocardial infarction was halved in the clopidogrel group (1.0% vs. 2.2%; HR 0.54), and death from any cause was numerically lower (2.4% vs. 4.0%; HR 0.71). Notably, stroke rates were similar between groups, and the risk of major bleeding was identical (3.0% in both groups; HR 0.97), dispelling concerns that clopidogrel might carry a higher bleeding liability [2].

These findings align with and reinforce previous results from the HOST-EXAM trial, which similarly showed that clopidogrel was superior to aspirin in preventing adverse

cardiovascular outcomes without an increase in bleeding after 12 months of DAPT [9]. The CAPRIE trial, although conducted in a broader atherosclerotic population, also demonstrated that clopidogrel conferred superior protection against composite vascular events compared to aspirin, particularly in patients with diabetes or peripheral arterial disease [4].

Therefore, the SMART-CHOICE 3 trial provides strong, practice-changing evidence favoring clopidogrel monotherapy over aspirin for long-term secondary prevention in high-risk post-PCI patients. With its favorable balance of efficacy and safety, mechanistic advantages, and consistency across trials and guidelines, clopidogrel monotherapy should be considered the preferred strategy in patients who have completed the initial DAPT phase, especially those at increased risk for bleeding or recurrent ischemic events.

Methods

The SMART-CHOICE 3 trial was a prospective, multicentre, randomized, open-label, parallel-group phase IV study conducted across 26 high-volume PCI centres in South Korea. This investigator-initiated trial was designed to evaluate the comparative efficacy and safety of clopidogrel versus aspirin as monotherapy in patients who had completed the standard recommended duration of dual antiplatelet therapy (DAPT) following successful percutaneous coronary intervention (PCI) with drug-eluting stent (DES) implantation [2].

Study Design and Participants

Eligible patients were adults aged 19 years or older who had undergone successful PCI and had completed a standard DAPT regimen of at least 6 months, with no major ischemic or bleeding events during that period. All enrolled patients were considered at high risk of recurrent ischemic events, defined by the presence of one or more of the following clinical or anatomical criteria: a previous history of myocardial infarction (MI), diabetes mellitus requiring oral or insulin therapy, or complex coronary anatomy, including multivessel PCI, long lesions requiring ≥38 mm stenting, bifurcation lesions requiring two-stent techniques, or left main interventions [2].

The study was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines. The protocol was approved by the institutional review board at each participating site. All patients provided written informed consent prior to randomization. The trial is registered with ClinicalTrials.gov (NCT04418479).

Randomization and Intervention

Between August 10, 2020, and July 31, 2023, a total of 5,542 patients were screened for eligibility, and 5,506 patients were randomized in a 1:1 ratio to receive either clopidogrel monotherapy (75 mg once daily) or aspirin monotherapy (100 mg once daily) [2]. The randomization process was web-based and stratified by site to ensure balanced allocation. Treatment was initiated immediately after randomization and continued for a minimum of three years or until study completion.

The median time between PCI and randomization was 17.5 months (interquartile range [IQR] 12.6–36.1 months), ensuring that participants had adequately passed the high-risk phase post-PCI and were stable candidates for de-escalated antiplatelet therapy.

Outcomes

The primary endpoint of the study was the cumulative incidence of a composite of death from any cause, non-fatal myocardial infarction, or non-fatal stroke. These events were assessed in the intention-to-treat population using time-to-event analysis.

Secondary endpoints included the individual components of the primary composite, as well as clinically significant bleeding (defined as Bleeding Academic Research Consortium [BARC] type 2, 3, or 5), stent thrombosis

(definite or probable), target lesion revascularization (TLR), and other adverse events such as thrombocytopenia, hepatotoxicity, or allergic reactions [2]. All clinical events were adjudicated by an independent clinical events committee that remained blinded to treatment assignment.

Safety outcomes, including bleeding events and any adverse drug reactions, were monitored throughout the follow-up period. Bleeding events were adjudicated according to BARC criteria, ensuring comparability with prior landmark trials such as TWILIGHT and HOST-EXAM [7,9].

Statistical Analysis

The study was powered to detect a statistically significant difference in the primary composite endpoint between the two treatment arms, with a hypothesized hazard ratio of 0.70 for clopidogrel versus aspirin. Assuming a 3-year event rate of 6.5% in the aspirin group, a total sample size of 5,506 patients was calculated to provide 80% power to detect a 30% relative risk reduction, with a two-sided alpha of 0.05.

Time-to-event curves were generated using the Kaplan–Meier method, and treatment effects were estimated using Cox proportional hazards models. The hazard ratio (HR) and corresponding 95% confidence interval (CI) were used to compare the incidence of clinical events between groups. Subgroup analyses were conducted across clinically relevant categories such as age ≥75 years, diabetes status, chronic kidney disease, and presentation with acute coronary syndrome (ACS). Statistical significance was defined as $p < 0.05$ for all analyses.

Follow-Up and Data Collection

Patients were followed for a median duration of 2.3 years (IQR 1.6–3.0 years), with standardized clinic visits scheduled at 1, 6, 12, 24, and 36 months post-randomization. At each visit, investigators collected data on medication adherence, vital signs, clinical status, and occurrence of adverse events. Compliance with the study medication was monitored by pill counts and self-reporting.

Data management was coordinated by an independent contract research organization using a centralized, web-based electronic data capture system. Interim analyses were conducted by an independent data safety monitoring board to ensure participant safety throughout the trial.

Results

The 5,506 patients were randomized in a 1:1 fashion to receive either clopidogrel (n = 2,752) or aspirin (n = 2,754) as long-term monotherapy following the standard completion of dual antiplatelet therapy (DAPT) after percutaneous coronary intervention (PCI) with drug-eluting stents [2]. The median interval between PCI and randomization was 17.5 months (IQR 12.6–36.1 months), ensuring a population representative of stable, post-revascularization patients who had tolerated DAPT without significant complications [14].

Primary Outcome: Composite of Death, MI, or Stroke

During a median follow-up duration of 2.3 years (IQR 1.6–3.0), the primary composite endpoint—cumulative incidence of all-cause mortality, non-fatal myocardial infarction, or non-fatal stroke—occurred in 92 patients (4.4%) in the clopidogrel group versus 128 patients (6.6%) in the aspirin group. The Kaplan–Meier estimated 3-year event rates were 4.4% (95% CI: 3.4–5.4) for clopidogrel and 6.6% (95% CI: 5.4–7.8) for aspirin, yielding a hazard ratio (HR) of 0.71 (95% CI: 0.54–0.93; $p = 0.013$), thereby indicating a statistically significant 29% relative risk reduction in favor of clopidogrel [2, 14]. These key outcome rates are further illustrated in Table 1, highlighting the event counts, corresponding incidence rates, and hazard

ratios with confidence intervals across treatment arms.

Table 1. Clinical Event Outcomes at 3 Years (SMART-CHOICE 3)

Event	Clopidogrel (n, %)	Aspirin (n, %)	Hazard Ratio (95% CI)
Composite (Death/MI/Stroke)	92 (4.4%)	128 (6.6%)	0.71 (0.54–0.93)
All-Cause Death	50 (2.4%)	70 (4.0%)	0.71 (0.49–1.02)
Myocardial Infarction	23 (1.0%)	42 (2.2%)	0.54 (0.33–0.90)
Stroke	23 (1.3%)	29 (1.3%)	0.79 (0.46–1.36)

These findings robustly support the hypothesis that clopidogrel monotherapy is not only non-inferior to aspirin but is, in fact, superior in preventing major adverse cardiovascular events (MACE) among high-risk post-PCI patients. The results parallel those of the HOST-EXAM study, which reported a similar reduction in ischemic outcomes with P2Y12 inhibitor monotherapy [9], and align with subgroup analyses from the TWILIGHT trial, further validating the long-term safety and efficacy of dropping aspirin after a standard DAPT course [7].

Individual Components of the Primary Endpoint

All-cause mortality occurred in 50 patients (2.4%) receiving clopidogrel and 70 patients (4.0%) in the aspirin arm. This is visually represented in the Kaplan–Meier curve shown in Figure 1, which illustrates a consistently lower cumulative incidence of death in the clopidogrel group.

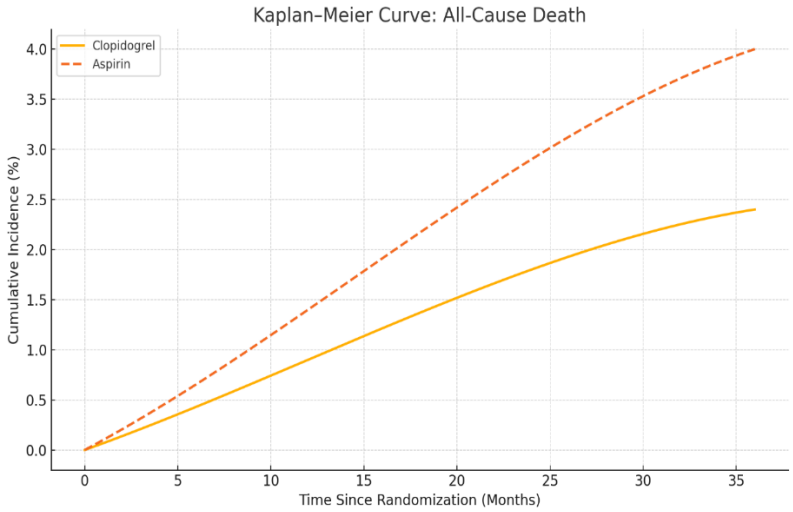

Figure 1: Kaplan–Meier Curve for all-cause Death

Although the difference narrowly missed statistical significance (HR 0.71; 95% CI: 0.49–1.02), the trend clearly favored clopidogrel, reflecting a clinically meaningful reduction in total mortality [2, 14].

As depicted in Figure 2, myocardial infarction rates were significantly lower in the clopidogrel group, with only 23 events (1.0%) compared to 42 events (2.2%) in the aspirin group.

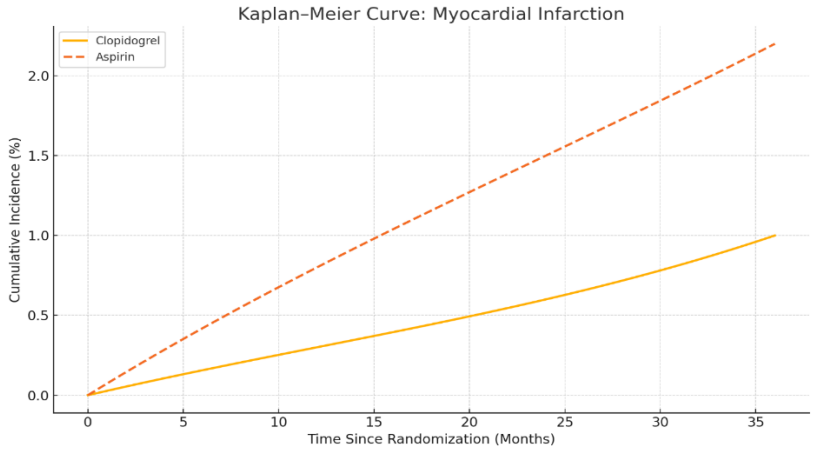

Figure 2. Kaplan–Meier Curve for Myocardial Infarction

This translates to a hazard ratio of 0.54 (95% CI: 0.33–0.90), confirming a 46% relative risk reduction in MI, a particularly compelling result in this high-risk cohort [2]. This mirrors earlier findings from the CAPRIE trial, which demonstrated clopidogrel's advantage over aspirin in reducing thrombotic events across diverse vascular territories [4].

Stroke incidence was virtually identical between the two groups: 23 events (1.3%) with clopidogrel and 29 events (1.3%) with aspirin. This finding is supported by the Kaplan–Meier analysis shown in Figure 3, where both groups demonstrate overlapping curves, suggesting no significant difference in stroke rates.



Figure 3. Kaplan–Meier Curve for Stroke

The hazard ratio was 0.79 (95% CI: 0.46–1.36), indicating no statistically significant difference, but reaffirming that ischemic cerebrovascular risk was not increased by omitting aspirin [2].

Bleeding Outcomes

Critically, there was no significant difference in major bleeding events between groups. At 3 years, the BARC-defined bleeding rate was 3.0% in both groups, with a hazard ratio of 0.97 (95% CI: 0.67–1.42) [2]. Figure 4 provides a visual representation of this parity, reinforcing that clopidogrel did not confer any excess risk of major bleeding compared to aspirin monotherapy.

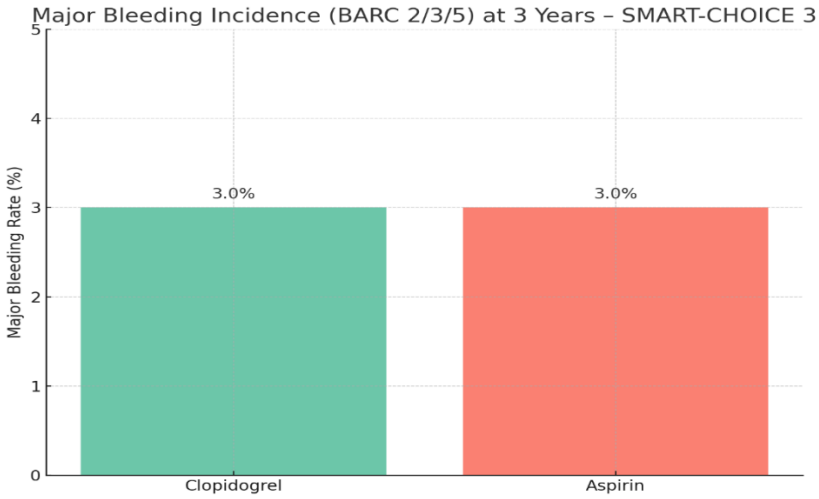

Figure 4. Major Bleeding Rates (BARC 2/3/5) for Clopidogrel and Aspirin

This parity in bleeding underscores one of the most reassuring aspects of the trial: clopidogrel's superiority in ischemic protection does not come at the cost of increased bleeding. This is especially relevant in light of prior concerns that P2Y12 inhibitors might elevate bleeding risk during monotherapy. In fact, results from TWILIGHT and HOST-EXAM further support that early aspirin discontinuation—regardless of P2Y12 inhibitor used—leads to reduced or equivalent bleeding risk compared to continued aspirin therapy [7,9].

Adverse Events and Safety Profile

The overall safety profile of clopidogrel was favorable. The incidence of adverse events—including thrombocytopenia, allergic reactions, and hepatic enzyme elevations—was low and did not differ meaningfully between the two arms. Importantly, no new safety signals were observed. There was no evidence of increased drug-related adverse effects in the clopidogrel arm, affirming its long-term tolerability and supporting its global use as a generic, cost-effective agent [2,5].

Subgroup Consistency

Prespecified subgroup analyses demonstrated the consistent benefit of clopidogrel across clinically relevant populations. Patients with diabetes mellitus, prior myocardial infarction, and complex coronary anatomy all showed numerically lower event rates in the clopidogrel arm, although interaction p-values were not significant. The magnitude of benefit appeared more pronounced in patients with multiple risk factors, reinforcing clopidogrel's effectiveness in those with heightened atherothrombotic vulnerability [2,6,10].

Discussion

The SMART-CHOICE 3 trial delivers definitive, real-world evidence in favor of clopidogrel monotherapy over aspirin for long-term antiplatelet maintenance following PCI in high-risk patients. This robust study provides compelling data demonstrating that clopidogrel significantly reduced the cumulative incidence of major adverse cardiovascular events (MACE)—comprising all-cause death, myocardial infarction (MI), or stroke—without an increase in bleeding risk [2].

The trial's primary endpoint was achieved with a 3-year event rate of 4.4% in the clopidogrel group versus 6.6% in the aspirin group, corresponding to a hazard ratio (HR) of 0.71 (95% CI, 0.54–0.93; p=0.013). This 29% relative risk reduction is both statistically significant and clinically meaningful, particularly in a population enriched with risk factors such as diabetes mellitus, prior MI, and complex coronary anatomy [2].

These findings build upon and extend the results of the earlier HOST-EXAM trial, which demonstrated a similar advantage of clopidogrel over aspirin in patients who had completed 12 months of DAPT after DES implantation [9]. SMART-CHOICE 3, however, included a broader range of post-DAPT time frames (median 17.5 months), making its conclusions more applicable to routine clinical scenarios. Importantly, the benefit was not limited to a reduction in composite events alone—clopidogrel also halved the risk of myocardial infarction (1.0% vs 2.2%; HR 0.54), while also numerically lowering all-cause mortality (2.4% vs 4.0%) [2]. These endpoint-specific hazard ratios are visually summarized in Figure 5, which demonstrates the relative superiority of clopidogrel across key clinical outcomes, most notably in myocardial infarction, overall mortality and stroke.

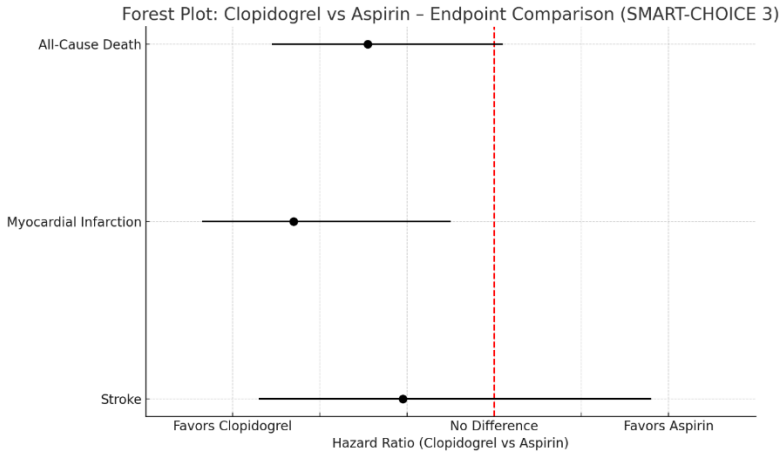

Figure 5: Forest Plot Comparing Hazard Ratios for all-cause Death, Myocardial Infarction, and Stroke

The absence of any difference in bleeding between the two groups (3.0% in both; HR 0.97) further strengthens the clinical appeal of clopidogrel. Given that bleeding is an independent predictor of mortality and hospitalization in cardiovascular patients [6, 7], a treatment strategy that preserves ischemic protection while minimizing hemorrhagic risk represents an optimal therapeutic.

The CAPRIE trial remains a cornerstone in clopidogrel's evidence base. In that study, clopidogrel reduced the risk of composite vascular events more effectively than aspirin, particularly in patients with diabetes and peripheral arterial disease—two high-risk phenotypes also represented in SMART-CHOICE 3 [4]. Although the CAPRIE population was broader, its findings complement SMART-CHOICE 3 by reinforcing the concept that P2Y12 inhibition alone is not only sufficient, but potentially superior to aspirin in specific high-risk subgroups.

The TWILIGHT trial further contributed to this paradigm shift. By demonstrating that early aspirin withdrawal and continuation of ticagrelor monotherapy reduced bleeding without increasing ischemic risk in high-risk PCI patients, TWILIGHT offered mechanistic and clinical rationale for aspirin de-escalation [7]. While TWILIGHT used ticagrelor, a more potent P2Y12 inhibitor, the SMART-CHOICE 3 trial proves that even clopidogrel—less potent, more accessible, and widely available as a generic—can achieve comparable benefits in long-term monotherapy, without increasing bleeding liability.

International guidelines are beginning to reflect this evolving evidence base. The 2021 American College of Cardiology/American Heart Association/Society for Cardiovascular Angiography & Interventions (ACC/AHA/SCAI) revascularization

guidelines similarly support personalized antiplatelet strategies post-PCI, including aspirin-free regimens for selected patients [10]. Recent guidance from the 2020 European Society of Cardiology (ESC) Guidelines lends further weight to these findings, recommending that in patients with stable coronary artery disease (CAD) or chronic coronary syndromes (CCS), long-term antiplatelet therapy should be carefully tailored based on individual ischemic and bleeding risk profiles. Specifically, in CCS patients with persistent ischemic risk and no high bleeding risk, extended monotherapy with a P2Y12 inhibitor such as clopidogrel may be a more appropriate and safer option than aspirin, especially given aspirin's documented increase in major gastrointestinal and extracranial bleeding events. These recommendations align with the paradigm shift toward aspirin-free strategies and provide an authoritative guideline-based rationale for considering clopidogrel as the preferred agent in long-term secondary prevention [12]. These endorsements further validate the findings from SMART-CHOICE 3 and reinforce a shift away from traditional, aspirin-centered therapy.

It is important to acknowledge that SMART-CHOICE 3 was conducted exclusively in a Korean population, raising questions about generalizability due to potential pharmacogenetic differences in clopidogrel metabolism—specifically, the prevalence of CYP2C19 loss-of-function alleles. However, the consistency of the results across ethnicities in prior trials such as HOST-EXAM and CAPRIE suggests that the benefits observed are not geographically confined [4, 9]. Additionally, SMART-CHOICE 3 enrolled only patients who had already tolerated DAPT with clopidogrel, effectively excluding those with primary non-responsiveness and making its findings more applicable to real-world clopidogrel "responders."

From a pharmacoeconomic perspective, clopidogrel's advantage becomes even more apparent. Unlike ticagrelor or prasugrel, which are costly and less widely accessible, clopidogrel is available generically and is affordable worldwide. Its safety, efficacy, and accessibility position it as a globally scalable solution for long-term secondary prevention post-PCI, especially in healthcare systems constrained by budget or access [5].

In summary, the SMART-CHOICE 3 trial marks a pivotal step forward in refining antiplatelet strategies following PCI. By demonstrating that clopidogrel monotherapy significantly reduces the risk of death, myocardial infarction, and stroke compared to aspirin—without increasing bleeding risk—it challenges long-standing therapeutic norms and supports a more tailored, patient-centric approach. These findings, in the context of a broader evidence landscape and evolving clinical guidelines, strongly advocate for the integration of clopidogrel monotherapy into routine practice for high-risk patients who have successfully completed DAPT.

Future directions should include broader validation of these results in Western populations and among genetically diverse groups, as well as exploration of monotherapy strategies beyond three years. However, based on the current data, clopidogrel monotherapy stands as the preferred long-term strategy for secondary prevention post-PCI in high-risk patients.

Conclusion

The SMART-CHOICE 3 trial provides robust, practice-shaping evidence that redefines the long-term antiplatelet strategy for patients who have completed dual antiplatelet therapy (DAPT) following PCI with drug-eluting stents. In a high-risk population—characterized by prior myocardial infarction, diabetes mellitus requiring pharmacotherapy, or complex coronary anatomy—clopidogrel monotherapy significantly reduced the incidence of major adverse cardiovascular events (MACE) compared to aspirin, with no

increase in bleeding or adverse drug-related events [2].

These results collectively establish that clopidogrel provides superior ischemic protection without compromising safety, reinforcing its value in high-risk secondary prevention. These findings are consistent with those of the HOST-EXAM trial, which similarly demonstrated the superiority of clopidogrel over aspirin monotherapy after 12 months of DAPT, both in reducing ischemic outcomes and in maintaining a favorable bleeding profile [9].

Aspirin, while historically foundational in cardiovascular prevention, is increasingly limited by its non-selective inhibition of COX pathways, variable pharmacodynamic response, and its associated gastrointestinal and hemorrhagic risks [1,6,11]. Clopidogrel, on the other hand, offers more targeted P2Y12 receptor inhibition, preserving beneficial endothelial functions and providing a more predictable antiplatelet effect [13]. In this context, the pharmacologic rationale for preferring clopidogrel over aspirin is not only mechanistically sound but clinically validate. In summary, clopidogrel monotherapy should be strongly considered as the preferred long-term antiplatelet strategy in high-risk patients who have completed standard DAPT following PCI. With superior efficacy in reducing MACE, equivalent bleeding risk, favorable tolerability, and broader accessibility, clopidogrel offers a clinically and economically compelling alternative to aspirin in modern cardiovascular practice.

Conflict of Interest

The authors declare no conflict of interest.

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