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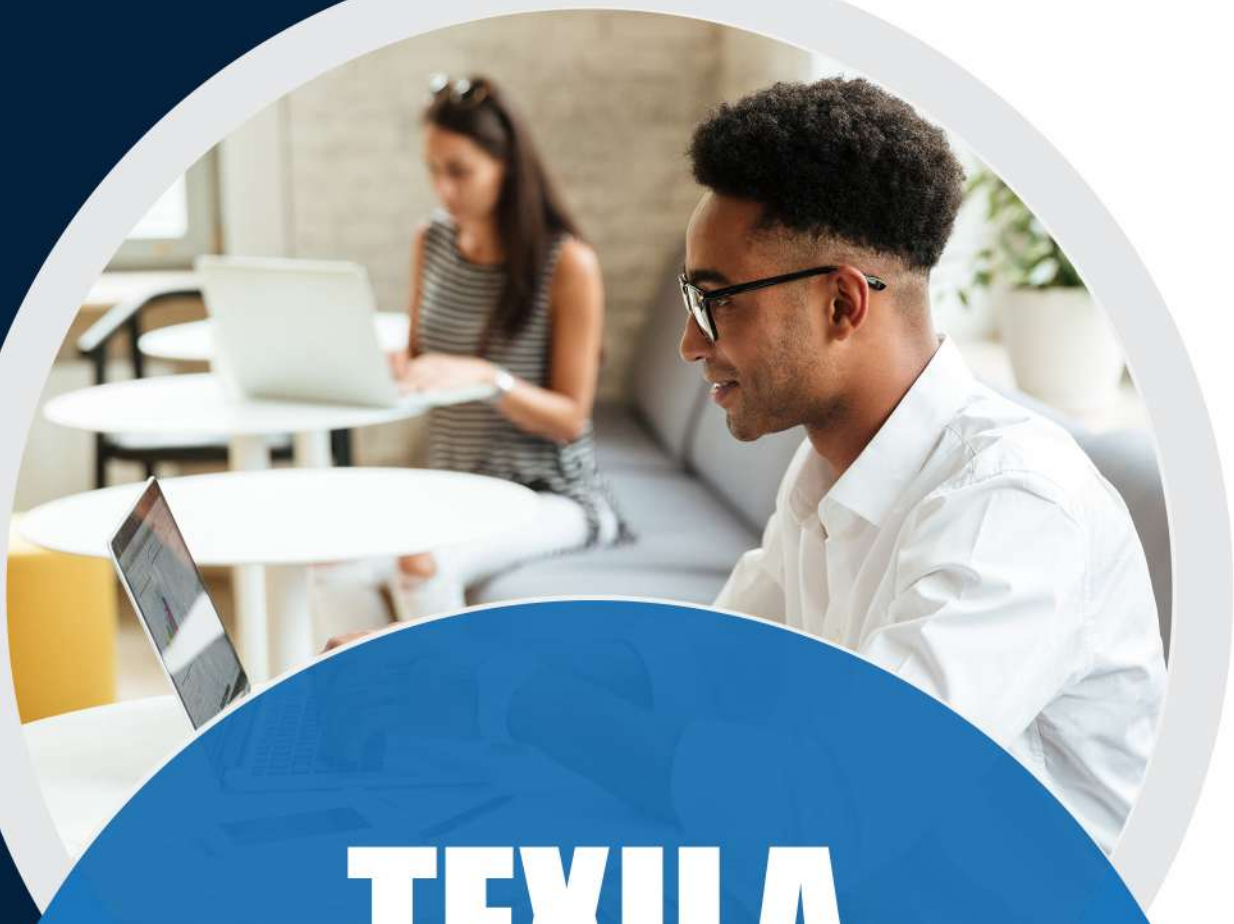

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An Exploration of the Quality Assurance Roles of the Various Regulators of Human Resources for Health Training in Zambia

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Abstract

This inquiry was conducted following reports that questioned the quality of higher education in Zambia, including the quality of Human Resources for Health (HRH) training. One of the notable reports was from research conducted by the Zambia Medical Association (2019). This inquiry built on all these reports by focusing on the roles of the various regulators (also referred to here as Actors) on how their individual and collective roles can play a role in improving the quality of HRH training in Zambia. Ideally, one does not expect to see any challenges in the quality of HRH training because when reading the acts and mandates of the various actors (summarized in Table 1), such as HPCZ, HEA, ZAQA, and local government authorities, there appears to enough authority to provide quality assurance. The inquiry focused on what could have gone wrong and what could have been improved.

Keywords: *Actors, Human Resources for Health (HRH), Intersectoral collaboration, Quality, Regulators, Training.*

Introduction

This research was commenced in 2018 following several reports questioning the quality of higher education training in Zambia. The sources of the reports included formal research from professional associations, expert opinions from professional colleagues, and press reports where these reports included universities being closed for various reasons related to the quality of training. A comprehensive report [1] published by the Zambia Medical Association identified many weaknesses in the quality of postgraduate medical training in Zambia. The entirety of the reports questioned the quality of higher education. However, this study focussed on the quality issues affecting Human Resources for Health (HRH) training. In an ideal situation, one does not expect to see any challenges in the quality of HRH training because when reading the acts and mandates (summarised in Table 1) of the Health Professionals Council of Zambia (HPCZ), Higher Education Authority (HEA), Zambia Qualifications Authority (ZAQA) and local government authorities, there appears to enough authority provide quality assurance. The conflicts indicated the absence of Intersectoral Collaboration (ISC).

Before 2013, Zambia only had two universities, but since the enactment of the Higher Education Act in 2013, there were many universities, including private ones, that started operating in Zambia, and inevitably the rapid increase in the learning institutions entails more work to regulate them. From the preliminary investigation done, there were no major issues of quality of higher education before 2013, as the two universities were few enough to be easily regulated. However, the rapid increase in the number of universities from 2013 was not matched by a rapid increase in regulatory initiatives. Hence this could explain the reports of poor quality that started emerging.

In an effort to understand the possible regulation issues were arising from, this study assessed the mandates (and their impact) of the respective mandates of regulators that were

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summarized in Table 1. As can be observed in Table 1, there was a possibility of overlap in the mandates of the regulators listed in it, and that could have been a contributor to them not being able to fully enforce quality in HRH training. There were also reports of regulators making contradictory decisions, for example, the HPCZ at one time closed the Copperbelt University School of Medicine, but the decision was opposed by the HEA, with the dispute ending up being resolved by the Attorney General [2]. On another occasion, the HPCZ closed a number of health facilities and training institutions, but this was reversed by the Ministry of Health a move that reportedly displeased stakeholders such as the Pharmaceutical Society of Zambia [3]. In another incident, a university changed its location with the local Government but did not inform the HEA, so the latter froze the operations of the university through the local government authority appeared to be fine with the decision to relocate the university [4]. All these conflicts suggested an overlap of powers among the regulators with not much collaboration among them, and all these could have been contributing factors to quality-related challenges. The overlaps could just be a component of the package of issues in the black box in Figure 1 below:



Figure 1. An Illustration of Where the Problem is Located

In the process of framing the problem, a sequence of three events were illustrated in Figure 1 above, where the potential to regulate higher education and the unsatisfactory quality outcome were noted. The question raised in Figure 1 was: if the regulators of quality in HRH training were available, with adequate authority, as depicted in the first box in Figure 1 above, then why did the third box exhibit questionable quality outcomes? The answer lies in the contents of the second box, the "black box". This inquiry helped to unpack the "black box", at least on the regulation side. As mentioned above, the preliminary research noted overlaps of mandates of the regulators as part of what was in the "black box". As shall be explained further, in this study, the reasons for and impact of these overlaps were uncovered. Below, is a "rich picture" that further illustrates that the regulators had powers that were given to them by law, but the desired result of quality training was not being achieved.

There have been several studies done on the quality of higher education in Zambia and they had all focused on the shortcomings of training quality in the learning institutions. This inquiry explored the role of the regulators. The insight on the roles of regulators provided by this research, availed a different perspective of how to address the issues of quality of HRH training in Zambia. From the above, it was clear that there was a problem in the governance of regulatory activities related to HRH training.

The inquiry aimed to find reasons why the various regulators were not able to assure quality in HRH training, despite having legal mandates to do so. The study also explored the reasons for absence of ISC among the regulators.

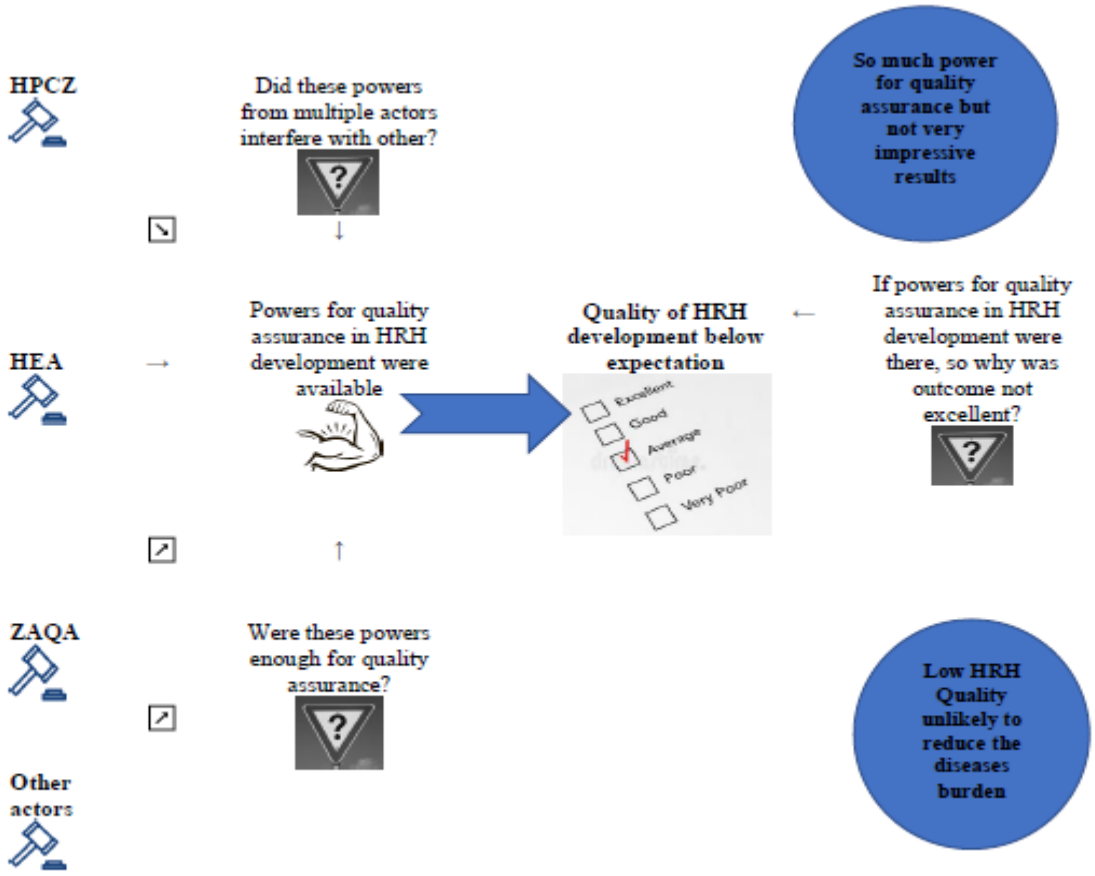

Figure 2. Rich Picture Describing the Problem

Materials and Methods

The inquiry was conducted as a qualitative case study, an approach selected to better understand the problems in the process of regulating HRH training. In such situations, a qualitative case study provides a detailed explanation of the problem [5] as the method has the power to explore this broad complex topic within real-life [6-9]. The inquiry started with a desk review that led to the formulation of Table 1 and was then followed by interviews of purposefully selected persons from the respective regulators mentioned in Table 1. As stated in the introduction, the underlying problems were suspected to be related to governance. Governance and regulatory issues in health have been known to be best investigated using qualitative approaches [10], hence selection of this investigation approach. The interviews took a Narrative approach, where respondents spoke freely then the research emerged from that narrative. Narratives are known to enable the exploration of social settings and interactive relations [11], which is exactly what this research was looking for, i.e., the interaction and relations of regulators of quality in HRH training.

Results

The desk review collated data from various sources, including scientific reports, legal documents, the press, and corporate reports. Collation and analysis of the data from the desk review showed that there was an overlap in the mandates of the Quality Assurance (QA) regulators (listed in Table 1), and that could have been a contributor to them not fully assuring quality in HRH training. This finding concurred with numerous reports that indicated overlaps. For example, the case of where the HPCZ at one time closed Copperbelt University

but the decision was opposed by the HEA, with the dispute ending up being resolved by the Attorney General [2]. In another case, the HPCZ closed several health facilities and training institutions, but this was overturned by the Minister of Health, a move that reportedly displeased stakeholders such as the Pharmaceutical Society of Zambia [3]. In another incident, the HEA closed a university for changing its location without informing HEA [4], but the Ministry of Local Government also had the authority to determine the University location and didn't seem bothered by the change in location. In the first part of the desk review, the legal mandates of all these regulators were reviewed and summarized in Table 1.

Table 1 showed that each function of the QA regulatory process could be handled by more than one actor, which indicated overlaps in the mandate. Further, from the incidences mentioned above, if some of the conflicts actually needed the interpretation of the Auditor General, then it also suggested that the mandates were not clear, so they needed a higher authority to interpret them. If it was complex enough to be referred to the Attorney General, then it meant it was not simple enough for routine quality assurance operations-another possible hindrance to QA operations. This further indicated that overlapping authorities were not the only content of the "black box", but there was also a problem with the interpretation of the respective mandates of the regulators.

In further review of press reports, it was also noted in the Zambia Daily Mail of 20th September 2019 [12] and on the website of the Higher Education Authority [4] that there were universities that were operating in Zambia illegally, they were named, and the public was warned to keep away from them. The Higher Education Act of 2013 mandated the HEA to work with the minister to close such institutions in Section 40 (1), as the Act read in part: "*The Minister may, after consultation with the Authority, by notice in the Gazette, close a public higher education institution, where the public higher education institution—(a) is not operated in accordance with the provisions or requirements of this Act;….."* The question that arose here was: if the HEA had all this power, why did it not just close these universities as opposed to taking a softer approach of telling the public to stay away from these universities? This indicated that the HEA was under utilising its mandate, and this could have been contributing to the low quality. This further indicated that overlapping authorities were not the only content of the "black box", but the inability to fully apply the law for QA was also in the box.

A few days later, in another press report on 25th September 2019 [13], the HEA was reported to have closed five universities, and this was confirmed on their website. It showed the HEA was becoming firmer in its actions, but it also showed that actions against erring institutions were not consistent at the time. If these universities that were closed committed the same offense as those who were just publicly named, then why did the two sets of offenders get different penalties? This finding showed that another element of the black box was inconsistency by the regulators in applying their regulatory powers. This meant that despite all the powers listed in Table 1, there was no guarantee of consistent response to threats to QA in HRH training.

At this point, it was established that there were overlaps in the mandates of the regulators, difficulties in interpreting the legal mandates of the various regulators, less than firm responses to violators of QA regulations, and inconsistent responses to QA challenges. After establishing these challenges, the data collection was expanded to include interviews.

Table 1. The Powers of the Various Regulators before 2021

Quality Assurance Function	**Actors Involved**	**Specific Constitutional Clauses of the Actors**
Setting-up of university	HPCZ	"A training institution shall not provide, or hold out as providing, training to prepare students for a health profession, unless the training programme is approved by the Council."
	HEA	"A person shall not operate a private higher education institution unless the private higher education institution is registered under this Act."
		"A person who intends to operate a private higher education institution shall apply to the Authority for registration of the private higher education institution in the prescribed manner and form upon payment of the prescribed fee."
	Local government	"To prohibit and control the development and use of land and buildings and the erection of buildings, in the interests of public health, public safety, and the proper and orderly development of the area of the council."
Training programs (control of)	HPCZ	"A training institution that intends to offer training in a health profession shall apply to the Council for approval of the training programme in the prescribed manner and form upon payment of the prescribed fee."
	HEA	"The Authority shall approve an application for registration if —*(h)* the learning programmes to be provided at the private higher education institution are of a quality that will enable the private higher education institution to provide a standard of higher education in accordance with this Act; and…".
Inspections	HPCZ	"The Council shall, at least every five years from the date of the approval of a training programme under section *thirty-three,* review the approved training programme, including the performance of the graduates of the programme".
	HEA	"An inspector may, for the purpose of enforcing the provisions of this Act, at any reasonable time, without prior notice, and on the authority of a warrant, enter any premises of a higher education institution that the inspector has reasonable grounds to believe is used by any person for the commission of an offence or contrary to the provisions of this Act, and..".
Influence on Exams	HEA	*"Determine* the terms and conditions on which examiners shall be appointed by the Senate and the remuneration to be paid to the examiners;"
	Respective universities	Each university sets and marks its own examinations
	HPCZ (no exam influence)	"Has passed the prescribed assessment examination conducted by the relevant training institution in Zambia, recognised by the Council;"

Influence on award of degrees	HEA	"Where a college or other educational institution is affiliated with a public higher education institution under subsection (1)—…. *(g)* all qualifications certified by the public higher education institution shall be signed by the Vice-Chancellor or Registrar of both the public higher education institution and the affiliated institution; and.."
	ZAQA	*"*Accredit a qualification or part-qualification recommended by an appropriate authority if it meets the relevant criteria;"
Recognition of foreign qualifications	HPCZ	"Subject to the provisions of this Act, a person who is trained outside Zambia and is not a holder of a qualification recognised by the Council, may apply for temporary registration."
		"The Council shall, upon receipt of an application made under subsection (1), issue the applicant with a temporary certificate of registration if the applicant—possesses such knowledge and training as may be prescribed;"
	ZAQA	*"*Recognise and validate competencies for purposes of certification obtained outside the country;"
Due diligence on recruitment (checks)	PSMD	Proof of qualifications, criminal investigations clearance, age eligibility, medical certificate, NRC, declaration of secrecy and issues probation.
	HPCZ	"A person shall not practise as a health practitioner, unless that person is registered as a health practitioner in accordance with this Act."
		"Provides a certificate of good standing from the professional registration body in the country where the person is currently practising;"
Additional studies (CMEs + PGs) both local and abroad	ZAQA	*"*Collaborate with its international counterparts on all matters of mutual interest concerning qualification frameworks"
	HPCZ	"The criteria for recognition by the Council of continuing professional development, training programmes and training institutions for purposes of this Act;"
		"Subject to the provisions of this Act, a person who is trained outside Zambia and is not a holder of a qualification recognised by the Council, may apply for temporary registration."
Governance	Minister of Health (HPCZ)	"The Minister may, by statutory instrument, on the recommendation of the Council, prescribe: the qualifications for registration of a person as a health practitioner; and the scope of practise for health practitioners registered under this Act….
		the type of continuing professional development and training required as a pre-requisite for the issuance of a practicing certificate;"
		"The Minister may, by statutory instrument, on the recommendation of the Council, make regulations to provide for continuing professional development and training to be undertaken by health practitioners."
		"The Minister may, by statutory instrument, on the relating to recommendation of the Council, make regulations to provide for—practicing certificates *(a)* the terms and conditions for the issuance of practicing certificates.

		"The type of continuing professional development and training and any other information required for the issuance of a practising certificate; and any other matter necessary for purposes of this Act."
		"The Minister may, on the recommendation of the Council, make regulations prescribing the circumstances and manner in which a health practitioner …. (a) may be removed from the Register; and…*(h)* who is removed from the Register, may be restored on the Register and the fee to be paid for the restoration."
	Minister of Higher Education (HEA)	"There is hereby constituted a Board of the Authority which shall consist of the following part-time members appointed by the Minister:"
		"The Minister may give to the Board general or specific directives which are consistent with the provisions of this Act and the Board shall implement the directives"
		"The Minister may give to a higher education institution general or specific directive which are consistent with the national policies and the provisions of this Act."
	Minister of Higher Education (ZAQA)	"There is hereby constituted the Board of the Authority which shall consist of the following part time members appointed by the Minister".
Financial sustainability of universities	HEA	"The funds of a public higher education institution shall consist of such moneys as may".
		"Adequate financial provision has been made or is guaranteed for the proper maintenance of the private higher education institution for a reasonable period".
Some WHO recommendations	University Financial Sustainability	"Establishing a team of faculty members whose primary responsibility is to teach. Just as research staff are currently employed in positions primarily to undertake research, teaching staff should be funded, responsible and rewarded for good teaching" (adapted by WHO from Hatem *et al.*, 2011).
		"Governments, funders and accrediting bodies should implement higher education policies for mandatory faculty development programmes that are aligned with the goal of relevant health professionals' education (in developing teaching and clinical skills) and linked to funding, promotion and reward"
	Clear process for student selection	The medical school must have an admission policy including a clear statement on the process of selection of students.
	Linking exams to global standards	The medical school must define and state the methods used for assessment of its students, including the criteria for passing examinations.
		There should be facilities for quiet study and for relaxation. If the hospital is geographically separate from the university campus, library and computer-based literature search facilities should be provided.
	research	Undergraduate medical education is greatly enhanced by a medical school environment in which research is actively pursued.
	other	Other teaching centres, such as community centres, also need appropriate resources.

From the interviews, HEA confirmed that overlaps were there before 2021, and they outlined what they had started doing to address them. The interview revealed that when the HEA noted that they had conflicts with other regulators, they took up the initiative to successfully advocate for the amendment of the Higher Education Act. The Act was amended in 2021, where this amended Act gave HEA the power to be overall in charge of higher education regulation over all the other actors mentioned in Table 1. An interview with the HPCZ indicated that the amendment of the Higher Education Act came with a consequential amendment of the Health Professional Councils of Zambia Act, which essentially reduced the authority of the HPCZ in the QA of HRH. A further investigation through desk reviews indicated that there were further consequential amendments of the Acts of the other actors in Table 1.

The amendment of the Higher Education Act meant that the regulatory authority of the HEA was increased, but that of other actors was reduced with their ability to complement QA work compromised. The positive part of this change was that there were unlikely to be any overlaps/conflicts like the one that ended up with the Attorney General. It is good to end conflicts mentioned in the introduction, but it minimizes the contribution of others to QA. The other actors just added to the HEA QA value chain but could add more value to the entire national QA value chain if given more authority. From the interviews, the HPCZ mentioned that they would be able to offer more in QA, but the amended Act limited them to only providing a curriculum to the HEA. An examination of the HPCZ's capacity showed that the HPCZ had a strong capacity and experience in regulating medical-related training as compared to the HEA- this finding indicated that having the latter take over the role of the former was likely to compromise the QA of HRH training. Further research on the impact of the amended Higher Education Act is on-going.

At this point, it was established that there were overlaps in the mandates of the regulators, difficulties in interpreting the legal mandates of the various regulators, less than firm responses to violators of QA regulations, and inconsistent responses to QA challenges. It was then found that the HEA had taken measures to address these challenges. After establishing these challenges, the HEA triggered the amendment of the law to adjust the mandates of the various regulators of higher education, including those regulating HRH training. The initiative to alter mandates appeared to have reduced the conflicts among the regulators, as the desk review did not find any conflicts after the law was amended, a fact that was verified in the interviews with the respective regulators. It was, however, not clear if this absence of conflicts entailed increased intersectoral collaboration.

As the data collection proceeded, it was noted that there was some form of ISC existing among the regulators. Though some collaboration exists between the actors after some reforms that were taken in 2021, it could be described as needing improvement as it was found that regulators other than the HEA were not playing a prominent role in quality assurance. ZAQA and Local Government were found to have some interaction with HEA under the current arrangement, but it was more of the ZAQA and Local Government only providing support to the HEA on selected subjects and not an iterative relationship. ZAQA's interaction with HEA was found to be at the point when HEA submitted proposed qualifications for new programs for ZAQA to consider and include in the National Qualifications Framework (NQF).

Local Government approves the use of premises for learning institutions before HEA gives permission to open the institution. However, there was no direct interaction between the Local Government of HEA, and the latter only received approval documents

from the former through the learning institution applying for approval. There was no interaction found between the Local Government and any other regulators, and there was no regular or direct interaction between ZAQA and other regulators such as HPCZ. This limited interaction among regulators was noted to be inadequate to be termed as ISC and also limited the contribution of other regulators in providing QA for HRH training.

It was also found that the HEA had created provisions for interaction with other regulators, notably, the Program Core Elements Review Meetings and Quarterly Meetings. One of the positive things that emerged from the HEA's reforms in 2021 was the creation of the Program Core Elements Review. This is a platform were universities present their programs, and the core elements of that program are reviewed by a panel and later subjected to validation by their peers. The outcome ensured that universities were offering programs that have undergone a more rigorous curriculum review than previously when universities would design their own programs and deliver them to students. This platform promoted the incorporation of expert views, provided peer review, and increased collaboration between the HEA and the training providers and, to some extent, between the HEA and other regulators.

Intersectoral collaboration has been defined as **"**a recognised relationship between part or parts of the health sector with parts of another sector which has been formed to take action on an issue to achieve health outcomes (or intermediate health outcomes) in a way that is more effective, efficient or sustainable than could be achieved by the health sector acting alone" [14]. In other words, ISC is a collaboration amid diverse social groups that permits them to resolve common problems. The relationship between the regulators of HRH training in Zambia can be described as "recognized" as it is enshrined in the law. However, the arrangement does not appear to create a more effective system than if the individual regulators were working on their own. To a large extent, the HEA was the only regulator that is maximizing its potential, while others, such HPCZ are not. Potentially more effective collaboration is where all stakeholders were contributing to the maximum of their potential.

It has been found that for ISC to succeed, the frames of the collaboration should be collectively reflected upon and negotiated to arrive at a joint determination of common goals [14]. From the findings, the stakeholders did not at any point have any reflection and/or negotiation on to agree on the framework of the collaboration.

Discussion

The findings of this inquiry showed that the assumption made in the introduction that there was an overlap of the powers of actors was true. Further, the issues raised on quality by other researchers, such as the ZMA, were confirmed by this inquiry. However, the findings on the contributions made by the various regulators have not been explored till now. There have been some achievements in resolving the problem of overlaps, but this was done at the expense of limiting the contribution of some regulators in the QA process.

The first achievement was that the problem of overlaps has been noticed by at least two actors, the HPCZ and the HEA. Noticing the overlaps was a major first steps to working towards findings solutions. If there was no notice of the overlaps, then all the efforts currently being made to end overlaps could not have been made at all.

The second achievement was that after noticing the stated regulatory challenges, at least two actors, ZAQA and HEA, amended the laws that governed their work where the amended Higher Education Act of 2021 appeared to be set to end any possible conflicts among the regulators. However, this achievement was made by increasing the

powers of one actor, the HEA, and reducing the powers of the actors to challenge this actor. Having most powers vested in one regulator is good for lessening conflict but it limits the role of other regulators. The best solution would have been to maintain the powers of the other regulators but put in place an effective system of conflict resolution. Each regulator has its area of specialty, so allowing each regulator to perform its function to the best of its ability will improve QA in HRH training. Having multiple regulators with sufficient authority also gives an opportunity for "checks and balances" or some form of "peer review" that could foster the upholding of standards. Having one regulator to serve as the sole regulator could take away the benefits of specialization that are on offer by other actors.

Thirdly, there were efforts made by the various regulators to improve their relations, for example, the HEA and HPCZ were reported to be in the process of developing a Memorandum of Understanding and were pondering conducting joint regulatory missions, after the conflict they had. The ZAQA had also been establishing closer working relations with HEA, especially in helping the latter package the higher education programs into the Zambia National Qualifications Framework. All these were positives, but more of bilateral relation improvements than ISC for all regulators. More needed to be done to bring all stakeholders around one table.

The reported conflicts highly were highly suggestive of the absence of Intersectoral Collaboration (ISC) in the regulation of higher education in Zambia. Intersectoral collaboration is associated with the process of decision-making in quality assurance as it helps the stakeholders to achieve common goals [15]. In several health-related projects, ISC has been noted to be an enabler [16]. Although the perception of the importance of ISC is neither uniform nor constant, but it varies across different types of coalitions because the salient features of each coalition are different [17] but it has been found to be feasible and useful [18]. Weaknesses in ISC in the regulation of training will therefore affect the quality of HRH training. Good quality of human resources in the health sector has a link to better patient treatment outcomes and eventually leads to a lower disease burden [19].

QA in higher education in Africa has come a long way and has a long history. Research [20] narrated the evolution of quality assurance in higher education in Africa. He noted that the history of quality assurance in higher education in Africa goes back to the founding of the first universities in Africa (for example, Fourah Bay College in Sierra Leone in 1827), all of which were affiliated to partner universities located in the colonizing countries (the United Kingdom, France, and Portugal). The research further noted that the following independence, governments had more control and interest in taking authority over higher education but the prioritized access (quantity) over quality. This led to an increase in the number of universities and their intakes but it compromised quality. There was also an introduction of private universities, which were of course, outside government control, so this led to governments setting up national quality assurance agencies to ensure minimum standards. Further, the emergence of the private sector in higher education had been known to add a layer of complexity to QA systems [21].

It was noted that the respective regulators were putting in a lot of effort to ensure the quality of HRH training. However, more needed to be done to improve QA in HRH by enabling the regulators work as a whole and not as a sum of parts. There was also needed to harness the expertise of all the actors so that others should not feel their expert contribution was being restricted. To enable the multiple regulators to work together, it means adjusting the way they are currently working. However, changing the way they operate is not straightforward as their respective actions are mandated by law, so changing what they do

could need adjusting the law. Having a consensus on the need for change would be a major first step in adjusting the working relations of the regulators. Research is on-going to establish how the regulators could work more effectively together.

Conclusion

The inquiry aimed to find reasons why the various regulators were not in a position to assure quality in HRH training, despite having legal mandates to do so. The study also explored the reasons for the absence of ISC among the regulators. The inquiry found that before 2021, the regulators had overlapping mandates that resulted in conflicts and created an environment that neither fostered QA in HRH training nor promoted ISC. The inquiry also found that in 2021 the mandates of the regulators were reviewed, where the revised mandates resulted in fewer conflicts but appeared to limit the contribution of some regulators to the QA process. It was also clear that both before and after 2021, the ISC framework was neither negotiated nor co-reflected, and this appeared to be the most significant cause of deficiency of ISC among the regulators of HRH training.

The findings of this inquiry are important for improving health, as the quality of HRH training affects the disease burden. Better quality in HRH training helps in addressing the country's disease burden. According to the WHO [22], poor quality of HRH, resulting from poor training results in poor health outcomes and subsequently holds back progress on improving health in countries at all income levels, a view similar to what is stated by the World Bank [23] and UNESCO [24]. Poorly trained HRH could lead to inaccurate diagnosis, medication errors, inappropriate or unnecessary treatment, inadequate or unsafe clinical facilities or practices, and prolonged hospital admissions, which not only increase the disease burden but also increase the cost of care. Enabling the regulators of quality in HRH training in Zambia to deliver better results will be a major step towards improving the quality of graduates and subsequently reducing the disease burden and fostering economic development. Further, quality human resources for health are needed to meet the targets of Universal Health Coverage [25] and reduce disease burden [26].

Conflict of Interest

The author has no conflict of interest on this research.

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Effects of Gadolinium-Based Contrast Agents on the Kidney, Liver, and Heart of Wistar Rats

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Abstract

The harmless potential of gadolinium-based contrast agent (GBCA) used in MRI studies was remarkable until when gadolinium was detected in the brain, bones, and skin. This study aimed to evaluate the effect of four GBCAs on the liver, heart, and kidney of Wistar rats. Twenty-five (25) male Wistar rats weighing 165-239 g were divided into 4 experimental and control groups after obtaining ethical approval from the Institutional Review Board (IRB) of the Nigerian Institute of Medical Research (NIMR). Specimens in the experimental groups received 2.5 mls / day of one GBCA and the control same normal saline through the lateral tail for 5 days consecutively / week. The Livers, Hearts and Kidneys were harvested 4 weeks following last injection. Pathohistology showed all kidney tissues exposed to Gadopentetate, 80 % to Gadodiamide, and 40 % to Dotarem and Cyclolux were inflamed. Sixty percent Gadodiamide and Doterem to the liver tissue, 50 % and 20 % to Gadopentetate and Cyclolux also inflamed. Samples exposed to Gadopentetate and Dotarem had 50 and 40 % of their heart tissue inflamed. Only those to Gadodiamide and Cyclolux were not affected. Injuries like necrosis, degeneration, and hypertrophy were also noted in all the tissues. All GBCAs were statistically significant in all tissue studied. Gadolinium-based contrast agents had a weak negative correlation with inflamed and degenerated tissues, also a weak positive correlation with hypertrophied tissue, but a moderate positive correlation with necrosis tissues of the kidney, liver, and heart.

Keywords: *Contrast agents, Heart, Histopathology, Kidney, Liver, Magnetic resonance imaging.*

Introduction

Magnetic Resonance Imaging can be used for fear that radiation exposure is a problem, such as in children and pregnant women [1]. It can as well be used when the CT scan findings are non-diagnostic [1]. A comprehensive evaluation of both morphology and function in renal disease is possible with MRI [2]. Compared with other hepatic imaging modalities, including ultrasonography (US), contrast-enhanced US, CT, and positron emission tomography-CT, it offers a more comprehensive evaluation of the liver, establishing, in many cases, an accurate tissue diagnosis [3]. The most used imaging methods for diagnosing hepatocellular carcinoma (HCC) in clinical practice are CT and MRI, with MRI more detailed compared to CT [4]. Cardiac MR is being more widely accepted, considered as "gold standard," and use for more accurate cardiac assessment such as left ventricular mass, volumes, ejection fraction, evaluation of pericardial disease, complex congenital cardiac anomalies, right ventricular dysplasia, disease

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of the major thoracic vessels including aortic aneurysms and dissection as its superiority over others is established [5]. Apart from the cost of MRI examinations, longer scan time, and contraindications in some patients, the anatomy images and information about patients' physiological and metabolic functions are more detailed than that of the CT [4]. The detailed diagnostic quality of an image may be achieved by the contrast agent's administration.

Tolerance to GBCAs is excellent. The tissue-specific agents do have some adverse effects, though none of them is life-threatening. Identification of nephrogenic systemic fibrosis (NSF) has forced a rethink about the liberal usage of MRI contrast agents [6, 7]. A study showed macrocyclic GBCAs to be more stable and equally safer than linear agents [8]. Studies identified GBCAs as the causative agent in NSF in a patient with impaired kidney function [9-11]. The increased kidney size in autosomal dominant polycystic kidney disease (ADPKD) is associated with the severity of renal function impairment [12], and GBCAs used during MR imaging are believed to contribute to kidney volume estimates from MR images [12]. Gadolinium-containing contrast agents (Optimark, Omniscan, Magnevist, Magnegita and Gado-MRT Ratiopharm) have been contraindicated in a high-risk patient with severe kidney problems, patients who are scheduled for or have recently received a liver transplant, and in newborn babies up to four weeks of age [9, 11, 13].

The prescribing information for all GBCAs should include elderly may be at particular risk of NSF due to the impaired ability of their kidneys to clear gadolinium from the body, no evidence to support the initiation of haemodialysis to prevent or treat NSF in patients not already undergoing haemodialysis, and the type and dose of contrast agent used should be recorded to minimize the risk of NSF with GBCAs. Body organs like the kidney and liver are known to primarily eliminate these agents; reduction in organ performance may increase the time taken for gadolinium to be retained in the body leading to high toxicity. Rogosnitzky and Branch [8] reported on FDA and EMA-approved GBCAs. They identified Gadobutrol, Gadoterate meglumine, and Gadoteridol as macrocyclic GBCAs having lower dissociation constants and are thought to be more stable, while the remaining are linear forms. [14] in their study complimented Rogosnitzky and Branch's reports with evidence in 2017 following the NSF crisis and reported macrocyclic were "safer" than linear GBCAs, despite clear evidence of differences among GBCAs of the same class. Magnetic resonance imaging contrast agents should be rapidly and substantially cleared from the body after injection and subsequently imaged to prevent chronic toxicity due to the slow deposit of dissociated free metal ions in specific tissues or organs [15]. It was earlier widely believed that GBCAs are rapidly and completely excreted from the body in an unharmed state [8], though the prevalence of allergic reactions to gadolinium is uncommon (0.07%), but higher in patients with histories of allergic reactions to iodinated contrast agents [16], evidence showed adverse side effects associated with the use of GBCAs [17, 18].

According to the Royal College of Radiologists [19], the incidence of acute or severe reactions is estimated to be 0.0025 % - 0.005 %, but major life-threatening to GBCAs is extremely rare. It was documented that GBCAs are associated with very low rate of immediate adverse events (0.06 %- 0.09 %), and most adverse events are mild and managed in the imaging department. There is no published work, to the best of the researcher's knowledge, on the effect of GBCA in the liver, kidney, and heart. We hypothesized that there are no differences in the effect of the gadolinium-based contrast agents (gadopentetate dimeglumine, Dotarem, gadodiamide and cyclolux) on the kidney, liver, and heart of Wistar rats. This study was designed to evaluate the effects of gadolinium-

based contrast agents on the kidney, liver, and heart of Wistar rats.

Materials and Methods

This experimental study, which involved 25 healthy male Wistar albino rats, was conducted at the physiology laboratory of Bayero University and histology and chemical pathology laboratories of Ysusuf Maitama Sule University, Kwanar Dawaki Campus Kano, all in Kano State, Nigeria, from January 2022 to June 2022. The health condition of the rats was only determined by thorough observations, body weight, age, and assessment. No blood or urine volume, heart rate, allergens and respiratory rate taken. This model was selected for this study owing to its smaller body size, high rate of survival, and lower tumor or lesion incidence compared to other outbreed rats. Only male animals with ages of $\geq 5 \leq 6$ weeks old were included in this study since the female hormones fluctuate during the reproductive cycle and could influence the outcome of the experiment [20], and also, they have reached maturity at this time [21, 22].

Ethical approval (IRB/21/038) for this study was sought and obtained in accordance with Nigerian animal welfare law and experimental protocols, compliance with "Guide for Care and Use of Laboratory Animals" summarized by Davidson *et al* [23] from Institutional Review Board (IRB) of the Nigerian Institute of Medical Research (NIMR), Yaba Lagos, Nigeria.

The sample size used for this study was determined using a method based on ANOVA calculations and has "E" value called the degree of freedom which must be between 10 and 20.

Where:

E= Degree of freedom ($\geq 10 \leq 20$), E= Total number of animals-Total number of groups. The study aimed at the effect of four different GBCAs on three system organs (liver, heart, and kidney) of Wistar rats. The study has five groups (four groups with each GBCA being administered and one control group).

E= (5x5)-5, E= 25-5, E=20.

The sample size for this study was reached at twenty-five (25) Wistar rats and a simple random technique was adopted to group the animals.

The data generation procedures involved using test agents (Gadopentetate dimeglumine known as magnetic (Gd-DTPA), an ionic Gd complex with a linear polyaminocarboxylic acid ligand. Gadodiamide, also known as Omniscan (Gd-DTPA-BMA), a linear, non-ionic Gd complex, Gadoterate meglumine known as doterem by Guerbet (DOTA-Gd), a macrocyclic ionic GBCA and Gadoterate meglumine known as cyclolux by Sanochemia (DOTA-Gd), also a macrocyclic ionic) and instruments (microscope and spectrophotometer). Each of the Wistar rat was assigned to either control or four other groups (n= 5 per group). The container where the animals were kept was identified and labeled groups A, B, C, D, and the control container 'group E' **(Figure 1).** The animals were in these containers, fed and observed for 14 days prior to other procedures. Each alphabet represented animals to be administered a specific GBCA. Animals in container 'E' received normal saline. Each contrast medium labeled A, B, C, D is drawn from its bottle and 2.5 mls/ day administered intravenously through the lateral tail vein to all the Wistar rat in each of the containers labeled groups A, B, C, and D for five days consecutively/ week, and the procedure continued for 4 weeks. The same is simultaneously done with saline for the container labeled group E. The animals were left to remain in each container for another 4 weeks after the last injection, and during this period, observations were made on the specimen's skins, eyes, and even if there was any casualty. Each was pinned down, being conscious, and dissected to harvest the desired organ **(Figure 2)**. No anesthesia was used in the procedure to prevent other problems with the organs. The kidney, liver, and heart tissue of each sample was harvested in sterile sample

bottles (**Plate 3),** the last day of the 8 weeks. The incineration method through licensed commercial medical waste company was used after the body parts, and carcasses of the Rats were bagged in a seal bag provided by the division of laboratory animals.

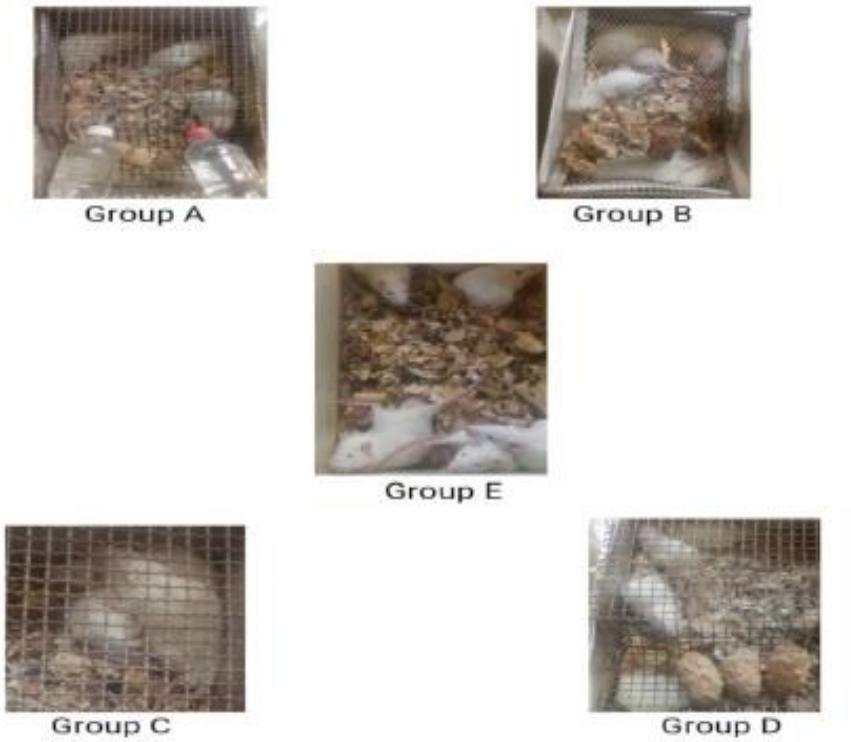

Figure 1. Male Wistar Rate in Containers



Figure 2. Wistar Rat Dissected for organ Harvesting

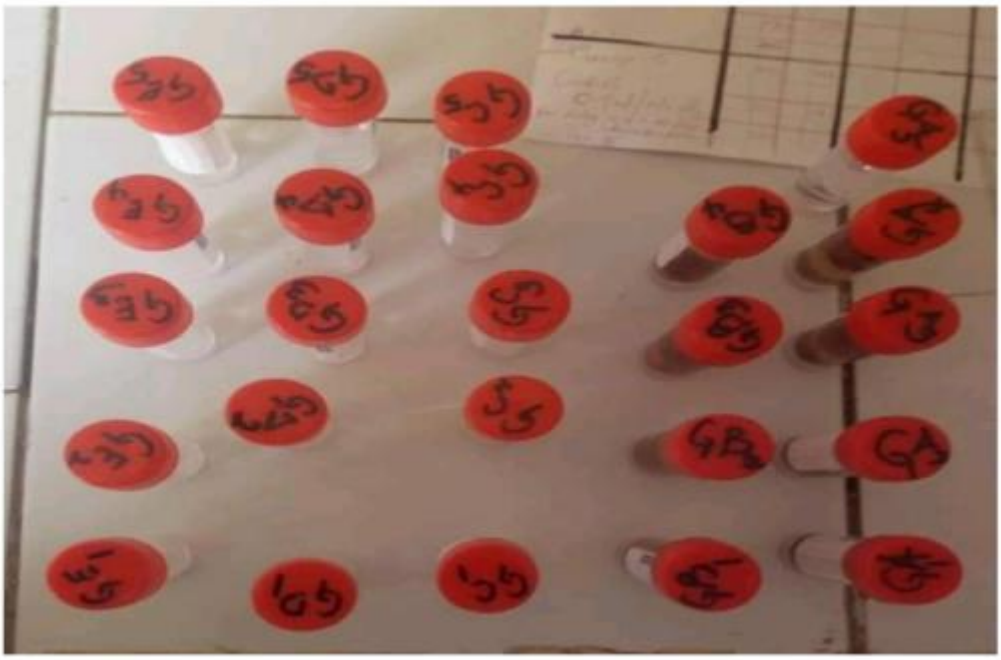

Figure 3. Labelled Sterile Sample Bottles

Potential toxicity associated with GBCAs in normal system organs in this study was tested. Acute toxicity at the injection site as well as repeated dose toxicity testing from spectrometry and histology studies were measured and documented. Careful observation was made from the period of injection of the agent to ascertain acute toxicity in all the animals as published data [24] identified skin lesions, skin thickening and cell swelling in rats. Repeated dose toxicity testing, described by Parasuraman [25], was adopted for toxicity testing. The animals received 20 intravenous injections each of 2.5 mmol GBCA per kilogram (gadolinium-exposed group) or saline (control group) over a period of 28 days (4 weeks). The animals were killed without anaesthesia. The kidney, liver, and heart tissues of each of the animals were harvested for histological changes and subjected to plasma mass spectrometry (PMS) for assessment and quantification of gadolinium retention.

The generated data were categorized into groups A, B, C, D, and E based on the type of contrast administered. The data were subjected to normality testing according to the objectives of the study and passed the normality test hence parametric method of data analysis was used. Both descriptive statistics (mean, standard deviation, and frequency) and inferential statistic (One-way analysis of variance [ANOVA]) were used for statistical analysis using the statistical package for social sciences (SPSS) software version 23(SPSS incorporated Chicago). Descriptive statistics with the mean values frequency and standard deviation documented. A one-way Analysis of variance was computed to compare the effects of the four different GBCAs on the tissues of the Kidneys, Livers, and Hearts of male Wistar Rats. The level of statistical significance was set at a p-value less than 0.05.

Results

Descriptive Statistical Information of the Sample Studied

Table 1 showed a descriptive statistic of sample's weight and length with and without tail. Average weight of the samples in all the groups with and without stood at 224.71 gram and 172.64 grams respectively. Also, the mean initial and end body length of the samples is 17.988 cm and 40.179 cm.

Table 1. Descriptive statistics: Weight and Length of the sample

Group A	**-**	**Wa (g)**	**Wb (g)**	**L a (cm)**	**Lb (cm)**
	Mean	169.75	227.75	17.200	37.625
	Std. Deviation	3.304	8.461	.8718	1.3376
	Minimum	165	217	16.5	35.7
	Maximum	172	237	18.3	38.8
	Skewness	-1.560	-.464	.676	-1.506
	Kurtosis	2.173	.028	-2.233	2.825
	N	4	4	4	4
Group B	Mean	171.60	227.00	18.640	40.420
	Std. Deviation	4.506	5.568	1.4433	2.6948
	Minimum	167	218	16.4	36.4
	Maximum	179	232	20.3	43.3
	Skewness	1.366	-1.304	-.898	-.819
	Kurtosis	2.494	1.683	1.478	.030
	N	5	5	5	5
Group C	Mean	175.20	220.40	17.800	40.820
	Std. Deviation	5.119	4.099	1.1136	2.2917
	Minimum	167	216	16.7	37.2
	Maximum	180	227	19.5	43.2
	Skewness	-1.199	1.192	1.016	-1.116
	Kurtosis	1.579	2.098	.187	1.340
	N	5	5	5	5
Group D	Mean	169.80	220.20	18.240	41.160
	Std. Deviation	1.789	9.680	1.7953	2.3437
	Minimum	167	209	15.4	37.9
	Maximum	172	231	20.3	43.8
	Skewness	-.821	-.310	-.988	-.353
	Kurtosis	2.363	-2.612	2.035	-.798
	N	5	5	5	5
Group E	Mean	173.40	228.80	17.900	40.360
	Std. Deviation	4.219	10.941	.9772	.6025
	Minimum	170	212	16.4	39.9
	Maximum	180	239	18.9	41.4
	Skewness	1.166	-1.064	-1.005	1.860
	Kurtosis	.581	.202	.465	3.688
	N	5	5	5	5
Total	Mean	172.04	224.71	17.988	40.179
	Std. Deviation	4.217	8.343	1.2756	2.2093
	Minimum	165	209	15.4	35.7
	Maximum	180	239	20.3	43.8
	Skewness	.606	-.194	-.047	-.268
	Kurtosis	-.314	-.765	-.487	-.582
	N	24	24	24	24

Wa= weight without tail, Wb= weight with tail, La= Length without tail, Lb=Length with tail, Group A=Gadopentetate dimeglumine, Group B= Gadodiamide, Group C=Dotarem, Group D=Cyclolux, Group E= Normal saline

Effect of GBCAs on the Kidney Liver and the Heart Tissues of Male Wistar Rats

Table 2 shows the presentation of the effect of GBCAs on the tissues of the kidney, liver, and heart of normal Wistar rats. A total of 72 tissues were sent for histopathology following four different GBCAs injections. Group A had 4 kidneys, 4 livers, and 4 hearts tissues harvested from samples subjected to gadopentetate dimeglumine, 12 tissue plates were examined in all, and the majority inflamed, 4 (33.33 %) were the kidney tissues, followed by 16.67 % liver and 2 heart tissue. Apart from cell increase (hypertrophy) noted in 8.3 % of the liver and heart tissues, pathohistology was experienced in all kidney tissues, 75 % of both liver and heart tissues, but 25 % of liver and heart tissue in this category were not affected by the contrast. All the tissue administered in group B contrast experienced one of necrosis, inflammation, degeneration, or hypertrophy. The kidney tissues had 60 % necrosis, 20 % hypertrophy, and 20 % cell degeneration. Inflamed livers and hearts in this group were 20 % and 80 %, respectively, a minority (20 %) of hearts and livers here had necrosis and 40 % liver cell degeneration. Groups C and D had 40 % heart tissues not affected by the agents administered. The remaining 3 hearts in group C were 20 % necrosis and 40 % inflamed, and group D 40 % hypertrophy and 20 % necrosis. The majority (60 %) of the liver tissues in group C were inflamed, and 20 % each of necrosis and hypertrophy. Hypertrophy is highest (60 %) with kidney tissue in group C, and necrosis in group D. samples administered with normal saline had no experience of any pathohistology as demonstrated in the table. Figure 4 illustrates the pathohistology plates of the Kidney, liver, and heart tissues studied.

Table 2. Histopathology of the Kidney, Liver, and Heart tissues after injection of GBCAs

Histological Features	Normal	Inflammation	Necrosis	Cell degeneration	Hypertrophy
Group A	**Gadopentetate dimeglumine (4 wistar rats)**				
Heart	1	2	0	0	1
Liver	1	2	0	0	1
Kidney	0	4	0	0	0
Group B	**Gadodiamide (5 wistar rats)**				
Heart	0	0	3	1	1
Liver	0	2	1	2	0
Kidney	0	4	1	0	0
Group C	**Dotarem (5 wistar rats)**				
Heart	0	2	0	0	3
Liver	0	3	1	0	1
Kidney	2	2	1	0	0
Group D	**Cyclolux (5 wistar rats)**				
Heart	2	0	1	0	2
Liver	0	1	2	0	2
Kidney	0	2	3	0	0
Group E	**Saline (5 wistar rats)**				

Heart	0	0	0	0	0
Liver	0	0	0	0	0
Kidney	0	0	0	0	0

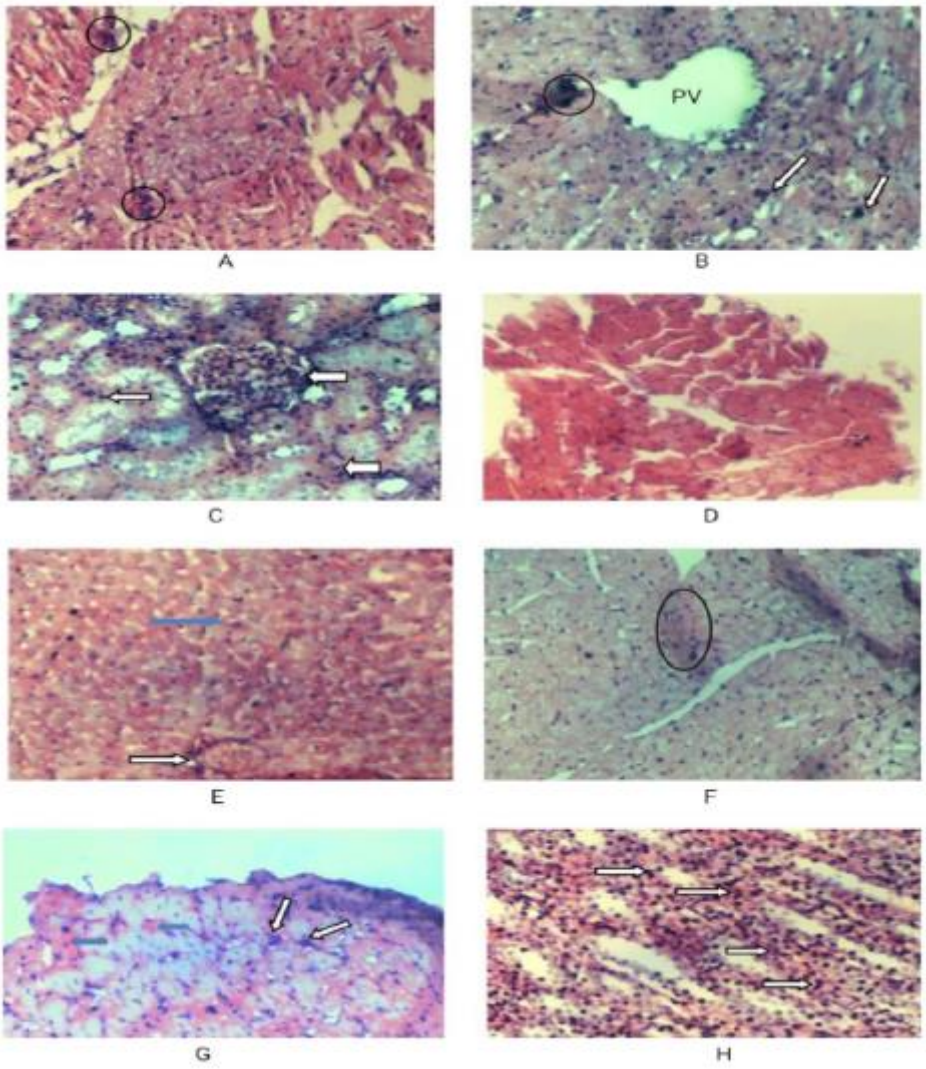

Figure 4. A-Heart Inflammation, B- Liver Inflammation Enlarged Hepathocytes, C – Nephron Inflammation, D – Heart Cell degeneration, E – Hepatocyte Ballooning Degeneration, F – Hypertropic Cardiomyopathy, G – Vascular Necrosis and Cardiomyocytes Hypertrophy, H – Kidney Cell Necrosis and Concomitant Increase in the Number of Cell

Table 3 shows the comparison of four different GBCAs on the tissues of the organs studied. The P and F values were defined. All the GBCAs were statistically significant in the kidney tissues 0.007, liver tissues < 0.001, and heart tissues < 0.001; the corresponding F-values were kidney 5.853, liver 27.658, and heart tissues 48.344.

Table 3. One-Way Analysis of Variance Comparing the Effects of the Four Different GBCAs on the Tissues of the Kidneys, Livers, and the Hearts of Male Wistar Rats

Organ	**Group**	**Mean±SD**	**F**	**P**
Kidney	Gadopentetate Dimeglumine	1.921±0.030	5.853	0.007*
	Gadodiamide	1.930±0.071		
	Dotarem	1.943±0.025		

	Cyclolux	2.054±0.075		
	Total	1.964±0.076		
Liver	Gadopentetate Dimeglumine	1.964±0.029	27.658	<0.001*
	Gadodiamide	1.880±0.113		
	Dotarem	1.745±0.034		
	Cyclolux	2.104±0.027		
	Total	1.921±0.149		
Heart	Gadopentetate Dimeglumine	2.022±0.024	48.344	<0.001*
	Gadodiamide	2.056±0.023		
	Dotarem	1.824±0.046		
	Cyclolux	1.966±0.030		
	Total	1.964±0.097		

Key: *= Significant at P<0.05

Relationship Between Four Different GBCAs Concentrations and the Histological Pattern of the Kidney, Liver, and the Heart of Male Wistar rats

Table 4 shows the relationship between all four different GBCAs concentrations and the histological patterns of the kidney, liver, and heart tissues of male Wistar rats. Pathohistology of inflammation (-0.426) showed a weak negative association between the GBCAs and this pattern, Necrosis (0.539) is moderate positive correlation, degeneration (-0.188) is a weak negative correlation, and hypertrophy (0.352) is a weak positive relationship. There was no correlation (0.098) between any of the GBCAs and the normal tissues of the kidney, liver, and the hearts.

Table 4. Pearson Product Moment Correlation showing the Relationships between Concentration of GBCAs with the Histological Pattern of the Tissue of the Kidneys, Livers, and the Hearts of Male Wistar Rats

Histological Pattern	R	P
Inflammation	-0.426	0.167
Necrosis	0.539	0.071
Degeneration	-0.188	0.559
Hypertrophy	0.352	0.262
Normal	0.098	0.763

Discussion

The effect of four different GBCAs on the tissues of the kidney, liver, and heart of Wistar rats were determined in this study. The study showed effect like inflammation, necrosis, hypertrophy, and degradation in the tissue of the kidney, liver, and heart of wistar rats when exposed to any one of gadopentetate dimenglumine, gadodiamide, dotarem, and cyclolux. This study agrees with other previous studies on accumulations of gadolinium in brain tissues but further revealed the accumulated gadolinium had effects on the tissue of the kidney, liver, and heart of wistar rats. Other studies also revealed the known behavior of gadolinium in brain tissues of rodents/ rats in previous studies [24, 26-28], including transfer to pops of fetuses affecting postnatal brain development [28] after injection of GBCAs. In some studies, accumulations of gadolinium were noticed in CSF [26], liver, skin, and bones [24, 29], also human and animal bodies [24, 29]. Macrocyclic GBCAs were previously believed to be more stable than linear (Guo *et al*., 2018), but further review considered the possibility of macrocyclic gadolinium

deposition in human brain [29]. This current study utilized two linear (gadopentetate dimeglumine and gadodiamide), together with two macrocyclic, brands of gadoterate (dotarem and cyclolux), and was observed that all the GBCAs had deposition of gadolinium in the tissue of the organs studied as this was confirmed through the spectrophotometric readings. In general, the incidence of acute adverse reactions in previous studies [17,18] was low (1.7 %); the four studied gadolinium agents here, were only trivial, as deliberate effort was made to consider the site of injection, then the behavior and moods of the rats. No significant remark was decided.

Most of the previous studies [17, 18, 24, 29, 30] included gadopentetate dimeglumine, gadodiamide, and doterem, but only very few [31] considered cyclolux a brand of gadoterate, without clear clinical evidence existing indicated that gadolinium retention causes toxicity. [31], clarifies the rejection of both gadopentetate dimeglumine and gadodiamide in medical practice, but established the continuous use of both cyclolux and dotarem.

This study ensured the inclusion of macrocyclic GBCA, both linear ionic and non-ionic to substantiate and possibly confirm the argument by most authors [30,32-34] on the stability of macrocyclic GBCAs over linear. The former was believed to be well tolerated and has a safety profile than the latter, but this present study revealed high level of injury from all the GBCAs used as evidence in the histopathology having one of inflammation, necrosis, hypertrophy, swelling of the cells, infection and also apoptosis, this could have been due to the retention of free Gd^{+3} in the studied organs for the period (4 weeks) prior to harvesting for laboratory examinations. It was evident in the current study that most of the tissues experienced some certain level of changes weeks after exposure to the GBCAs studied. The samples exposed to gadopentetate dimeglumine had all kidneys and 50 % hearts plus 50 % livers inflamed.

The samples in this group 25 % normal histology of both the liver and the heart and 25 % liver necrosis and heart hypertrophy. Group 2, in this current study that, received gadodiamide had 80 % of the kidneys, 40 % liver, and none of the heart tissues inflamed as demonstrated in table 4. The heart tissues of those samples that received this agent had about 60 % necrosis, while cell degeneration is noticed in the liver tissue of about 40 % of these samples. All the hearts, livers, and kidneys of the samples administered gadodiamide had one injury or the other, and there was no normal histology noticed in the end. Group C and D were brands of gadoterate meglumine, their administration in their respective groups had 40 % normal kidney tissues for those that received Dotarem and same 40 % normal heart tissues for Cyclolux in group D. Sixty percent of the tissue of the livers and hearts of those that received Dotarem were inflamed and hypertrophied respectively. Also, 40 % had inflamed kidney and heart tissues. The remaining samples in group C, had 20 % hypertrophied liver tissue and 20 % liver and kidney tissue necrosis. Cyclolux in group D inflamed 40 % of the kidney and 20 % of the liver tissues. Kidney necrosis of 60 % of the samples, 40 % hypertrophy of the liver, also 40 % of liver and 20 % heart necrosis were caused by this agent. Several authors [35-39] gave similar findings on tissue with GBCAs used in this present study but were reportedly linked to impair organs. Autopsy findings already showed accumulation of Gd^{+3} in brains, bones, and skin tissue [40].

Also, [41] identified deposition of gadolinium in neuronal tissue, which was analyzed by inductive plasma mass spectroscopy, similar to the method used in the current study to detect retention of Gd^{+3} in the studied organs. This preclinical study clarified the previous confusion [42] on the effect of retained gadolinium in a patient with normal renal function and possibly heart and liver functions. The degree of damage shown from

the present results following injection of all the GBCAs indicated that the substances were no longer chelated (this substance was chelated by ligands aimed to help in its clinical use), but the Gd^{+3} from the substances (GBCAs) was released inside the sample (Wistar rats) as evidence in this study thereby accumulating in the organs [43-45].

Highest path histology seen with group A contrast is inflammation (kidney > Liver=heart) followed by hypertrophy (Liver= heart) while lowest is necrosis and cell degeneration. Inflammation is highest in group B heart > liver, followed by necrosis (kidney > liver = heart), but liver degeneration > kidney hypertrophy are the lowest in this category. This signifies that the GBCAs used in this study were very unsafe because of their toxicity. The saline concentrate recorded zero in the samples they were administered. Major and Meade [46] questioned the efficiency of chelates to completely resist Gd^{+3} dissociation from its substance, and it appears to agree with the current study.

Conclusion

Most of the tissues of the heart, liver, and kidney of the male Wistar rats were damaged by gadopentetate dimeglumine, gadodiamide, dotarem and cyclolux. This study showed there were significant statistical differences among the GBCAs used.

Histology results showed correlations between the concentration of GBCAs and histological patterns of the kidneys, livers, and hearts of male Wistar rats. Specifically, samples exposed to Gadopentetate dimenglumen, Gadodiamide, Dotarem, and Cyclolux concentrations reported more significant differences in kidneys, livers, and hearts of Wistar rats than those exposed to normal saline.

Conflict of Interest

There was no conflict of interest declared among the authors.

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Predictive Factors of IT Systems Adoption by SME Employees in Developing Countries: Evidence from SME Employees in North Kivu, DRC

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Abstract

This research aimed to identify the determinants of technology usage among SME employees in the North Kivu Province of the Democratic Republic of Congo. We based our model on the Technology Acceptance Model. In addition to perceived usefulness and ease of use, the proposed model includes relative advantage as a predictor of technology usage. This study used the PLS-SEM method to test the proposed hypotheses from 247 responses. The results confirmed the hypotheses. The research findings demonstrate a positive relationship between perceived usefulness and use, perceived ease of use and use, and relative advantages and use of new technologies. Congolese SME managers can rely on these findings to highlight these key determinants in promoting technology usage among SMEs in a country where technology usage by businesses remains low.

Keywords: *Perceived ease of use, Perceived usefulness, Relative advantages, SI adoption, Technology.*

Introduction

The emergence of information technologies has been the most important event in the management field in recent decades [1], making technology adoption one of the most discussed topics in the literature over the last years [2-3]. Every year, several studies are carried out on this topic. The critical role IT plays in SMEs can explain the growing interest in technology [4]; in addition to allowing companies to increase productivity and performance [5], technology also serves as a means of allowing the company to react to its external environment [4] quickly. Considering the importance given to information systems [6-7], there is a growing interest in understanding their critical success [8].

Several studies have been conducted worldwide on information systems [9]. However, according to [10], generally, these studies have focused on developed countries in North America and Europe. While some researchers are gradually addressing developing countries [11-12], in DRC, few studies address information systems [2]. The author notes that the introduction of computerized business information systems has just lately become a government priority in the DRC. This slower adoption of computer-based information systems raises questions since it has already been established that information systems are valuable to businesses regardless of industry [12].

This author suggests that the debate, even in the developing country, no longer revolves around the value of computer-based information systems but on how to derive their benefits. To benefit from IS in a country where SMEs are gradually embracing computerized IS, understanding the drivers of post-adoption behavior is essential [13] to enable management to rely on them for IS success. For several years the value of SMEs in an economy

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has been proven. They are development enablers, especially in developing countries [14-15]. To be efficient, SMEs use computerized IS [16-18].

In investigating the predictive factors of IS adoption, several authors have focused on large companies [19] in developed countries [20], thereby creating a research gap in developing countries and especially in the DRC, which has a very different context compared to the other countries. The adoption of IS has been very slow in DRC, and related studies are at an early stage [21]. This study, therefore, addresses this research gap by identifying the predictive factors of IS usage among Congolese SME employees.

Several models have been proposed in the literature to capture the determinants of IS adoption. The Technology Acceptance Model (TAM) developed in 1989 by [22], is the most widely used and has been validated by several researchers [23-25]. But despite its high popularity, to our knowledge, not enough studies have been conducted in the DRC context.

The findings of this research may be helpful to managers/owners of Congolese SMEs in migrating to computerized systems and thus join the government's ambition to prioritize digitalization [26]. In addition, this research would serve as a reference for other research on management information systems in this country, where SMEs' computerization is struggling to start entirely. Consequently, the author addresses the following central question: What are the predictive factors of adopting computerized information systems by employees in North Kivu, DRC?

Theoretical Framework and Hypothesis Development

Understanding the reasons behind users' acceptance and usage of new technologies is critically important for the new systems' development and implementation [13,27], and consequently, several models have been developed. The TAM model is the most frequently used model in information systems research [28-29]. Since its introduction in 1989 by [22], the model has been validated by several empirical studies [30-32]. Inspired by the theory of reasoned action developed by [33], the TAM model, in its simplest form, argues that actual use of technology is predicted by perceived ease of use, perceived usefulness, attitude towards service, and behavioral intention [29].

Despite its popularity among information systems researchers and practitioners, due to its inadequacies, the TAM model has been subjected to various criticisms and improvements [34-35]. Some researchers criticize, for example, the model's exclusion of structural and cost imperatives which influence new technology usage [36]. According to [37] the TAM model suffers from a limited descriptive and predictive capacity. In addition, the continuous discussions around the TAM model have distanced researchers from other relevant information system-related topics [37]. Moreover, efforts to adapt the model to the evolving IT context have created chaos by proposing several versions of the model, thus creating confusion about which of these versions is commonly accepted [37]. Although criticized, the TAM is still the most widely used model for predicting the acceptance or rejection of new technology [25].

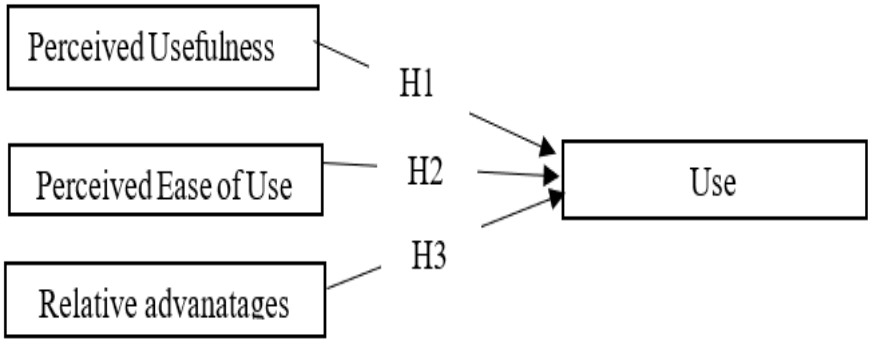

Figure 1. Research Model

Information systems research has identified two main determinants for predicting the adoption of new technology: perceived usefulness (PU) and perceived ease of use (PEOU) [38]. Perceived usefulness is "the degree to which a person believes that using a particular system would enhance his or her job performance" [22]. Thus, a higher perceived usefulness system is a system that users believe has a positive use/performance ratio (Davis, 1989). Several empirical studies show a positive relationship between PU and system usage [39-41].

Hypothesis 1(H1): Perceived usefulness positively and significantly influences system usage.

Perceived ease of use refers to "the degree to which a person believes that using a particular system would be free of effort" [22]. Typically, a system perceived as more straightforward to use than another is more likely to be accepted by users [22]. Several studies [42-44] have tested and confirmed the positive relationship between a system's perceived ease of use and usage.

Hypothesis 2(H2): Perceived ease of use positively and significantly influences the usage of an information system.

However, another construct closely related to perceived usefulness explains technology adoption and use. This is a relative advantage, RA [45]. [46] Comparative advantage is "the degree to which an innovation is perceived as being better than the idea it supersedes." The willingness of the users to switch to a new technology increases when the technology is perceived to be better than the one it replaces [47-48]. Concerning the link between relative advantages and system usage, [49] suggests a positive relationship. Accordingly, we suggest the following hypothesis:

Hypothesis 3(H3): Relative advantages positively influence system usage.

Materials and Methods

The survey involved 247 employees of SMEs in North Kivu Province. Since we did not know the total number of employees in the entire province and could not reach all of them, we applied the convenience sampling method. We used a 5 to 1 Likert scale questionnaire (Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree) to collect the data. A minimum of 3 items represented each construct in the model. Respondents were informed of the purpose and nature of the survey before the actual data collection. They were also clearly informed of the anonymous nature of their responses.

This study used partial least squares structural equation modeling (PLS-SEM) analysis, specifically Smart PLS3, for hypothesis analysis. PLS-SEM is a statistical instrument that researchers use to analyze empirical data and test relationships simultaneously [50]. PLS-SEM was chosen for its ability to explore several relationships quickly.

Results

Evaluation of the Measurement Model

The study examined three indicators for the convergent and discriminant validity of the model: Cronbach's Alpha, Composite Reliability, and average variance, AVE. The respective values of Cronbach's Alpha and Composite Reliability should equal 0.7 except for exploratory studies and the AVE at least 0.5 [50]. The values shown in Table 1 are respectively greater than 0.7 and 0.5, reflecting a good validity level.

Table 1. Relevant Indicators of the Measurement Model

Latent Construct	Cronbach's Alpha	Composite Reliability	AVE
-	>0.7	>0.7	>=0.5
PEOU	0.763	0.873	0.708
PU	0.707	0.818	0.529
RA	0.743	0.826	0.502
U	0.719	0.877	0.780

Structural Model Assessment

The evaluation of the explanatory power of the model requires the measurement of the divergence between its respective variables [51]. The R^2 and path coefficients are key measures for evaluating a structural model [52]. As indicated in Figure 2, the R^2 value was found to be 0.34 for usage. Thus, the three technology adoption predictors under analysis (PU, PEOU, RL) account for about 34% of the technology use (U). The findings validated all the proposed hypotheses. These were validated since the p-value was found to be less than 0.05 and the path coefficient was positive for the different situations. H1 is supported since Perceived usefulness positively affects the use (coefficient=0.147, p-value=0.032). As for H2, there is a positive relationship between Perceived ease of use (coefficient=0, 266, p-value=0.001). The third hypothesis found a positive relationship between relative advantages and use (coefficient=0.355, p-value=0.000).

Table 2. Factors affecting employee technology usage

Hypothesis	Path	Path Coefficient	p-value	Remarks
H1	PU-U	0,147	0,032	Supported
H2	PEOU-U	0,266	0,001	Supported
H3	RA-U	0,335	0,000	Supported

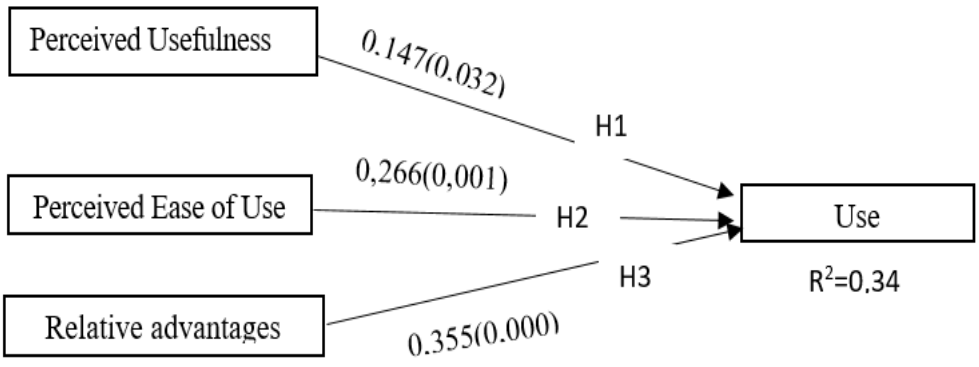

Figure 2. Structural Model

Discussion

Technology adoption is one of the most discussed topics in the information systems literature [53]. Given this background, we surveyed SME employees on the factors encouraging the use of information technology in their everyday work. The study's findings showed that technology usage is positively influenced by perceived usefulness, perceived ease of use, and relative advantages.

The perceived usefulness assumption is fully supported in the literature [42-44]. Consequently, the more valuable an employee perceives a technology, the more likely they will want to use it [43]. In addition to perceived usefulness, perceived ease of use has been identified as a determinant of technology use by SME employees in North KIVU. This hypothesis is consistent with the findings of several other research studies that establish a positive relationship between perceived ease of use and the use of new technology [42-44, 54]. The last hypothesis about the link of relative advantages to computer system use was also confirmed. This is consistent with the findings of [49].

Furthermore, the low R^2(0.34) may be explained by omitting some explanatory constructs from the model. Other constructs can explain technology adoption in addition to the TAM model [55]. Although we have included the relative advantage variable in the model, several other possible explanations exist for adopting new technology. Several additional factors are cited in the literature. [56] identified six more factors to explain technology adoption. These include social influence, technology anxiety, trust, perceived risk, perceived fitness, and resistance to change. Furthermore, [57] mention self-efficacy, subjective norm, pleasure, anxiety, facilitating conditions, social influence, innovation, and satisfaction as key determinants of t new technology usage.

Ultimately, the results revealed three factors - perceived usefulness, perceived ease of use, and relative benefits - influencing technology use among SME employees in Beni, North Kivu. This research helps SMEs in developing as they now know where to focus when adopting new technologies. To use the latest technologies, the employees should consider them beneficial, easy to use, and providing several benefits compared to the systems they replace.

Conclusion

In a country where SMEs are gradually moving towards computerized information systems, understanding the predictive factors of these systems' usage is essential. The present study, conducted in the Democratic Republic of the Congo, was designed to address this issue by examining the factors that predict the utilization of computer-based technologies among SMEs' employees in North Kivu. In developing countries, very few studies address information system issues. This situation is explained mainly by the low level of computerization of businesses in these countries. Our study has consequently been found relevant in the desire to fill this research gap.

We used the expanded TAM model to achieve our goal and collected data from 247 employees selected by the convenience sampling method. The proposed model was tested using the PLS-SEM method. As a result, all hypotheses were confirmed. Perceived usefulness, perceived ease of use, and relative advantages positively influenced employee technology usage. Since employees perceive technology to be valuable and easy to use, they are likely to use it continuously. Beyond these two determinants, employees use technologies more widely if they think they are better than the systems they are meant to replace.

The main theoretical implication of this study is the use of relative advantage as a predictive factor of employee technology

usage. This variable complemented perceived service and perceived ease of use, traditionally used to predict individual and group behavior toward new technologies.

From a practical point of view, these research results can be used by managers of Congolese SMEs in migrating to computer-based information systems. As a result of this study, the managers now better understand the elements that must be emphasized to implement the new technologies successfully. To promote the computerization of SMEs, managers must highlight the system quality to reinforce its perceived usefulness, ease of use, and relative advantages.

In addition to the new evidence and practical implications, this research is subject to some limitations. First, we only identified three determinants predicting further technology usage. Future research may include other variables such as social influence, facilitating conditions, and perceived risk. Moreover, we only surveyed employees in one province of the DRC; hence, the study can be extended to the other twenty-five provinces to identify a general trend across the country.

Conflict of Interest

The author declares no conflict of interest.

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The Impact of Covid 19 on School Administrators' Leadership Attributes in Selected Schools in Jamaica

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Abstract

Principals have been called upon to utilize their personal leadership resources in Jamaican schools during the novel Corona Virus pandemic. This crisis has forced a radical shift in the landscape of school leadership and management not only in Jamaica but globally. The purpose of this descriptive quantitative study was to ascertain the impact of Covid-19 on principals' level of compassion and care, openness and communication, adaptiveness, resilience and courage, consultation and collaboration, empowerment, and decisiveness. Additionally, it sought to assess whether there were differences in these leadership attributes based on school level, region, and gender. A 24-item questionnaire developed and validated by Balasubramanian and Fernandes (2022) and achieved an overall Cronbach Alpha of .84 was used to collect data. The sample included 50 principals and vice principals selected conveniently from the 7 regions 18 completed and returned the questionnaire, 15 females and 3 males. The data were coded and imported into the SPSS, version 27, and were screened, cleaned, and analyzed using weighted means and standard deviations and MANOVA. The mean ranges for interpretation include: 1.00 – 2.33 = Low Attribute; 2.34 – 3.67 = Moderate Attribute and 3.68 – 5.00 = High Attribute. The results showed that the principal participants scored high on leadership attributes. These findings hold critical and practical lessons for handling future crises. They show that effective leaders in many schools can function effectively in a crisis given that the policy makers provide adequate guidance and regulations with a relevant resources.

Keywords: *Adaptiveness, Compassion and care, Consultation and collaboration, Empowerment and Decisiveness, Openness and Communication, Resilience, and Courage.*

Introduction

Personal leadership resources are required in schools during a crisis situation such as the novel Corona Virus pandemic. The Covid-19 pandemic has forced a radical shift in the landscape of school leadership and management globally. This global transition to virtual education is novel, as school leaders are required to shift focus from traditional modalities of teaching and learning to virtual learning modalities [1]. This sudden transition is now called the new normal that educational leaders are forced to influence change in [2-4]. Thus, the roles and responsibilities of educational leaders have forced educational leaders to utilize their personal leadership resources. Key among these resources were compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment, and decisiveness. At the same

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time, most educational leaders are said to lack effective skills in utilizing these resources required to inspire and motivate teachers to use best practices and support professional development necessary in curriculum development and implementation in this environment [5]. With this shift to virtual learning, the need was created for educational leaders to understand their own leadership attitudes towards virtual learning since they are the master implementers of the curriculum shift [6]. Hence, their attitudes will shape the school ecosystem and how they implement the virtual curriculum and impact the learning outcomes. The leadership attitudes of principals are of paramount importance since many have been resistant to instantiating virtual learning because of the perceived additional requirements on the educator as opposed to that of traditional face-to-face instruction [7]. However, Covid-19 has created huge changes to the practices of leaders, the vision they have for education, and the nexus between their supervision of teachers and teachers' views of their leadership effectiveness. These changes mean that in education, it cannot be business as usual. Virtual learning seems to be the new normal. Furthermore, leadership in virtual learning is complex and requires collaboration between leaders and teachers to identify barriers and engage in problem-solving activities to address current and emerging barriers.

The change brought on by Covid-19 has forced the Jamaican government to implement emergency adjustments to curricula and their delivery. Many teachers bemoan the fact that there is inadequate support and resources provided to function in the virtual learning classroom by school leaders. Educational leaders are expected to provide the necessary tools teachers need to adapt traditional learning approaches to cater to all student's needs in a virtual setting [8]. Many teachers are of the view that educational leaders are unable to engage them in capacity-building activities that inspire, influence, motivate and develop their capacity to function in the virtual space. Thus, teachers are at varying levels of adoption and implementation of the virtual learning system in their classrooms. This has contributed to the teachers being stressed and frustrated in the classroom [8]. Thus, effective leadership in virtual learning at all levels of learning environments is even more challenging. Moreso, effective virtual learning has been found to enhance students' learning experiences by overcoming barriers associated with access to resources and support [9]. It is important to identify a leadership model in the literature to benchmark the administrators' e-leadership of virtual learning in their organizations.

This understanding should provide insights into strategies that can be employed to understand the characteristics of effective educational e-leaders. This design will be appropriate to describe effective leaders' characteristics to show the extent to which educational leaders understand their roles as change agents in a technological era. However, the variables will be assessed without manipulation in any form or way. The results from this descriptive research should help policy makers to capture the current conditions of teachers implementing virtual learning and underlying patterns of events. Despite the pivotal role that crisis leadership plays in educational organizations, especially in the wake of Covid-19, there is a scarcity of empirical research in our context. No study was found that examines if differences exist in the influence of demographic characteristics of leaders on their tendency to exhibit leadership traits. Thus, this study contributed to the body of knowledge on this matter.

Related Literature

There is an existing body of global literature on the importance of understanding crisis in the context of education reform, which focuses on economic crisis, natural disasters, and terrorism events [10]. However, international research on

school leaders shows a high level of stress and anxiety brought on by crisis situations [11-13]. School principals were found to be affected by the 'ongoing and evolving nature of the crisis and coped by suppressing these feelings in front of staff and students [13]. Compassion and care are said to provide a sense of togetherness during the Covid-19 crisis. It has been positioned that leaders' ability to cultivate and spread a sense of togetherness among workers is essential during the Covid-19 pandemic [14]. That is, leaders should place emphasis on forging a connection instead of correction [15]. Leaders must take time to listen to employee concerns and demonstrate geniuses of care about employees' well-being mentally, emotionally, and physically through connective decisions [15, 16]. The act of empathy and moving compassionately in the skin of employees is vital during Covid-19 as the tragedy was common during this pandemic [17-18]. When leaders practice these attributes, their policy implementation and decisions are made from an advocacy standpoint [17].

Openness and communication have been found to be essential leadership principle when experiencing a crisis, as it assists in inspiring a shared vision in the organization [15, 19]. It has been posited that regular communication in updating employees in a crisis is pivotal to crisis management and a key responsibility of the leader [16]. It helps the leader in making employees feel comfortable in an uncomfortable situation. The situational context should be permeated with honesty and transparency, factuality, frequency, iterativeness, clarity, and directness through multiple channels [16, 19]. Additionally, adaptiveness is critical to effectively operating in Covid-19 adventure due to the level of uncertainty and turbulence it entails. Therefore, leaders must be agile, continually learning and tweaking their responses according to the context, conditions, and situation [16, 20]. This adaptive mindset is required for effective decision-making and critical thinking, inquiring into new processes, restructuring strategies of action, and understanding the situation at hand [16]. This mindset is required to adopt new paradigms in novel situations.

Additionally, resilience and courage have been found to be highly practiced by effective leaders in a crisis situation. When a leader exhibits resilience, obstacles and temporary setbacks are used to forge new pathways [21]. Under duress, resilient leaders utilize courage; make hard decisions and sacrifices which are needed to protect strategic pathways during a novel crisis [15].

The findings on effective school leaders show that these leaders score high in consultation and collaboration. In a novel crisis, leaders must seek the contributions of others in decision-making [22]. With a complex situation such as the Coronavirus pandemic, inclusive decision-making and stakeholder collaboration is needed to achieve strategic goals [16, 23]. Therefore, leaders must be equipped to share knowledge and expertise [24], gathered from internal and external expert colleagues to make informed decisions [15].

Another attribute that effective leaders scored high on is empowerment which signifies that leaders stimulate the self-motivation of subordinates by motivating them to go beyond the call of duty to perform and contribute to the goals of the organization [25]. To cultivate a sense of empowerment, leaders must add value and seriousness to the contribution made by employees to the decision-making process [26] and facilitate employees' creative ideas as contributors through open discussions [25]. At the same time, a decisive way is crucial in any crisis situation for swift response in leadership. Also, directness, strength, and the ability to adopt a lead-role approach is important [18]. A quick response has been a recognized characteristic of decisive educational leadership during the Covid-19 pandemic. Since decisive leadership does not allow time to source employees' input of ideas, the leader must formulate and communicate well-defined

expectations and influence others to assist, in achieving the established priorities without feeling left out of the decision-making process. Therefore, the decisive leader must be prepared to make rapid, high-impact, hard decisions in scarce information settings based on experience, intuition, consensus, and common sense [15].

With regards to the relationship between demographic characteristics and the leadership attributes of compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment; decisiveness, research findings have shown some interesting findings. In terms of the area in which the schools are located, it was suggested that principals who are aware of local socioeconomic levels act in advance of government assistance, such as its systems of providing vouchers [27]. In relation to the level of the education system that the school is found, many authors suggest that from the onset of a crisis, for example, the Covid-19 crisis, the type of organization or situational context of the school became of significant, with schools making decisions on their approaches based on their local community's needs [27]. For gender, a study found that female leaders received higher trust to lead organizations in times of crisis when the female leader displays high levels of relational behaviors and when uncertainty about the crisis's consequences is minimal [28]. Relational qualities always help restore trust in a company.

The author further suggested that female leaders' relational qualities can aid in the rebuilding of trust in an organization more than male leaders' relational qualities during uncertain times. However, only if the crisis is considered to be predictable, controllable, and with low levels of uncertainty. The findings from research on gender stereotypes reported that in times of crisis, stereotypically "female" traits are given more importance for a leader to possess and that stereotypically "male" traits are less desirable [29].

Materials and Methods

The sample of the study included 50 principals and vice principals selected conveniently from the 7 regions that schools are divided into in Jamaica. Out of 50 participants, 18 (36%) completed and returned the questionnaire. Of the 18 participants, there were 15 (83.3%) females, and 3 (16.7%) males. The research was a quantitative approach. The quantitative research approach has been used to assess a myriad of issues in education as a scientific and systematic process that collects data in numerical form to make sense of the complexity of issues [31].

This approach was appropriate to study and understand the impact of Covid-19 on school administrators' leadership effectiveness of virtual learning in an empirical manner. Thus, it will entail the collection and analysis of numerical data with the use of mathematical, statistical tools [32]. A quantitative approach was ideal to describe the variables in a numerical way.

The collected data were analyzed using quantitative statistical tools. The data were coded and imported into the SPSS, version 27. The data were screened, cleaned then analyzed. Descriptive statistics were computed to illustrate the characteristics of the sample and show the spread of the data. Weighted means and standard deviations were computed to ascertain principals' level of compassion and care, openness and communication, adaptiveness, resilience and courage, consultation and collaboration, empowerment, and decisiveness.

The mean ranges for interpretation include: 1.00 – 2.33 = Low Attribute; 2.34 – 3.67 = Moderate Attribute, and 3.68 – 5.00 = High Attribute. Mean, and standard deviation were appropriate statistics as they offer an objective measure of participants' opinions and gives a basis for comparison of participants' perceptions.

Results

Research Question 1

What are principals' levels of compassion and care; openness and communication, adaptiveness; resilience and courage; consultation and collaboration; empowerment and decisiveness during Covid-19?

Analysis – Impact of Covid 19 on School Administrators' Leadership Attributes

The data in table one show that the principal participants exhibited high leadership attributes during the Covid-19 pandemic while implementing virtual learning. For compassion and care the responses were: (M = 3.93; SD = 0.47). Also, for: openness and communication the responses were thus: (M = 4.64; SD = 0.49); adaptiveness (M = 4.54; SD = 0.54); resilience and courage (M = 4.51; SD = 0.64); consultation and collaboration (M = 4.44; SD = 0.71); empowerment (M = 4.06; SD = 0.84), and decisiveness (M = 4.29; SD = 0.71).

Table 1 shows that the principal participants exhibited high leadership attributes during the Covid-19 pandemic while implementing virtual learning.

Table 1. Descriptive Statistics

Leadership Attributes	Mean	Std. Deviation	Interpretation
Compassion and care	3.93	0.47	High Compassion and care
Openness and communication	4.64	0.49	High Openness and communication
Adaptiveness	4.54	0.54	High Adaptiveness
Resilience and Courage	4.51	0.64	High Resilience and Courage
Consultation and Collaboration	4.41	0.71	High Consultation and Collaboration
Empowerment	4.06	0.84	High Empowerment
Decisiveness	4.29	0.71	High Decisiveness
Valid N (listwise)	-	-	-

Research Question 2

Are there significant differences in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment and decisiveness) based on region?

$H_0$1: There are no statistically significant differences in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment and decisiveness) based on region.

Analysis – Principal Leadership Attributes Based on Region

The results from the statistical analysis showed that there are statistically significant differences in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment; decisiveness) based on region. The multivariate main effect of region on the combined dependent attitude variables was statistically significant, F (7, 5) = 366.795, p = .000, Pillai's 'trace = .000, partial eta square, η^2_p = .998. The observed power was 1 (see Table 2).

Table 2 shows there are statistically significant differences in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment; decisiveness) based on region. The multivariate main effect of region on the combined dependent attitude variables was statistically significant.

Table 2. Multivariate Tests

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Powerd
Intercept	Pillai's Trace	.998	366.795b	7.000	5.000	.000	.998	2567.568	1.000
	Wilks' Lambda	.002	366.795b	7.000	5.000	.000	.998	2567.568	1.000
	Hotelling's Trace	513.514	366.795b	7.000	5.000	.000	.998	2567.568	1.000
	Roy's Largest Root	513.514	366.795b	7.000	5.000	.000	.998	2567.568	1.000
Region	Pillai's Trace	3.371	1.832	42.000	60.000	.016	.562	76.955	.990
	Wilks' Lambda	.001	2.512	42.000	26.904	.007	.712	66.616	.872
	Hotelling's Trace	28.591	2.269	42.000	20.000	.026	.827	95.304	.938
	Roy's Largest Root	16.529	23.613c	7.000	10.000	.000	.943	165.291	1.000
a. Design: Intercept + Region									
b. Exact statistic									
c. The statistic is an upper bound on F that yields a lower bound on the significance level.									
d. Computed using alpha = .05									

The statistical multivariate main effect created the need for a separate assessment of the univariate effects. However, Levene's test was first done to evaluate the homogeneity of variance of each dependent variable. The results of the Levene's test showed that the equal variance assumption was violated for compassion and care (p = .020); openness and communication (p = .004); adaptiveness (p = .011); resilience and courage (p = .059); consultation and collaboration (p = .021); empowerment (p = .011); decisiveness (p = .037), as shown in Table 3).

Table 3 shows the results of the Levene's test showed that the equal variance assumption was violated for compassion and care (p = .020); openness and communication (p = .004); adaptiveness (p = .011); resilience and courage (p = .059); consultation and collaboration (p = .021); empowerment (p = .011); decisiveness (p = .037).

Table 3. Levene's Test of Equality of Error Variancesa

	F	df1	df2	Sig.
Compassion and care	4.161	6	11	.020
Openness and communication	6.576	6	11	.004
Adaptiveness	4.990	6	11	.011
Resilience and Courage	2.918	6	11	.059
Consultation and Collaboration	4.112	6	11	.021
Empowerment	5.000	6	11	.011
Decisiveness	3.411	6	11	.037
Tests the null hypothesis that the error variance of the dependent variable is equal across groups				
a. Design: Intercept + Region				

The univariate main effects were evaluated via the output from the Tests of Between-Subjects Effects analysis (see appendix A). When multiple univariate tests are conducted, Bonferroni adjustment of the significance level is applied to reduce the likelihood of Type 1 error.

Hence the significance level of 0.0125 was applied to leadership attributes as influenced by Covid-19. Since the assumption of homogeneity of variance assumption was violated in the case-dependent variables, an even stricter significance level of .001 was adopted.

Significant values of age group were found only on the dependent variables of compassion and care; openness and communication; adaptiveness; resilience and courage, with significant values of (p = .010; < 0.0125), (p = .015; < 0.0125); (p = .011; < 0.0125) and (p = .010; < 0.0125), respectively.

Results

The null hypothesis 1 was rejected as the statistical analysis showed that there was a difference in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment; decisiveness) among regions of principals at the primary institutions in Jamaica. The univariate result showed significant values of the region only on the dependent variables of challenges of compassion and care; openness and communication; adaptiveness; resilience and courage.

Research Question 3

Are there significant differences in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and

courage; consultation and collaboration; empowerment and decisiveness) based on the school level?

$H_0$2: There is no statistically significant differences in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment and decisiveness) based on the school level.

Analysis – Principal Leadership Attributes Based on School Level

The results from the statistical analysis showed that there are no statistically significant differences in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment; decisiveness) based on the school level. The multivariate main effect of school level on the combined dependent attitude variables was not statistically significant, F (7, 9) = .688, p = .760, Pillai's 'trace = .000, partial eta square, η^2_p = .325. The observed power was .276 (see Table 4).

Table 4 shows that there are no statistically significant differences in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment; decisiveness) based on the school level.

Results

The researcher failed to reject the null hypothesis 2 as the statistical analysis showed that there is no difference in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment; decisiveness) based on school levels of principals at the primary and secondary institutions in Jamaica. Thus, there was no need for a separate assessment of the univariate effects.

Research Question 4

Is there significant differences in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment and decisiveness) based on gender?

H_0 3: There are no statistically significant differences in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment and decisiveness) based on gender.

Analysis – Principals' Leadership Attributes Based on Gender

The results from the statistical analysis showed that there is no statistically significant differences in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment; decisiveness) based on gender. The multivariate main effect of gender on the combined dependent attitude variables was not statistically significant, F (7, 1.034^b) = .420, p = .465, partial eta square, η^2_p = .420. The observed power was .255 (See Table 5).

Table 5 shows that there are no statistically significant differences in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment; decisiveness) based on gender.

Table 4. Multivariate Tests

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Powerd
Intercept	Pillai's Trace	.992	166.640b	7.000	9.000	.000	.992	1166.480	1.000
	Wilks' Lambda	.008	166.640b	7.000	9.000	.000	.992	1166.480	1.000
	Hotelling's Trace	129.609	166.640b	7.000	9.000	.000	.992	1166.480	1.000
	Roy's Largest Root	129.609	166.640b	7.000	9.000	.000	.992	1166.480	1.000
Schoolelevel	Pillai's Trace	.650	.688	14.000	20.000	.760	.325	9.638	.276
	Wilks' Lambda	.448	.634b	14.000	18.000	.804	.330	8.879	.244
	Hotelling's Trace	1.010	.577	14.000	16.000	.846	.335	8.076	.212
	Roy's Largest Root	.690	.986c	7.000	10.000	.491	.408	6.902	.244
a. Design: Intercept + Schoolelevel									
b. Exact statistic									
c. The statistic is an upper bound on F that yields a lower bound on the significance level.									
d. Computed using alpha = .05									

Table 5. Multivariate Tests

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Intercept	Pillai's Trace	.994	239.540[b]	7.000	10.000	.000	.994	1676.782	1.000
	Wilks' Lambda	.006	239.540[b]	7.000	10.000	.000	.994	1676.782	1.000
	Hotelling's Trace	167.678	239.540[b]	7.000	10.000	.000	.994	1676.782	1.000
	Roy's Largest Root	167.678	239.540[b]	7.000	10.000	.000	.994	1676.782	1.000
Gender	Pillai's Trace	.420	1.034[b]	7.000	10.000	.465	.420	7.239	.255
	Wilks' Lambda	.580	1.034[b]	7.000	10.000	.465	.420	7.239	.255
	Hotelling's Trace	.724	1.034[b]	7.000	10.000	.465	.420	7.239	.255
	Roy's Largest Root	.724	1.034[b]	7.000	10.000	.465	.420	7.239	.255
a. Design: Intercept + Gender									
b. Exact statistic									
c. Computed using alpha = .05									

Results

The researcher failed to reject the null hypothesis2 as the statistical analysis showed that there is no difference in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment; decisiveness) based on the gender of principals at the primary and secondary institutions in Jamaica. Thus, there was no need for a separate assessment of the univariate effects.

Discussion

It was found that the principal participants showed high leadership attributes during the Covid-19 pandemic while implementing virtual learning. It showed that for compassion and care the responses were (M = 3.93; SD = 0.47). Compassion and care are said to provide a sense of togetherness during the Covid-19 crisis. It has been posited that leaders' ability to cultivate and spread a sense of togetherness among workers is essential during the Covid-19 pandemic [14]. That is, leaders should place emphasis on forging a connection instead of correction [15]. Leaders must take time to listen to employee concerns, and demonstrate geniuses of care about employee's well-being mentally, emotionally, and physically through connective decisions [15, 16]. The act of empathy and moving compassionately in the skin of employees is vital during Covid-19 as the tragedy was common during this pandemic [17-18]. When leaders practice these attributes, their policy implementation and decisions are made from an advocacy standpoint [14].

Also, it was found that for openness and communication, the responses were (M = 4.64; SD = 0.49). Communication has been found to be an essential leadership principle when experiencing a crisis as it assists in inspiring a shared vision in the organization [15, 19]. It has been shared those regular communication by updating of employees in a crisis is pivotal to crisis management and a key responsibility of the leader [16]. It helps the leader in making employees feel comfortable in an uncomfortable situation. Through multiple channels, the situational context should be permeated with honesty and transparency, factuality, frequency, iterativeness, clarity and directness [16, 19]. Additionally, adaptiveness attracted responses thus: (M = 4.54; SD = 0.54). Operating in the Covid-19 adventure demanded adaptive leadership due to a sense of uncertainty and turbulence it entails. Therefore, leaders must be agile, continually learning and tweaking their responses according to the context, conditions, and situation [16, 20]. This adaptive mindset is required for effective decision-making and critical thinking, inquiring into new processes, restructuring strategies of action, and understanding the situation at hand [16]. This mindset is required to adopt new paradigms in novel situations.

Additionally, resilience and courage were found to be highly practiced by leaders (M = 4.51; SD = 0.64). When a leader exhibits resilience, obstacles and temporary setbacks used to forge new pathways [21]. Under duress, resilient leaders utilize courage, and make hard decisions and sacrifices which are needed to protect strategic pathways during a novel crisis [15].

The results also that leaders score high in consultation and collaboration (M = 4.44; SD = 0.71). In a novel, crisis leaders must seek the contributions of others in decision-making [22], which a complex situation such as the Coronavirus pandemic in inclusive decision-making and stakeholder collaboration to achieve strategic goals [16, 23]. Therefore, leaders must be equipped to share knowledge and expertise [24] gathered from internal and external expert colleagues to make informed decisions [15].

Another attribute that the leaders scored high in was empowerment (M = 4.06; SD = 0.84). This signifies that leaders stimulate the self-motivation of subordinates by motivating them

to go beyond the call of duty to perform and contribute to the goals of the organization [25]. To cultivate a sense of empowerment, leaders must add value and seriousness to the contribution made by employees to the decision-making process [26] and facilitate employees' creative ideas as contributors through open discussions [26].

At the same time, decisiveness scores high as a leadership attribute exercised by the administrators (M = 4.29; SD = 0.71). In any crisis situation, timing is critical for swift response in leadership. Also, directness, strength, and the ability adopt a lead-role approach is important [18]. A quick response has been a recognized characteristic of decisive educational leadership during the Covid-19 pandemic. Since decisive leadership does not allow time to source employees' input of ideas, the leader must formulate and communicate well-defined expectations and influence others to assist in achieving the established priorities with feeling left out of the decision-making process. Therefore, the decisive leader must be prepared to take rapid, high-impact, hard decisions in scarce information settings based on experience, intuition, consensus, and common sense [15].

The results further showed that there was a difference in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment; decisiveness) among regions of principals at the primary institutions in Jamaica. The univariate result showed significant values of the region on the dependent variable of compassion and care; openness and communication; adaptiveness; resilience and courage. Similarly, it was suggested that principals who are aware of local socioeconomic levels act in advance of government assistance, such as its systems of providing vouchers [27]. Thus, for those students who were in need of meals instead of vouchers to, all students who would normally receive lunch through the PATH programme, not just those previously benefited.

The results showed that there is no difference in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment; decisiveness) based on school levels of principals at the primary and secondary institutions in Jamaica. Contrary to these results, many authors believe that from the onset of the Covid-19 crisis, the type of organization or situational context of the school became of significance, with schools making decisions on their approaches based on their local community's needs [27].

The results of this study showed that there is no difference in the scores of the composite dependent variable (compassion and care; openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment; decisiveness) based on the gender of principals at the primary and secondary institutions in Jamaica. However, unlike this study, another study conducted found that female leaders received higher trust to lead organizations in times of crisis when the female leader displays high levels of relational behaviors and when uncertainty about the crisis's consequences is minimal [28].

Relational qualities always help restore trust in a company. The author further suggested that female leaders' relational qualities can aid in the rebuilding of trust in an organization more than male leaders' relational qualities during uncertain times. However, only if the crisis is considered to be predictable, controllable, and with low levels of uncertainty. Findings from research on gender stereotypes reported that in times of crisis, stereotypically "female" traits are given more importance for a leader to possess and that stereotypically "male" traits are less desirable [29].

Conclusion

Overall, the findings of this analysis of the impact of Covid-19 on school leaders' leadership show that the leaders exhibit the attributes at high levels from policy and situational levels; from making abrupt decisions to collaboration and care during the sudden changes in curriculum development and implementation. School leaders were operating under immense pressure during this crisis management process [33] in an environment which as unconducive to effectively exhibit personal leadership resources in carrying policy directives and satisfy students and staff needs through communication, consultation and measured deliberative decision-making. The results showed that the principal participants scored high on the leadership attributes of compassion and care, openness and communication; adaptiveness; resilience and courage; consultation and collaboration; empowerment; decisiveness during the Covid-19 pandemic. These findings hold critical and practical lessons for handling the future crisis. It showed that there are effective leaders in the education system that can function in a crisis once the government provides adequate guidance and regulations with a relevant resource. An important lesson from the findings of this study is that a well-coordinated system of consulting with school leaders on urgent matters of leadership with timely information can ensure that the effects of any future crisis will be minimal. This would afford school leaders to make informed decisions in the nest interest of their schools and students, based on current.

Conflict of Interest

The researcher is a vice principal who has been trained in crisis management.

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Covid-19 Vaccine Hesitancy in Northern Nigeria

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Abstract

The rapid development of the Covid-19 vaccine candidates through new and improved technologies and the rapidity with which these vaccine candidates were trialed and approved for public administration was highly commendable. However, the rapid administration of the Covid-19 vaccines raises a lot of concern among various world populations. This concern, relating directly to the safety and intents of the big pharmaceutical companies and governments, has led to the greatest form of health promotion initiative resistance in recorded human history. The universal level of hesitancy against the Covid-19 vaccines is now a subject of major concern among public health experts. This study which seeks to identify factors fostering Covid-19 vaccine hesitancy was conducted among the COVID-19 vaccine hesitant populations in Northern Nigeria. Findings from this study indicate that 84% of the study population makes use of the internet and other social media platforms for their news information sources. 42% of the study population would follow the guidance of their healthcare workers on issues relating to the Covid-19 vaccines. Covid-19 vaccine hesitancy in Northern Nigeria is largely fostered by a lack of appropriate information and a huge knowledge gap about the Covid-19 vaccines. It is, therefore, imperative that Government engages the young people of Northern Nigeria as critical stakeholders in the fight against Covid-19 vaccine hesitancy. Proper and tailored health educational programs, and meaningful engagements of religious leaders, parents, and healthcare workers in health promotion activities can help overcome the current challenge of Covid-19 vaccine hesitancy in Northern Nigeria.

Keywords: *Covid-19, Healthcare Workers, Immunization, Vaccine, Northern Nigeria, Vaccine Hesitancy.*

Introduction

The Covid-19 global pandemic has alerted the entire world to the poor state of the global public health emergency preparedness and readiness to combating emerging diseases [1]. While some parts of the world are gradually recovering from the devastating impacts of the Covid-19 global pandemic, other nations are still reeling and grossly embattled with the multi-variants of the SARS-CoV-2 infections. Yet, in the face of a common human enemy potent enough to cause devastating health and economic effects at a global level, there also was found a common and unified global resolve to defeating this enemy [2]. The rapid transmission rate and case fatalities associated with the SAR-CoV-2 infection created a global panic, and the pandemonium that ensues in a bid to curbing the spread of this infection has invariably led to a massive downturn in the global economy. There are now increasing records of Long Covid (LC) (long-term effects of Covid-19 infections) and increasing reports of mental health challenges directly relating to the after-effects of the Covid-19 lockdowns and movement/travel restrictions [3, 4].

The global resolve to defeat this common enemy led to the rapid exchange of scientific information during the lockdowns and travel

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restrictions. Real-time research findings were rapidly disseminated among researchers, and published papers in journals were readily and openly accessed on the internet. Research pre-prints were also made rapidly available for the ease of knowledge exchange among the global scientific body. These cross-cutting collaborations and cooperation led to the rapid development of vaccine candidates using new and advanced scientific technologies [2]. These vaccine candidates were rapidly trialed at various clinical and population-based settings, and rapid approvals were given for their administration at population levels. While the rapidity with which these Covid-19 vaccine candidates were given approvals for public administration raises lots of questions regarding safety and the intentions of the big pharmaceutical companies and governments, evidence has shown the many beneficial effects of these vaccines [5]. In addition, despite the inequitable distribution of the Covid-19 vaccines, the COVAX Initiative, through the efforts of the GAVI Alliance, has ensured that all nations of the world are able to get certain doses of the Covid-19 vaccines. Most African countries, especially the Sub-Saharan African (SSA) nations, have been disproportionately affected in these global inequities [6].

While the challenge of inequitable distribution exists in SSA, a greater challenge that has been recorded globally now borders on Covid-19 Vaccine Hesitancy, thus, the availability of the Covid-19 vaccine does not transmit into its acceptance among populations. The wave of social misinformation and disinformation and the politicization of vaccine science as regards the Covid-19 vaccines has led us back to an old but familiar challenge of vaccine hesitancy [7]. The pockets of vaccine hesitancy that have been recorded throughout human history have now reached an alarming rate in the 21st century [7]. Africa, and indeed Nigeria, has always battled with the challenge of vaccine hesitancy among its teeming population. The rejection of the Polio vaccine in Northern Nigeria and the protracted efforts it has taken the Nigerian Government to fighting poliomyelitis among its Northern population is a testament to this hesitancy [8]. The hesitancy towards the Covid-19 vaccine has, however surpassed the polio vaccine resistance. The Covid-19 vaccine hesitancy now cuts across all social demographics and religious inclines in Nigeria. The few available Covid-19 vaccines are now getting expired, with only a few members of the population accepting to take the vaccines [9]. This challenge is closely associated with the gross mistrust that the people have in the Nigerian Government. While studies have shown that some members of the population do not believe in the existence of Covid-19, some studies have also indicated the need for better education on the subject of Covid-19 vaccination among the population [10]. This study seeks to identify the factors fostering Covid-19 vaccine hesitancy among the population of Northern Nigeria. It is hoped that a thorough understanding of these factors will help inform the implementation science approaches to be employed at reaching the Covid-19 vaccine hesitant population in Northern Nigeria.

Theoretical Framework

Vaccine hesitancy in Northern Nigeria is not new as this part of the country has always battled with the acceptance of vaccines. Lived experience with experimented vaccines trialed by a global pharmaceutical company, that eventually led to the death of several children in Northern Nigeria always comes up whenever a new vaccine is being introduced to this part of the country. The hesitancy against the Covid-19 vaccines in Northern Nigeria is therefore not a surprise as the people are always ready to relay the facts of their past experience. Studies from Northern Nigeria have all indicated a marked level of hesitancy on the part of the Northern Nigerian population to accepting the Covid-19 vaccines [8, 10]. *Objective of Study:* The objective of this study is to identify the factors influencing Covid-19 vaccine hesitancy among

the Covid-19 vaccine hesitant population of Northern Nigeria. *Problem Statement:* Despite the availability of the Covid-19 vaccines, a large number of the population in Northern Nigeria are hesitant to take the Covid-19 vaccines. *Research Question:* What are the factors influencing Covid-19 vaccine hesitancy among the Covid-19 vaccine hesitant population in Northern Nigeria?

Materials and Methods

Study Site and Population

This study is a clustered, and a randomized cross-sectional survey among the population of three (3) states in the three (3) geo-political zones of Northern Nigeria. The geo-political zones are North-East, North-West, and North-Central, respectively. The study was conducted between the months of January 2022 to April 2022 at the three mega cities of Yola, Kano, and Jos, respectively. The target population were Nigerian citizens of 18 years of age and above. While participation in the survey was voluntary and consensual, the semi-structured questionnaire was randomly administered to presenting and consenting individuals who have not taken the Covid-19 vaccine and who affirms their unwillingness to take the vaccine. Trained volunteers who helped in the administration of the questionnaires also helped in bridging the language barrier encountered by a few of the study participants who could not speak fluent English.

Sample Size Determination

The sample size for this study was determined using the Online *"Creative Research Systems®"* (CRS) sample size calculator at 99% Confidence Level (CL). The structured questionnaire was administered to randomly presenting, willing, and consensual participants.

Measures and Data Collection

The semi-structured questionnaire administered was designed into three key sections. The first section captured basic information on social demographics such as age, gender, religion, ethnicity, education, and employment status. The second section captures information on the perceived risks of contracting the Covid-19 infection, and this centers around the marital status of individual participants means of transportation, housing type, quality of food, observance of Covid-19 Infection Prevention and Control Measures (IPCMs), and family sizes. The third section asks questions about the drivers of Covid-19 vaccine hesitancy, including sources of information, Knowledge about the Covid-19 vaccine, future willingness to take the Covid-19 vaccine, history of vaccination, and the individual influencers of the Covid-19 vaccine uptake. The questionnaire was piloted with 100 participants who were later excluded from the study. The essence of this pilot study was to test the simplicity of the tool and to validate the use of the study questionnaire.

Data Analysis

Data collected in this study were analyzed with simple descriptive statistics, ANOVA, and the Pearson Correlation and Regression Analysis using the Excel Data Analysis Tool Pack. All collected data were securely kept in an encrypted format and duly archived in a backup folder.

Ethical Considerations

Participation in this study was totally consensual and voluntary, with Informed Consent sought only from the participants. All participants gave both verbal and written consent or thumb print before participating in this study. All information given are treated with confidentiality and complete anonymity. As the questionnaire contains simple, non-invasive measurements and questions dealing with basic demographics and social characteristics relating to Covid-19 Vaccine Hesitancy, and because this study focuses more strategically on the vaccine-hesitant population, there was no need for information or responses that could be linked to any participant.

Results

Because verbal and written consent was sought by the trained volunteers from the study participants, all respondents answered the questions in the questionnaire. The painstaking efforts of the Study Volunteers to ensure that all fields of the questionnaire were answered reflect in the successful administration of 500 hundred questionnaires at each of the three geo-political zones in Northern Nigeria. A total of 1,500 questionnaires were administered in Northern Nigeria as it regards this study.

Basic Social Demographics

Table 1. Gender Distribution among the Study Participants

Male	Female
860 (57%)	640 (43%)

From the total 1,500 participants in this study, 57% (n=860) were males, while 43% (n=640) were females. The statistical analysis of gender in relation to Covid-19 vaccine hesitancy reveals a perfect negative correlation (r=-1), with a p-value =1 at a 95% Confidence Level (CL). With F stat (0) < F crit (9.6), it is thus concluded that gender has no significant relationship with Covid-19 vaccine hesitancy in Northern Nigeria.

Table 2. Age Distribution of the Study Participants (Years)

18-24 Yrs	25-31 Yrs	32-38 Yrs	39-45 Yrs	46-52 Yrs	>53 Yrs
370 (25%)	470 (31%)	340 (23%)	110 (7%)	120 (8%)	90 (6%)

The data above reveals a majority of the Covid-19 vaccine hesitant population in Northern Nigeria are young adults and middle-aged individuals between 18 to 38 years (79%). At the same time, the statistical analysis gives a p-value =1, with an F stat (0) < F crit (3.7), the correlation analysis (r=0.78) gives a very strong positive correlation between age and Covid-19 vaccine hesitancy in Northern Nigeria.

Table 3. Religions of the Study Participants

Christianity	Islam	Traditional Religion	Others
840 (56%)	638 (42.5%)	20 (1.3%)	2 (0.2%)

Religion plays a major role in Nigerian society. Hence, a total of 98.8% of the study participants actively practice one form of religion or the other. The statistical analysis of collected data reveals an F stat (0) < F crit (4.3) with a p-value =1. This shows that the relationship between religion and Covid-19 vaccine hesitancy is not statistically significant. However, a correlation value of r=0.90 shows a very strong positive correlation between religion and Covid-19 vaccine hesitancy in Northern Nigeria.

Table 4. Educational Levels of the Study Participants

Primary	Secondary	Tertiary	No Education
60 (4%)	270 (18%)	1150 (77%)	20 (1%)

A majority of the study participants had tertiary education (77%), with only 1% (n=20) of the study population who did not have any form of educational training. The majority of the study participants (n=1,480) have had one form of education or the other. The statistical analysis

reveals no significant relationship between education and Covid-19 vaccine hesitancy (p-value=1); however, the correlation analysis reveals a perfect positive relationship (r=1) between education and Covid-19 vaccine hesitancy in Northern Nigeria. This clearly indicates that academic education and Covid-19 vaccine hesitancy are akin to each other, especially in Northern Nigeria.

Table 5. Nature of Employment of the Study Participants

Government	Private/Business	NGO	Farming	Student
440 (29.3%)	440 (29.3%)	80 (5.3%)	100 (6.7%)	440 (29.3%)

The majority of the participants in this study tend to be evenly spread in their employment endeavors. Government civil servants, those in private and self-managed businesses, and students all have an equal distribution of 29.3% each. Participants in farming practices were 6.7% (n=100), while participants working with Non-Governmental Organizations (NGOs) represent 5.3% (=80) respectively.

Perceived Risks of Contracting Covid-19

Table 6. Marital Status of the Study Participants

Married	Single
670 (44.7%)	830 (55.3%)

While the marital status of individuals can be used to assess the perception of risk, especially in relation to the Covid-19 pandemic, this parameter has, however had no impact on the Covid-19 vaccine hesitant population in this study. From the total of 1,500 participants, 55.3% (n=830) were single and yet to be married, while 44.7% (n=670) were already married. The narrow margin between these two populations could be an indicator of the lack of any major significance between marital status and Covid-19 vaccine hesitancy in Northern Nigeria.

Table 7. Personal Means of Transportation of the Study of Participants

Yes	No
520 (35%)	980 (65%)

The above table shows that 65% (n=980) of the study population not having a personal means of transportation but rather relying on public means of transportation. Commuting by public means on each day of the week is a potential source of exposure to the Covid-19 infection. With many citizens and members of the population not adhering to the Covid-19 IPCMs, commuting through public means remains an active source of risk and a means through which the SARS-CoV-2 can be contracted.

Table 8. Housing types of the Study Participants

Personally Built Housing	Family Housing	Rented Apartments
350 (23%)	730 (49%)	420 (28%)

The data presented in the table above reveals 49% (n=730) of the study participants lived in communal or family houses. Family houses usually consist of members of the extended

family. The congestive nature of family or compound houses makes for the easy spread of the SARS-CoV-2 infection, especially in places where the Covid-19 IPCMs are not observed. While communal living is a way of life that is well encouraged in most parts of Africa, and in Nigeria in particular, this poses a risk for major infectious disease transmissions among family members.

Table 9. Negative Impacts of the Economic Downturn on the Quality of Food Available to the Study Participants

Yes	No
1160 (77%)	340 (23%)

Nutrition remains an integral component of maintaining good health and well-being. To fight diseases and other infectious agents, the body needs to have built enough immunity that can only be acquired through good nutrition or through immunization. With the emergence of Covid-19 in late 2019, the world has witnessed a tremendous economic downturn, which has affected all countries, families, and individuals. 77% (n=1,160) of the study population indicates that the current spate of the economic downturn has affected their nutritional status. This is because their individual abilities to purchase good nutritive food has grossly diminished. Poor nutrition invariably leads to poor or low levels of immunity, and this remains a very strong predisposing factor to easily contracting the SARS-CoV-2 infection.

Table 10. Family Sizes Distribution among the Study Participants

1-3 Members	4-6 Members	7-9 Members	>9 Members
390 (26%)	560 (37%)	360 (24%)	190 (13%)

With the communal nature of living in Northern Nigeria, it is no surprise that the average family size at this part of Nigeria ranges between 4 to 6 children. A staggering 61% (n=920) of the study population live in families of between 4 to 9 members. At the same time, 26% (n=390) live in families of three minimum members. In addition, 13% (n=190) of the study population lives in families with greater than 9 family members. It is important to note that the more members of families living in a single house, the higher the chances of contracting the SARS-CoV-2 infection.

Table 11. Observance of Covid-19 IPCMs among the Study Population

Yes	No
1170 (78%)	330 (22%)

It is of note that while the 1,500 participants in this study are a cohort of the Covid-19 vaccine hesitant populations in Nigeria, a majority of this population are very diligent at observing the Nigerian Government laid down Covid-19 IPCMs. 78% (n=1,170) of the study population observes the Covid-19 IPCMs, while 22% (n=330) remain adamant and not adhering to the Covid-19 IPCMs as instructed by the Government. It is also important to note that a handful of this population believes that Covid-19 is a hoax of the Government that further impoverish the population.

Drivers of Covid-19 Vaccine Hesitancy

Table 12. Sources of Information

Radio	Television	Internet/Social Media Platforms
470 (31%)	640 (43%)	1260 (84%)

While information remains key to human survival currently and age, the persistent wave of misinformation and disinformation in the 21st century is now a cause for concern. From this study, 84% (n=1,260) of the participants relies on the use of the internet and other social media platforms for their information sources. With the advent of mobile phones and other hand-held devices, people now prefer to get their information in real time and on the go. While 31% (n=470) and 43% (n=640) of the study participants still listen to traditional radio and television stations to get news information, a majority (84%) of the study population do not rely solely on these traditional channels to get information. The statistical analysis of this data reveals a very strong Positive correlation (r=0.89) between sources of information and Covid-19 vaccine hesitancy. While this relationship is not perfect, a calculated p-value=0.94 also shows that there is no significant relationship between sources of information and Covid-19 vaccine hesitancy among the study population.

Table 13. Participants Need for more Knowledge about the Covid-19 Vaccine

Yes	No
1320 (88%)	180 (12%)

The analyzed data from this study, as shown in Table 13 (above) reveals a staggering 88% (n=1,320) of the study population do not have adequate Knowledge about the Covid-19 vaccine. This data reveals a major knowledge gap between the Government of Nigeria, the Covid-19 program implementers, and the Nigerian population. Only 12% (n=180) of the study population seems to have adequate Knowledge about the Covid-19 vaccines. The statistical analysis of this data shows a perfect negative correlation (r=-1) between Covid-19 vaccine knowledge and Covid-19 vaccine hesitancy. Thus, this indicates that the lesser the level of Knowledge of people about the Covid-19 vaccines, the higher the chances of hesitancy. With a calculated p-value=0.04 [F stat (23.12) > F crit (18.51)], and at a CL of 95%, there is a significant positive relationship between the level of Knowledge about the Covid-19 vaccines and Covid-19 vaccine hesitancy in Northern Nigeria.

Table 14. History of Vaccination among the Study Participants

Yes	No
770 (51%)	730 (49%)

From the 1,500 participants in this study, 51% (n=770) have had a history of vaccination, while 49% (n=730) had no history of ever taking a vaccine. The correlation analysis reveals a perfect negative association (r=-1) between previous vaccination history and Covid-19 vaccine hesitancy. This clearly indicates that the lower the history of vaccine uptake, the higher the chances of not accepting the Covid-19 vaccine. A further ANOVA of the collected data gave a p-value=0.79, which indicates that there is no statistical significance between a history of vaccination and Covid-19 vaccine hesitancy.

Table 15. Willingness among the Study Participants to take the Covid-19 Vaccine only if recommended by any of the Followings

Imam	Pastor	Community Leader	Parents	Friends	Healthcare Workers	Teacher	Boss	Partner
220	230	70	430	80	630	40	30	150
(14.7%)	(15.3%)	(4.7%)	(28.7%)	(5.3%)	(42%)	(2.7%)	(2%)	(10%)

The data presented in Table 15, reveals three major influencers of Covid-19 vaccine uptake among the Covid-19 vaccine hesitant population in Northern Nigeria. Religious leaders have 30% (n=450) influence on the hesitant population, while parents have a 28.7% (n=430) influence on their wards. Healthcare Workers (HCWs), however have a staggering 42% (n=630) influence at convincing the Covid-19 vaccine hesitant populations to accept the Covid-19 vaccines. The statistical analysis of the primary data reveals a perfect negative correlation (r=-1) between the influences of religious leaders and parents on Covid-19 vaccine uptake. This clearly indicates that the higher the level of motivation to accept the Covid-19 vaccine from religious leaders and parents, the lower the level of hesitancy. Further analysis of the collected data however shows a perfect positive correlation (r=1) between the influences of HCWs on the Covid-19 vaccine-hesitant population in this study. This correlation data portends that the higher the level of engagement of HCWs at educating the Covid-19 vaccine hesitant population on the need to take up the Covid-19 vaccines, the higher will be the level of acceptance among the hesitant population.

Discussion

The deleterious impacts of the global Covid-19 lockdowns on routine immunizations and the global Covid-19 vaccine hesitancy challenges are well documented across all regions of the world [11-14]. Findings from this study has revealed some critical Covid-19 implementation science gaps in Northern Nigeria. While the Government of Nigeria and other national and international donor/funding agencies are making efforts to mitigate the impacts of the Covid-19 global pandemic on the Nigerian population, it is also imperative that our approaches and methods at reaching the population be well-guided. Data from this study has shown a well-defined age group, among which the possibility for Covid-19 vaccine hesitancy is much higher (18-38 years). Younger to middle-aged adults who are mostly unmarried or single and who mostly live in extended family houses have higher chances of being hesitant to the Covid-19 vaccine uptake in Northern Nigeria.

It can be seen from this study that a majority (84%) of the population of Northern Nigeria gets their news information from the internet and other social media platforms. The advent of mobile phones and other hand-held devices has made possible the availability of new information on the go. Studies have shown that many citizens in Northern Nigeria do not believe that Covid-19 exists [10], and many more believe that Covid-19 is a government hoax at further deceiving the population [15]. While much has been published about the disinformation created by some religious leaders, fake news information, political distrust in leadership, and the failure of some parents to permit their wards to take the Covid-19 vaccines [16-18], findings in this study has highlighted the need to bridge the Covid-19 vaccine knowledge gap found among 88% of the study population. Many have heard about Covid-19, yet, they still do not have an understanding on how the Covid-19 vaccines were developed and how these could be rapidly approved for public administration without ill intentions on the part of governments. Many skeptics among the Covid-19 vaccine hesitant population exists, but

this skepticism is akin to the inadequate Knowledge about the Covid-19 vaccine currently prevalent among the population. In view of the findings from this study, however, much needs to be done at better educate the population on subjects relating to the Covid-19 vaccines. In addition, with the protracted history of vaccine hesitancy in Northern Nigeria [19, 20], and the gross disconnect between political leaders and the citizens, the Government of Nigeria needs to do more in a bid to ease this strained relationship between the leaderships and their followers. Neglecting the place of trust in governance could also account for vaccine apathy as currently being witnessed with the Covid-19 vaccine hesitancy in Northern Nigeria [21]. With distrust in what the Government has to say comes the quest for answers from other sources. However, in the absence of adequate self-efficacy and the inability to assess the right digital or online information, people can be easily misinformed [22]. In a survey study conducted in the Philippines and Malaysia, online information seeking was found to be one of the factors negatively impacting confidence in the Covid-19 vaccines [14].

This study has revealed a critical gap relating to the influence of the Nigerian HCWs on the Covid-19 vaccine hesitant population. There is a perfect positive correlation between the influence of HCWs and Covid-19 vaccine hesitancy. Many Covid-19 vaccine hesitant populations (42%) are waiting for their respective HCWs to educate and convince them on the need to accept the Covid-19 vaccines. Several global studies and reviews have corroborated the findings in this study, thus, showing the powerful influence of HCWs on healthcare seekers and their ability to use their prime positions to convince the population to accept the Covid-19 vaccines [23-26]. 30% of the participants in this study agreed that they would follow the guidance of their religious leaders. This puts religion and religious leaders in a prime position of influence when it comes to the acceptance of the Covid-19 vaccine among the populations of Northern Nigeria. Religion plays a vital role in the lives of the citizens of Nigeria as it affects all facets of social, political, and economic life. In a cross-sectional survey on Covid-19 vaccine confidence and hesitancy in the Philippines and Malaysia, religion was found as one of the factors negatively impacting confidence in the Covid-19 vaccine uptake [14].

The influence of parents on their wards regarding decision-making cannot be overemphasized. Despite the adult population involved in this study, a surprising 28.7% of the study participants indicated that their decision to take the Covid-19 vaccines is dependent upon the guidance of their parents. This strong influence of parents on vaccine uptake by their wards have been supported by findings from several other studies at different parts of the world (27-30].

Many studies and literature have suggested ways to overcome the present wave of Covid-19 vaccine hesitancy among the population [31, 32]. However, it is imperative that informed and well-tailored strategies be employed to overcome the present challenge facing the nation and in effect, the global community. Findings from this study clearly agree with the findings from other researchers in the country on the need to device strategic implementation science approaches to combating the current challenge [33, 34]. The Nigerian Government and its health promotion agencies need to do more to reach out to the population through all means of news and information dissemination. Emphases now need to be placed on the use of the internet and other social media platforms to reach the Nigerian population with news information. Social media platforms and groups now need to be meaningfully engaged with health promotion discourses surrounding Covid-19 testing and vaccinations. Due to the lack of adequate information about the development of the Covid-19 vaccines, 88% of the study participants seek for better information through various online and social media platforms. The misinformation and conspiracy theories peddling on these social

media and online platforms, however, further confuse the choices and decisions of individuals regarding the Covid-19 vaccines. With low self-efficacy at assessing and identifying the right information, the individual is discouraged from accepting the Covid-19 vaccine. The dilemma created, however, opens the opportunity for the HCWs to help guide and convince the Covid-19 hesitant individual to accept the Covid-19 vaccines. Thus, accepting the Covid-19 vaccines in Northern Nigeria is largely dependent on the level of self-efficacy of the individual at identifying the right information about the Covid-19 vaccines and the influencing power of HCWs.

Strengths of the Study

This study was conducted at the three geo-political zones of Northern Nigeria, with three mega cities selected for this study due to cost implications. One (1) mega city was selected from each of the three (3) geo-political zones. While several studies have been conducted on various topics relating to Covid-19 in some parts of Northern Nigeria, this is the first study to be conducted among clusters of Covid-19 vaccine-hesitant populations in Northern Nigeria. This study also identifies, very specifically, factors influencing Covid-19 vaccine hesitancy among the population of Northern Nigeria. A much larger study on Covid-19 vaccine Hesitancy in Northern will be needed to cover all the states in Northern Nigeria. Such a study will further help to firmly establish the findings in this study.

Conclusion

While not neglecting the traditional use of radio and television stations, the young population of Northern Nigeria now needs to be actively engaged as critical stakeholders in the dissemination of information surrounding Covid-19 health promotions. Religious leaders and parents need to be actively engaged on topics relating to the Covid-19 vaccines. Adequate education and the engagement of religious leaders and parents as critical stakeholders in the well-being of their followers and wards will further strengthen the good intention of the Government at assuring good health for all its citizens. HCWs at all levels need to be well-educated on subjects relating to Covid-19, including Covid-19 vaccinations. Because studies have shown the lack of motivation and drive on the part of HCWs to accept the Covid-19 vaccines [35, 36], it is imperative that HCWs in Northern Nigeria become aware of their status as critical stakeholders in the current efforts aimed at ensuring that Nigeria attains a safe level of herd immunity against the SARS-CoV-2 infection. All HCWs should be actively engaged in continuous Covid-19 education exercises and certification programs. With 42% of the Covid-19 vaccine-hesitant population in Northern Nigeria relying on their HCWs to guide them on issues relating to the Covid-19 vaccines, it is most urgent that the Government of Nigeria, through the Federal Ministry of Health (FMoH) and its allied agencies, organize training programs and webinars aimed at further educating its health workforce on the subject of Covid-19 and other related subjects. When the population, the religious leaders, parents, and HCWs are well equipped through proper education on subjects surrounding health promotions, including Covid-19 related topics, it is obvious from this study that only then can we foster a society devoid of misconceptions about the safety of the Covid-19 vaccines.

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Declaration

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Conflict of Interest

The author declares no conflict of interest.

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Access to Finance: The Determinants and Limitations to the Supply Side of Finance for Liberia's Rural Market

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Abstract

This critical piece of research paper reviews the literature on the key determinants of finance for Liberia's rural market. It also takes into account the limitations of the supply of finance for the rural market of Liberia, with the unabated need for the diversification of the Liberian economy in the face of intermittent shocks in the global economy. The study unearthed that investment in agricultural small and medium-sized enterprises (SMEs) will prove adequate in triggering sustainable economic growth and development through poverty alleviation, job creation, and food security which are the drivers of the supply of finance for rural dwellers in Liberia. Notwithstanding, the study found that the supply of finance for Liberian agricultural SMEs is constrained by the lack of creditworthiness information, weak judicial enforcement of contracts and corporate transparency, land ownership, high non-performing loans, and financial literacy. The keywords used in this article include gross domestic product, small and medium-sized enterprises, non-performing loans, inflation, credit rating, bankruptcy, value chain, urbanization, food security, human capital, and risk aversion.

Keywords: *Bankruptcy, Credit rating, Human capital, Inflation, Small and medium-sized enterprises, Value chain.*

Introduction

Liberia is the least developed country found in Sub-Saharan Africa, which country suffered virtually three decades of civil conflict and the outbreak of two deadly global pandemics, which include the Ebola virus and Covid-19, with cross-cutting catastrophic consequences. Worst of all, the country is confronted with widespread poverty, pervasive corruption, and food insecurity. With financial inclusion being proven to be very effective in promoting sustainable economic development through inclusive growth and income equality, the Government of Liberia, through the Central Bank of Liberia, adopted a national financial inclusion strategy aimed at ensuring the accessibility of financial services to all segments of the Liberian society. With funding from the International Fund for Agricultural Development (IFAD) and technical support from Afriland Bank, the Central Bank of Liberia has established twelve (12) rural community financial institutions in eight (8) of the fifteen (15) counties of Liberia. However, the supply of finance for the rural market in Liberia is constrained by the interplay of several factors. Prominent amongst these include no creditworthiness information, a high rate of non-performing loans, weak enforcement of judicial contracts, and low financial literacy among rural dwellers. The Central Bank of Liberia needs to strengthen the capacity of the newly established credit bureau in order to effectively assess the credit risks of borrowers and track the credit ratings and history of borrowers. This will reduce adverse selection and moral hazards that give rise to the occurrence of non-performing loans. The availability of credit history/ ratings of borrowers will also aid commercial banks in expanding credit to the rural populace. The Government of Liberia should strengthen the

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judiciary system to ensure that the commercial courts become effective in adjudicating cases related to loan defaults. Furthermore, the Central Bank of Liberia should see it as a priority to provide robust financial literacy training opportunities for those in the rural financial market of Liberia. With much objectivity, the most effective antidote to address these constraints is ensuring a functional credit bureau for evaluating and tracking the credit history of borrowers. The major limitation to the achievement of the financial inclusion strategy is limited financial support for the full implementation of the strategy to spread financial services to the rural poor. The Central Bank of Liberia has made some strides toward the achievement of its objectives related to the national financial inclusion strategy by establishing a credit bureau. The overarching objective of this study is to identify the determinants and limitations to the supply side of finance for Liberia's rural market and proffer solutions to harness those determinants that are not working with the implementation of the national financial inclusion strategy by the Central Bank of Liberia. Furthermore, this paper contributes to the literature on rural finance in driving sustainable economic development in developing countries. This paper is structured into three cardinal parts: section one encompasses the background, section two covers the literature review, which underpins the study, and section three concludes the study. Financial inclusion is a concept of novelty in Liberia. Though there are rural community financial institutions in Liberia, there are no research studies conducted regarding the assessment of the performance of these institutions. Further research is needed to be conducted to explore this area of the rural finance market in Liberia.

Background

With the compelling need for the diversification of the Liberian economy as a result of global shocks which continue to affect the country's traditional exports such as diamond, iron ore, and palm oil, a shift to robust nationwide agricultural activities to diversify the country's economic base will suffice in boosting the country's Gross Domestic Product (GDP) and creating job opportunities for the youthful population that constitutes over 65% of Liberia's population as evidenced by the 2008 National Population & Census Report.

Financial inclusion could ideally be harnessed in this context to propel this envisioned economic transformation. It is no doubt to assert that the improvement of financial inclusion in Liberia has the potential to concretize the resilience of the Liberian economy against external shocks by supporting economic diversification through a private sector-led development approach which will expand credit options and risk sharing between enterprises and households. The Agenda for Transformation (AfT), which is now being supplanted by the Pro-Poor Agenda for Prosperity and Development (PAPD), Liberia's medium development strategy envisioned access to financial services as a paramount driver for private sector development, job creation, and gender equality [1].

In spite of the implementation of the national financial inclusion strategy (NFIS) by the Central Bank of Liberia (CBL) through the use of the Mobile Money platform and the creation of rural community financial institutions, the population of Liberia from age 15 and above with no bank accounts is still significant. This means that a huge portion of Liberia's populace is found outside of the formal banking sector. In 2011, the percentage of Liberians aged 15 and above with bank accounts, including Mobile Money alone or in conjunction with someone else, was 14.68%. The percentage increased in 2017 to 28.16% and further increased to 44.2% in 2021 [2].

Ironically, financial institutions, such as commercial banks which are mainly needed to channel financial services to the rural population, have limited physical presence across the country. From a broader context, the

limited presence of commercial banks across the fifteen counties of Liberia is principally accounted for by factors such as low profitability for the last several years, poor asset quality, weak lender protection, lack of money market, poor infrastructure, weak communication, and difficult land registration scheme [1].

The year 2020 was marred by uncertainty in the global economy, which was basically due to the Covid-19 pandemic, which led to the shrinkage in investment and business levels. This was also compounded by trade tension between two world superpowers: USA and China as well as the post-Brexit developments that occurred in the Euro Zone [3]. Notwithstanding, with the dwindling effect of Covid-19 in 2021, the global economy changed to a positive outlook due to the recovery from the pandemic. Global economic growth was projected at 4.3 percent in advanced economies, 6.3 percent in emerging and developing economies, and 3.2 percent in sub-Sahara Africa largely on the expectation of containment of the pandemic and other recovery-supported policies. Similarly, from the angle of inflation, at the end of 2021, inflation in advanced economies was projected at 1.3 percent, while in emerging markets and developing economies, it is projected at 4.2 percent [3].

On the domestic front, the economy of Liberia was projected to contract further by 3.0 percent from a contraction of 2.5 percent recorded in 2019. The deteriorating conditions in the tertiary sector, coupled with the uncertainty of the Covid-19 pandemic, induced a downward trend in the Liberian economy and is currently exacerbated by Russia's invasion of Ukraine a major food basket of the world. At the end of 2019, the country's inflation rate was reduced to 13.1 percent due to the monetary stability of the exchange rate and favorable prices of oil. Liberia's 2021 economic outlook seems to be positive, with an estimated growth rate of 3.2 predicated upon activities in both manufacturing and the service industry that make up of small and medium-sized enterprises, and inflation is estimated to reduce to a single digit based on the sustenance of the CBL rigid monetary policy reform [3]. In the face of Liberia's rebound from the effect of Covid-19, ubiquitous poverty lingers in Liberia at an increasing rate. It was reported in 2016 that an estimated 44% of Liberians were living on less than $2 dollars a day, and this projection was anticipated to attain 52 percent in 2021 [4]. With Liberia's current focus on achieving sustainable development and growth, with agriculture and manufacturing being pivotal to the country's economic growth, there is a heavy reliance on the private sector, which predominantly comprises small and medium-sized enterprises (SMEs) with 112,532 taxpayers as of 2020 [5] to stimulate the anticipated growth level. Paradoxically, SMEs in Liberia are confronted with challenges such as weak managerial capabilities, an unskilled workforce, fragmented markets, limited diversification, limited access to capital and credit, and limited market information [6].

Pillar two of the Pro-Poor Agenda for Prosperity and Development (PAPD), which is the National Development Plan of Liberia, articulates a call for the need to increase productivity via value chain intervention with a focus on agricultural production and marketing. This seeks to improve access to finance for SMEs as a long-term strategy for alleviating poverty and food insecurity. Without a doubt, investment in agriculture for SMEs, poverty alleviation for rural populations, and food security are the principal drivers of the supply of finance for the rural market in Liberia [6].

Literature Review

Theoretical Literature Review on Determinants and Limitations to the Supply Side of finance for Liberia's Rural Market

The Determinants of the Supply of Finance for Liberia's Rural Market

An enormous number of SMEs in Liberia are found in the agricultural sector. These

businesses continue to serve as engines for Liberia's economic growth through the provision of job opportunities, poverty reduction, and food security. What remains paradoxical for these SMEs is that they are mainly faced with capital and credit constraints to unlock their growth and expansion. These capital and credit constraints affect the supply side of rural finance in terms of outreach, penetration, infrastructure, accessibility, technology, and financial literacy.

Outreach

Financial institutions in Liberia are grappling with reputational risk regarding customer service. Many banks in Liberia, if not all, are popularly rated for having poor customer service. With the advent and institutionalization of the financial inclusion strategy in Liberia, there are no adequate visible outreach activities or programs to educate the rural population about the availability of rural finance. It is indicated by [7-9] that with the use of outreach programs, banks or financial institutions are able to provide the needed knowledge and information to resolve or simplify the qualms of consumers. By that, these financial institutions can become effective in the involvement of the rural market in financial inclusion. In the same vein, [10] carried out several studies that focused on the indicators of outreach that are integral to financial inclusion. With a similar focus, [11] drew an inference that banks' lending models are faced with huge challenges stemming from outreach. As such, it becomes a hypothesis that there is a nexus between outreach and financial inclusion.

Penetration

An important aspect of the supply of financial services in the eyes of financial inclusion is the term penetration. This term suggests the deepness to which the bank can provide financial services and products to the populace. This profundity can be measured or determined by demographic, cultural as well as other factors that inhibit the flow of finance. In their respective studies, [12] and [13] formed a linkage between the economic growth of a nation to the financial inclusion of rural households. They further acknowledged that penetration is a key determinant of financial inclusion. [11] examined and noted the various forms of financial inclusion predicated upon the different levels of penetration. In a nutshell, penetration is measured by the extent to which the supply of financial services is adequate to meet the needs of households. One of the main indicators of financial inclusion is the segment of the population from 15 years and above with bank accounts, including Mobile Money, exclusively or in conjunction with someone else. Liberia has a low score (44.2%) as of 2021when it comes to meeting this indicator. The achievement of the overall objective of financial inclusion through the supply side of finance to the rural market will remain elusive if the emphasis is mainly placed on the accessibility of financial services rather than their adequacy.

Availability

The financial inclusion ecosystem of Liberia continues to be challenged by poor public and private investments in the area of infrastructure, including roads, communication channels, technology, and electricity. It is proven that the accessibility or the lack of proper structure for supplying financial products and services to every individual is the fundamental factor for the creation of financial inclusion or exclusion. In order to identify and address the access and barriers to financial inclusion, [12] conducted a study that observed that financial exclusion results from the lack of financial products for some sections of the population. Consequently, it is hypothesized that the availability of financial products and services is an important aspect of financial inclusion. [13-15] all developed an index of financial inclusion with the usage of availability as a measurement of financial inclusion.

Accessibility

Liberia's financial landscape is not well developed as commercial banks are disproportionately dispersed across Liberia so do the rural community financial institutions. For commercial banks, their limited presence is mainly due to low profitability, weak lender protection, poor infrastructure, poor asset quality, and more [1]. [7], viewed the term accessibility as the combination of physical aspects such as the distance to bank branches, ATMs, and necessary documentation, among many others. From the perspective of a developing country, [19] found that access to affordable banking services and innovation can lead to total financial inclusion. Similarly, the obtainment of financial services validates inclusion [20], and [13] opined that access to financial services enables individuals economically. In the eyes of financial inclusion, accessibility is the convenience and ease of using the available banking services. Broadly speaking, there are always products and services that are available to consumers. However, every service is not accessible. This is due to a variety of reasons unique to different groups of consumers.

Technology

With the continuous advancement in global technology aimed at revolutionizing business processes, time minimization, cost reduction, and improved products and services, the banking technologies for Liberia's rural market are still lagging behind other banking sectors in sub-Saharan Africa. As a consequence, traditional baking is still heavily practiced in rural Liberia. Though the Central Bank has introduced Mobile Money and other digital financial services, the impact on rural baking is minimal. The technology aspect of financial inclusion encompasses innovative technologies in the banking sector, like internet banking and mobile banking. The improvement of financial inclusion is seen as being heavily dependent on these new technologies [14]. Obviously, [21] found that the advent of social media has a huge impact on access to and use of financial services. [22] proposed the use of technology as a result of its potential to make available financial services in remote areas. [23, 24] in their studies, identified technology as an important and positively influential factor of financial inclusion.

Financial Literacy

A significant portion of the rural dwellers in Liberia lacks financial literacy due to limited training opportunities to hone their financial management skills to either manage their personal or business finance. This gap is negatively impacting their ability to develop competitive loan proposals. This impinges on their ability to access finance. By definition, financial literacy is the dimension to which households and individuals are educated or informed of the knowledge and skills needed to manage finances and make informed financial decisions. [14] revealed that financial literacy is a key determining factor for financial inclusion and exclusion. On the other hand, [25] inferred that financial literacy is not as important as its utilization. A similar study conducted by [24, 26; 27] pointed out that financial attitude, financial behavior, and financial knowledge define the level of financial literacy, which then determines financial inclusion.

The Limitations to the Supply side of finance for Rural Markets

Limitations to the supply side of rural finance form an integral part of many financial theoretical and empirical pieces of literature. In this article, a few of these works of literature have been considered.

These important pieces of literature attributed the limitations to the supply of finance for the rural market to low levels of education, skills training, and experience, demographic aging, imperfect information, uncertainty, and risk aversion, limited access to land and capital as well as occupation/residential choice paradigm [28-30].

Low Levels of Education, Skills Training

It is generally believed that labor in rural markets in developing and least developed countries is to a greater extent, made up of non-skilled labor, which is being provided by those possessing a diminutive degree of formal education or vocational training which falls beneath the national threshold with huge dissimilitude in relation to setting characterized by urbanization. Frankly speaking, a dismal agricultural output coupled with choices regarding types of work is spurred by poor skills, which often results in low wages and salaries and fluctuations in employment activities. With respect to entry into the non-farm economy, education is a key factor. [29, 31-37] indicated that education being represented by knowledge and skills are favorably and greatly linked to the involvement in rural non-agricultural wage employment. Also, [38-40] argued that this reduces participation in activities centered around agriculture. This suggests that the ability of the workforce to assume non-farm-related activities is limited by low employable skills.

Empirical evidence indicates that during the period of transition in economies, the movement of labor declined more than anticipated. This drew the attention of [34] to dwell on the significance of structural constraints involving the inter-sectorial labor movement in Slovenia and inferred that the strictness in labor supply results from the poor educational accomplishment of farm holders. This causes a similarly uncompetitive situation in the off-farm labor market.

[41] theorized that broad and specialized education, as well as vocational training along with experience from a job, influence the movement and cost allocation of labor. According to [42], this characterizes a great hurdle to the movement of labor and to well-organized labor allocation. Those shifting from agriculture and seeking alternative employment opportunities are faced with hindrances arising from insufficient human capital which fails to provide the needed skilled labor. According to studies carried out by [43], unemployment lingers amongst workers found in the lowest education and skills brackets of the workforce. This comes as a consequence of their inability to access different jobs.

Demographic Aging

It is accentuated the aging of the population as a drawback for rural settings [44]. Demographic aging miniaturizes the future provision of labor and employment levels of the working population. This gives rise to slow economic development and reduces output. Another key factor that exacerbates this situation is the movement of skilled workers to the cities to pursue better opportunities. With agriculture being the major source of employment for rural dwellers, the shifting of skilled workers through urbanization leaves the sector with few workforce and limited skills with predominantly old folks. The resultant effect has been poor labor allocation in relation to agricultural activities, thus causing destitution with respect to human capital when considering other sectors of the economy [30].

Imperfect Information

[45] found that the inability of labor to move and unemployment is caused by the lack of perfect information regarding the location and presence of employment opportunities. The field of agriculture involves huge costs related to the search for employment, and the varying demand for labor in the context of farm-related production creates unpredictability surrounding the acquisition of wage labor [31]. It is very salient to emphasize that the financial structure of any economy is largely dependent on adequate sharing of information across lenders and borrowers in the loan market. Informational disequilibrium creates binding constraints for the supply of finance. Informational frictions create challenges to the delineation between high- and low-quality investment projects which makes investment decisions difficult. Investments that are heavily private

informational-based have a riskier nature. They often result in internal finance constraints due to disequilibrium and threaten the existence of the loan market owing to the issues of adverse selection, which gives rise to moral hazards. As a result, agents who have projects characterized by the likelihood of great feat become victims of the challenges of underinvestment due to credit rationing amongst loan seekers. The allocation of investment in an economy with private information is not optimal. This leads to a slow pace in the growth of an economy with imperfect information than one with full information.

Uncertainty and Risk Aversion

Economic theory notes that the choices farmers make to allocate their labor are premised on the desire to increase their utility. This pushes them to segment their supply of labor into on-farm- and non-farm activities in a way that ensures equilibrium for marginal returns on all activities. For risk-averse farmers, limited time is apportioned to activities that are characterized by more risks with the same returns. This suggests that farmers will prefer working in areas with small risks and lower wages [46]. The absence of perfect insurance against risk engenders a major limitation for rural households since the means to reduce differences in production plans are underdeveloped [47]. [48] points out that with suitable access to risk insurance, rural households are likely to withhold innovation, avoiding the espousal of innovative activities or the extension of new ones. From another perspective, poorer farmers tend to supplant higher probable yields, related to greater risks, with safer investments [45].

Limited Access to Land and Capital

One of the outstanding challenges that continue to adversely affect the supply side of rural finance for rural markets is limited access to land which is compounded by the lack of capacity to access credit. This constrains farmers' ability to invest in technology and equipment and their modernization [49]. Moreover, this inability affects farmers when it comes to investing in start-up business ventures and other off-farm activities that produce inflows [46].

The Limitations to the Supply Side of finance for Liberia's Rural Market

With specificity, the below factors contribute to the limitation of the supply side of rural finance in Liberia in general.

No Creditworthiness Information

Historically, Liberia had never had credit rating agencies since its existence dating from 1822. By that, for lenders, there is virtually no creditworthiness information available due to the lack of a comprehensive database for borrowers' credit history. The credit bureau established by the Central Bank of Liberia (CBL) is in the process of upgrading the credit reference system. With the coming effect of the national identification system, it is highly likely that this will add value to the modernization of the credit reference system for Liberia [50].

Weak Enforcement of Judicial Contract and Corporate Transparency

Sadly, pervasive corruption in Liberia has undermined the judicial system with a cross-cut devastating effect. Judicial contract enforcement and corporate transparency are weak, resulting in poor protection of lenders. As of 2020, Liberia scored 35.2% in enforcing contracts as compared to Ghana, Sierra Leone, Kenya, and Rwanda, with scores of 54%,55.9%, 58.9%, and 69.1%, respectively [51].

The High NPL Rate Combined with Liberia's Weak Insolvency Scheme

The Central of Liberia (CBL) annual reports over the last five years have pointed to high non-performance loans (NPLs) ratio to total loans. Particularly, the CBL 2021 annual report cited that the financial sector of Liberia remains challenged by rising in non-performing loans (NPLs), with NPLs ratio to total loans increasing

from 21.17 percent in 2020 to 22.41 in 2021. Notably, the high NPL rate combined with Liberia's weak insolvency scheme weighs on the balance sheet of banks, making lending more difficult and non-inclusive. These factors make catering to smaller, less publicly known operators, such as households and MSMEs, riskier.

Land Ownership

For many years, land rights and ownership became a source of conflict and in extreme cases, resulted in the loss of lives amongst contending parties. However, in recent years, the establishment of the Land Authority has created clear mechanisms to avoid and mitigate conflicts associated with land ownership. Currently, land ownership rights are not well defined under the current law, and there is a very limited secondary market for land and real estate, partly because non-citizens (notably the Lebanese and Indian minorities who are very active in the business) cannot own real estate. Furthermore, all privately held land plots in Liberia are not mapped and registered in the immovable property registry, and there is no legal system that requires verification of the identity of the parties to a property transaction [52].

Poor Corporate Transparency

The general public perception of corporate transparency is very poor, and the recovery rate at the time of bankruptcy is very low. The CBL is being perceived as not providing the public and the markets with all relevant information on its strategy, assessments, and policy decisions as well as its procedures in an open, clear, and timely manner [1].

Low Financial Literacy

The ability to understand and make use of a variety of financial skills, including personal financial management, budgeting, and investing, is crucial. Also, the ability to comprehend financial principles and concepts, such as the time value of money, compound interest, managing debt, and financial planning, can boost one's capacity to access finance through the presentation of a convincing business plan. In Liberia, financial literacy is generally low, and individuals and SMEs have limited capacity to prepare good business plans and convincing investment opportunities [1].

Research Method

The method used for this study is searching for the literature on rural finance. A systematic review was carried out. To ensure that this study is informed by sufficient theoretical underpinning, several books, theses, journals, articles, and reports related to the determinants and supply side of rural finance were sought, gathered, and thoroughly reviewed by the author. Moreover, an interview was held with the Manager of the rural community financial institution in Sanniquellie as a representation of key stakeholders of the rural community financial institutions of Liberia. Also, the author's personal knowledge and observations regarding the trend of rural finance in Liberia were utilized as sources of information in the development of this article. The outcome of these reviews, interviews, personal knowledge, and observations formed the core basis for the literature review and findings of this study. This study was carried out in Liberia with a specific focus on the rural setting.

Results

The results/findings from the study through a systematic literature review are presented under two major classifications:

1. Determinants for the supply of finance for Liberia's rural market- The study found that the supply of finance for Liberia's rural market is majorly influenced by the following:
   a) Outreach,
   b) Penetration,
   c) Availability,
   d) Accessibility,
   e) Technology and,
   f) Financial literacy.

2. Limitations to the supply side of finance for Liberia's rural market-The study established that the limitations to the supply side of finance for the rural market of Liberia include:
    a) Lack of creditworthiness information,
    b) Weak Enforcement of Judicial contract,
    c) High NPL rate combined with Liberia's weak insolvency scheme,
    d) Land ownership,
    e) Poor Corporate transparency,
    f) Low financial literacy.

Discussion

Notably, the combination of various factors, including outreach, penetration, availability, accessibility, technology, and financial literacy, make up the determinants of finance for the rural market of Liberia. Since the inception of the national financial inclusion strategy by the Central Bank of Liberia, which is fundamentally meant to make financial services accessible to all segments of Liberia society with much affordability and convenience, there has not been adequate visibility of outreach programs across the country to educate and sensitize the populace regarding the accessibility of financial services. This has rendered a certain portion of citizens, especially the rural population, incapable of obtaining the needed financial services to suit their needs. The provision of financial services has not fully penetrated all nooks and crannies of Liberia. The country covers 38,000 square miles with fifteen (15) political sub-divisions and a population of about 5 million. Currently, there are only twelve (12) rural community financial institutions found in only eight of the fifteen counties. This disproportionate distribution of the rural community financial institutions speaks volumes of the lack of penetration of financial services in rural Liberia. The level to which financial services are needed to be readily available remains another daunting situation in Liberia. The availability of financial services does not commiserate with the needs of the populace. The infrastructure for the ecosystem of financial inclusion should provide accessibility to reduce the time and costs associated with accessing finance. The case for Liberia is antithetical or opposite. People seeking financial services, especially the rural populace, are constrained to travel longer distances with bad topography, which involves long hours and huge costs. The overall technological landscape for the banking sector is poor. The rural banking sector has not been adequately modernized. These rural financial institutions had not migrated to the use of modern banking technologies. These gaps affect their ability to expand financial services to rural dwellers. Finally, the supply of finance for the rural market of Liberia is being impacted by the level of financial literacy amongst the rural populace. Generally, the rural populace of Liberia lacks the requisite financial literacy when it comes to financial management. This is due to limited training opportunities to hone their capacities to adequately manage their personal and corporate finances to their advantage. Admittedly, these determinants for the supply of finance for the rural market of Liberia are not working effectively. Policy actions are needed to harness these determinants for the effective and efficient flow of financial services to the rural populace of Liberia.

It is important to divulge that the lack of creditworthiness information, weak enforcement of a judicial contract, high non-performing loans rate combined with Liberia's weak insolvency scheme, land ownership, poor corporate transparency, and low financial literacy play a contributory role to the limitations to the supply side of finance for Liberia's rural market. Firstly, Liberia has been struggling for many years to establish credit rating institutions that assess, compile, and store the creditworthiness and history of borrowers and potential borrowers. Though there currently exists a credit bureau at the Central Bank of Liberia, there are no creditworthiness records upon which lending institutions could base their decisions to lend to

those seeking loans. This challenge is adversely affecting the lending capacity of banks. This, in turn affects the supply of finance to the rural market. Secondly, another outstanding disgusting constraint to the flow of financial services to the rural populace in Liberia is the degree of rampant corruption across all sectors of Liberian society. The business environment or financial sector of Liberia is no exception. This had led to a weak judicial system and poor enforcement of contracts in the case of default by a party to a contract. As a result, banks cannot get adequate and timely redress in the default of loans for repayment. This continues to limit banks and other lending organizations from expanding their loan portfolios. Thirdly, the annual reports of the Central Bank of Liberia for the past several years have indicated a persistent increase in the ratio of non-performing loans to the total loan portfolios of commercial banks. The imperfect information that subsists between lenders and borrowers and the inability of lenders to incur the high cost of monitoring the projects of various borrowers gives rise to adverse selection and moral hazards, which subsequently accounts for loan defaults. The resultant effect of this is the use of collateral and credit rationing, which limits the flow of financial services to the rural market. Fourthly, Land ownership still remains a major source of conflict in Liberia, which is affecting the spread of banks across the country, mainly in the rural parts of Liberia. While it is true that the Government of Liberia had made some gains in tackling this through the creation of the Land Authority and the new Land Act that contains mechanisms for land ownership, rights, and conflict resolution, more needs to be done. Persistent fraudulent sales and resale of land as well as tribal conflicts surrounding land, are on the increase in Liberia. In the face of these, commercial banks feel jittery and disinclined to get embroiled in land conflict or fraud, which could cause reputational risk and financial losses for them. Due to this, commercial banks have a limited presence in the rural parts of Liberia. Fifthly, Liberia has a low functional literacy rate. In the midst of this, the Central Bank of Liberia and the commercial banks have not done much to promote corporate transparency regarding their operations, strategies, assessments, and policy decisions. For example, less than a year following the ushering in of the current government, there was a widespread public perception of missing 16 billion Liberia Dollars coupled with a huge liquidity shortage that affected all commercial banks in Liberia and eroded public confidence in the banking sector. The Central Bank and commercial banks did not do well in providing transparent and synchronized information to the public about these situations. Consequently, for fear of bank failure, the public made huge withdrawals from commercial banks and resorted to saving money in their homes. This badly affected the banks and worsened the liquidity crisis in Liberia until the intervention of IMF and USAID through technical support strengthened the financial system of the country, thus restoring public confidence in the banking sector. Lastly, many of the borrowers in the rural parts of Liberia are noted to possess a low level of financial literacy. This impinges on their ability to access sizeable loans needed to support their endeavors aimed at supporting their livelihoods. Specifically, they are unable to develop competitive business plans and loan proposals that will enhance their chances of attracting sizeable loans.

Conclusion

The achievability of sustainable development and economic growth in Liberia greatly hinges on sizable investment in agriculture. In this case, a substantial and unhindered flow of financial services to the country's agricultural SMEs and other segments of the rustic population is the best antidote for driving income-generating activities such as job creation and savings for the rural populace. Incontestably, a boost in agricultural activities through the supply of financial services to the rural market will significantly enhance the country's capacity to

adequately mobilize domestic resources to support the national budget in the sectorial allocation of strategic resources to spur the desired level of national transformation. Interestingly, this endeavor will tackle and alleviate the pervasive degree of poverty and food insecurity that Liberia is currently experiencing. This research paper excavated that investment in agriculture for SMEs, poverty eradication, and food security are the fundamental determinants of the supply of finance for Liberia's rural market. Most importantly, the study concludes that creditworthiness information, weak judicial enforcement of contracts and corporate transparency, land ownership, high non-performing loans, and financial literacy are the principal constraints confronted by the rural market of Liberia in accessing financial services to support their livelihoods. This paper posits that the Government of Liberia, through the Central Bank of Liberia, is incrementally getting on the right trajectory to mend these constraints with the advent of the national financial strategy (NFIS), which was espoused a few years ago. In summation, this paper calls for a more solidified and concerted effort to be exerted by the Government of Liberia and its development partners in strengthening the implementation of the NFIS through the vibrant policy design supported by empirical data to address these challenges head-on aimed at improving the financial ecosystem for the rural dwellers of Liberia which will ineluctably bolster sustainable development and economic growth.

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Conflict of Interest

I write to categorically state that I do not have any personal relationship with any of the editors of the Publishing House. Also, I have no commercial, legal or financial relationship with the publication business involving the Publishing House. I am a bona fide student of Texila American University. As part of the partial requirements for a Ph.D., I am required to publish two articles.

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Assessment of Knowledge about Hygiene during Covid-19 Pandemic in Catchment Area of Kaziba Health Centre

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Abstract

Introduction: Hygiene is an essential element of public health that could reduce transmission of several diseases and their consequences. In Sub-Saharan Africa, water and sanitation-related diseases are highly prevalent, causing illness, disease and even death. The main objective of this study is to assess knowledge about hygiene in context of Covid-19 in catchment area of Kaziba health centre from January to October 2021. Materials and Method: our study was descriptive and prospective cross-sectional. A random sampling was carried out to collect data through survey questionnaire with 384 participants. Data was captured in Excel spreadsheet and imported into SPSS for analysis. Results: 93.2% of households had heard about hygiene. 43.8% of households did not know correct definition of hygiene. 98.4% of households had a toilet within the courtyard which ¾ were traditional. 53.1% of toilets had cleaning material. 72.1% of households washed their hands using soap (50.5%). 68.5% of households did not know the WHO's handwashing technique. 57.3% of households had running water. 61.2% of water well or fountain were protected. 37% of households disposed their wastewater in the public places. More than ¾ of heads of households knew waterborne diseases. Negligence of environmental sanitation was 79.2%. 66.4% of households suffered from poor hygiene-related diseases such as Covid-19 (6.5%). Conclusion: poor of knowledge about hygiene in the population of this catchment area due to the existence of certain diseases related to poor hygiene observed in our results. There is need to increase awareness channels on hygienic practices and environmental sanitation.

Keywords: *Covid-19, Household, Hygiene, health, Kaziba.*

Introduction

Hygiene is an essential element of public health that could reduce the transmission of several diseases and their consequences in the population. In many countries, water, sanitation, and hygiene (WASH)-related infections have a high prevalence, thus causing illness, disease and even death for many people, especially children [1]. Therefore the improvement of hygienic practices is of paramount importance to limit the transmission of diseases related to water and sanitation [1]. Although hygiene can drive the intention to change behavior, it only occurs when people have the appropriate water and sanitation facilities [1].

The sixth sustainable development goal (SDG) is to ensure the availability and sustainable management of water and sanitation for all by 2030, whereas the access to water, sanitation and hygiene remains one of the main challenges of the 21st century [2]. Though some progress made towards achieving universal access to basic water, sanitation, and hygiene services. Between 2016 and 2020, the global picture for water, sanitation and hygiene portrayed an increment from 70% to 74% of global population with safely managed drinking

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water at home, from 47% to 54% of sanitation services and from 67% to 71% of handwashing facilities with soap and water [1]. In 2020, almost 25% world's population lacked safely managed drinking water in their homes and almost 50% world's population lacked safely managed sanitation. There are still billions of people that lack basic services especially in rural places. The statistics depict one in three people do not have access to safe drinking water, two out of five do not have a basic handwashing facility with soap and water, and more than 673 million people still practice open defecation [1]. In the inception of Covid-19 pandemic, 33% of world population could not wash their hands with soap and water within their homes, therefore, this Covid-19 pandemic has resurfaced the substantial importance of WASH for preventing and containing diseases [3].

There are factors that drive water and sanitation crisis in Africa [4]: a) access to water supply and sanitation: the use of sanitation facilities separate human waste from human contact, however, the inaccessibility to safe toilets leads people to opt to open defecation where the human waste is transferred back to people through food and water resources. It has been found that one in four people that openly defecate worldwide live in Sub-Saharan Africa (SSA). The human use of contaminated water and poor sanitary conditions lead to increased vulnerability to waterborne diseases such as diarrhea, cholera, dysentery, typhoid fever, etc. In addition, poor sanitation, and water supply lead to neglected tropical diseases (NTDs) such as trachoma, soil-transmitted helminths, and schistosomiasis, lymphatic filariasis and onchocerciasis. In SSA, more than 25% of the population spend more than half hour per trip to collect water. Almost 115 people die every hour from diseases related to poor sanitation, poor hygiene, and contaminated water. b) Sanitation gap: it is reported that even in SSA countries with high water coverage, 25% of people still lack adequate sanitation in urban settings, yet this situation is worse in rural settings. c) Emergencies and disasters: flood and drought are the main devastating water-related disasters in SSA. Flooding process contaminates drinking water, also destroys hygiene and wastewater systems, meanwhile drought denies people water supplies that cause food insecurity leading to malnutrition which finally cause death. d) Water resources: Africa is the only continent with high population growth rate which drives demand for water yet decreases the availability of water resources. Perpetual armed conflicts in SSA lead to displacement of millions of people within country or across countries. This displacement of people brings challenges-related to WASH for host communities or countries. Surface water is the most reliable source used for more than ⅔ of SSA countries, however, this surface water is highly polluted and not considered safe for drinking. Therefore, the access to sanitation and clean potable water remain minimal for numerous African communities across SSA countries.

The clean water supply and security (water storage, water usage monitoring and water contamination) remain the challenges in many SSA countries [6].

In terms of sanitation, certain risky practices are common in rural areas, for example, 75% of households practice open defecation against only nine percent in urban areas. Elsewhere, only seven percent of rural households use improved latrines against 50% of urban households. However, in rural areas, the water source is not located within the courtyard or near the place of residence as in urban areas where 27% of households report having it in or near their usual home [1].

Current data indicates that the Covid-19 virus is transmitted by respiratory droplets or by contact [6, 7]. Contact transmission occurs when contaminated hands touch the mucous membranes of the mouth, nose or eyes; the virus can also be transferred from one surface to another by contaminated hands, which facilitates transmission by indirect contact [8].

The outbreak of a new respiratory virus, such as Covid-19, is followed by the development of vaccines and treatments, and these may have limited effect in containing or interrupting the complete spread of the Covid-19 virus. It is therefore important to identify and practice public health measures such as hand hygiene to reduce or stop the spread of Covid-19 [9]. Hand hygiene is extremely important to prevent the spread of the Covid-19 virus. It also interrupts the transmission of other viruses and bacteria that cause common cold, flu and pneumonia, thereby reducing the overall disease burden. Despite strong awareness on the importance of hand hygiene in preventing Covid-19 infection, the access to hand hygiene facilities, including alcohol-based hand rubs, as well as soap and water, is often suboptimal in the community and in health facilities, especially in low- and middle-income countries [1, 3].

Hand hygiene and the use of alcohol-based hand rubs are among the preventive measures considered to be very effective with a high level of evidence [10].

According to WHO, "the provision of safe water, for sanitation and hygienic conditions are essential to protect human health during all infectious disease outbreaks, including Covid-19, on the other hand, populations without efficient water, sanitation and hygiene facilities are therefore more vulnerable to contamination by the Covid-19 virus [8]. Hygienic practices and particularly hand washing with soap, constitute an effective barrier to the spread of the Covid-19 virus. However, it is estimated that 40% of the world's population, or three billion people do not have handwashing facilities with soap and water at home [11].

Nowadays, in the Democratic Republic of Congo (DRC), access to water is becoming a persistent problem, insofar as many the local population has no access to drinking water in order to provide for their whole needs [12]. Water is essential for life; however, it can be a source of disease when hygienic measures are not well applied. The low rate of access to drinking water, sanitation and hygiene makes the DRC vulnerable country to several diseases, particularly to Covid-19 and this is the reason why the World Bank is investing in drinking water supply, sanitation, and hygiene services to fight the pandemic [13].

Good hygiene practices are a vital first line of defense against Covid-19 and are at the heart of the World Health Organization public health recommendations [8].

A study noted that hand hygiene and the use of alcohol-based hand rubs are increasingly studied in healthcare settings, however, there are only a few studies on this subject in community settings [14].

Overall, the access to quality water and, adequate sanitary and hygienic conditions allow the prevention of many other waterborne diseases. DRC is an endemic country for cholera and has been facing Ebola epidemic since August 2018 [15]. The fight against the Covid-19 pandemic in the water, sanitation and hygiene sector in the DRC remains substantial.

A study conducted on the compliance with the alcohol-based hand rub solutions showed that the overall compliance rate was 39% for hand hygiene, however the friction with the alcohol-based hand rubs solution is much less frequent (5%) [16]. Washing hands with soap is one of the most crucial measures to prevent the spread of the coronavirus. Infected people can indeed spread the virus on surfaces or by touching other people after coughing or sneezing into their hands. Healthy people can become carriers if they touch contaminated surfaces and then touch their mouth, nose, or eyes [17].

Indeed, all this requires good education of the populations and financial support for the provision and/or construction of sanitary facilities. It is also necessary to strengthen WASH interventions to prevent households from facing the risks generated by the low level of access to WASH [18]. Therefore, communication strategy for behavior change related to hygiene and sanitation will focus on

advocacy, interpersonal communication and mass communication [19].

Towards this deplorable WASH situation, we were embarked to carry out this study to get in-depth knowledge on hygiene in the catchment area of Kaziba health centre, to raise the concerns of these communities in terms of hygiene and to make relevant recommendations that long term hygienic practices for these communities.

The main objective of this study is to assess knowledge about hygiene in the context of Covid-19 in the catchment area of Kaziba health centre from January to October 2021.

The specific objectives were to:

1. Assess the knowledge, attitudes and practices related to hygiene in the population and their socio-demographic characteristics.
2. Assess the status of water and sanitation facilities in the catchment area of Kaziba health centre.
3. Identify the consequences and highlight the main problems related to poor WASH practices.
4. Assess the importance of hygiene practice in the households.

Materials and Methods

Study Setting: this study was carried out at Muchingwa cluster located in the chiefdom of Kaziba, Walungu territory of South Kivu Province, DRC and extended along the road linking Bukavu -Uvira passing through Nyangezi-Ngomo. Muchingwa cluster is made up of six localities (villages) and has a heterogeneous population of 7,163 inhabitants (Source: Kaziba Chiefdom Office, Statistics Report 2020).

Study design and period: a descriptive and prospective cross-sectional study was conducted in Muchingwa cluster from January to October 2021.

Study participants: the heads of household or their representatives were the participants aged from 20 years and above living in the Muchingwa cluster during the data collection period. Exclusion criteria: children, teenagers, people who do not live in Muchingwa cluster.

Sample size calculation and sampling procedures: owing to the total population of Muchingwa cluster (7,163) that is less than 10,000 inhabitants, Schwartz formula $n = Z^*2P(1-P) / i^2$ was used for a definite calculated sample size of 384. A simple random probability sampling was carried out giving each head of household or a representative an equal chance of being chosen.

Study variables: independent variables: socio-demographic characteristics, availability of water and sanitation. Dependent variable: hygiene.

Data collection tools and procedures: data regarding the variables were collected through anonymous in-person survey questionnaire filled out by the heads of households or their representatives. Data were collected by field data collectors who were followed by supervisors. A two-day orientation was given to the field data collectors and supervisors about the objective and the relevance of the study, data collection tools and interaction with the participants. During this process of the data collection, the supervisors and the field data collectors were provided with facemasks and alcohol-based hand rub solutions, and they were guided to comply with public health measures. The survey questionnaire was made of binary option and multiple option questions with either one or many options. The supervisors assessed the consistency and completeness of data daily.

Statistical analysis: Microsoft excel spreadsheets were initially used to capture data then to import into SPSS (version 21). Descriptive statistics was carried out and presented with narration and tabulation.

Ethics approval and consent to participate ethical clearance was obtained from the institutional review board (IRB) of the University of Kaziba. A written informed consent was obtained from each participant before data collection.

Results

Socio-demographic characteristics of the study participants: in this study, a total of 384 participants was involved. There were 57.3% (220) female participants versus 42.7% (164) male participants with 20 – 30 prevailing age group (32%) (See Table 1).

Table 1 shows that the age group between 30 and 30 is the most represented (32%).

Table 1. Age Group of Heads of Households

Age Group (years)	Frequency (n)	Percent (%)
20 - 30	123	32
31 - 40	95	24.7
41 - 50	86	22.4
≥ 51	80	20.8
Total	384	100

Almost ⅔ of participants were married [65.4% (251)], however, 21.9% (84) were single and 12.7% (49) were widowers. More than half (50.5%) of study participants had secondary level (See Table 2).

As can be seen in the Table 2, more than half (50.5%) of heads of households have secondary level of education.

Table 2. Distribution of Educational Level for Participants

Educational Level	Frequency (n)	Percent (%)
Primary Level	67	17.4
Secondary Level	194	50.5
College or University Level	72	18.8
No Formal Education	51	13.3
Total	384	100

Looking at the main activity of the heads of households, many participants were farmers (27.3%), followed by the businessperson (22.9%) as it can be seen in Table 3.

Table 3 portrays that farming (27.3%) is the most activity for the heads of households follow by business (22.9%).

Table 3. Distribution of Main Activity of Heads of Household for Participants

Activity of Household Head	Frequency (n)	Percent (%)
Civic Servant	81	21.1
Transporter	7	1.8
Businessperson	88	22.9
Technician	28	7.3
Farmer	105	27.3
Unemployed	69	18
Others	6	1.6
Total	384	100

When it comes to the awareness of hygiene, almost all household (93.2%) had already heard about the hygiene [93.2% (358) vs. 6.8% (6.8%)]. There were 43.8% participants who

defined hygiene as a set of measures to make something clean as presented in Table 4.

Regarding the latrine/toilet, almost all household (98.4%) had a latrine/toilet within the courtyard [98.4% (378) vs. 6% (1.6%)]. There were three types of latrine/toilet at the study setting, among those three types, the traditional or dry latrine/toilet covered ¾ (291) while modern toilet without running water were 17.4% (67) and modern with running water were 6.8% (26). Regarding the toilet with sewage disposal system, there were 45.8% (176) that had septic tank whereas 54.2% (208) had no septic tank. There were 53.1% (204) toilets that had cleaning material yet 46.9% (180) had not. It was found that 72.1% of heads of households had the habit of washing their hands after using the toilet or eating foods, or from a walk [72.1% (277) vs. 27.9% (107)]. More than half [50.5% (194)] of heads of households used soap as cleansing agent for washing their hands whereas some used ash [18% (69)] and others nothing [31.5% (121)]. There were 68.5% of heads of households who did not know the handwashing technique according to WHO [68.5% (263) vs. 31.5% (121)].

As presented in table 4, set of measures to make something clean is significantly reported than other definitions.

Table 4. Distribution of Definition of Hygiene according to Heads of Households

Definition of Hygiene	**Frequency (n)**	**Percent (%)**
It is the set of principles and practices tending to promote health	115	29.9
Set of measures to make a something clean	168	43.8
Keep waste where it belongs	54	14.1
Do not know	47	12.2
Total	384	100

In line with the household water supply system for domestic use, it was found that more than half [57.3% (220)] had running water, while some drew from water well or fountain [25.5% (98)] and others were drawing water from neighbors [17.2% (66)]. Concerning the distance from water supply system for domestic use, more than ¾ [82.3% (316)] drew the water from 500 meters, while for some the distance was less than 500 meters [12.5% (48)] and for others the distance was between 500 – 1000 meters [5.2% (20)]. A good rate of participants [61.2% (235)] indicated that the water well or fountain was protected, unlike some [24.7% 995)] mentioned that the water well or fountain was not protected, and others did not know [14.1% (54)]. Regarding the practice of storing water in households, almost all household (98.2%) stored water [98.2% (377) vs. 1.8% (7)]. It was discovered that boiling of water was the most common method (56.5%) for water treatment for the households (See Table 5). Boiling water (56.5%) is the main method of treatment of drinking water as displayed in Table 5.

Table 5. Method of Treatment of Drinking Water

Method	**Frequency (n)**	**Percent (%)**
Chlorination	8	2.1
Filtration	41	10.7
Boiling	217	56.5
Other	118	30.7
Total	384	100

Concerning the wastewater disposal method of the households, a good number of households (37%) disposed their wastewater in the public places as displayed in Table 6. Table 6 shows that the majority of heads of households evacuate their wastewater in public places (37%).

Table 6. System of Evacuation of Household Wastewater

Evacuation System	Frequency (n)	Percent (%)
Septic tank	56	14.6
Pit latrine	65	16.9
Public places	142	37
Vacant land	121	31.5
Total	384	100

On the other hand, the household waste disposal method, more than half (50.5%) of households used burying method as it can be seen in Table 7. Table 7 displays that many heads of households practice burying in a hole (50.5%) as system of garbage disposal.

Table 7. System of Garbage Disposal

Disposal System	Frequency (n)	Percent (%)
Garbage collection	28	7.3
Charrette	21	5.5
Dumping in the bush	81	21.1
Burying in a hole	194	50.5
Incineration in a corner of property	60	15.6
Total	384	100

More than ¾ of heads of households had knowledge on the existence of waterborne diseases [76.3% (293) vs. 23.7% (91)]. Most heads of households (79.2%) reported that there were people that neglected the environmental sanitation [79.2% (304) vs. 20.8% (80)] which led to the environmental destruction and the outbreak of diseases. Concerning the experience of households about some diseases related to deficient hygiene, it was found that Cholera (20.8%) was the top leading disease according to the heads of households (See Table 8).

From Table 8 we can see that 33.9% of heads of households highlight that cholera, typhoid fever, and diarrhea are the main waterborne diseases secondary to deficient hygiene, follow by cholera (20.8%).

Table 8. List of Waterborne Diseases in the Study Setting

Disease	Frequency (n)	Percent (%)
Covid-19	7	1.8
Typhoid Fever	73	19
Cholera	80	20.8
Diarrhea	41	10.7
Amebiasis	7	1.8
Dysentery	15	3.9
All diseases	31	8.1
Two to four diseases	130	33.9
Total	384	100

It was also discovered that 66.4% of households had already suffered from poor hygiene-related diseases [66.4% (255) vs. 33.6% (129)] of which the majority (55.1%) had one-episode diarrheal diseases since the year started as presented in Table 9. Table 9 displays that more than half (51%) of households had one episode of diarrheal diseases from January to October 2021.

Table 9. Episodes of Diarrheal Diseases from January to October 2021

Episode	Frequency (n)	Percent (%)
One	196	51
Two	133	34.6
Three	21	5.5
None	34	8.9
Total	384	100

It was noticed that a small number (6.5%) of household members had already suffered of Covid-19 [6.5% (25) vs. 93.5% (359)]. The lack of civic virtues (44.8%) was found to be the main factor that led to poor environmental hygiene according to the heads of households as portrayed in Table 10. Table shows that 44.8% of heads of households claimed that lack of civic virtues was the leading factor to poor hygiene.

Table 10. Factors Leading to Poor Hygiene

Factors	Frequency (n)	Percent (%)
Lack of sensitization about hygiene	165	43
Lack of civic virtues of the population	172	44.8
Lack of basic education	33	8.6
Do not know	14	3.6
Total	384	100

Several heads of households underscored that sensitization on waste management practices (45.1%) was the best method to improve the environmental hygiene (See Table 11). There was less than half (45.8%) of heads of households who claimed that there was no channels of sensitization regarding the environmental hygiene [45.8(176) vs. 54.2% (208)]. As can be seen in Table 11, sensitization on waste management practices (45.1%) was the substantial method to improve the environmental hygiene.

Table 11. Methods of Improving Environmental Hygiene

Methods	Frequency (n)	Percent (%)
Sensitization on waste management practices	173	45.1
Education on preventive measures for diseases linked to poor waste management	153	39.8
Avoidance of defecation everywhere in the environment	52	13.5
Other	6	1.6
Total	384	100

Discussion

This study was designed to contribute to the improvement of the living conditions of the population in terms of hygiene aimed at reducing several diseases due to poor hygiene and sanitation practices of the catchment area of Kaziba health centre.

1. The first specific objective of this study was to assess the knowledge, attitudes and practices related to hygiene in the population and their socio-demographic characteristics.

Age: the current study revealed that the most striking age range is between 20 and 30 representing 32% of the study population. This result aligns with [9] that reported the similar trend. However, this result contrasts with previous studies which found 30 years and above as the most represented group [20, 21]. A possible explanation could be that people above 30's are those who often leave for work during the day.

Gender of heads of households: the findings reveals that 57.3% households were headed by women. These findings contradict those of previous studies that found the predominance of male gender respectively 59.8% and 79.9% [22, 21]. A possible explanation may be related to different customs in certain regions.

Education level of heads of households: this study revealed that 50.5% heads of households has secondary level of education. These results are somewhat surprising given that other research shows that almost half (49.7%) have completed secondary education and 48.1% have entered tertiary education and sometimes graduated. These results are consistent with those of a previous study [20].

Main activity of the heads of households: this study revealed that farming is the most activity that the heads of households were involved (27.3%) followed by the business (22.9%). A possible explanation for this could be that most people who live in rural areas mainly do agriculture owing to lack of other jobs.

Knowledge about the hygiene**:** it was found that almost all heads of households (93.2%) declare having heard about the hygiene. The results of this study show that there may be a relationship between the level of education and knowledge about the hygiene.

Definition of hygiene according to the heads of households surveyed**:** the important finding is that 43.8% of heads of households believed that hygiene is a set of measures to make something clean. This finding was unexpected and suggests that most heads of households are unaware of the true definition of hygiene. A possible explanation for these results may be the lack of knowledge about hygiene as a whole.

2. The second specific objective was to assess the status of water and sanitation facilities in the catchment area of Kaziba health centre.

Existence of latrines/toilets by households surveyed: an interesting finding was that 98.4% of households had a latrine/toilet within the household or courtyard. These results are consistent with a report which showed that 4.2% of population practiced open defecation (Bottom to the fore). The possible explanation could be that some households might have the latrines/toilets placed in a certain distance within the courtyard since some properties were not fenced.

Type of latrines/toilets found at household level: the current study found that most households had a traditional or dry latrine (75.8%). The results of this survey were consistent and higher than those from another survey which found 24.7% of households with traditional latrines [23]. The reason is not clear, but it may have something to do with the socioeconomic status of the study participants, nonetheless these results may not be generalized to the entire population of this study.

Mode of sewage disposal at the household level: this study revealed that there were 54.2% of households that had no septic tank. So far there is no study consistent with this finding, therefore further studies are needed.

Cleaning materials for latrines/toilets at the household level: an important finding is that 53.1% of households declared having the cleaning materials for the latrines/toilets. Findings from this survey do not corroborate with those of a previous study which indicate that the cleanliness of the latrines/ toilets was a challenge [24].

Water supply system at the household level**:** **t**he most important finding was that 57.3% of households had running water within household. This finding was unexpected and suggests that the water supply is more plentiful in more than half of households. These results are in line with those of previous studies which show that only 60% of people in sub-Saharan Africa have access to improved water sources [12] and 65.1% had improved water source [21].

Protection of source of water supply: the findings of this survey revealed that 24.7% of households indicated the water well or fountain were not protected. Comparing these findings with those of other studies which found that 33% of the rural population are still using water from unprotected source of supply [1].

Water storage practice at the household level: what is surprising is that almost all households (98.2%) practice water storage. The findings of this survey align with a previous study that found almost similar trend shortage [25, 21]. A possible explanation could be the prevention of water shortage in case of unnoticed interruption of water supply.

Treatment methods for drinking water: the important result was that boiling water was the most method used (56.5%) by households for water treatment was boiling. What is curious in this result is that only 30.7% do not apply methods for the treatment of drinking water. This result is higher and consistent with a previous study which found boiling water method (43.3%) was the main method for drinking water treatment [21].

3. The third specific objective was to identify the consequences and highlight the main problems related to poor WASH practices.

Disposal system of household wastewater: this study revealed that a good number of households (37%) evacuate their wastewater on public places against 31% on vacant lands. This findings are not consistent with those of study conducted in Burkina Faso [26]. There is no possible explanation to this practice.

Knowledge of the Existence of Waterborne Diseases: an interesting finding is that 76.3% of households were aware of waterborne diseases compared to 23%, which can be explained by the effect of having heard of or suffered from it. These results align with the previous study which found that waterborne diseases were prevalent in rural areas [27].

Washing hands after using latrine/toilet, before eating or after a walk: the current study revealed that only 72.1% of householders would report that they routinely wash their hands after using the toilet, before eating or after a walk. Regarding this practice of washing hands, only ½ of households use soap for handwashing and more than ⅔ of households do not know handwashing technique according to WHO.

These results support the conclusions of a report that present the availability of handwashing facilities in low- and middle-income countries is very low, only 19% of people wash their hands with soap after defecating [1]. This result can be explained by the ignorance of the population of this group in terms of hand washing.

Negligence of the environmental sanitation: this study revealed that 79.2% of households claimed that some people were neglectful at some extent of environmental sanitation that may contribute to the spread of diseases. A possible explanation attached to the negligence of environmental sanitation seemed the lack of civic virtues of certain community members.

4. The fourth specific objective was to assess the importance of hygiene practice in households.

Households who have ever suffered from poor hygiene-related disease(s): the current study revealed that 66.4% of households

suffered from poor hygiene-related disease(s). What is surprising is that 33.9% of heads of households indicated that typhoid fever, cholera and diarrhea were the main diseases associated to poor hygiene, in addition the results show that 20.8% of households suffered from cholera alone owing to poor hygiene which align with previous study [28]. A couple of studies found that diarrheal diseases were prevalent in rural areas [29, 30]. Many households did not know that there is a strong relationship between hygiene and Covid-19**.** These results support the conclusions of [1] which shows that each year 1.8 million people, 90% of whom are children under five, have diarrheal diseases (including cholera). There are several possible explanations for this result, however the ignorance could be the main factor that led to poor hygiene.

Households who have already had episodes of diarrheal diseases: this study revealed that 51% of households would report having had one diarrheal episode, followed by 34.6% who had it twice from January to October 2021. This results are not consistent with any previous study. However, there are other possible explanations due to either by non-effective water treatment or by food.

Lack of civic virtues as root cause of poor environmental hygiene: the current study revealed that 44.8% heads of households claimed that poor environmental hygiene was associated to lack of civic virtues of some community members.

Heads of householders involved in the improvement of environmental hygiene: the current study found that some heads of households (45.1%) were involved in sensitization of the community on waste management practices. This findings corroborate with those of [28] which indicate that there is still gap in knowledge in environmental hygiene

Conclusions

Compliance with hygiene measures poses a huge problem in the catchment area of Kaziba health center and highlights shortcomings in the knowledge and practices of heads of households. A good number of heads of households, female gender, aged between 20 and 30 years had low knowledge of hygiene definition, principles, and practices in the context of Covid-19 pandemic. A remarkable level of ignorance towards the relationship between poor hygiene and Covid-19 is critical for the prevention and/or control of Covid-19. The human centered design approach is substantial to address the problems of hygiene via buying-in the individual and collective commitment. Improving hygienic practices is of paramount importance to limit the transmission of water- and sanitation-related diseases. Although hygiene can lead to the intention to change behavior, the transition from intention to action only occurs when people have the appropriate water and sanitation facilities. Continued sensitization on hygiene principles and standardized practices in the catchment area of Kaziba health centre may be the best channel to curb down the hygiene-related diseases such as diarrhea and Covid-19. Further study should be undertaken at community level to assess the compliance with hand hygiene practice and the use of alcohol-based hand rubs as well as their relevance and technical skills.

Conflict of Interest

The authors declare no conflict of interest.

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Making the Law Work for Human Resources for Health (HRH) Training in Zambia

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Abstract

There are several institutions in Zambia that play an important role in regulating the quality of higher education, including Human Resources for Health (HRH) training. However, there were reports of overlaps in the legal mandates of these institutions. In 2021, one of the institutions, the Higher Education Authority (HEA), responded to this challenge by successfully facilitating the amendment of the laws that regulated the quality of higher education. This research investigated whether the amended laws were still suitable enough to ensure quality in higher education and in HRH training.

Keywords: *Actors, HRH, Law, Regulators, Training, Quality.*

Introduction

Before the year 2013, Zambia only had two Universities, the University of Zambia and the Copperbelt University, which were established in 1965 and 1987, respectively. Later, the Higher Education Act No. 4 of 2013 was enacted, and it provided for the establishment of more institutions of higher learning, both public and private. The Act also led to the creation of the Higher Education Authority (HEA) of Zambia, which was created to provide quality assurance, regulation of private and public higher education institutions and registration of private higher education institutions. The Higher Education Act of 2013 gave Authority to the HEA to compliment the efforts of the already existing regulators of Human Resources for Health (HRH), such as the Health Professionals Council of Zambia (HPCZ).

In the year 2019, there were signs that the coordination and working relationship among the regulators of HRH training was not working well, as cold be observed from several incidents that occurred during that year. The HPCZ at one time closed the Copperbelt University School of Medicine, but the decision was opposed by the HEA who, reopened the institution. The dispute ended up being resolved by the Attorney General [1]. On another occasion, the HPCZ closed a number of health facilities and training institutions, but this decision was over-ruled by the Minister of Health. The incidents indicated the presence of overlaps in Authority and possibly different interpretations of quality standards. In an apparent response to these overlaps and conflicts, in 2021, the HEA had the Higher Education Act of 2013 amended. The amended Act, the Higher Education Authority, 2021, gave the HEA more Authority, among other privileges, over other regulators to assure quality in higher education, including regulation of HRH training.

It is yet to be seen if this amended law fosters quality training in HRH training than the one it replaced. The amended law was just about a year old at the time of this research, so it was too early to measure its impact on the quality of HRH training. However, this initial period of implementing the amended Act also

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serves as an opportunity for collating "lessons learned" that could in turn lead to further improvement of the said law and its application. This If these lessons around the amended Act are not harnessed, opportunities to improve the inquiry were aimed at studying some of the operational aspects of the amended Higher Education Act and how they could potentially influence the quality of HRH training in Zambia, especially in the wake of the Zambia Medical Association report [2] that indicated that there as more work to be done improving the quality in HRH training.

In 2018, the Zambia Medical Association (ZMA) sanctioned a study on the state of post-graduate medical training (HRH training) in Zambia. The study was in response to the establishment of additional post-graduate training programs in Zambia. The assessment evaluated the state of medical training institutions in seven thematic areas of governance, academic progression assessment processes, accreditation and affiliation status, human resource, the existence of innovation alongside the learning and training activities, training resources/funding, and availability of learning/training facilities. The assessment targeted a total of 23 medical training institutions with a total of 91 training program activities in provinces. The following are the key findings:

1. Management: it was found that management structures were established across all the training institutions/sites of the respective training programs, but there was generally lacked documentation, worse so in public institutions compared to private institutions threatening not only the respective institutional memory but also weakening the running of the various programs.
2. Academic Progression Assessment Processes: The assessment found strong progression and assessment processes in each of the training programs across the sites, but once again, this was done generally with weak documentation.
3. Accreditation and Affiliation Status: The majority of the assessed training institutions did not meet the required standards of accreditation and affiliation.
4. Human Resource Development (HRD) Status: Generally, the institutions offering the programs were noted to have invested in human resource development as well as in its documentation. The HRD referred to by the report was the capacity of teachers.
5. Availability of Training Innovations: With a few exceptions, there was not much innovation going on in the training institutions amongst the programs.
6. Training Resources: although the human resources for teaching were there in most institutions, there were still a few that lacked adequate teaching capacity.
7. Funding: Funding across all the programs in all the institutions under study, especially the public institutions, was low.
8. Adequacy of training Facilities: With a few exceptions, the assessment across all programs and training sites found key training facilities such as library services, specialized lab services, specialised clinical equipment/clinical skills services, and Information and Communication Technology (ICT) services for the training activities generally to be either not available or inadequate [2].

The findings from the report of the ZMA can be addressed if there is an effective HRH training regulatory system in place, supported by good law. It should also be noted that the mere presence of a good law will not be enough to get the desired results, but that law needs to be fully implemented to be effective. The Interviews with several regulators, including the HEA, HPCZ, Zambia Qualifications Authority, and the Lusaka City Council (which falls under the Ministry of Local Government), revealed mixed views on the amended Higher Education Act. Some opined that the amended

act presented the best opportunity to improve higher education training quality, including HRH training. Some opined it was counter-productive to HRH training quality, and others had no opinion at all. The concern of this inquiry was the possibility of the law not being effective in fostering the quality of HRH training. This inquiry, therefore, examined at the law to determine if it was effective enough to address challenges such as those identified in the ZMA's report.

The presence of the law was a big step towards quality HRH training as long as the law is adequate for that purpose. Further, even when the law is adequate, the manner in which it is applied influences the achievement of the desired QA outcomes. If the law was not working for assuring quality in HRH training as per Stage 3, then it is not working. What can be done to Stage 1, Stage 2, or both? This was the question that this inquiry was responding to attempting to answer. Figure 1 below depicts how the law can be made to work for the improvement of the quality of HRH training.

To examine the challenges and opportunities of the amended Higher Education Act of 2021 of Zambia on Human Resources for Health training.

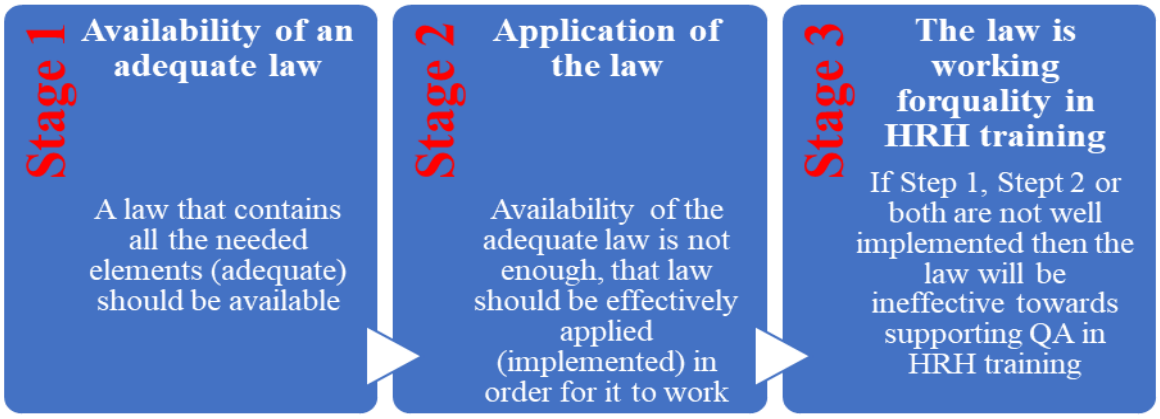

Figure 1. A Depiction of how to Make the Law Work for Quality HRH Training

Materials and Methods

The inquiry was a qualitative case study, whose data was obtained from desk reviews and interviews.

A qualitative case study is a method that has the power to explore a broad and complex topic [3] like the one that was studied in this inquiry, and they it gives more detailed responses [4]. Qualitative case studies have the power to explore a broad and complex topic within a real-life setting [5-7] like the topic studied here, hence the selection of the approach. Qualitative approaches are recommended for the evaluation of policy, regulations, and governance frameworks in health [5]. The inquiry involved a desk review of the Higher Education Act and related documents and also included interviewing purposefully selected persons from the regulators, namely, HEA, HPCZ, ZAQA and Lusaka City Council. The interviews were done using a Narrative approach (not pre-set questions), where the respondents spoke freely, allowing the study to emerge from the interviews, which is an appropriate approach for exploring details of social settings and interactive relations [6], such as the interactions of the regulators of HRH training in Zambia. Observations were also

made in one of the stakeholder meetings, the Program Core Elements Review Meeting.

Results

Interviews and desk reviews revealed that on 21st March 2013, Parliament assented to the Higher Education Act No. 4 of 2013. This Act provided for the establishment of the Higher Education Authority and defined its functions and powers. The Act further provided for quality assurance and quality promotion in higher education, among others. The Act repealed and replaced the University Act of 1999 [10]. The University Act of 1999 [10] was the law that guided the only two Universities that existed at the time, the University of Zambia, and the Copperbelt University, which were established in 1965 and 1987 respectively. The Higher Education Act No. 4 of 2013, which replaced the University Act of 1999, provided for the establishment of more universities, both public and private.

After several universities were established by the Higher Education Act of 2013, it was amended by parliament in 2021. The main reason given for the amendment was what was described as "duplication." The full statement read: *"It has been noted that various higher learning institutions have Authority to accredit LPs both for foreign and local higher learning institutions. This has created a duplication of functions between HEA and other higher learning institutions. Cabinet felt the need to remove the duplication that currently exists between the Authority and other higher education learning institutions and bring about order in terms of accreditation of LPs for both local and foreign learning institutions" [11]).* Relevant parts of the amended Act [12] were reviewed, and the following were some of the notable findings:

Powers of Actors

After examining the amended Act, it was noted that almost all the authority to assure quality e.g., accreditation, was taken away from other actors and awarded to one actor, the HEA. As part of the repeal and replacement of section 20 of the Act of 2013, specifically on the Criteria for registration of private higher education institutions, the powers to approve an application for registration of a private higher education institution were awarded to the HEA. The HEA was also granted Authority to de-register institutions. Previously, other regulators such as HPCZ would do registration and deregistration of institutions offering health-related programs.

In being granted the power to register, the HEA was also mandated to consider the suitability of the name of the applying institution, premises suitability, institution responsiveness to learner needs, presence of operational plan, health & safety standards are met, availability of adequate financial provision, presence of qualified teaching personnel and presence of suitable training facilities. This broad mandate indicated that the HEA had the overall Authority to decide who is accredited and who is not. However, some aspects, such as premises suitability, health, and safety, etc. will need the support of other regulators, such as the Ministry of Local Government- but the final decision is made by the HEA.

Part IVA on Accreditation of Learning Programmes in Higher Education Institutions (23A), the Act reads, "*Despite any other written law, the Authority (HEA) shall, in consultation with relevant professional institutions, accredit learning programmes offered in a higher education institution for the purpose of— (a) setting and safeguarding the quality of learning programmes; (b) recognising learning programmes; and (c) ensuring the continuous improvement of the quality of learning programmes*." This part of the Act promotes collaboration of HEA with professional institutions such as HPCZ, but it also overrules all the laws that could have been mandating the other institutions (by stating "*despite any other written law.*"), the laws that

previously gave power to the other regulators, which in turn reduces their role in HRH training QA. The question is whether this reduction in power of other stakeholders promotes QA or does the opposite. It reduces the potential for conflicts but reduces the participation of other regulators whose role has been partly pacified by law.

Further reduction of powers of other regulators was made as consequential amendment of legislation that mandated other regulators, and the full statement was as follows:

"Following the approval by Cabinet to amend the Higher Education Authority Act No. 4 of 2013, Cabinet also approved amendments of other consequential legislation across the higher learning institutions, and these are as follows:

1. *The Zambia Institute of Purchasing and Supply (Amendment) Bill, 2021, and The Accountants (Amendment) Bill, 2021, under the Ministry of Finance;*
2. *The Zambia Institute of Advanced Legal Education (Amendment) Bill, 2021, under the Ministry of Justice;*
3. *The Zambia Institute of Marketing (Amendment) Bill, 2021, under the Ministry of Commerce, Trade and Industry;*
4. *The Zambia Chartered Institute of Logistics and Transport (Amendment) Bill, 2021, and The Engineering Institution of Zambia (Amendment) Bill, 2021 under the Ministry of Transport and Communications;*
5. *The Health Professions (Amendment) Bill, 2021 under the Ministry of Health;*
6. *The Zambia Institute for Tourism and Hospitality Studies (Amendment) Bill, 2021, under the Ministry of Tourism and Arts; and,*
7. *The Urban and Regional Planners (Amendment) Bill, 2021 under the Ministry of Local Government."*[13]

In the above consequential amendments, the Authority of all the listed actors to independently undertake QA activities such as registration and accreditation was removed from them. Previously, HRH training institutions were registered, accredited, and monitored by the HPCZ. That Authority was now solely in the hands of the HEA. However, the HPCZ could be called upon to perform limited contributions, such as approving a learning curriculum and providing peer review in learning program evaluations. The HPCZ is a specialized agency designed to foster quality in HRH, while the HEA has more general skills. Therefore, moving Authority from the former to the latter appeared to be a step back in QA for HRH training as it reduced the benefits of specialization.

Section 23D states: *"The Authority shall accredit a learning programme of a higher education institution if……(j) the staff to be employed are adequate for the efficient delivery of the learning programmes and possess the necessary qualifications and experience in the relevant field;"* This is a great law, as the qualifications of the staff have an impact on the quality, so that should be examined before accreditation. However, its application has been questioned by some stakeholders during the interviews. Those who questioned it opined that for programs such as the Master of Medicine (MMed), which are highly specialised and is more of a "job on training", the HEA may not be fully equipped to monitor who is teaching whom and what is being taught, as such kind of monitoring requires someone who is embedded in the program and understands the intricacies of the medical profession. It was, therefore, suggested that for such specialised HRH training programs, the Authority to ensure QA should be left to the HPCZ.

Before the Higher Education Act amendment, the Ministry of Local Government used to approve and accredit some institutions and recognize some foreign qualifications under the Urban and Regional Planners Act, of 2011. The amendment of the Higher Education Act led to the consequential amendment of the Urban and Regional Planners Act, 2011.

Removing the Authority from the Ministry of Local Government to approve and accredit some institutions and also recognize some foreign qualifications appears justified as the Local Government is unlikely to have the expertise in training, so this was a positive change of the amendment. The consequential amendment of the Urban and Regional Planners Act involved the deletion of the following paragraphs:

"29. The Minister may, by statutory instrument, on the recommendation of the Council, make regulations to provide for— (a) the terms and conditions for the issuance of practising certificates; (b) the type of continuous professional development and training, and any other information required for the issuance of a practising certificate; and." This paragraph was deleted from the Urban and Regional Planners Act. All the mandate in the deleted paragraphs was accorded to the HEA. Unlike that of the Health Professional Council of Zambia Act, this amendment appears justifiable, as higher education training is not a specialty of the Local Government. Other paragraphs deleted from the Urban and Regional Planners Act were as follows:

"42. (1) The Minister may, on the recommendation of the Institute, by statutory instrument, recognise any foreign institution providing training in planning. (2) The Institute may register a person as a planner under subsection (2) of section fifteen who is not a citizen of Zambia or is not practising or working as a planner in Zambia prior to the application if that person— (a) is engaged to work as a planner in Zambia under an international agreement entered into by the Government of the Republic of Zambia; or (b) undertakes the such number of courses as the Institute may determine and passes the final examination for the courses." This deletion appeared justifiable as institutions such as HEA were already performing this function, and their specialty places them in a better position to undertake this work, and not the Ministry of Local Government. The other deleted paragraph was:

"60. (1) (g) the requirements and conditions for the recognition of local and foreign qualifications accredited by the Institute for purposes of registration under this Act;" The deletion of this paragraph also appeared justifiable because the ZAQA was already performing that role. On amendment of such parts of the law, the identified "duplication" appeared to hold.

Notifying/Warning the Public:

The amended Higher Education Act also contains clauses on what should be done when a learning institution does not comply with QA requirements. One of those measures is to notify the public by publishing the names of defaulting institutions.

Section 23G subsection (5) reads, *"The Authority shall, where it revokes the accreditation of a learning programme, publish a notice of the revocation in the Gazette and a daily newspaper of general circulation in the Republic."* Desk review revealed that on this part of the Act, the HEA had performed well in informing the public about universities that are operating illegally. For example, on 18 March 2021, the HEA published on its website a list of universities operating illegally [14], and this was also published in the local press, including the Zambia National Broadcasting Corporation [15] website. These publications have even spread to foreign newspapers [16]. This amendment is reasonable as it safeguards prospective students from enrolling with unaccredited universities.

On Penalties for those Breaking the Law

The amended Act also gives the HEA a mandate to penalize the institutions that break the law, and the parts of the Act that do so include the following:

Section 23 reads in part *"(A) (5) A person who contravenes subsection (4) or operates a*

de-registered private higher education institution or institute commits an offence and is liable, on conviction, to a fine not exceeding three hundred thousand penalty units or to imprisonment for a term not exceeding three years, or to both"…….23B. (1) A higher education institution shall not offer a learning programme that is not accredited. (2) A higher education institution which contravenes subsection (1) commits an offence and is liable, on conviction, to a fine not exceeding two hundred thousand penalty units or to imprisonment for a term not exceeding two years, or to both."

Similarly, Section 23G subsection (1) reads, *"The Authority may suspend or revoke a certificate of accreditation if the holder of that certificate of accreditation— (a) obtained the certificate on the basis of fraud, negligence or misrepresentation; (b) assigns, cedes or otherwise transfers the certificate without the prior approval of the Authority; (c) fails to comply with any term or condition of the certificate; or (d) operates the registered higher education institution in contravention of this Act or any other relevant written law."*

The above-mentioned sections of the law appear sufficient to deter malpractices. However, a check on the Zambia Legal Information Institute portal [17], a repository for court cases, couldn't reveal any learning institution that has ever been taken for prosecution for breaking the law, and yet, according to HEA publications, there are many who frequently break the law. The amended Act is in itself adequate in how to respond to defaulters, but it appears it is not fully applied. If there have been a lot of offenders since the law was enacted and no one has ever been convicted in a court of law, then it suggests that the law is not being fully applied. The HEA would probably need to establish closer collaboration with institutions such as the National Prosecution Authority, Zambia Police Service, etc, who could help in fully applying the law for QA. That could make the law work for QA in HRH. Otherwise, the lack of application could promote impunity.

Along with the powers to penalize that there given to the HEA, the learning institutions were given room to exculpate themselves when accused. Section 23G subsection (2) reads, *"The Authority shall, before suspending or revoking a certificate of accreditation under subsection (1), notify the holder of the certificate of its intention to suspend or revoke the certificate, giving reasons for its decisions and requesting the holder of the certificate to show cause within a reasonable period that may be specified in the notice, why the certificate should not be suspended or revoked."* This part of the Act is commendable, in a fair society, the suspected institution should be given a chance to explain. It demonstrates that the Act is not meant to be punitive but also seeks to explore reasons behind a suspected wrong. This approach could enable HEA and partners to help the offenders to comply.

Section 23G subsection (6) reads:" The *Authority may, in addition to a suspension or revocation of a certificate of accreditation of a learning programme, charge the holder of a certificate of accreditation the cost of carrying out the enforcement action."* Passing to cost of enforcement to the offender appears to be a just call, but maybe more costs need to be passed on too. However, there is no mention of making any reparations to students who may fall victim to poor-quality teaching or end up out of class because their learning institution is closed as a result of default. The students who pay high fees and place their trust in learning institutions to give them quality training end up in limbo if the institution is closed or suspended. A check was done with the Zambia Competition and Consumer Protection Commission on whether there is a law to protect students (consumers) in such cases. From the response, the only law mentioned was that such reparations are only available when an organization becomes insolvent. The insolvent company is liquidated, and the proceeds could be used for

compensation of various stakeholders. There was no law found on what should happen to end-users/consumers in cases where a university licence is suspended, or a university closed for reasons other than insolvency. The law in Zambia that protects consumers in the event of company insolvency is captured under the Zambia Corporate Insolvency Act No. 9 of 2017 [18]. In a situation where a university is suspended or closed by the powers mentioned in the Higher Education Act, the student will have to take the more difficult route of suing the learning institution for breach of contract. The Higher Education Act should have a provision to protect students as well.

On Implementation of the Amended Higher Education Act of 2021

For the law to be applied, there must be some policies and practices to support its implementation. As a means of applying the law, the regulators, led by the HEA, were making efforts towards increasing collaboration. As part of the practices to apply the law, there were some platforms that were created for the various regulators to interact.

The HEA was noted to be making efforts to foster cooperation among the stakeholders. The HEA had been convening quarterly meetings with Quality Assurance Agencies and Awarding Bodies, a platform consisting of the Nursing and Midwifery Council of Zambia (NWCZ), Teaching Council of Zambia (TCZ), Health Professions Council of Zambia (HPCZ), Zambia Institute of Marketing (ZIM), Zambia Institute of Chartered Accountants (ZICA), Examinations Council of Zambia (ECZ), Ministry of General Education (MoGE), Technical Education, Vocational and Entrepreneurship Training Authority (TEVETA), Higher Education Authority (HEA), and Zambia Qualifications Authority (ZAQA). More stakeholders may need to be included into this platform. For example, the stakeholder in charge of approval land use and building suitability may also need to be part of such a platform, considering that land and building approval plays a key role in the whole quality assurance process.

The HEA has also been playing another positive role in doing the law work for quality higher education training. In 2021, the HEA embarked on undertaking sensitization workshops on the amended Higher Education Act to make all stakeholders how the law can support QA. The HEA also mentioned in the sensitization workshops that they were developing guidelines to assist the implementation of the amended Act. Sensitizing stakeholders on the Act is an important and commendable initiative. The HEA could also use this platform to get feedback from stakeholders on how they feel about this amended Act. This feedback could guide the development of the guidelines they referred to in the sensitization meetings. If this is not done, then the sensitization meetings could create an impression of a one-way flow of information as opposed to one that generates consensus among regulators.

It was also found that the HEA had created provisions for interaction with other regulators, notably, the Program Core Elements Review Meetings and Quarterly Meetings. One of the positive things that emerged from the HEA's reforms in 2021 was the creation of the Program Core Elements Review. This is a platform were universities present their programs, and the core elements of that program are reviewed by a panel and later subjected to validation by their peers. The outcome ensured that universities were offering programs that have undergone a more rigorous curriculum review than previously when universities would design their own programs and deliver them to students. This platform promoted the incorporation of expert views provided peer review, and increased collaboration between the HEA and the training providers and to some extent, between the HEA and other regulators. Sitting as an observer in this platform was part of the investigation

process of this inquiry that revealed that the Program Core Elements Review Meetings could be the most relevant and effective platform that has been created to support the implementation of the Higher Education Act.

Discussion

It has been opined that some laws were only good on paper but proved ineffective in assuring quality [19]. This inquiry identified the potential pitfalls, if not addressed, that could render the amended Higher Education Act a law only good on paper. The Higher Education Act of 2021 was a positive step towards improving the quality of HRH training as it strengthened the role of the HEA and reduced the possible recurrence of conflicts with other regulators. However, more work may need to be done on both its adequacy and application to make it work better for quality HRH training.

There had been several studies done on the quality of higher education in Zambia, and they have all focused on the shortcomings of the learning institutions. This research explored the role of the law, especially the mandates of the regulators, in improving the quality of education. An insight into the mandates of regulators provided a different perspective of how to address the issue of the quality of HRH training, thus adding to the Body of Knowledge (BOK) on this subject. Overall, a more detailed inquiry is required to evaluate the impact that the amended Act has on each regulator and impact on quality of HRH training. Then this result should inform further amendment for a more comprehensive law. The outcome of the evaluation should be used to further amend the law to address its gaps. The amendment is necessary for promoting QA for HRH training. A more comprehensive law will give an overarching framework to ensure quality training that could further build public trust and confidence in the system. To increase the chances of the Higher Education Act succeeding, there should be specific attention paid to its expected outcomes, where the focus should be to improve the quality of education and not just to address operational issues like "duplication" or conflicts.

Conclusion

This inquiry set out to explore the challenges and opportunities of the amended Higher Education Act of 2021 of Zambia on Human Resources for Health training, with a view to identifying what could make the law work for quality HRH training. Laws are amended for various reasons, for example, to make them more effective, to increase coherence, etc. When that law is amended, the law should be able to serve the people, and the law should work for the people. The amended Higher Education Act of 2021 has taken a step towards working for the people through its intention of improving the quality of higher education. The amended Act has brought an end to the possibility of conflicting decisions being made by regulators, as it grants the final decision to the HEA. However, it was found that the Higher Education Act of 2021 was not fully adequate and was not being fully applied and this could render it a law that doesn't work for the people. The law needs to be amended to harness the contribution of other regulators that have specific specialties and address the interests of end-users such as students. The application of the law should ensure the full participation of all stakeholders and full enforcement of the law.

The amended Higher Education Act could have done its part of ending conflicts, but it has taken away the benefits of specialization in the regulation of HRH training in Zambia because the Subject Matter Experts (SMEs) are not able to fully contribute to the process. Human Resource Management experts[20] note that the benefits of having SMEs is to have leadership in a particular work area that is always abreast of latest developments and research in their area of specialty. SMEs, therefore, tend to have extensive knowledge, which enables organizations to avert or minimize challenges

using their strong knowledge of their domain. SMEs are professionals with a deeper knowledge of how a particular industry operates and it has been opined that the healthcare industry is very distinct from other industries, and it requires specialised industry-oriented knowledge to be successful [21]. The HPCZ are SMEs when it comes to matters related to health and medical training, and in order to get the full benefits of the HPCZ's specialty, they need to be given a bigger role in the regulation of HRH training, but the amended Higher Education Act seems to have done the opposite. The law needs further amendment to grant SMEs more leadership in the regulation of HRH training if better results are to be achieved.

Conflict of Interest

The author has no conflict of interest on this research.

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Adsorptive Removal of Copper (II) Ions from Aqueous Solution using Acid and Thermally Activated Iron Oxide Sand

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Abstract

Heavy metal pollution of water bodies is a common problem in Zambia, whose economy depends on copper mining. Removal of Cu^{2+} ions from the solution via adsorption using iron oxide ore was investigated. The composition of the adsorbent was determined by XRF and ICP-OES. Iron oxide had predominantly Fe_2O_3 at 60 % with less than 3% of SiO_2 and Al_2O_3. The Cu^{2+} ion concentrations were measured before and after adsorption using Atomic Absorption Spectroscopy (AAS). The effects of initial concentration, pH, acid activation, and thermal activation of the adsorbent on adsorption were investigated. A decrease in the adsorption of Cu^{2+} ions with an increase in the initial concentration of adsorbate (Cu^{2+}) was observed. The adsorption of Cu^{2+} ions on acid-activated Iron oxide compared to thermally activated iron oxide ranged from 83-73%, respectively. Adsorption of Cu^{2+} ions was pH dependent with an optimum pH of 7. Acid activation of the adsorbent had better absorptivity since acids cause mineral dissolution, which increases the surface area and porosity of the adsorbent. Iron Oxide adsorbents have the potential to the removal of Cu^{2+} ions from aqueous solutions.

Keywords: *Adsorption, Copper ions, Heavy metals, Iron oxide, Pollution.*

Introduction

Environmental pollution continues to be a main source of health problems in the world due to the wide uses of chemical materials, chemical detergents, presence of bacteria, and fungi in water bodies [1]. The major sources of these metals in industrial waste-waters include electroplating, mining, fertilizers, pulp and paper, mining and foundry activities, steel production, carbon combustion, solid waste incineration, ceramics, textiles, fertilizers, pigments, batteries, and petroleum industries. Water reservoirs are contaminated by the run-off from these industries [2]. Heavy metals in drinking water pose a threat to human health. Populations are exposed to heavy metals mainly through water consumption, and some heavy metals can bio-accumulate in the human body (e.g., in lipids and the gastrointestinal system) and may induce cancer and other risks [3].

Several methods, such as electrochemical treatment [4], reverse osmosis, adsorption [5], membrane filtration [6], solvent extraction [7], and chemical precipitation [8], have been used to remove heavy metals from contaminated water. Adsorption is a particularly attractive method because of its low cost, high efficiency, and ease of operation [9]. In recent years, the need for safe and economical methods for the elimination of heavy metals from contaminated waters has necessitated research interest towards the use of low-cost adsorbents as alternatives to commercially available activated carbon and zeolites [10]. Inorganic oxides such as iron oxides have large surface areas and chemical and mechanical stability and can sorb heavy metals via adsorption and ion exchange. Iron oxide ore was chosen because it is very abundant in

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Zambia, specifically the central province [11]. Furthermore, Iron oxide is one of the metal oxides classified as low-cost adsorbents [12]. Sorption of toxic metals on oxides and clay minerals reduces their concentration and mobility in aqueous solution and natural environment [13]. Zambia largely depends on copper mining. In the process of mining, heavy metal effluents are released into water bodies causing water pollution [14]. One of the major problems Copper Mining has caused in Zambia is water pollution. There is an urgent need to research on cost-effective methods which can be used to remove Copper ions from water in Zambia [15]. In an economy like Zambia that is largely dependent on copper mining [16], the development and engineering of iron oxide as adsorbents for the removal of heavy metals such as copper offers exciting research opportunities in heavy metal mitigation in water.

Experimental Section

Materials

Chemical reagents for the preparation of adsorbate (Cu ions) and other chemicals provided by Mopani Copper Mines Plc included $CuSO_4.5H_2O$ and Amis 0348. Amis 0348 stands for African Mineral Standards 0348 used for certification of copper, cobalt oxide, or sulfides. One adsorbent Iron oxide was collected from Delca Palms Boarding School, Mkushi, Central Province, Zambia. The adsorbent was grounded and sieved to the particle size of 125 µm and dried for 2hrs at 105^oC.

Elemental Characterization of the Adsorbents

Elemental composition of the iron oxide ore sample was conducted at Analytical laboratory, Mopani Copper Mines Plc, Kitwe, Zambia.

X-ray Fluorescence (XRF) Analysis

About 0.3g of iron oxide was mixed with of 3g lithium nitrate, 1g lithium tetra borate, 1g lithium bromide, followed by an additional 5g of lithium tetra borate. Afterward, fusion of each mixture was done at a temperature of 1050 ^oC. The fused pellets were then analyzed using X-ray Fluorescence (XRF) on a Spectro Xepos spectrometer with the Amis 0348 samples used as quality control standards.

Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) Analysis

Acid digestion was used to prepare iron oxide adsorbents for ICP analysis. A 0.25g of adsorbent was mixed with 20 mL of concentrated HNO_3, 10 mL of concentrated $HClO_4$, and 10mL of concentrated HF and heated at 150 ^oC on a Digi PREP LS heating block. For quality control purposes, Amis 0348 (Laboratory standard) was used as a quality control standard and was prepared by acid digestion in the same way as the adsorbents. The standard was used to verify the entire analytical system and eliminate bias from analytical results by comparing the results of the standard with the values stated on the Certificate of Analysis for Amis 0348.

Thermal and Acid Activation of Adsorbents

For thermal activation**,** 30g of adsorbent was heated at a temperature of 650℃ for 4 hours and then allowed to cool naturally to room temperature. Whereas, for acid activation, 10 g of adsorbent was added to 50 mL of 0.5MHCl solution and stirred at 70° C for 30 min at 140 rpm. Afterward, the activated acid adsorbent was washed with distilled water to achieve neutrality (pH 6.9), thereafter, the adsorbent was oven dried at 120° C for 3 hours and cooled for further use [17].

Stock Solution Preparation Adsorption Experiments

A 1000 mg/L stock solution of Cu^{2+} ions was prepared by dissolving 3.96g of Copper (II) Sulfate pentahydrate ($CuSO_4.5H_2O$)99% in 1000 mL of distilled water. From this stock solution of Cu, working solutions of concentrations ranging from 10, 20, 40, 60, and 80 mg/L were prepared by dilution. In order to study the adsorption of

Cu^{2+} ions onto iron oxide adsorbents, the following factors were investigated:

1. The effect of concentration on the adsorption of metal ions.
2. The effect of pH on the adsorption of metal ions.

The Effect of Concentration on the Adsorption of Metal Ions

In order to investigate the effect of concentration on the adsorption of metal ions, 1.0 g of adsorbent was separately added into 50 ml of metal ion solution of varying concentrations (between 10-100 mg/L), while keeping all other parameters constant (shaker speed= 140 rpm; contact time= 3 hrs.; adsorbent mass=1.0g; temperature= 25℃, pH=7.0). After 3 hours, the mixture was filtered, and the filtrate Cu^{2+}concentrations were measured before and after adsorption using Atomic Absorption Spectroscopy (Anlytikjena, Model novAA 400P). The percentage of Cu^{2+}removal was calculated using Equation 1.

$$Cu^{2+}\ \text{removal}\ (\%) = \frac{\text{Initial}\ Cu^{2+} - \text{Final}\ Cu^{2+}\ \text{concentration}}{\text{Initial}\ Cu^{2+}\ \text{concentration.}}\ \text{x}\ 100 \quad \text{Equation 1}$$

The Effect of pH on the Adsorption of Metal Ions

Similarly, the effect of pH on the adsorption capacity of iron oxide was investigated under the same conditions as the effect of concentration. Except in this case, 0.1MNaOH and 0.1MHCl solutions were used to adjust the pH of the metal solution after the addition of the adsorbents to the metal ion solution. After 3 hours, the mixtures were filtered, and the Cu^{2+} concentrations were measured using Atomic Absorption Spectroscopy, and the percentage of Cu^{2+} removal was calculated using Equation 1.

Results and Discussion

Characterization of Adsorbents

X-ray Fluorescence Analysis

The results for the elemental analysis of the adsorbents using XRF are shown in Table 1. Iron oxide sand had predominately a high percentage of iron in relation to silicon and aluminum.

Table 1. Elemental Composition of Raw Inorganic Adsorbent using XRF

Component	Iron oxide (%)
Si	1.18
Al	0.51
Fe	42.57
Ca	0.12
Mg	0.11

In order to express the elemental composition as oxide-based results, the results from Table 1 were multiplied by the stoichiometric oxide conversion factors for SiO_2 (2.1392), Al_2O_3 (1.8895), Fe_2O_3 (1.4297), CaO (1.3992) and MgO (1.6582) [18]. The oxide-based compositions of the two adsorbents are depicted in Table 2. It is evident that iron oxide had up to 18.29% oxygen sites.

Table 2. Oxide-based Composition of Raw Inorganic Adsorbents using XRF

Component	Iron oxide (%) (IO)	Oxide Content (%)
SiO_2	2.53	1.35
Al_2O_3	0.96	0.45
Fe_2O_3	**60.86**	**18.29**

CaO	0.17	0.05
MgO	0.18	0.07

Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) Analysis

Elemental composition of the adsorbents was also verified by ICP-OES analysis, however, the use of acid digestion removed silica from the samples. The use of HF during acid digestion makes silica to volatilize before analysis HF breaks up strong Si-O bonds to form SiF_6^{2-} ions in acidic solution. Silicates are converted to volatile SiF_4, which will be lost in open-vessel digestion procedures [19]. Therefore, ICP analysis did not analyze the concentration of silica in the adsorbent. Table 3 shows the ICP-OES results for the major elements in iron oxide being Al and Fe. Using stoichiometric oxide conversion factors, the oxygen content of the individual elements is expressed in Table 4. The results from ICP-OES mirror those from XRF, except that elemental data from ICP is on the lower side.

Adsorption Experiments

The Effect of Concentration on the Adsorption of the Metal Ions

In order to investigate the effect of concentration on the adsorption of metal ions, several adsorption experiments were conducted while varying concentrations between 10-100 mg/L.

Table 3. Elemental Composition of Raw Inorganic Adsorbent using ICP-OES

Component	Iron oxide (%)
Al	0.50
Fe	>31.26
Ca	0.02
Mg	0.07

Table 4. Oxide based composition of inorganic adsorbents using ICP-OES

Component	Iron oxide (%)	Oxide Content (%)
SiO_2	-	-
Al_2O_3	0.95	0.45
Fe_2O_3	>44.69	**13.43**
CaO	0.03	0.01
MgO	0.12	0.07

Table 5. Percent Removal of Cu^{2+} ions using Acid Activated and Thermally Activated Iron Oxide from Different Concentrations of the Ions

Adsorbent	Cu^{2+} initial concentration (mg/L)	Cu^{2+} final concentration (mg/L)	Cu^{2+} removal (%)
Acid Activated			
Iron oxide (IO)	10	1.7	83
Iron oxide (IO)	30	5.4	82
Iron oxide (IO)	80	15.2	81
Iron oxide (IO)	100	20	80
-	-	-	Mean = 82±1
Thermally activated			

Iron oxide (IO)	10	2	80
Iron oxide (IO)	30	6.6	78
Iron oxide (IO)	80	19.2	76
Iron oxide (IO)	100	25	75
-	-	-	Mean = 77±4

The high adsorption of acid-activated adsorbents can be attributed to the fact that acid treatments help in the specific surface area increase, acidic centers, surface functional group modification, and high porosity with solids [17]. Acid activation results in several significant changes in clay adsorbent. Primarily, as most of the clay minerals possess the ion-exchange ability, ion-exchange reactions will occur. The exchangeable cations, usual cations of alkali or alkaline earth elements, e.g., Na^{+}, K^{+}, or Ca^{2+} located in the interlayer space of adsorbent, will be substituted for protons resulting from the dissociation of an acid. Protons of the acid easily penetrate into the interlayer space and react mainly with cations of the octahedral sheet. This process is known as "dealumination" as it comprises the substitution of octahedral Al^{3+} or Fe^{2+}/ Fe^{3+} ions by protons and the formation of additional Si-OH groups in the tetrahedral sheet. Consequently, the occurrence of ion exchange and dealumination enhances the surface and structural characteristics of clay minerals towards the adsorption of cations on dangling OH groups [20]. Thermal activation of clay minerals at elevated temperature results in the desorption of adsorbed gases and water molecules and the evolution of the free surface. However, at high pH, the structural integrity of the clay can undergo partial damage or entire structure collapse, followed by a reduction of surface activity [21].

The decrease in percent adsorption of Cu^{2+} on iron oxide as the initial metal concentration increased is apparent as shown in Figure 1. As the concentration of metal ions increased, accessibility of adsorption sites reduced, leading to low adsorption of metal ions. The reduction in the accessibility of adsorption sites by the metal ions was due to the competition of the metal ions for the limited adsorption sites. This may be because at lower concentrations, almost all ions were adsorbed very quickly, but a further increase in initial metal ion concentrations led to saturation of the adsorbent surface [3]. This means that the available binding sites had been saturated, and the adsorbent could no longer bind further ions as the number of sites available on the adsorbent is constant.

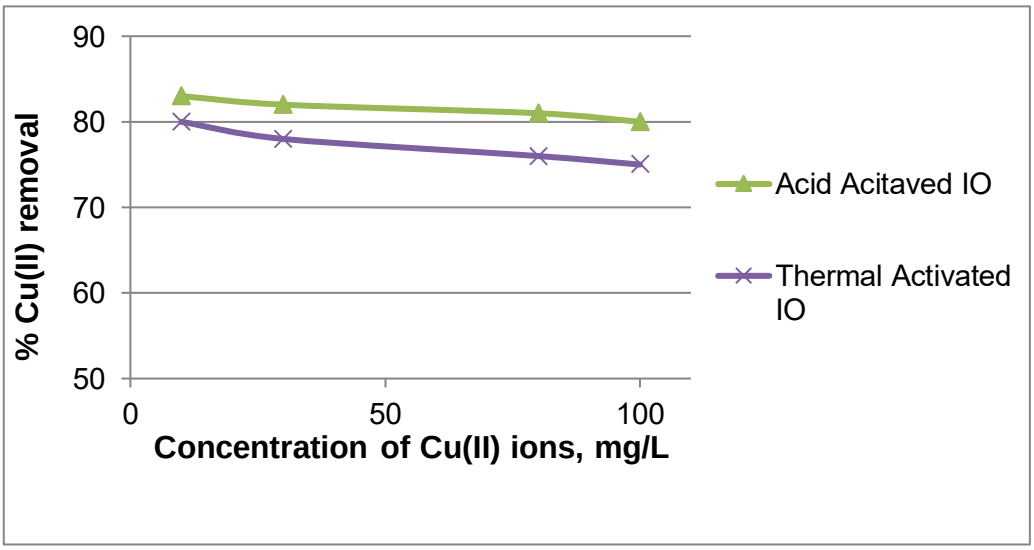

Figure 1. The Effect of Concentration on the Adsorption of Cu^{2+} ions

The Effect of pH on the Adsorption of Metal Ions

In order to investigate the effect of pH on the adsorption of Cu2+, several experiments were conducted at different pH values of 1.0, 4.0, 6.5, 7.0 and 8.5. The impact of pH on the adsorption of Cu2+ is shown in Figure 2. As pH increased from 1, the number of adsorbed ions also increased and peaked at pH 7 for Cu ions. The effect of pH on the adsorption of Cu2+ using both acid-activated- and thermally activated iron oxide is shown in Figure 2. The amount of Cu2+ removed was up to 80-95% at pH 7. It was established that the sorption of Cu2+ escalated as the pH increased to an optimum value of 7.

This result agrees to that reported by [22] where a low pH leads to the dissolution of cations such as Fe2+ and Al3+ that ultimately compete with copper (II) ions for adsorption. As pH increases, more hydroxide (OH-) sites are generated on the adsorbent leading to electrostatic interaction between the Cu2+ ions and the OH-1 [22]. In the pH range of 4 to 6, a slight increase in metal removal is observed which might be explained by the fact that the adsorption sites are no more affected by the pH change. An increase in Cu2+ as the pH increases can be explained by surface sites and by decreased positive charge, which results in a lower repulsion on the basis of decreased competition between protons and positively charged metal ions during adsorption [23].

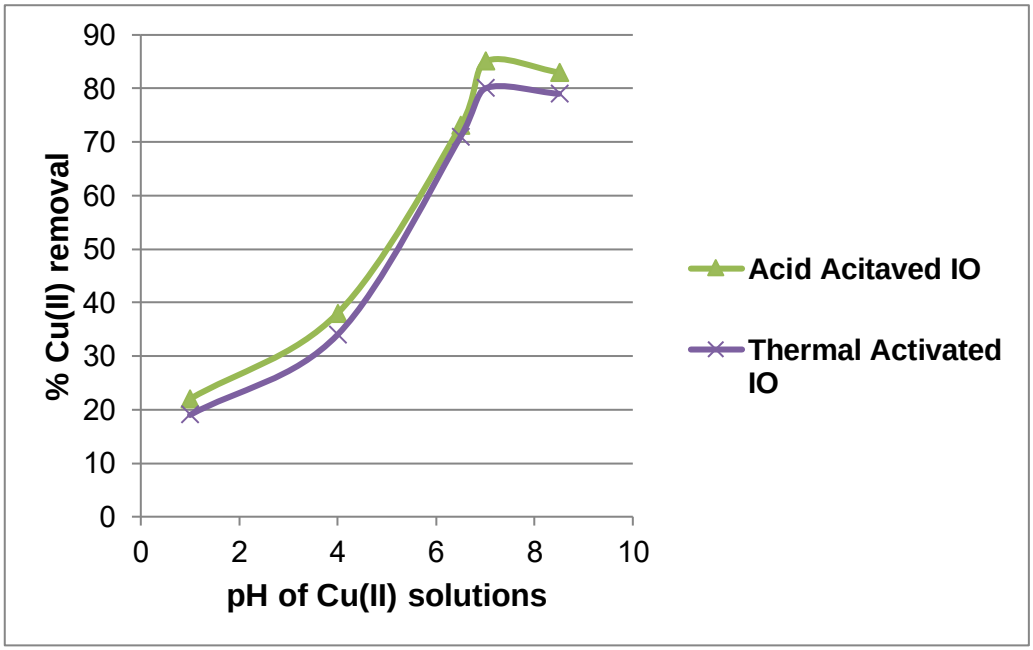

Figure 2. Effect of pH on the Adsorption of Copper (II) Ions on Iron oxide (IO)

Additionally, after pH of 7, a decrease of metal removal for Cu^{2+} compared to pH 6 is observed. At a higher pH, copper ions are precipitated in the form of hydroxides, and this reduces the rate of adsorption and, consequently the removal capacity of heavy metals. The precipitation of the metal ions makes them immobile, and this reduces the adsorption of these metal ion. This can also be explained by the increasing amount of Na^{+} in the solution (due to pH adjustment), which competes with the remaining Cu^{2+} on the exchangeable sites [24]. Acid activation proved to be a better method of adsorbent activation than thermal activation. Chemical activation or modification usually provides the strongest effect on the structure and properties of materials because of the chemical interactions of a modifying agent and the surface of the material. Acid treatments help in the specific surface area increase, acidic centers, surface functional group modification, and high porosity with solids [17].

Conclusion

The use of Iron oxide for the removal of copper (II) ions from an aqueous solution via adsorption process has demonstrated the extent to which the metal ions can be removed by these two adsorbents. The results showed that as the initial metal concentration increased, the percentage removal of Cu^{2+} decreased. As the concentration of metal ions increased, accessibility of adsorption sites reduced, which led to low adsorption of metal ions. The reduction in the accessibility of adsorption sites by the metal ions was due to the competition of the metal ions for the limited adsorption sites. This may be because at lower concentrations, almost all ions were adsorbed very quickly, but a further increase in initial metal ion concentrations led to saturation of the adsorbent surface.

Acid activation was found to be a better method of adsorbent activation as compared to thermal activation because the acid treatment causes mineral dissolution, which increases the surface area and porosity of the adsorbent. Firstly, for the concentration with a low pH, the content of H^+ is high, which will lead to mineral dissolution, releasing ions such as Mg (II), Fe (II), and Al (III). These ions compete with copper (II) ions for adsorption sites. At elevated pH, the content of H^+ decreases, leading to many hydroxyl groups on the adsorbents, thus, increasing the rate of adsorption of Cu ions. Secondly, if the pH is low, the surface groups are protonated. Consequently, it will produce a positive surface charge which may weaken the ability to form complexes with Cu^{2+} ions.

Finally, the research has shown that abundant iron oxide can be engineered for the adsorption of metals, and this work prompts an extension to the removal of lead (Pb) ions which has affected the Kabwe Township in Zambian that closed after the depletion of PBS galena ore.

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Disclosure Statement

The authors report there are no competing interests to declare.

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Gadolinium Distribution in the Kidney, Liver, and Heart of Wistar Rats after Administration of Gadolinium-Based Contrast Agents

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Abstract

Magnetic resonance imaging (MRI) is an established non-invasive and non-destructive medical imaging modality for the assessment of various organ systems in the human body. Gadolinium-Based Contrast Agent (GBCA) enhanced and improved images from MRI and was believed to be entirely excreted through urine in normal kidney function within 24 hours after injection. Previous studies identified gadolinium accumulations in the brain, bones, and skin of animals. This study evaluated gadolinium retention in normal kidneys, Liver, and heart of Wistar rats after administration of GBCAs in male Wistar rats. Twenty-five male Wistar rats of ages ≥ 5 weeks or ≤ 6 weeks in 4 experimental and 1 control groups were studied. Ethical considerations were obtained from the Institutional Review Board (IRB) of the Nigerian Institute of Medical Research (NIMR), Nigeria. Samples in experimental groups each administered 2.5 mls of 4 different GBCAs, and the control group same per day of saline intravenously through the lateral tail for five days a week and continued for 4 weeks. The kidney, Liver, and Heart tissues of these samples were harvested 4 weeks after the last injection and sent for spectrometry evaluation. Samples in the control group had no gadolinium accumulation. Groups administered gadopentetate dimeglumine, and gadodiamide had greater cardiac metrics (0.397 and 0.390). The higher renal metric was experienced by samples that received dotarem and cyclolux (0.397 and 0.377), though the sample exposed to cyclolux reported more Liver metric (0.407) than other concentrations. Wistar rats' Kidneys, Liver, and Heart retained gadolinium weeks after injection of GBCAs.

Keywords: *Dotarem and Cyclolux, Gadolinium, Gadodiamide, Gadopentetate dimenglumine, Magnetic resonance imaging.*

Introduction

Magnetic resonance imaging (MRI) is a well-established non-invasive, and non-destructive medical imaging modality for the assessment of various organ systems in the human body [1], including the kidney, hepatic structures, and cardiovascular system. They often provide images that are superior to those obtained with computed tomography (CT) scans and have the advantage of avoiding iodinated radio-contrast agents having more overall toxicity [2]. Impaired or pathologic organs may retain gadolinium after injection of GBCAs during MRI scan and should therefore be used with extreme caution [3, 4]. Lately, a growing body of data [5-7] demonstrated that gadolinium gathers in tissue (brain, bone, and kidney) of patients exposed to GBCAs during MRI. Retention of gadolinium has been studied to increase in those who have repeated GBCAs exposure [5, 6]. Studies found that linear GBCAs cause much greater brain deposition of gadolinium than macrocyclic GBCAs in

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animals and humans [8,9]. Many arguments were generated about the use of linear GBCAs in 2017 despite continuous use for nearly 30 years with the only reported major adverse event being NSF [10]. [11], reported on the behavioral abnormalities of fetal mice when exposed to 100 doses of linear GBCAs, and rats live approximately 3 years and assume sexual maturity in ≥ 6 weeks [12-14]. The American College of Radiology and the US Food and Drug Administration (FDA) refused to restrict the use of linear GBCAs (FDA). The decision on the use of the linear GBCAs during MRI studies in the USA, Japan, and Europe are totally different because it is still unclear whether the gadolinium accumulation in the brain is toxic [10], though the Japanese radiologists use of the agent has drastically decreased from 64.7 % in 2014 to 24.7 % in 2016[15]. Gadolinium depositions in the human body have received fundamental interest associated with impaired or pathologic organs after injection of GBCAs during MRI; this retention had been documented with the brain, bone, and soft tissues following repeated administrations and has resulted in numerous lawsuits. There is, however, concern for normal major organs to prevent unforeseen toxicity. We hypothesized the following: i) there is no concentration of gadolinium in the tissue of the kidney, Liver or heart of Wistar rats and that there is no statistically significant difference in the concentration distributions of the four different GBCAs on the Kidney, Liver, and Heart of male Wistar rats. Therefore, this study aimed to determine the concentration distributions of the gadolinium-based contrast agents after administration in the kidney, Liver, and heart of Wistar rats.

Materials and Methods

Research Design

This was an experimental study. This design was adopted because the animal understudy have biological and behavioral characteristics closely resemble to those of humans, and animal-like rats are susceptible to most similar health conditions as humans. All variables and their relationships were carefully identified. Predictions that are specific and testable were decided.

Area of Study

The animals were housed and later sacrificed at the physiology laboratory of Bayero University, Kano State, Nigeria, under standard conditions. They had free access to water and diet (normal rat foodstuff). They were acclimatized for two weeks prior to the onset of this experiment. The histology and mass spectrometry was conducted at histology and chemical pathology laboratories Ysusuf Maitama Sule University, Kwanar Dawaki Campus Kano, Nigeria.

Ethical Consideration and Selection Criteria

All methods adopted in this study were conventionally in line with Nigerian animal welfare law and experimental protocols, compliance with the “Guide for Care and Use of Laboratory Animals” summarized by [16]. The experiments were conducted after an ethical approval (IRB/21/038) was obtained from the Institutional Review Board (IRB) of the Nigerian Institute of Medical Research (NIMR), Yaba Lagos, Nigeria.

Inclusion Criteria

1. Male Wistar Rats.
2. Ages ≥ 5 ≤ 6 weeks.

Exclusion Criteria

1. Female Wistar Rats due to hormonal fluctuations.
2. < 5 weeks of age not equating to adult human.

Sample Size Determination and Sampling Technique

A simple approach to calculating sample size was adopted in this study since the effect of different GBCAs is to be examined, plus to

avoid complex statistical calculations and ethical issues. This method is based on ANOVA calculations and the sample size for this study was reached at twenty-five (25) Wistar rats. A simple random technique was adopted to group the animals.

Animal Specimen

The animals studied were twenty-five (25) healthy male wistar albino rats, and their health condition was only determined by thorough observations, body weight, age, and assessment. No blood or urine volume, heart rate, allergens and respiratory rate taken. This model was selected for this study owing to their smaller body size, high rate of survival, and lower tumor or lesion incidence compared to other outbreed rats. The ages of the animal were $\geq 5 \leq 6$ weeks old, because they have reached maturity at this time [14, 17]. The male breeds were studied since the female hormones fluctuate during the reproductive cycle and could influence the outcome of the experiment (18]. The animals received 20 intravenous injections each of 2.5 mmol GBCA per kilogram (gadolinium-exposed group) or saline (control group) over a period of 28 days (4 weeks). The animals were killed without anaesthesia. The kidney, Liver, and heart tissues of each of the animals were harvested for histological changes and subjected to plasma mass spectrometry (PMS) for assessment and quantification of gadolinium retention.

Experimental / Test Agents

The contrast media used for this study were:

1. Gadopentetate dimeglumine known as magnetect (Gd-DTPA), is an ionic Gd complex with a linear polyaminocarboxylic acid ligand. The chemical formula is $C_{28}H_{54}GdN_5O_{20}$.
2. Gadodiamide, also known as Omniscan (Gd-DTPA-BMA), a linear, non-ionic Gd complex with the chemical formula of $C_{16}H_{28}GdN_5O_9$.
3. Gadoterate meglumine, known as doterem by Guerbet (DOTA-Gd), a macrocyclic ionic GBCA having the chemical formula of $C_{23}H_{42}GdN_5O_{13}$.
4. Gadoterate meglumine, known as cyclolux by Sanochemia (DOTA-Gd), also a macrocyclic ionic.

Instrument and Procedures for Data Collection

Instrument used in this study are:

1. Microscope.
2. Spectrophotometer.

Method of disposal of Animal

The incineration method through the licensed commercial medical waste company was used after the body parts, and carcasses of the Rats are bagged in a seal bag provided by division of laboratory animals.

Statistical Analysis

Data were categorized into groups A, B, C, D, and E based on the type of contrast administered. Statistical analysis was done on the statistical package for the social science SPSS version 23 (SPSS incorporated, Chicago) using descriptive statistics (mean values, frequency, and percentages).

Results

GBCAs in the Tissues of the Kidney, Liver and Heart of Male Wistar Rats

Table 1 shows the absorbance values of gadolinium in tissues of the organs studied from concentration of different GBCAs administered. The group that received gadodiamide had gadolinium absorbance, Heart > Kidney > Liver (0.404, 0.397, 0.376). Kidney > Heart > Liver absorbance of Gd^{+3} (0.383, 0.359, 0.346) in group that received dot area, whereas Heart > Liver > Kidney absorbance of Gd^{+3} (0.394, 0.371, 0.386) in group that received gadopentetate dimeglumine. The group that received cyclolux had Gd^{+3} Liver > Kidney >Heart (0.412, 0.405, 0.389). The only

group with Liver =kidney=Heart =0 from concentration was the group that received normal saline. Figure 1 shows the spectrometric curve of absorbance gadolinium plotted against the GBCAs concentration, and Figure 2 illustrates the graphical distribution of the GBCAs in the Kidney, Liver, and heart tissue of samples studied.

Table 1. Gadolinium Absorbance and GBCAs Concentration in the Kidney, Liver, and the Heart of Male Wistar Rats

Gadopentetate Dimeglumine	**Kidney**			**Liver**			**Heart**		
	Abs.	**Conc.**	**Total**	**Abs.**	**Conc.**	**Total**	**Abs.**	**Conc.**	**Total**
1	0.363	1.523	1.886	0.377	1.579	1.956	0.394	1.647	**2.0410**
2	0.369	1.547	1.916	0.386	1.615	2.001	0.384	1.607	**1.9910**
3	0.366	1.559	1.925	0.372	1.559	1.931	0.389	1.627	**2.0160**
4	0.371	1.587	1.958	0.379	1.587	1.966	0.394	1.647	**2.0410**
Total	**1.469**	**6.216**	**7.685**	**1.514**	**6.340**	**7.854**	**1.561**	**6.528**	**8.0890**
Gadodiamide									
1	0.363	1.523	1.886	0.352	1.479	1.831	0.391	1.635	**2.0260**
2	0.366	1.535	1.901	0.331	1.395	1.726	0.396	1.655	**2.0510**
3	0.397	1.659	2.056	0.360	1.511	1.871	0.397	1.659	**2.0550**
4	0.365	1.531	1.896	0.390	1.631	2.021	0.397	1.659	**2.0560**
5	0.368	1.543	1.911	0.376	1.575	1.951	0.404	1.687	**2.0910**
Total	**1.859**	**7.791**	**9.650**	**1.809**	**7.591**	**9.400**	**1.985**	**8.295**	**10.279**
Dotarem									
1	0.372	1.559	1.931	0.332	1.399	1.731	0.352	1.479	**1.831**
2	0.371	1.555	1.926	0.329	1.387	1.716	0.359	1.507	**1.866**
3	0.383	1.603	1.986	0.331	1.395	1.726	0.335	1.411	**1.746**
4	0.374	1.567	1.941	0.346	1.455	1.801	0.355	1.491	**1.846**
5	0.372	1.559	1.931	0.336	1.415	1.751	0.352	1.479	**1.831**
Total	**1.872**	**7.843**	**9.715**	**1.674**	**7.051**	**8.725**	**1.753**	**7.367**	**9.120**
Cyclolux									
1	0.370	1.551	1.921	0.398	1.663	2,061	0.389	1.627	**2.016**
2	0.401	1.675	2.076	0.406	1.695	2.101	0.376	1.575	**1.951**
3	0.405	1.691	2.096	0.407	1.699	2.106	0.380	1.591	**1.971**
4	0.405	1.691	2.096	0.412	1.719	2.131	0.376	1.575	**1.951**
5	0.402	1.679	2.081	0.410	1.711	2.121	0.374	1.567	**1.941**
Total	**1.983**	**8.287**	**10.270**	**2.033**	**8.487**	**10.520**	**1.895**	**7.935**	**9.830**
Normal Saline									
1	0.000	0.0712	0.0712	0.000	0.0712	0.0712	0.000	0.0712	**0.0712**
2	0.000	0.0712	0.0712	0.000	0.0712	0.0712	0.000	0.0712	**0.0712**
3	0.000	0.0712	0.0712	0.000	0.0712	0.0712	0.000	0.0712	**0.0712**
4	0.000	0.0712	0.0712	0.000	0.0712	0.0712	0.000	0.0712	**0.0712**
5	0.000	0.0712	0.0712	0.000	0.0712	0.0712	0.000	0.0712	**0.0712**
Total	**0.000**	**0.3560**	**0.3560**	**0.000**	**0.3560**	**0.3560**	**0.000**	**0.3560**	**0.3560**

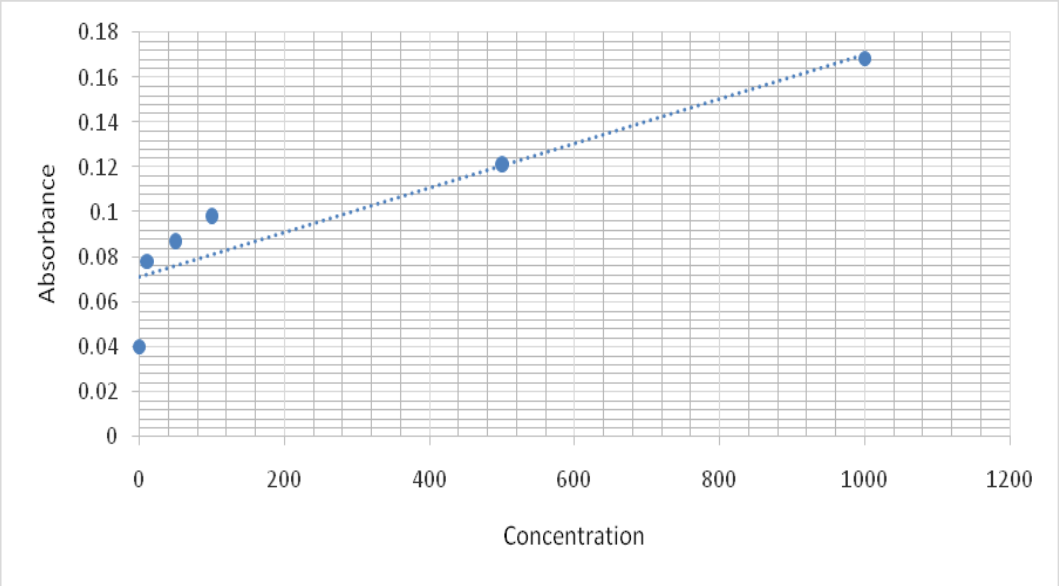

Figure 1. Spectrometry Curve of Absorbance Gadolinium against GBCAs Concentration in the Tissues of the Kidney, Liver, and Heart of Male Wistar Rats

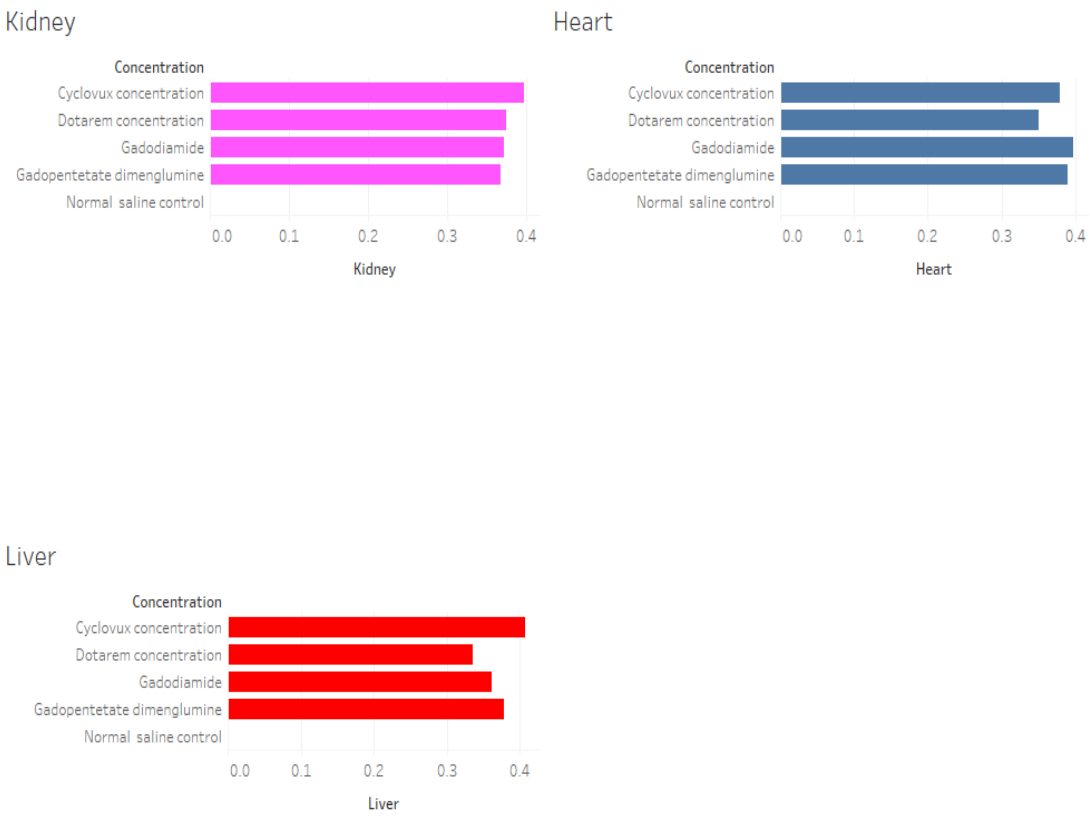

Figure 2. Distribution of GBCAs in the Tissues of the Heart, Liver and Kidney of Male Wistar Rats

Discussion

This current study utilized two linear (gadopentetate dimeglumine and gadodiamide), together with two macrocyclic, brands of gadoterate (dotarem and cyclolux) and was observed that all the GBCAs had deposition of gadolinium in the tissue of the organs studied as this was confirmed through the spectrophotometric readings, in agreement with previous study [19]. We found that the Gadopenetate Dimeglumine absorbance and concentration in the organs studied were highest in the heart, followed by the kidney and the least was found in the Liver. The absorbance and concentration of Gadodiamide was found to be highest in the heart, followed by kidney, and the least was recorded in the Liver of the Wistar rats. With regards to the Dotarem contrast agent, both the absorbance and concentration were mostly found in the kidney, followed by the heart and the least in the Liver of the animals. The Liver had the highest absorbance and concentration of the Cyclolux contrast agent. These findings imply that different contrast agents accumulate or are being retained at different amount depending on the types of the agent as well as the tissues of the organ under investigation. These findings agree with the findings of the studies conducted by [8, 20-23], which also reported that the degree of deposition of contrast agents used MRI varies with the types of agent used as well as the tissues of the organs examined. According to [24], gadolinium is a none naturally occurring biological component, and once administered into the tissues of an animal, it is retained for a long duration.

Conclusion

All the GBCAs had deposition of gadolinium in the tissue of the organs studied, as this was confirmed through the spectrophotometric readings. The concentration of the agents' deposition varies with the types of the agent administered as well as the tissues of the organ under investigation.

Conflict of Interest

None declared among the authors.

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Impact of Training on Virtual Instructional Leadership in Jamaica During the Covid-19 Pandemic

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Abstract

Globally, instructional leadership is critical to the educational reform agenda of schools. The purpose of this study was to ascertain educators' perceived effectiveness of virtual instructional leadership training on school leadership in Jamaica during the Covid-19 pandemic. It also sought to examine if there are statistically significant differences in the scores of the composite dependent (instructional resource provider; maintain visible presence; professional development; maximize instructional time; monitoring students' progress; feedback on teaching learning; curriculum implementation) based on school level, capacity in which educators work and gender. The instrument used to collect data for this study was adopted by the researcher. The instrument was converted into a Google Form to make it easier for distribution and data collection. The authors reported that the instrument achieved reliability of Cronbach Alpha amongst the tenets ranging from 0.87-0.80. Overall, the instruments' reliability statistic is. 95. The data was analyzed using weighted means and MANOVA. The results revealed that the educators rated four dimensions of the instructional leadership scale High, maintaining visible presence; professional development; feedback on teaching learning, and curriculum implementation. In addition, instructional resource provider; maximize instructional time, and monitoring students' progress were rated moderate. Another finding of this study is that there is no statistically significant difference in the scores of the composite dependent variables based on school level, capacity served, and gender. Another implication of the finding of this research is that principals must ensure that instructional time is maximized by managing and planning for instruction, assessment, and other teacher-student activities while developing strong relationships with teachers and students by rewarding them for achieving targets.

Keywords*: Covid 19 Pandemic, Curriculum implementation, Feedback on teaching and learning, Instructional resource provider, Maintain visible presence, Maximize instructional time, Monitoring students' progress, Professional development, Virtual instructional leadership.*

Introduction

Globally, instructional leadership is critical to the educational reform agenda of schools. The role of the instructional leader is to provide teachers with essential resources and ongoing professional development for students' success [1]. The widespread Coronavirus Disease (Covid-19) recorded its first case in Jamaica on March 9, 2020 immediately following was the mandatory closing of schools on March 12, 2020. Since then, schooling has never been the same in Jamaica. School administrators and teachers had to plan how to mitigate teaching students remotely, which was a first in the education system on a large scale in Jamaica,

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especially at the early childhood, primary, and secondary school levels. However, there was a huge concern that many principals lacked the skills in instructional leadership that would effectively lead the new normal brought on by the pandemic. Moreso, a principal's pedagogical beliefs and instructional leadership behaviors will affect their adoption of virtual learning and leadership. One of Jamaica's Ministry of Education's main thrusts focuses on the utilization of Information and Communication Technology (ICT) as a primary avenue for improving the teaching-learning process across all school and grade levels. An effective school leader is one who has mastered instruction and is able to demonstrate to his or her staff that they are an effective instructional leader [1]. Consequently, in light of the pandemic, the school leader will need to effectively demonstrate this attribute.

Related Literature

Instructional leadership is essential in educational reform. The role of the instructional leader is to provide teachers with essential resources and ongoing professional development for students' success [1]. Resources relevant to the curriculum and their skillful implementation are made possible through the management of effective instructional forecasts to support the effective implementation of the curriculum [2-3].

In relation to maintaining of visible presence, the instructional leader's presence must be felt in all areas [4]. The principal must supervise and evaluate teachers' instructional practices and professional development. This role is necessary to assess learning targets, an exhibition of practices of learning, and establish programs and exercises on guideline [5]. The instructional leader must assess teachers' professional development needs and offers purposeful professional development opportunities to develop teachers' instructional skills, knowledge, and attitude [6]. The principal must also do follow-ups to evaluate the effectiveness of professional development opportunities and give feedback and constructive criticisms. Principals must ensure that instructional time is maximized. This includes managing and planning for instruction, assessment, and other teacher-student activities. Thus, teacher and student supervision is critical to the effective functioning of the school. This should also include tokens and other motivation strategies for students and teachers who meet expectations and beyond.

Principals must monitor student learning progress to gather data pertinent in making instructional decisions and providing feedback to students and parents on their progress and learning achievements [7]. Effective instructional leaders conduct regular classroom inspections, set and communicate clear evaluation criteria, give feedback on teaching learning through collaboration with staff and students [8-10]. Thus, the dimension of providing feedback on teaching and learning becomes paramount. This can include being visible physically throughout the school, providing praise and feedback to teachers concerning their growth and capacity development. It must be noted that giving praise and feedback to parents is essential and other activities on student's behaviours helps to ensure instructional time is maximized [11]. In relation to curriculum implementation, the principal must seek to provide an environment that caters to the efficient instructional development, management, and organization of content, interventions, and monitoring in the teaching-learning space [12-13]. The instructional leader must possess adequate learning, aptitudes, and expertise [14] to ensure sufficient learning action, scope of syllabus in time, and astute supervision [12].

Capacity served and school level served by principal influences the effectiveness of the principals' instructional supervision [15]. These factors influence technical, human, and conceptual skills of supervision. These consist of a set of skills required for the planning,

staffing, and coordination of supervision. That is, skills that are concerned with the use of knowledge and methodology required to carry out established tasks. These skills also include forming productive relationships with people and the ability to see the school through the lens of system thinking. Research shows that gender influences different patterns of instructional leadership [16-19]. Their results revealed a small but statistically significant effect of gender on instructional in instructional leadership practices, which are meaningful. Female leaders tend to achieve higher ratings on transformational leadership as well as engaging in more contingent reward behaviours associated with transactional leadership [20].

Materials and Methods

In an effort to ascertain the effectiveness of the Virtual Instructional Leadership training on school leadership in Jamaica during the pandemic, literature was reviewed thoroughly to find an instrument that could be adapted and or adopted to be utilized in gathering the data for this study. Having found one, the authors were written seeking and receiving permission to utilize the instructional leadership scale questionnaire. Assistance was sought and received from the National College of Educational Leadership (NCEL) in assisting with the administering of the instrument to all participants who participated in a Virtual Instructional Leadership course. The researcher made minor changes to the adopted instrument to include keywords such as virtual and online. The instrument was converted into a Google Form to make it easier for distribution and data collection. The authors reported that the instrument achieved reliability of Cronbach Alpha amongst the tenets ranging from 0.87-0.80. Overall, the instruments' reliability statistic is. 95. This is highly respectable and made the instrument appropriate to collect data for this study. The data were analyzed using weighted means and MANOVA.

The birth of this research came about as the impact of the Covid-19 pandemic has led to the Ministry of Education engaging several stakeholders to assist with the training of teachers on how to utilize varying online platforms and community physical resources to engage students through professional development sessions with various stakeholders such as the Jamaica Teaching Council. Through forged partnerships with UNICEF, the National College for Educational Leadership (NCEL), and the Ministry of Education and Youth (MOEY) the course Virtual Instructional Leadership was created in April 2020. The primary aim of this course was to help school leaders at the early childhood, primary and secondary levels within the seven educational administrative regions to gain the necessary exposure to not only applicable technologies but to increase and expand their knowledge of the plethora of tools, resources, platforms and best practices that can be employed while leading remotely. The training was targeted for at least 50 cohorts of school leaders, with at least 250 per cohort group. This training was done in preparation for school leaders to begin their planning for the new school year on the preposition that they will utilize digital collaborative tools, development of accountability systems that would guide the virtual participation and effective supervision of staff while adopting Virtual Learning Environments (VLEs) and other digital resources to bolster the teaching and learning process within their specific context. Hence, the aim of the Virtual Instructional Leadership course was to increase the ICT competencies of the school leaders, which would play a critical role in their delivery of excellent student-centered teaching-learning constructs and outcomes, effective monitoring and evaluation of both students and teachers within the virtual context. The course was a deliberate attempt to equip Jamaican school leaders in having the requisite knowledge to face the complex challenges of leading remotely during this

global pandemic. With the training completed, there is no documented study on the effect it had on school leaders as they led within the context of their school for the new school year. Hence the main objective of this study was to determine the effect of Virtual Instructional Leadership training on principals'' school leadership in Jamaica during the pandemic.

Results

Research Question 1

What is educators' perceived effectiveness of Virtual Instructional Leadership training on school leadership in Jamaica during the Covid-19 pandemic?

Analysis – Impact of Covid 19 on School Administrators' Leadership Attributes

The data in table one show that the educator participants rated four of the seven dimensions of the instructional leadership scale High. These were: maintain visible presence (M = 3.93; SD = 0.47); professional development (M = 3.77; SD = 0.63); feedback on teaching learning (M = 4.54; SD = 0.54), and curriculum implementation (M = 4.24; SD = 0.63). This result shows that these dimensions of the instructional leadership scale were highly effective during the Covid-19 pandemic while implementing virtual learning. This suggests that educators will continue to use these attributes in similar and novel situations in schools.

In addition, three of the seven dimensions of the instructional leadership scale were rated Moderate. These are: instructional resource provider (M = 3.51; SD = 0.43); maximize instructional time (M = 3.40; SD = 0.54), and monitoring students' progress (M = 3.59; SD = 0.83). These findings suggest these dimensions of the instructional leadership scale were perceived as effective during the Covid-19 pandemic while implementing virtual learning, but they could be improved upon. This suggests that educators will continue to use these attributes in similar and novel situations in schools. However, it is important for administrators and policy makers to ascertain how these dimensions can be more effectively implemented.

Table 1 shows that the educators rated four dimensions of the instructional leadership scale High, maintaining visible presence; professional development; feedback on teaching learning, and curriculum implementation. This result shows that these dimensions of the instructional leadership scale were highly effective during the Covid-19 pandemic while implementing virtual learning.

Table 1. Descriptive Statistics

Dimensions of IL Scale	**Mean**	**Std. Deviation**	**Interpretation**
Instructional resource provider	3.51	.43	Moderate effectiveness
Maintain visible presence	3.97	.58	High effectiveness
Professional development	3.77	.63	High effectiveness
Maximize instructional time	3.40	.53920	Moderate effectiveness
Monitoring students' progress	3.59	.82696	Moderate effectiveness
Feedback on teaching learning	3.86	.66594	High effectiveness
Curriculum implementation	4.24	.63392	High effectiveness
Valid N (listwise)	-	-	-
The mean ranges for interpretation include: 1.00 – 2.33 = Low effectiveness; 2.34 – 3.67 = Moderate effectiveness and 3.68 – 5.00 = High effectiveness.			

Results

The educators rated four dimensions of the instructional leadership scale High, maintain visible presence; professional development; feedback on teaching learning, and curriculum implementation. This result shows that these dimensions of the instructional leadership scale were highly effective during the Covid-19 pandemic while implementing virtual learning. This suggests that educators will continue to use these attributes in similar and novel situations in schools. In addition, three of the seven dimensions of the instructional leadership scale were rated Moderate: instructional resource provider; maximize instructional time, and monitoring students' progress. These findings suggest these dimensions of the instructional leadership scale were perceived as effective during the Covid-19 pandemic while implementing virtual learning, but they could be improved upon. This suggests that educators will continue to use these attributes in similar and novel situations in schools. However, it is important for administrators and policy makers to ascertain how these dimensions can be more effectively implemented.

Research Question 2

Is there statistically significant differences in the scores of the composite dependent variable (instructional resource provider; maintain visible presence; professional development; maximize instructional time; monitoring students' progress; feedback on teaching learning; curriculum implementation) based on school level?

H_01: There is no statistically significant differences in the scores of the composite dependent (instructional resource provider; maintain visible presence; professional development; maximize instructional time; monitoring students' progress; feedback on teaching learning; curriculum implementation) based on school level.

Analysis – Instructional Leadership Scale Based on School Level

The results from the statistical analysis showed that there is no statistically significant difference in the scores of the composite dependent variables (instructional resource provider; maintain visible presence; professional development; maximize instructional time; monitoring students' progress; feedback on teaching learning; curriculum implementation) based on school level. The multivariate main effect of school level on the combined dependent instructional leadership variables was not statistically significant, F (42, 180) = 1.106, p = .533, Pillai's Trace = .533, partial eta square, η^2_p = .184. The observed power was .905 (see table 2). However, less frequently used statistic, Roy's Largest Root (.001), showed statistical significance, F (7, 30) = 1.125, p = .001, Roy's Largest Root = .001, partial eta square, η^2_p = .529. The observed power was .983 (see table 2). This finding can be taken with caution if used to make the decision at the different school level.

Table 2 shows that there is no statistically significant difference in the scores of the composite dependent variables (instructional resource provider; maintain visible presence; professional development; maximize instructional time; monitoring students' progress; feedback on teaching learning; curriculum implementation) based on school level. The multivariate main effect of school level on the combined dependent instructional leadership variables was not statistically significant, F (42, 180) = 1.106, p = .533, Pillai's Trace = .533, partial eta square, η^2_p = .184.

Research Question 3

Is there a statistically significant difference in the scores of the composite dependent variable (instructional resource provider; maintain visible presence; professional development; maximize instructional time;

monitoring students' progress; feedback on teaching learning; curriculum implementation) based on capacity served?

H_02: There is no statistically significant differences in the scores of the composite dependent (instructional resource provider; maintain visible presence; professional development; maximize instructional time; monitoring students' progress; feedback on teaching learning; curriculum implementation) based on capacity served.

Analysis – Instructional Leadership Scale Based on Capacity Served

The results from the statistical analysis showed that there is no statistically significant difference in the scores of the composite dependent variables (instructional resource provider; maintain visible presence; professional development; maximize instructional time; monitoring students' progress; feedback on teaching learning; curriculum implementation) based on capacity served. The multivariate main effect of school level on the combined dependent instructional leadership variables was not statistically significant, F (7, 29) = 1.236, p = .224, Pillai's Trace = .533, partial eta square, η^2_p = .224. The observed power was .669 (see Table 3).

Table 3 shows that there is no statistically significant difference in the scores of the composite dependent variables (instructional resource provider; maintain visible presence; professional development; maximize instructional time; monitoring students' progress; feedback on teaching learning; curriculum implementation) based on capacity served.

Research Question 4

Is there statistically significant differences in the scores of the composite dependent variable (instructional resource provider; maintain visible presence; professional development; maximize instructional time; monitoring students' progress; feedback on teaching learning; curriculum implementation) based on gender?

H_03: There is no statistically significant differences in the scores of the composite dependent (instructional resource provider; maintain visible presence; professional development; maximize instructional time; monitoring students' progress; feedback on teaching learning; curriculum implementation) based on gender.

Analysis – Instructional Leadership Scale Based on Gender

The results from the statistical analysis showed that there is no statistically significant difference in the scores of the composite dependent variables (instructional resource provider; maintain visible presence; professional development; maximize instructional time; monitoring students' progress; feedback on teaching learning; curriculum implementation) based on gender. The multivariate main effect of school level on the combined dependent instructional leadership variables was not statistically significant, F (21, 90) = .716, p = .807, Pillai's Trace = .807, partial eta square, η^2_p = .143. The observed power was .509 (see Table 4).

Table 4 shows that there is no statistically significant difference in the scores of the composite dependent variables (instructional resource provider; maintain visible presence; professional development; maximize instructional time; monitoring students' progress; feedback on teaching learning; curriculum implementation) based on gender.

Table 2. Multivariate Test

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Pillai's trace	1.106	.968	42.000	180.000	.533	.184	40.665	.905
Wilks' lambda	.248	.995	42.000	120.712	.491	.207	31.589	.745
Hotelling's trace	1.843	1.024	42.000	140.000	.445	.235	43.002	.912
Roy's largest root	1.125	4.820[a]	7.000	30.000	.001	.529	33.743	.983
Each F tests the multivariate effect of School Level. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.								
a. The statistic is an upper bound on F that yields a lower bound on the significance level.								
b. Computed using alpha = .05								

Table 3. Multivariate Tests

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[d]
Intercept	Pillai's Trace	.989	369.008[b]	7.000	29.000	.000	.989	2583.058	1.000
	Wilks' Lambda	.011	369.008[b]	7.000	29.000	.000	.989	2583.058	1.000
	Hotelling's Trace	89.071	369.008[b]	7.000	29.000	.000	.989	2583.058	1.000
	Roy's Largest Root	89.071	369.008[b]	7.000	29.000	.000	.989	2583.058	1.000
Capacityserved	Pillai's Trace	.448	1.236	14.000	60.000	.274	.224	17.307	.669
	Wilks' Lambda	.590	1.251[b]	14.000	58.000	.266	.232	17.509	.672
	Hotelling's Trace	.631	1.262	14.000	56.000	.260	.240	17.664	.674
	Roy's Largest Root	.504	2.159[c]	7.000	30.000	.067	.335	15.113	.714
a. Design: Intercept + Capacityserved									
b. Exact statistic									
c. The statistic is an upper bound on F that yields a lower bound on the significance level.									
d. Computed using alpha = .05									

Table 4. Multivariate Tests

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[d]
Intercept	Pillai's Trace	.987	313.637[b]	7.000	28.000	.000	.987	2195.457	1.000
	Wilks' Lambda	.013	313.637[b]	7.000	28.000	.000	.987	2195.457	1.000
	Hotelling's Trace	78.409	313.637[b]	7.000	28.000	.000	.987	2195.457	1.000
	Roy's Largest Root	78.409	313.637[b]	7.000	28.000	.000	.987	2195.457	1.000
Gender	Pillai's Trace	.429	.716	21.000	90.000	.807	.143	15.031	.509
	Wilks' Lambda	.618	.704	21.000	80.951	.817	.148	14.093	.467
	Hotelling's Trace	.544	.691	21.000	80.000	.830	.153	14.501	.480
	Roy's Largest Root	.348	1.493[c]	7.000	30.000	.208	.258	10.450	.524

a. Design: Intercept + Gender

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

d. Computed using alpha = .05

Discussion

The educators rated the instructional leadership dimensions of maintain visible presence, professional development; feedback on teaching learning and curriculum implementation high. This result shows that these dimensions of the instructional leadership scale were highly effective when used during the Covid-19 pandemic while implementing virtual learning. This suggests that educators will continue to use these attributes in similar and novel situations in schools. In addition, the seven dimensions of the instructional leadership scale: instructional resource provider, maximize instructional time, and monitoring students' progress were moderately rated. These findings suggest these dimensions of the instructional leadership scale were perceived as effective during the Covid-19 pandemic while implementing virtual learning, but they could be improved upon. This indicates that educators will continue to use these attributes in similar and novel situations in schools. However, it is important for administrators and policy makers to ascertain how these dimensions can be more effectively implemented. Being an instructional resource provider is critical to achieving the school's vision and its objectives; it is the role of the instructional leader to provide teachers with essential resources and ongoing professional development for students' success [1]. Resources relevant for the curriculum and their skilful implementation are made possible through the management of effective instructional forecast to support the effective implementation of the curriculum [2-3].

In relation to maintaining of visible presence, the instructional leader's presence must be felt in all areas [4]. The principal must supervise and evaluate teachers instructional practices and professional development. This role is necessary to assess learning targets, exhibition of practices of learning, and establishing programs and exercises on guideline [5]. The instructional leader must assess teachers' professional development needs and offers purposeful professional development opportunities to develop teachers' instructional skills, knowledge, and attitude [6]. The principal must also do follow-ups to evaluate the effectiveness of professional development opportunities, give feedback and constructive criticisms. Principals must ensure that instructional time is maximized. This includes managing and planning for instruction, assessment, and other teacher-student activities. Thus, teacher and students supervision is critical to the effective functioning of the school. This should also include token and other motivation strategies for students and teachers who meet expectations and beyond.

Principals must monitor student learning progress to gather data pertinent in making instructional decisions and providing feedback to students and parents on their progress and learning achievements [7]. Effective instructional leaders conduct regular classroom inspections, set and communicate clear evaluation criteria, and give feedback on teaching learning through collaboration with staff and students [8-10]. Thus, the dimension of providing feedback on teaching and learning becomes paramount. This can include being visible physically throughout the school, providing praise and feedback to teachers concerning their growth and capacity development. It must be noted that giving praise and feedback to parents is essential and other activities on student's behaviours help to ensure instructional time is maximized [11]. In relation to curriculum implementation, the principal must seek to provide an environment that caters to the efficient instructional development, management and organization of content, interventions, and monitoring in the teaching learning space [12; 13]. The instructional leader must possess adequate learning, aptitudes, and expertise [14] to ensure sufficient learning action, scope of syllabus in time, and be an astute supervision [12].

Additionally, the results from the statistical analysis showed that there is no statistically significant difference in the scores of the composite dependent variables (instructional resource provider; maintain visible presence; professional development; maximize instructional time; monitoring students' progress; feedback on teaching learning; curriculum implementation) based on school level, capacity served and gender. Thus, the multivariate main effects of school level, capacity served and gender on the combined dependent instructional leadership variables were not statistically significant. The capacity served and school level served by a principal influences the effectiveness of the principals' instructional supervision [15]. These factors influence technical, human, and conceptual skills of supervision. These consist of a set of skills required for the planning, staffing and coordination of supervision. That is, skills that are concerned with the use of knowledge and methodology required to carry out established tasks. These skills also include forming productive relationships with people and the ability to see the school through the lens of system thinking.

Research shows that gender influences different patterns of instructional leadership [16, 8, 18-19]. Their results revealed a small but statistically significant effect of gender on instructional in instructional leadership practices which are meaningful. Additionally, research suggests that female leaders tended to achieve higher ratings on transformational leadership as well as engaging in more contingent reward behaviours associated with transactional leadership [20].

Conclusion

The findings of this study revealed that educators strongly rated the instructional leadership dimensions of; maintain visible presence; professional development; feedback on teaching learning and curriculum implementation high. This result shows that these dimensions of the instructional leadership scale were highly effective when used during the Covid-19 pandemic while implementing virtual learning. The implication of this finding is that educators will continue to use these attributes in similar and novel situations in all levels of schools. In addition, the seven dimensions of the instructional leadership scale: instructional resource provider, maximize instructional time, and monitoring students' progress were moderately rated. The lessons from these findings are that these dimensions of the instructional leadership scale can be effective during the Covid-19 pandemic while implementing virtual learning, but they could be improved upon. The implications are that educators will continue to use these attributes in similar and novel situations in schools. Further research is needed to provide information on how administrators and policy makers can effectively implement these dimensions in their practice. As an instructional resource provider, the principal must share the school's vision and its objectives by providing teachers with essential resources and ongoing professional development for students' success. To do this, the principal must manage instructional forecast effectively to support the effective implementation of the curriculum. This requires the principal to be visibly present and must be felt through supervision and evaluation of teaches instructional practices and professional development in an effort to assess learning targets, exhibition of practices of learning, and establishing programs and exercises on guideline.

Another implication of the finding of this research is that principals must ensure that instructional time is maximized by managing and planning for instruction, assessment and other teacher-student activities while developing strong relationships with teachers and students by rewarding them for achieving targets. Principals must monitor student learning progress to gather data pertinent in making instructional decisions and provide

feedback to students and parents on their progress and learning achievements through regular classroom inspection, set and communicate clear evaluation criteria, give feedback on teaching learning through collaboration with staff and students. Thus, the dimension of providing feedback on teaching and learning becomes paramount as teachers must be updated concerning their growth and capacity development. It must be noted that giving praise and feedback to parents is essential and other activities on student's behaviours helps to ensure instructional time is maximized. In relation to curriculum implementation, the principal must seek to provide an environment that caters to the efficient instructional development, management, and organization of content, interventions, and monitoring in the teaching-learning space [12-13].

Another finding of this study is that there is no statistically significant difference in the scores of the composite dependent variables (instructional resource provider; maintaining visible presence; professional development; maximize instructional time; monitoring students' progress; feedback on teaching learning; curriculum implementation) based on school level, capacity served and gender. Nevertheless, it must be noted that the capacity served and school level at which the principal operates influence the effectiveness of the principals' instructional supervision [15]. Therefore, principals must develop technical, human, and conceptual skills of supervision. These will provide the principal with a set of skills required for the planning, staffing, and coordination of supervision. This will provide the principal with the knowledge and methodology required to carry out established tasks forming productive relationships with staff and to see the school through the lens of system thinking. In addition, gender influences different patterns of instructional leadership [16, 8, 18, 2,19]. Their results revealed a small but statistically significant effect of gender on instructional in instructional leadership practices which are meaningful. It is also established that female leaders tended to achieve higher ratings on transformational leadership as well as engaging in more contingent reward behaviours associated with transactional leadership [20]. Thus, further research is needed to ascertain how gender influences principals' instructional leadership using larger sample sizes and diversity at all levels of the education system.

Conflict of Interest

The researcher is a Vice Principal who has been trained by NCEL in the course Virtual Instructional Leadership.

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Drivers of Covid-19 Vaccine Hesitancy in Southern Nigeria

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Abstract

Hesitancy against the Covid-19 vaccines cuts across all nations of the world, but this may not be unconnected to the trolls of misinformation and politicization surrounding the Covid-19 science. Findings from this study reveal that 84.7% of the study population lacks adequate information about the Covid-19 vaccines. 50% of the study population is skeptical about the safety of the Covid-19 vaccines. 100% of the study participants make use of the internet and other social media platforms for their sources of news information. 55.3% of the study population would follow the advice of their healthcare workers pertaining to the Covid-19 vaccines. 26.7% of the study population would listen to instructions given by their parents pertaining to the Covid-19 vaccines, while 20.7% of the study population would follow the guidance of their religious leaders respectively. Thus, the main drivers of Covid-19 vaccine hesitancy in Southern Nigeria are a lack of correct information about the Covid-19 vaccines, misinformation on social media platforms, resistance from religious leaders and parents, and a lack of support for the Covid-19 vaccine uptake on the part of healthcare workers. It is, therefore, imperative that in order to overcome the present challenge, the population of Southern Nigeria should be educated on Covid-19 related subjects and engaged with health promotion initiatives. While accepting the Covid-19 vaccines by the hesitant populations in Southern Nigeria is largely dependent upon the attitudes and influences of religious leaders, parents, and healthcare workers, a much larger study is required to fully establish the ramifications of these important findings.

Keywords: *Covid-19, Healthcare Workers, Immunization, SARS-CoV-2, Southern Nigeria, Vaccine Hesitancy.*

Introduction

Vaccines and Immunization efforts remain one of the greatest achievements in Public Health in recent times. It is also of note that tremendous achievements and progress have been made in recent years in Nigeria regarding routine childhood immunizations. This is largely attributed to the successful introduction and implementation of the National Program on Immunization (NPI) at all levels of the Nigerian Healthcare System [1]. The routine immunization of small children and the occasional vaccination of the general population against some vaccine-preventable diseases has brought much wellness and health to the citizens of Nigeria, thereby drastically reducing the average annual cost expended on healthcare by households [2]. Despite these commendable achievements however, Nigeria has remained one of the countries in the world with a protracted history of vaccine hesitancy and resistance [3]. The tremendous successes and achievements recorded in public health within the past decades have been largely attributed to the beneficial effects of vaccines on the health of populations [4]. Hesitancy to vaccine administrations has always been in history, but at no point in recorded human history has there been so much controversy and politicization of vaccine science as currently being recorded with the Covid-19 vaccines [5]. Covid-19 Vaccine Hesitancy in Nigeria poses a big challenge to the

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fragile Nigerian health system and the country's economy. Since March 2020, when the WHO declared Covid-19 as a global pandemic [6], all economies in the world have suffered a massive dip in their internal Gross Domestic Product (GDP) and revenue generation. The Nigerian economy is still struggling due to the impact of the Covid-19 pandemic.

The rapid development of the Covid-19 vaccines and their availability for public administration, though not equitably distributed to countries like Nigeria [7], has brought a measured relief to wearied economies and health systems. The possibility of reduced case fatalities reduced mortalities, and reduced chances of hospitalization, especially when complete doses of these vaccines are taken, makes a case for its universal acceptance. However, the wave and barrage of skepticism and social misinformation surrounding the Covid-19 vaccines has led to an alarming level of hesitancy. The unwillingness on the part of the Nigerian population to take the few available doses of the Covid-19 vaccines is fueling a Covid-19 Epidemic and the chances of mutated variants of the SARS-CoV-2 virus thriving among the population. The already weakened health system in the country is overwhelmed, and the government is already over-stretched economically. The poor state of the global economy and the massive debts the country owes mean that the country may not be able to survive another phase of general lockdowns in order to curb the spread of evolving variants of the SARS-CoV-2 virus [8].

The Nigerian population needs to accept and take the Covid-19 vaccine in order for the economy to recover and also in order for the Nigerian health system and structures can be better re-engineered and equipped to meet the 21st-century health challenges. Accepting these vaccines is, however, premised upon understanding the drivers of the Covid-19 vaccine Hesitancy among the population. Identifying these drivers will help to guide our Covid-19 vaccine administration strategies. Covid-19 Vaccine Hesitancy remains a major problem in Nigeria [9]; hence, an understanding of the drivers of Covid-19 vaccine Hesitancy among the Nigerian population is needed to prevent a possible resurgence of SARS-CoV-2 infections in the country [10].

While various studies have been conducted among the general populations of Nigeria on subjects relating to Covid-19 vaccine hesitancy, none of these studies have specifically focused on identifying the drivers of Covid-19 vaccine hesitancy among cohorts of the Covid-19 vaccine hesitant population. This study seeks to address this gap by identifying the specific drivers of Covid-19 vaccine hesitancy among the adult populations of Southern Nigeria. The identification of these drivers will help in devising strategic and tailored Covid-19 vaccine implementation science approaches to these specific populations and groups.

Theoretical Framework

The problem of vaccine hesitancy in Nigeria is protracted as witnessed by the polio vaccine resistant in some parts of Nigeria. However, while this challenge and resistant against the polio vaccine have been largely mitigated after years of efforts and community engagements, the resurgence of vaccine hesitancy associated with the Covid-19 vaccines in recent times have brought back a familiar problem. Several studies in Nigeria have all indicated the lack of willingness on the part of the Nigerian population to accept the Covid-19 vaccines.

The objective of this study is to identify the drivers of Covid-19 vaccine hesitancy among the Covid-19 vaccine hesitant population of Southern Nigeria. *Problem Statement:* With the rapid availability of the Covid-19 vaccine for public administration, many members of the population in Southern Nigeria are still hesitant to take these vaccines. *Research Question:* What are the specific drivers of Covid-19 vaccine hesitancy among the Covid-19 vaccine hesitant population in Southern Nigeria?

Materials and Methods

Study Site and Population

This study is a randomized and clustered cross-sectional survey among the population of three (3) mega cities in the three (3) geo-political zones of Southern Nigeria. The geo-political zones are South-West, South-East, and South-South, respectively. The study was conducted between the months of January 2022 to June 2022 at the three mega cities of Lagos, Enugu, and Port Harcourt, respectively. The target population were Nigerian citizens of 18 years of age and above. Participation in the survey was voluntary and consensual, with a semi-structured questionnaire randomly administered to presenting and consenting individuals who affirms their unwillingness to take the Covid-19 vaccine. Expert volunteers who helped in the administration of the questionnaires also helped in bridging the language barrier encountered by a few of the study participants who could not speak fluent English.

Determination of Sample Size

After pulling the total number of study participants from all relevant studies relating to this subject in Nigeria to date, the sample size was determined using the Online *"Creative Research Systems®"* (CRS) sample size calculator at a 99% Confidence Level (CL) and at 1% Confidence Interval (CI). A convenience sampling method was applied in the administration of the questionnaire at the study sites.

Measures and Data Collection

The administered questionnaire was designed to identify the drivers of Covid-19 vaccine hesitancy among the population of Southern Nigeria. Questions addressed relates directly to the participant's level of knowledge about the Covid-19 vaccines, sources of news information, possible reasons for not taking the Covid-19 vaccines, and identifying individuals that could help influence the decisions to accept the Covid-19 vaccines. Basic social demographics relating to age, gender, religion, education, and housing were also captured in the questionnaire. The questionnaire was piloted with 100 participants in a bid to test the simplicity of the tool and to validate the study questionnaire. These initial 100 participants were later excluded from the study upon perfecting the use of the tool.

Data Analysis

Data collected in this study were analyzed with simple descriptive statistics and the Pearson Correlation Analysis, Regression Analysis, and ANOVA using the Excel Data Analysis Tool Pack. All collected data were securely encrypted and archived in a backup folder.

Ethical Considerations

In this consensual and totally voluntary study, Informed Consent was duly sought from each of the participants. All participants gave both verbal and written consent or thumb print before participating in this study. Information given are treated with absolute confidentiality and complete anonymity. The questionnaire contains simple, non-invasive measurements and questions dealing with basic variables relating to Covid-19 Vaccine Hesitancy. The study also focuses mainly on the vaccine-hesitant population of Southern Nigeria; hence, information or responses that could be linked to any participant or individuals were not required.

Results

A total of 1,500 questionnaires were successfully administered and answered from Southern Nigeria. From the three (3) selected mega cities at each of the three (3) geo-political zones in Southern Nigeria, 500 duly filled questionnaires were returned for analysis. The multi-lingual expert volunteers who helped in the administration of the questionnaires also helped in closing the language barrier gaps encountered by a few of the study participants by interpreting the content of the questionnaire to the participants and translating and transcribe some responses from the participants as necessary.

Table 1. Participants Need for More Knowledge about the Covid-19 Vaccines

Yes	No
1,270 (84.7%)	230 (15.3%)

Data presented in the above table shows 84.7% (n=1,270) of the study participants require more knowledge and education about the Covid-19 vaccines. The massive knowledge gap about the Covid-19 vaccines could help explain the reason for the current wave of hesitancy being experienced in Southern Nigeria. The Pearson Correlation Analysis of the primary data reveals a perfect negative (r=-1) correlation between the level of knowledge about the Covid-19 vaccines among the study participants and Covid-19 vaccine hesitancy. This clearly indicates that the lower the level of knowledge about this vaccine, the higher the level of hesitancy experienced. A further ANOVA of the same data indicates that there is a significant positive relationship between Covid-19 vaccine knowledge and Covid-19 vaccine hesitancy, with a p-value =0.000778 [F sta (84.5) > F crit (7.709)], at 95% Confidence Level (CL).

Table 2. Participants' Primary Sources of News Information

Radio	Television	Internet/Social Media Platforms
390 (26%)	380 (25.3%)	1,500 (100%)

While some of the study participants still listen to news information via traditional radio and television stations (51.3%), all participants in this study actively make use of the internet and other social media platforms for their news information sources (100%). The dynamic use of mobile and other hand-held devices has made possible the availability of new information on the go. This data shows that the young and vibrant youth of Southern Nigeria is actively engaged on social media and on the internet. The Correlation analysis of the primary data indicates a strong negative correlation (r=-0.90784) between sources of news information and Covid-19 vaccine hesitancy in Southern Nigeria. This shows that the barrage of information received via the media platforms, especially the internet and other social media platforms, as seen in this data, has had some negative impact on the uptake of the Covid-19 vaccines among the study population. A further ANOVA of the collected data shows a very strong positive relationship (p-value = 0.000422) between sources of news information and Covid-19 vaccine hesitancy. This statistical record is highly significant at 95% CL, with an F stat 115.8474 > F crit 7.708647, respectively.

Table 3. Participants who are Skeptical About the Safety of the Covid-19 Vaccine

Yes	No
750 (50%)	750 (50%)

The data above shows that 50% (n=750) of the study participants are skeptical about the safety of the Covid-19 vaccines. These fears and skepticism may not be unfounded with the barrage of misinformation about the Covid-19 vaccines available especially on social media and internet platforms. Despite a strong positive correlation between skepticism about the safety of the Covid-19 vaccines and Covid-19 vaccine hesitancy (r=0.80), a p-value= 0.40652 shows that there is no significant relationship between skepticism and Covid-19 vaccine hesitancy.

Table 4. I am Willing to take the Covid-19 Vaccine if Recommended by Any of the Following

Imam	Pastor	Community Leader	Parents	Friends	Healthcare Workers	Teacher	Boss	Partner
0	310	50	400	20	830	0	70	100
(0%)	(20.7%)	(3.3%)	(26.7%)	(1.3%)	(55.3%)	(0%)	(4.7%)	(6.7%)

Based on the information presented in Table 4 (above), an overwhelming majority of the study participants will listen to advice about the Covid-19 vaccines from healthcare providers (55.3%). While 26.7% (n=400) of the study participants will follow the guidance given by their parents, a further 20.7% (n=310) will also listen to advise from their religious leaders. The Pearson Correlation Analysis indicates a very strong positive correlation (r=0.16, r=0.24, and r=0.79) between the influence of religious leaders, parents, and HCWs on the study participants to accepting to take the Covid-19 vaccine.

Discussion

The advent of Covid-19 has brought so many changes to our common ways of life, and many gains made in our healthcare delivery systems for several decades have been reversed due to this development. The global lockdowns that followed the Covid-19 pandemic affected immunization programs and activities, which could potentially lead to the spread of many preventable diseases [11]. With the entire world in a state of pandemonium due to the rapid spread of the SARS-CoV-2 infections, the rapid roll-out of the Covid-19 vaccines was highly encouraging. However, the global wave of resistance and hesitancy against the Covid-19 vaccines remains a major cause for concern [12]. Many studies have been conducted in different parts of the world on the state of readiness of various populations to accept the Covid-19 vaccines when made available for public administration; findings, however, have been very alarming as these studies all indicate poor levels of acceptability [13, 14]. The level of acceptance of the Covid-19 vaccines ranges from 60 percent to 80 percent on average at different part of the world. Studies conducted in Nigeria indicate about 30 percent to 40 percent of the population are unwilling to take the Covid-19 vaccines. While a study conducted by the African CDC in fifteen (15) African countries indicates that only 79% of the population is willing to accept the Covid-19 vaccines [15, 16]. It should be noted that the CDC study does not put into consideration the country-centric acceptance rate; thus, the 79% acceptance rate has largely shielded the low level of acceptance applicable to some of the countries in the study. Studies on the level of Covid-19 vaccine acceptability in Nigeria have yielded varied outcomes [15-17].

In Africa, there is a record of polio vaccine boycott in Northern Nigeria and parts of Cameroun due to fear that this vaccine might cause infertility [18]. Hesitancy and Resistance against the Covid-19 vaccine, however, cuts across all countries and different racial groups for different reasons. Studies conducted in the UK and Ireland have indicated some interesting psychosocial characteristics and demographics of the Covid-19 vaccine hesitant populations [19]. Studies conducted in the USA has also identified certain unique characteristics among the vaccine hesitant populations in the USA [20]. In Nigeria, there has been studies conducted among the general populations to ascertain the level of Covid-19 vaccine acceptance, of which the Covid-19 vaccine hesitant populations form a subset of the findings [21, 22]. There is, however not a single study conducted that exclusively focused on the Covid-19 vaccine hesitant populations in Nigeria until this study.

Skepticism is fostered by a lack of adequate information on a particular subject matter, and this study has revealed this challenge, with 50%

of the study population skeptical about the safety of the Covid-19 vaccines. This finding is corroborated in a study on the barriers of child immunization completion among parents. The study shows that some parents do not believe that vaccines are safe, while others do not believe that vaccines are necessary to protect their children from diseases [23]. From this study, 26.7% of the study population clearly indicated that they would follow the instructions of their parents regarding the Covid-19 vaccines. The influence that parents have on the decision of their wards in vaccine acceptance cannot be overemphasized. In a global overview of systematic reviews of parent-level barriers to the uptake of childhood vaccinations, the study identified health systems, access, beliefs and concerns, health perceptions and experiences, information and knowledge, and social or family influences as some of the major barriers to childhood vaccination uptake [24]. Additionally, in a systematic review on barriers to childhood immunization in Sub-Saharan Africa (SSA) in 2020, the review clearly identified the influence of parents/caregivers as a major barrier to childhood immunization uptake [25].

Despite the fact that the current study was conducted among the adult population of Southern Nigeria, the influence of parents on the participants' decision to accept the Covid-19 vaccines can be clearly seen in this study (26.7%).

84.7% of the study population indicate that they require more information about the Covid-19 vaccines. Thus, the government and donor/funding agencies will do well to further intensify efforts at engaging and properly educating HCWs and religious leaders about the safety and importance of the Covid-19 vaccines. With 100% of the participants in this study seeking information via online and social media platforms, studies have shown that the self-efficacy of individuals in assessing the relevance of digital or online information also plays a role in the acceptance or rejection of the Covid-19 vaccines [26]. The barrage of vaccine misinformation and misconception has fueled the poor uptake of the Covid-19 vaccine globally [27-29]. Lack of trust in government and political leadership, coupled with the politicization of the Covid-19 science, has grossly undermined the efforts of the government to persuade citizens to take these vaccines.

55.3% of the participants in this study affirm they will follow the advice of their HCWs regarding uptake and acceptance of the Covid-19 vaccines. In a cross-sectional study on factors influencing the acceptability of Covid-19 vaccination in Malaysia, 97.3% of the study participants indicated that recommendations from their medical doctors would influence their decision [30]. Several other studies have indicated similar responses on participants' willingness to follow the recommendations of their healthcare provider regarding the Covid-19 vaccination [31-33].

20.7% of the study participants indicate that they will listen to the instructions of their religious leaders on the subject of the Covid-19 vaccines. Studies have shown that personal and religious beliefs and individual perceptions about the existence of Covid-19 is also affecting the current wave of Covid-19 vaccine hesitancy in Nigeria [9, 29]. A cross-sectional survey on Covid-19 vaccine hesitancy and confidence in the Philippines and Malaysia indicates a high prevalence of Covid-19 vaccine hesitancy. The same study also reveals that other factors negatively impacting confidence in the Covid-19 vaccines include rural dwellings, the Christian religion, and online information seeking [34].

Myriads of reasons for Covid-19 vaccine hesitancy abounds among the vaccine-hesitant populations; hence, reaching and persuading the Covid-19 vaccine hesitant populations in Nigeria is of paramount importance if the country is to move rapidly into the next phase of economic recovery, health systems strengthening and preparedness for the next pandemic. Coercing and passing uninformed unilateral policies aimed at forcing citizens to be

taking the Covid-19 vaccines could be tantamount to Health Imperialism which could further fuel fears of government and political conspiracies in the Covid-19 saga. Critical findings in this study indicate the need for the government of Nigeria to do more to educate the population about the Covid-19 vaccines. With 84.7% of the study population requiring more knowledge about the Covid-19 vaccines, it is imperative that the government and its agencies of health promotions actively engage the Nigerian population through all media and educational means.

The need for more knowledge about Covid-19 vaccines and the sources of news information utilized by the study participants have a direct correlation and a significant relationship with Covid-19 vaccine hesitancy in Southern Nigeria. Findings from this study has shown that the population in Southern Nigeria can be effectively reached through the internet and other social media platforms.

Therefore, the efforts of the government at mitigating the social disinformation about the Covid-19 vaccines through publicities and jingles should not be limited to traditional radio and television stations. The efforts of the government to re-orienting the Nigerian population about the safety of the Covid-19 vaccines should be scaled up to the internet and all other social media platforms where young Nigerians are mostly active. Social media platforms and groups can be used for youthful discourses on subjects relating to Covid-19 and the importance of vaccination among the population.

While HCWs, religious leaders, and parents remain the main drivers of Covid-19 vaccine hesitancy in Southern Nigeria, the government of Nigeria and its supporting partners will do well to design meaningful programs and policy advocacy forums geared at engaging these critical stakeholders on the Covid-19 vaccine roll-out and other related topics.

Strengths of the Study

This is the first time that a study focusing mainly on the Covid-19 vaccine hesitant populations will be conducted in the Southern geo-political zones of Nigeria. This study was also conducted at the three (3) mega cities located at these zones. This study has also clearly highlighted the drivers of Covid-19 vaccine hesitancy in Southern Nigeria.

Conclusion

Based on this study from Southern Nigeria, it can be concluded that the government's public health agencies, the National Orientation Agency (NOA), and other supporting donor partners should scale up efforts at curbing the spate of disinformation about the Covid-19 vaccines on all active social media platforms in Nigeria. Aside from continuing the Covid-19 vaccine campaigns and jingles on the traditional radio and television stations, the internet and social media platforms should also be seen as viable vehicles of communicating to the vibrant, youthful population of Southern Nigeria. Findings from this study has shown that active engagements, proper education, and advocacy efforts geared towards religious leaders, parents, and HCWs in Southern Nigeria can help encourage the rapid uptake of the Covid-19 vaccine among the population. The youth of Southern Nigeria also needs to be better engaged as critical stakeholders in the government's efforts at mitigating the impacts of the Covid-19 pandemic.

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Conflict of Interest

The author declares no conflict of interest.

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Attitudes and Intentions of Health Personnel towards Covid-19 Vaccination in Kaziba Health Zone

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Abstract

Introduction: SARS-CoV-2 is a virus of the coronavidae family and of the beta coronavirus group, such as those responsible for SARS and MERS. This Covid-19 is more contagious than SARS and MERS but with a lower death rate. Covid-19 vaccine is a pharmaceutical tool to control the transmission of Covid-19 among the health personnel and the general population. The acceptance of Covid-19 vaccination remains reluctant among the health personnel. The purposes of this study are to determine the intentions and attitudes of health personnel vis-à-vis to Covid-19 vaccination and, to determine the reasons for accepting and refusing Covid-19 vaccination among health personnel in Kaziba Health Zone from 15 to 28 July 2021. Material and methods: our study was descriptive retrospective cross-sectional study. A random sampling method was carried out to collect the data through survey questionnaire with 102 health personnel. The data was analyzed with SPSS and Chi-square test was carried out. Results: the intentions and attitudes of the health personnel vis-à-vis to Covid-19 vaccination was (31.4%), and the participants who declared the mandatory Covid-19 vaccination was 31.4%. The health personnel who accepted the covid-19 vaccine were 21.6%, however, those who refused was 45.1%. Conclusion: health personnel do not have acceptable intentions and attitudes towards Covid-19 vaccination. Only nurses and midwives, physicians and healthcare assistance staff were agreeable to Covid-19 vaccination to control the pandemic. Lack of information was the main refusal reason for Covid-19 vaccination. The health personnel were not willingly too mandatory Covid-19 vaccination.

Keywords: *Attitudes, Covid-19, Health personnel, Intentions, Kaziba, SARS-CoV-2, Vaccination.*

Introduction

The first case of the new Covid-19 emerged in December 2019, in Wuhan, Hubei province, China [1]. This Covid-19 rapidly spreads worldwide, as of 11 March 2020 Covid-19 was declared pandemic of international concern [2. To control the transmission of SARS-CoV-2, pharmaceutical intervention such as vaccine remains vital [3, 22]. Some countries embarked on vaccination campaigns to curb down the transmission of Covid-19 [4], a vaccination certificate was proposed and issued to all recipients to allow the international and social domestic activities [5], therefore, as condition to embark on the international travels one supposed to possess Covid-19 vaccination certificate. However, the mandatory possession of Covid-19 vaccination certificate is still rejected by a good number of people since there is an inequality of vaccine supply between the developed and non-developed countries [6]. It is vital to gather local data on the people ideas and behavior, also the global impact towards the Covid-19 vaccination to allow the implementation of the best strategies to encourage Covid-19 vaccination acceptance.

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These best strategies will improve vaccination coverage rate and enable the best communication strategies during the vaccination campaign. The collection of data for the health personnel carry a significant relevance owing to the cardinal role the health personnel play in the process of vaccination activities [7]. Though, the African continent is relatively less affected by Covid-19 than other continents such as America and Europe, there are concerns about the precariousness of the Africa health system towards high transmission rate of SARS-CoV-2 [8]. As of 25 January 2020, Asian continent recorded a prevalence of 2,062 [9]. America and Europe were the continents that recorded large number of cases and deaths. As of 30 October 2020, Europe continent recorded 10,520,014 cases and 279,657 deaths [10]. On the other hand, as of 2 November 2020, in the American continent, the USA was the most affected country worldwide with 9,032,465 cases and 228,998 deaths [9]. Africa continent notified its first case in February 2020 in Egypt. As of 25 June 2020, Covid-19 spreads to all 54 countries of the African continent [11]. As of 11 July 2020, DRC recorded 7,905 cases and 189 deaths, ranking the country at 11th position out 54 countries in the African countries. There is still low extent of the implementation of public health measures and the provision of the health service delivery towards Covid-19 pandemic. In addition, it has been found a certain level of negligence in line with hygiene and aseptic measures to figure out among the most challenges during the assessment of the public health measures and the health service delivery. SARS-CoV-2 spreads through aerosols from one person to other(s) in close contact [11]. Another study indicated that Covid-19 infection from one patient hospitalized in South Korea spread to other 118 patients who previously were not infected [12]. To control Covid-19 pandemic at global extent, Covid-19 vaccine has been found to be ultimate pharmaceutical tool. Even though the research has made significant progress to the development of a certain number of vaccine brands, these vaccines are still at experimental stage of clinical control trials with expectant results [10]. On the one hand, the development of the vaccines provide a solution to control Covid-19 pandemic. On the other hand, there is number of concerns regarding the deployment and acceptance of the vaccines against SARS-CoV-12 [12]. Therefore, the objectives of this study were to determine the attitudes and intentions of health personnel vis-à-vis to Covid-19 vaccination as well as the reasons for accepting and refusing Covid-19 vaccination among the health personnel in Kaziba health zone from 15 to 28 July 2021.

Materials and Methods

Study area: this study was conducted at the Kaziba Health Zone (General Reference Hospital and Health Centers) which is located in Walungu territory of South Kivu Province, DRC. Kaziba General Reference Hospital is the main public hospital located in Kaziba centre which is 54km away from Bukavu (provincial capital city of South Kivu) along the road Bukavu-Nyangezi-Kaziba. Kaziba Health Zone services an estimated total population of 142,852 in 2020.

Study design and period: an observational descriptive retrospective cross-sectional study was carried from July 15 to 28, 2021.

Study participants: the source population of this study was all health personnel aged between ≤ 30 and ≥ 51 years.

Sample size calculation and sampling procedures: the sample size was determined by using the following formula: $n = (e^2*p*q) / d^2$. The expected minimum sample of n + n / 10n. Based on the total number of 200, after carrying out the exclusion criteria and considering the time (limiting factor), our definite sample size was 102.

Study variables: dependent variables were attitudes and intentions of health personnel vis-à-vis to Covid-19 vaccination, reasons for accepting and refusing Covid-19 vaccination among health personnel, and opinions of health

personnel on mandatory vaccination to the population. Independent variables were age, gender, health professional group and work department, educational attainment, involvement in the care of Covid-19' patients.

Data collection tools and procedures: data regarding the variables were collected through anonymous in-person survey questionnaire filled out by selected health personnel. Data were collected by field data collectors who were followed by supervisors. A one-day orientation was given to the field data collectors and supervisors concerning the purpose of the study, data collection tools and interaction with the participants. During this process of the data collection, the supervisors and the field data collectors were provided with facemasks and hand-sanitizer solutions, and they were guided to comply with public health measures in place. The survey questionnaire was made of binary option. The supervisors assessed the consistency and completeness of data daily.

Statistical analysis: Microsoft excel spreadsheets were initially used to capture data then to import into SPSS (version 21). Descriptive statistics was carried out and presented with narration and tabulation. Chi-square test analysis was performed to identify statistically significant variables using a cut-off p-value < 0.05

Ethics approval and consent to participate ethical clearance was obtained from the institutional review board (IRB) of the University of Kaziba. A written informed consent obtained from each participant before data collection.

Results

Socio-professional characteristics of the study participants: in this current study, a total of 102 participants was involved. There were 58 (56.9%) male participants (56.9% vs 43.1%). The age group 31-40 was most represented (37.3%) as presented in Table 1.

Table 1 presents the age groups of the health personnel of Kaziba Health Zone with age group 31 – 40 being more representative.

Table 1. Health Personnel Age Groups

Age Groups (Years)	Frequency (n)	Percent (%)
≤ 30	34	33.3
31 – 40	38	37.3
41 – 50	13	12.7
≥ 51	17	16.7
Total	102	100.00

Nurses and midwives were the health professional much represented (66.7%) (See Table 2). As can be seen from Table 2, the health personnel with certificate level reported significantly more than others.

Table 2. Educational Attainment of Health Personnel

Educational Attainment	Frequency (n)	Percent (%)
Certificate level in Technical Sciences	44	43.1
Diploma Level	33	32.4
Degree Level in any field than medicine	14	13.7
Degree in Medicine	10	9.8
Postgraduate specialization	1	1.0
Total	102	100.00

Regarding the educational attainment, a large proportion of health professional was certificate level (43.1%) (See Table 3). Table 3 displays the breakdown of health personnel per professional categories with nurses and midwives representing more than ⅔ of personnel.

Table 3. Distribution of Health Personnel per Subgroup

Health personnel subgroup	Frequency (n)	Percent (%)
Nurses and Midwives	68	66.7
Physicians	10	9.8
Health personnel assistance staff	9	8.8
health personnel diagnostic staff	14	13.7
Health personnel emergency staff	1	1.0
Total	102	100.00

Looking at the work department, many participants (20.6%) were found in the department of internal medicine as portrayed in Table 4. Less than 10% of health professional were directly involved in care of Covid-19 patients (9.8% vs. 90.2%).

Table 4 presents different departments organized at hospital and health centre level in Kaziba health Zone with internal medicine having many personnel than other departments.

Table 4. Distribution of Health Personnel per Department

Department	Frequency (n)	Percent (%)
Internal Medicine	21	20.6
Pediatrics	15	14.7
Surgery	6	5.8
Obstetrics-Gynecology	15	14.7
Emergency	2	2.0
Imaging	1	1.0
Pharmacy	4	3.9
Others	38	37.3
Total	102	100.00

Accordingly, our results indicate that there was statistically significant association (χ^2 (4) = 9.837 at p = .04 level) between health personnel subgroup and intentions and attitudes vis-à-vis to Covid-19 vaccination as shown in Table 5. Table 5 shows the Chi-Square test with significant p = 0.04 level.

Table 5. Chi-Square Test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.837[a]	4	0.043
Likelihood Ratio	14.052	4	0.007
Linear-by-Linear Association	1.783	1	0.182
N of Valid Cases	102		
a. 5 cells (50.0%) have expected count less than 5. The minimum expected count is .31.			

Among the health personnel categories, there were respectively healthcare assistance (44.4%), physicians (40%) and, nurses and midwives (33.8%) (See Table 6). It can be seen from the data in Table 6 that the healthcare assistance, physicians and nurses and midwives were the health personnel willingly to accept Covid-19 vaccination.

Table 6. Intentions and Attitudes of Health Personnel vis-a-vis to Covid-19 Vaccination

Health personnel subgroup		**Intentions and attitudes vis-à-vis Covid-19 vaccination**		**Total**
		Yes	**No**	
Nurses and Midwives	Count	23	45	68
	% Within health personnel subgroup	33.8%	66.2%	100.0%
Physicians	Count	4	6	10
	% Within health personnel subgroup	40.0%	60.0%	100.0%
Healthcare assistance staff	Count	4	5	9
	% Within health personnel subgroup	44.4%	55.6%	100.0%
Healthcare diagnostic staff	Count	0	14	14
	% Within health personnel subgroup	0.0%	100.0%	100.0%
Healthcare Emergency staff	Count	1	0	1
	% Within health personnel subgroup	100.0%	0.0%	100.0%
Total	Count	32	70	102
	% Within health personnel subgroup	31.4%	68.6%	100.0%

The reasons for accepting Covid-19 vaccination: the main reason for vaccination acceptance was the contribution to the control of Covid-19 pandemic (21.6%) (See Table 7). Table 7 shows that the contribution to the control of the pandemic was the reason for accepting vaccination among health personnel.

Table 7. Reasons for Accepting Covid-19 Vaccination among Health Personnel

Reasons for Accepting	**Frequency (n)**	**Percent (%)**
To protect themselves	21	20.6
To protect their families	8	7.8
To protect their patients	5	4.9
To contribute to control of pandemic	22	21.6
More than two reasons	11	10.8
Others	35	34.3
Total	102	100.00

While the reasons for refusing Covid-19 vaccination were attributed to lack of information as portrays in Table 8. Looking at Table 8, it is apparent that the reason not enough

information about the vaccine reported significantly than other reasons.

The opinions of the health personnel regarding mandatory Covid-19 vaccination to population**:** the result of this study depicts that there was a high rate (37.2%) of health personnel being against to Covid-19 vaccination (31.4 vs. 68.6).

Table 8. Reasons for Refusing Covid-19 Vaccination among Health Personnel

Reasons for Refusing	**Frequency (n)**	**Percent (%)**
Concerns about vaccine efficacy	9	8.8
Concerns about vaccine safety	1	1.0
Perception that Covid-19 is not a dangerous disease	2	2.0
Not enough information about the vaccine	46	45.1
Perception of not being at risk for infection	9	8.8
More than two reasons	9	8.8
Others	26	25.5
Total	102	100.00

Discussion

In this current study, we have tried to determine the intentions and attitudes of health personnel vis-à-vis to Covid-19 vaccination, as well as the reasons for accepting and refusing Covid-19 vaccination among the health personnel in Kaziba health zone from 15 to 28 July 2021. Accordingly, our results indicated that there was statistically significant association ($\square^2$ (4) = 9.837 at p = .04 level) between health personnel subgroup and, intentions and attitudes vis-à-vis to Covid-19 vaccination. Among the health personnel categories, there were respectively healthcare assistance (44.4%), physicians (40%) and nurses and midwives (33.8%). These results are in accord with recent studies indicating that there was high rate of accepting Covid-19 vaccination [14, 15].

The reasons for accepting Covid-19 vaccination, the contribution to control of Covid-19 pandemic was found to be the main reason among the health personnel (21.6%). The findings of this study are not consistent with one research which found 57.8% of vaccination acceptance rate among the health personnel [14]. A cross-sectional study found that the reasons for health personnel accepting Covid-19 vaccination was to protect themselves against Covid-19 [19]. The reasons for refusing Covid-19 vaccination, the lack of information regarding the Covid-19 vaccine was discovered as the main reason (45.1%) among the health personnel. These results are in keeping with previous observational study, which found the same reason as for our study [16, 23]. However, another study revealed that there was eager desire of vaccine acceptance, in addition, this study suggested several strategies to address the vaccination hesitation among the health personnel and the general population to reach the heard immunity [17]. Other studies found that vaccine safety [20], efficacy [24] and negative attitudes and poor perceptions were the main reasons for refusing Covid-19 vaccination [25]. Regarding the mandatory Covid-19 vaccination to the health personnel and general population, less than ⅓ (31.4%) of the study participants was willingly to comply with mandatory Covid-19 vaccination (31.4% vs. 68.6%). These results do not seem to be consistent with other research which found a moderate acceptance level of health professional towards mandatory Covid-19 vaccination [14]. The findings of this study reveal that the participation rate of male gender was 13.8% higher than of the female gender (56.9% vs 43.1%) among the health personnel. These findings mirror that of a previous study that found a same trend where the male gender represented 40.4% (18), yet they are not

consistent with a study that found a high female participation rate [21]. A possible explanation for these findings may be that Bashi women are more interested in farming than in studies. Most participants were between 31 and 40 years (37.3%). These results disagree with the findings of other research which found that the age group of 41-50 years was prevalent (31%) [14]. A possible explanation for this might be associated to a small number of the health personnel in Kaziba health zone. The findings indicate that the health personnel that had certificate level were more responsive (43.1%) to this study than other health personnel groups. A possible explanation to this high percentage of health personnel that hold certificate level is due to the lack of universities in Kaziba territory. In the past, there was only a health college in the territory. The results of the study indicate that the department of internal medicine has higher number (20.6%) of health personnel than others reflecting only the data from the hospital. These results support previous research [14] into this area which found similar result in the department of internal medicine (38%). In addition, we found that the health professional who worked in the health centers did not how to classify themselves according to the departments (refer to another department). It is somewhat surprising that only 9.8% of health personnel are involved in the care of patients with Covid-19. However, this study proves that the poor involvement of health personnel in the care of patients with Covid-19 is because Kaziba health zone does not have the necessary commodities to enable the diagnosis and management of Covid-19 cases.

Conclusion

Our study on intentions and attitudes of health personnel vis-à-vis to Covid-19 vaccination in Kaziba health zone found that male participants aged between 31 and 40 years were more represented. Healthcare assistance, physicians and nurses and midwives were the health professional who accepted the Covid-19 vaccine. The reason for accepting Covid-19 vaccination was the contribution to the control of Covid-19 pandemic whereas the reason for refusing Covid-19 vaccination was the lack of information concerning Covid-19 vaccine. There is, therefore, a definite need for the Ministry of Public Health to mobilize more commodities for screening, diagnosis, and care of Covid-19 cases. Moreover, more information about Covid-19 vaccine should made available to enhance the vaccine uptake among the health personnel and the general population. Greater efforts are needed to ensure a substantial involvement to care of the health personnel.

Conflict of Interest

The authors declare no conflict of interest.

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Access to Finance: Determinants and Limitations to the Demand Side of Finance for Liberia's Rural Market

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Abstract

This study reviews the theoretical literature regarding determinants and the limitations to the demand side of rural finance in Liberia with the coming into effect of the National Financial Inclusion Strategy (NFIS). The outcome of this study reveals that education, income level, household assets, and agriculture rank as the outstanding drivers of the demand for finance in Liberia's rural market. Obviously, the demand for financial services in the rural market of Liberia is very high. However, the demand is limited by a litany of factors such as slow economic growth & lack of job opportunities, poor public infrastructure, structural unemployment, few diversification opportunities, seasonality in agriculture, imperfect information & supervision, and poor social protection and market failures. The keywords used by the author in this article encompass creditworthiness, information asymmetry, financial inclusion, Pareto efficiency, poverty alleviation, and rural finance.

Keywords*: Credit worthiness, Financial inclusion, Information asymmetry, Pareto efficiency, Poverty alleviation, Rural finance.*

Introduction

Access to financial services acts as a key driver for propelling economic growth and poverty reduction. Financial services provide the tools to invest in income-generating activities, save for the future, and much more. Despite the development of rural community financial institutions in Liberia and the implementation of the National Financial Inclusion Strategy (NFIS), the Liberian financial market faces challenges that continue to negatively impact financial inclusion, especially the determinants for the demand for finance for the rural population of Liberia. These challenges among other things include limited access points, particularly in rural areas, poor infrastructure, and slow economic growth/limited job opportunities for the rural populace.

In order to mitigate these challenges, strong public policies are needed to support the implementation of national financial inclusion strategies by increasing the spread of rural community financial institutions across the country. The policies should also call for the allocation of adequate resources to improve the road network in the rural parts of Liberia with rural community financial institutions, and provide stable electricity, information technology infrastructure, and improve communication channels and provide job opportunities for the rural populace. From all indications, the best solution to address these gaps is to improve the infrastructure landscape for the rural market. The major limitations to the overall improvement of the rural finance market in Liberia are incessant widespread corruption, waste, and abuse of state resources that continue to undermine national development. In terms of achievement, there is an incremental spread of rural community financial institutions (RCFIs) in Liberia. Currently, there are twelve RCFIs in

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the fifteen counties of Liberia. The objective of this study is to identify the determinants and limitations to the demand side of finance for Liberia's rural market and proffer solutions to harness those determinants that are not working in the wake of the operationalization of the national financial inclusion strategy by the Central Bank of Liberia. Moreover, this paper contributes to the literature on rural finance in driving sustainable economic development in developing countries.

The remaining portion of the paper is layout in the following manner: section two (2) presents the literature review, section three (3) constitutes the research methodology, section four (4) encompasses the presentation of the research results/findings, section five (5) covers the discussion of the research results/findings and section six (6) presents the conclusion of the study. Financial inclusion is a concept of novelty in Liberia. Though there are rural community financial institutions in Liberia, there are no research studies conducted regarding the assessment of the performance of these institutions. Further research is needed to be conducted to explore this area of the rural finance market in Liberia. Liberia is a country replete with natural resources, founded by the American Colonization Society (ACS) in 1822 as a home to freed slaves. The country is located in West Africa. The virtually two decades of fratricidal conflict decimated the country's population and caused its social, political, and economic decadence making it a fragile state [1].

While reeling from the effect of the Ebola Virus which hit Liberia in 2014, again in 2020, the country witnessed a horrific outbreak of the Covid-19 Virus pandemic with a devastating effect at a cross-cutting level. Notably, these two global pandemics led to the plummeting of the prices of Liberia's key export commodities including iron, rubber, and palm oil. As a result, the major value chains of these commodities that provide a livelihood to the rural population were badly affected. As such, poverty alleviation visibly became the major determinant of the demand for financial services in Liberia, especially for rural dwellers [1]. The emergence and spread of the Rural Community Financial Institutions (RCFIs) through the implementation of the NFIS by the Central Bank of Liberia, has relatively created some means for the rural populace of Liberia to access finance as a way of supporting their livelihoods.

The project sought to address rural communities' lack of access to financial services. To achieve this objective, the project proposed the creation of twelve (12) Rural Community Financial Institutions (RCFIs). These institutions were to be created in rural areas with a high concentration of workers receiving salaries and/or larger farming communities where a possible agricultural value chain is created [2].

As of December 2021, there are twelve (12) rural community financial institutions in Liberia with geographical distribution in eight (8) of the fifteen counties as follows:

Table1. Number of Rural Community Financial Institutions in Liberia

County	**Number of RCFIs**
Gbarpolu	1
Grand Kru	1
Lofa	3
Nimba	3
River Gee	1
Rivercess	1
Sinoe	1
Bong	1
Total 12	

Source: CBL 2021 Annual Report

Between 2020 and 2021, RCFIs performance took an upward trend. Deposits increased by 22.36 percent to L$227.57 million, from L$185.98 million. Moreover, loans & advances dilated by 43.95 percent from L$128.52 million to L$185.01 million [2]

According to CBL 2021 Annual Report, RCFIs have been funded by the International Fund for Agricultural Development (IFAD) through a Rural Community Finance Project with technical support from Afriland Bank Liberia. The project which commenced in August 2019, is worth about US$5.5million and a grant of US$0.5 million and is expected to provide additional resources for the RCFIs in the form of an improved capital base, fixed assets, IT system, and human resources for these entities as well as support the establishment of ten (10) additional RCFIs across Liberia.

The presence and steady spread of RCFIs across Liberia presents a positive step and opportunity in breaking long-term entrenched barriers to the spread of financial services to the rural poor, and this seems to incrementally bridge the gap between the banked and unbanked populations in present-day Liberia. In spite of the minimal gains realized so far regarding financial inclusion in Liberia, there is still a need for the formulation of strong public policies that build a diverse ecosystem involving commercially viable financial- service providers, and sustainably increase access to a wide range of financial services for small-scale rural producers and ordinary rural dwellers.

There are different definitions that various authors, scholars, and researchers have ascribed to the term financial inclusion. The term financial inclusion is defined in many ways based on contextual usage and uniqueness. From a broad spectrum, financial inclusion refers to the degree of access of households and firms, especially poorer households, and small and medium-sized enterprises (SMEs), to financial services.

According to World Bank, financial inclusion is defined as the "proportion of individuals and firms that use financial services" [4]; while the Asian Development Bank stated it is "ready access for households and firms to reasonably priced financial services [5]. Furthermore, the Alliance for Financial Inclusion has identified "four ways through which financial inclusion can be defined, in order of complexity: access, quality, usage and welfare" [6], and the Consultative Group to Assist the Poor (CGAP) considers financial inclusion as "a world where everyone can access and effectively use the financial services they need to improve their lives that does not mean developing separate financial markets for the poor" [7].

Assertively, financial inclusion has immensely contributed to economic and financial development via growth inclusivity and better equality of income. Predicated upon its consequentiality, it is fast becoming entrenched and dominant in the contemporary discourse of finance and development. This uniqueness has given financial inclusion humongous consideration by many scholars, researchers, and global development institutions including the World Bank, the Asian Development Bank, International Monetary Fund, and more [8].

Moreover, in a bid to optimize financial inclusion in spurring economic development, G20 leaders recently approbated the Financial Inclusion Action Plan and established the Global Partnership for Financial Inclusion. These two landmark interventions are significantly geared toward the expansion and availability of financial services. Additionally, the importance of financial inclusion has given rise to Asia-Pacific Economic Cooperation (APEC) Finance Ministers' Process. Consequently, this led to the establishment of mechanisms for reviewing and evaluating matters related to financial inclusion. The ever-growing relevance of financial inclusion to the achievement of financial and economic development has made the development of financial inclusion a major objective for the implementation of the Association of Southeast Asian Nations

(ASEAN) Framework on Equitable Economic Development [8].

Many countries around the world have espoused several approaches to the implementation of financial inclusion. One of these approaches is the provision of rural finance to the rural section of the population that cannot access institutional finance through traditional banking institutions. Similarly, Liberia has adopted rural finance as one of its key strategies to achieve financial inclusion.

A litany of authors, scholars, and institutions has contributed to the body of knowledge in the field of rural finance with varying definitions of what it entails. Rural financial services "encompass all savings, lending, financing, and risk minimizing opportunities (formal and informal) and related norms and institutions in rural areas" [9].

Rural finance is the provision of financial services for rural farming and non-farming populations at all income levels [10]. For many decades, rural credit has been used as a major development strategy by emerging economies. The inception of the use of rural credit can be traced to the 1950s following many decades of government policies aimed at the advancement of colonial economic interest over agricultural-based production. To provide colonial powers with agricultural goods, credit was fundamentally made accessible to large-scale commercial production with smallholders and local markets being left unattended to [11]. With the passage of time and the emergence of independent nations, development strategies took a paradigm shift with the emphasis being placed on the provision of assistance to the rural poor. As a way of ending the low flow of capital, low productivity and low savings of the rural poor, rural credit along with other inputs including
improved seeds, fertilizers, organic pesticides, and other capital investments were considered as key strategy [11]. Interestingly, the dawning of the Green Revolution in the 1960s provided an indication that farming yields had the potential to increase significantly provided that improved seeds, fertilizer, and other inputs were used. This success attributable to the Green Revolution paved the way for the obtainment of resources for the Agency for International Development (AID) and the World Bank to underwrite the cost of research intended to ameliorate agriculture-based technology and advance the role of rural financial institutions such as rural development banks and cooperatives as the only lenders of credit to the rural poor [11]

Several paradigms and policies have been used in developing countries to address the difficult and costly problems of providing financial services in rural areas. The old rural finance (RF) paradigm dates back to the 1960s and 1970s. Based on lessons learned from the old paradigm and revised financial systems approach, the new RF paradigm merged in the late 1980s which gained a broader consensus in the 1990s [12]. The old Rural Finance (RF) paradigm dates to the 1960s and 1970s. Rural Finance got momentum in the 1960s and 1970s all around the world, particularly in Asia and Latin America. Many rural credit projects were taken up under public sectors. Since the special costs and risks involved in RF made formal financial institutions reluctant to extend & expand credit facilities in rural areas, therefore, governments and donors were urged to intervene in rural financial markets. The following types of interventions were advocated by the researchers/ practitioners under this paradigm:

1. Lending quotas on banks and other financial institutions.
2. Refinance schemes, of Loans at preferential interest rates.
3. Credit guarantees; and
4. Targeted lending by development finance institutions (DFIs).

The interventions were intended to increase rural lending by reducing the costs and risks to lenders that made loans to preferred rural clients and sectors. Subsidized interest rates, Loan waivers, and forgiveness programs were also used to reduce the debt burden of priority-sector

borrowers, especially following floods, droughts and periods of floods, droughts, and periods of low farm prices. Credit was considered an important means to speed agricultural development, expand exports, promote small farmers, reduce poverty, and ensure cheap food supplies to urban areas. Multilateral and bilateral donors invariably supported the approach taken by many governments and funded many of the targeted supply-led projects. This approach helped some developing countries, especially in Asia, to improve agricultural yields in the short term. But it was not sustainable over the long term. It was also costly and failed to reach most rural households.

After the ill-fate of most of the RF programs under the old paradigm, microfinance providers, such as NGOs and credit unions emerged in the late 1970s which became known as the new rural finance paradigm [13]. They targeted the unbanked poor, who had been left out by the huge investments made in the financial market under the old paradigm. These microfinance institutions in fact brought about the revolution by proving that the poor are bankable, but the customary banking system had failed to serve them appropriately. Based on the lessons learned from the old paradigm and the emerging microfinance revolution, the new RF paradigm began to emerge in the late 1980s which gained momentum in the mid-1990s. The new paradigm adopts a financial systems approach, using market principles to deliver financial services in rural areas. This system is aimed at facilitating rural development that, in turn, will promote asset creation and poverty reduction. The new paradigm treats finance as a way to expand and integrate markets, rather than as a policy tool for targeting a specific segment of the market. The new RF paradigm is based on the principle that a commercial and market-based approach is most likely to reach large numbers of clients on a sustained basis. It recognizes that financial services are part of an interactive system of financial infrastructure and social and cultural norms. Government has a role to play in establishing a favorable or "enabling" policy environment, infrastructure and information systems, and supervisory structures to facilitate the smooth functioning of rural financial markets, but it should play a more limited role in direct interventions.

In most rural settings in developing countries, access to finance is greatly affected by a high degree of information asymmetry which necessitates the role of intermediation or intermediaries between the deficit spending unit and the surplus spending unit in the circular flow of resources in the economy. In this context, surplus units are defined as economic units whose income exceeds spending on goods and services. Conversely, deficit units are those economic units whose spending on goods and services is more than their income.

It has become a known and undebatable fact that lending to the poor population is crucial to poverty alleviation. However, traditional financial institutions have exhibited more disinclination in granting credit to poor households due to their inability to meet the selection criteria such as the imposition of physical collateral set by these financial institutions. As a way of eradicating moral hazard emanating from information asymmetry between the banks and borrowers, banks often resort to collateral requirements for loans. The usage of collateral helps in the determination of the worthiness of microcredit as well as addresses the problems of incentivization and enforcement.

In generality, the application to take a loan is not sufficient evidence of demand. As such, the demand for loans or credit can be viewed from two perspectives: the legitimate demand and the spurious demand. Legitimate demand is defined by the willingness and ability of the rural population to demand different types of financial services at the prices and terms and conditions at which they are offered or could be offered under competitive conditions, while a spurious demand for loans suggests the loans that people do not plan to repay or that they do not expect will be

collected. Under a loan arrangement, an amount of current purchasing power that is certain is exchanged for an uncertain promise to repay in the future. The possibility of spurious demand for loans necessitates the need to define legitimate demand as the existence of a true willingness and ability to repay the loan, given the terms and conditions included in the "price" vector of the transaction.

In examining the demand side of rural finance, it is important to consider a few kinds of literature that provide a theoretical underpinning for the demand side of rural finance. Household borrowing is principally induced by two factors which encompass income vacillations and lower savings. The temporary oscillations in households' income cause them to incur debt [14]. In addition to this, it is argued that people choose to seek borrowing due to the insufficiency of their savings, and they also use these borrowings to meet their investment needs [15]. The rationale for peoples' desire to borrow is profoundly supported by the Life Cycle Income Hypothesis (LCIH). The proponent of this hypothesis, Franco Modigliani postulated that income vacillations and lower savings are the two reasons that give rise to borrowing or credit by households.

According to LCIH, households save at an early age and dissave in old age. In some cases, households tend to borrow due to temporary gyrations in their income. This theory accentuates that income during a lifetime is hump-shaped, it is low at early ages and after attaining a maximum point, it declines. It further underscores that the more the income is hump-shaped, the greater the debt is incurred [16].

Generally, there often exists a gap between people's current income level and their desired level of income. To fill this gap, people often become constrained to resort to borrowing or loan-seeking behavior [17, 18]. People employ the surplus realized from their loans to underwrite the costs of education, consumption, and housing. The demand for households' debt varies with age [19]. The variation in households' debt according to age has been emphasized by some researchers. They noted that debt increases at decreasing rate with age [20-22].

Studies also unearth that the extent of the incurrence of household debt amount is determined by the size of households. With income being constant, it has been proven that controlling expenditure is a daunting task. As a result, debt becomes necessary to incur [23, 21, 24]. The volume of loans that households can access is greatly influenced by income level. This is justified by the significance of income to loan granting decisions considering credit worthiness which provides a cushion against the risk of potential credit default. Individuals in higher income brackets have the prospects of being granted large amounts of loans [25, 19, 26]. The employment status of households is very key in affecting demand for loans or debt. Secured and predictable jobs bolster a secured environment for the repayment of loans. Since people with lucrative and secured jobs in the formal sector are likely to possess high creating ratings, it is very easy for them to access huge loans of varied sizes [27]. Inarguably, a positive relationship subsists between households' education and their level of earnings. In most cases under ideal conditions, people's level of educational attainment dictates their remunerations. The positive influence of education on income is a key determinant of people's debt-carrying capacity. With higher education and work-related expertise, people can decide to seek loans with the hope that their projected income will enable them to liquid [28]. In many countries, financial institutions operating within the formal sector normally use collateral as the main prerequisite for granting loans to people due to moral hazards resulting from information asymmetry. In this regard, financial assets have been considered some of the best collaterals owing to their positive relationship with debt. Financial assets serve as mortgages in obtaining loans [29]. Another form of financial asset exists in the form of home

ownership which is noted to be crucial in discussing debt as many people take home loans. It mainly accounts for the upsurge in household debt in many countries [30].

Access to information addresses information asymmetry amongst participants in the economy and is crucial in ensuring the wider participation of all in the processes of development. Notwithstanding, the task lies in ensuring the smooth flow of public information to rural citizens. The evolving innovations in the application of information communication technologies have explored a new epoch of propagating information. Interventions such as credit counseling, awareness creation, and financial education tailoring to the benefits of financial inclusion are consequential for the effective growth and development of financial services in rural settings. Technology is another factor that promotes awareness or education which affects the demand for rural finance. It is very pivotal in integrating strategies for achieving inclusive growth. The utilization of technology infrastructure is critical in building up a reliable credit information system and database on customers, reducing transaction costs and facilitating better pricing of risk, improving the efficiency of the financial system, and thereby increasing the access of unbanked rural people efficiently. The application of technology to rural finance has proven to be effective in reducing transaction costs sharply and the time taken by banks in processing applications, maintaining accounts, and disbursing loans. It has a great deal of potential to address the challenges associated with outreach and credit delivery in rural areas, more cost-effectively. However, more studies need to be conducted in assessing the extent to which IT platforms can provide a variety of financial services to rural clients at affordable costs and on a timely basis.

Studies evidence that the demand for credit is a function of two factors:

1. The ability to repay which is dependent on the income level at current loan terms and conditions, and
2. Investment opportunities that encompass feasible income-generating activities. The repayment capacity of a household is a function of the net revenue of household/firm, seasonality of income risk, and net revenue: The net revenue of a household is perhaps the most important in terms of debt-carrying capacity.
3. The seasonality of income in conjunction with the annual net revenues as well as the consistency of income is a principal factor in determining loan reimbursement. Highly variable incomes may not be consistent with rigid repayment schedules. This volatility in peoples' incomes creates a limiting factor in peoples' decision to borrow or not. For people found in the agricultural sector, this risk remains one of the major driving forces affecting production and investment decisions in transition economies. In such cases, the most predominant types of risk affecting farm investment decisions are price/inflation risk, policy risk, and production risk. As a result of these risks, farmers in some countries are provided limited loan sizes.

The key determinants for the demand side for rural finance for Liberia's rural market include education, income level, household assets, and agriculture/smallholder farming.

Education plays a major part in driving the demand for rural finance in Liberia. As of 2021, the rural population in Liberia was reported at 47.43% [31]. With limited employment opportunities for these rural dwellers, access to education often influences their decisions to access credit to support the educational endeavors of their dependents from the primary level up to university.

Households' income level in rural Liberia is invariably low. This factor determines the need for households to seek credit. Moreover, household assets are crucial elements that

households base their decision on when borrowing. This is since most microfinance institutions in Liberia hook their lending on physical assets as security.

Evidently, 60% of Liberia's population earns their basic livelihoods from agriculture including forestry which accounts for 31.5% of the country's 2021 gross domestic product (GDP) [32] Predominantly, agricultural activities are carried out by smallholder farmers with limited technology. To boost their financial capacity to increase their wealth and food production through agricultural projects, these smallholders rely on both formal and informal financial as well as non-financial institutions for loans/credits.

The adoption of the Grameen Model of rural financing by Rural Community Financial Institutions has been very successful in reducing credit risk among loan seekers. The Grameen model is also known as the "grassroots" of microfinance models. Its originator is Professor Mohammed Yunus from Bangladesh who introduced it in the 1970s [33].

This model seeks to link the unbanked population to the banked population. Using this model, instead of collateral, which is costly and unaffordable for the unbanked population, prominent businesswomen are placed in groups to access loans. With the financial capacity of the prominent businesswomen, they can cover up for other women in the groups with limited or no creditworthiness in the event of potential credit default. To preclude the risk of default, those prominent women within those groups assume the responsibility of monitoring the business activities or investment projects of their group members [34].

The combination of several factors accounts for the limitations to the demand side of finance for Liberia's rural market. Prominent amongst these are slow economic growth and lack of job opportunities, poor public and private investment, structural unemployment, few diversifications of opportunities, low income, seasonality in agriculture, imperfect information and supervision, and poor social protection and market failures.

Though the Central Bank of Liberia (CBL) 2021 annual report points to steady growth of the Liberian economy with projected GDP of 3.6% in 2021 and an inflation forecast of 7.6%, the country is still challenged by a high unemployment rate. In 2021, the unemployment rate for Liberia was 4.1 %. The unemployment rate of Liberia increased from 2.1 % in 2002 to 4.1 % in 2021 growing at an average annual rate of 4.11% [35]. Comparatively speaking, in general terms, rural areas are often lagging when it comes to socioeconomic indicators and are branded by low levels of GDP per capita which culminate in lower standards of living, lower incomes, and limited access to services quality products [36]. The unfavorable labor market conditions in Liberia result in limited job opportunities that remain one of the outstanding constraints to the demand side of rural finance.

Poor infrastructure including roads network, communication channels, and electricity continue to pose a huge challenge to Liberia's overall development. Specifically, this has limited the flow of financial services to the rural position by imposing huge transaction costs. It was pointed out that poor infrastructure, non-competitive markets, and poor information all lead to high transaction costs [37].

A few pieces of literature highlight structural unemployment in rural areas as being one of the limitations to the demand for rural finance. It is emphasized that high unemployment levels in rural areas are often of a structural nature, due to insufficient education and skills of workers [38]. Accordingly, it was suggested that disproportionality between labor demand and supply emanates from the lack of match between the job skills required by firms and those being provided by workers [39].

Due to limited vocational institutions across the rural landscape of Liberia, there has been insufficient specialized education for rural dwellers to seek other employment opportunities. With agriculture being the

primary occupation for 60% of Liberia's population, this shows that there are few diversification opportunities for rural dwellers to drift away from on-farm employment irrespective of minimum farm assets to pursue alternative income-generating means aside from agriculture [40]. This leads to structural impediments to adjustments in labor [41]. In addition to that, it is opined that the decisions of individuals regarding the discontinuance or continuation of farm activity is either contingent upon the favorable condition in off-farm labor markets which is demand-pull factors, or strategy for survival when rigid off-farm labor markets conditions arise otherwise known as distress-push factors [42]. Obviously, these conditions affect the demand for rural finance in Liberia.

In a general context, the rural areas in Liberia are characterized by low income as compared to the urban settings. This is said to be accounted for by low human capital, low wages, and low job quality which usually limit the opportunities and living standards of the rural dwellers. These conditions are exacerbated by limited social protection programs.

Another limiting factor that affects the demand for rural finance for Liberia's rural market is seasonality in agriculture. The nature of agricultural activities is noted to be seasonal. This seasonality spurs gyrations in the demand for labor and the productivity of labor owing to seasonal employment, migration, changes in wages, and ubiquitous unemployment [43].

Imperfect information and supervision rank as some of the major limitations to the demand for rural finance in Liberia's rural market. Asymmetric information between lending organizations and borrowers creates moral hazards leading to a high ratio of non-performing loans (NPLs) to total loan portfolios. Particularly, the CBL 2021 annual report cited that the financial sector of Liberia remains challenged by rising in nonperforming loans (NPLs), with NPLs ratio to total loans increasing from 21.17 percent in 2020 to 22.41 in 2021. Notably, the high NPL rate combined with Liberia's weak insolvency scheme weighs on the balance sheet of banks, making lending more difficult and non-inclusive.

Poor social protection and market failures in Liberia contribute to the limitations of the demand side of rural finance. International best practice suggests that Social Protection programs tend to perform better if important interactions between them are exploited. Unfortunately, there is a lack of coordination necessary to realize the full potential of such interventions in Liberia [44]. The proper functionality of the labor market which encompasses social protection, efficiency, and fairness is fostered by labor market institutions with the objective to achieve sound labor market governance [45]. The disparities in the performance of economies across countries stem from fluctuations in labor market institutions. Generically, labor codes and social protection are said to be underdeveloped or poorly carried out in rural areas as a result of the prevalence of self-employment, casual labor, and informal agreements which are inaccessible to governments. Additionally, the case in Liberia is worst for hard-to-reach areas. Poor transportation systems and communication channels make it challenging to provide social protection to people living in the rural part of Liberia. Inarguably, market institutions, policies, and regulations form an integral part of the determination of the allocation and distribution of labor. Failure to ensure the adequate functioning of these factors has the proclivity to give rise to market failures. The intervention of the government in the market through policy prescriptions should generate outcomes that demonstrate Pareto efficiency to preclude the inefficient allocation of resources.

There is a compelling need for the policy actors of Liberia to address these constraints faced by Liberia's rural market in accessing finance. I believe robust policy measures will suffice in remediating these gaps to ameliorate the flow of financial services to the rural poor in

Liberia. These measures will eventually help in poverty alleviation and sustainable development in the medium to long run.

Research Method

The method used for this study is searching for the literature on rural finance. A systematic review was carried out. To ensure that this study is informed by sufficient theoretical underpinning, several books, theses, journals, articles, and reports related to the determinants and demand side of rural finance were sought, gathered, and thoroughly reviewed by the author. Moreover, an interview was held with the Manager of the rural community financial institution in Sanniquellie as a representation of key stakeholders of the rural community financial institutions of Liberia. Also, the author's personal knowledge and observations regarding the trend of rural finance in Liberia were utilized as sources of information in the development of this article. The outcome of these reviews, interview, personal knowledge, and observations formed the core basis for the literature review and findings of this study. This study was carried out in Liberia with a specific focus on the rural setting.

Results

Findings from the study through literature review are presented under two major headings:

1. Determinants for the demand for finance for Liberia's rural market- It was revealed that the demand for finance for Liberia's rural market is fundamentally driven by the following factors:
   a) education.
   b) households' income level, and assets; and
   c) agriculture.
2. Limitations to the demand side of finance for Liberia's rural market-The study shows that the below constitutes the limitations to the supply side of finance for the rural market of Liberia:
   a) Slow economic growth and lack of job opportunities.
   b) Poor public and private investments.
   c) Low income.
   d) Seasonality in agriculture.
   e) Imperfect information and supervision; and
   f) Poor social protection and market failure.

Discussion

As indicated by the findings which evolved out of this study, the rural market of Liberia's demand for finance is mainly influenced by educational pursuit, income level, and assets of households as well as agriculture. Investment in education is considered paramount for addressing Liberia's human capacity gap aimed at propelling national development. For this reason, many parents and adult Liberians in rural areas seek loans/credits to finance the educational endeavors of their children and dependents as well as themselves [31]. Few available jobs that offer low wages and salaries for rural dwellers in Liberia lead to an income gap. To fill this income gap resulting from low wages/salaries, they are constrained to obtain loans to cope with many expenditure streams. Agriculture is the major occupation for Liberia's rural dwellers who accounts for 60% of the population [40]. As such, this heavy dependence on agriculture as a primary source of support for their livelihoods creates a huge demand for finance.

As it relates to the limitations of finance for the rural market of Liberia, the slow pace of economic growth and lack of job opportunities are inhibiting the capacity of the rural populace to access finance. The fact remains indisputable that the Liberian economy is becoming to experience gradual growth with a projected GDP of 3.6 in 2021 [3]. However, unemployment among youths comprising graduates from tertiary, vocational/technical institutions as well as the uneducated ones remains a daunting task to surmount with the country's unemployment rate of 4.1% as of 2021 [35]. Most importantly, public, and private investments in infrastructure such as roads, electricity, communication, and

information technology are generally poor in the rural parts of Liberia. These have contributed to the development of limited channels for the flow of financial services to rural dwellers through financial and non-financial institutions. Those seeking financial services are often constrained to commute over longer distances to access financial services which leads to high transaction costs for these rural dwellers. The continuous advancement in the technological epoch has given rise to the demand for certain skill sets for certain jobs. It has become obvious that this has brought about structural unemployment of many rural dwellers who do not have the required skill sets for the few available jobs. Interestingly, agriculture ranks as the primary occupation for 60% of Liberia's population [40]. This has caused the workforce of the rural population to be largely confined to agriculture. Sadly, this has not been able to engender an environment that provides diversification of opportunities for the rural populace. Additionally, low income has continued to characterize Liberia's rural setting. This is largely attributed to the scantiness of jobs coupled with limited and low education and skills of the rural populace. This has given rise to low-income levels among people found in this segment of the population. Another daunting situation for rural dwellers is the seasonal agricultural activities in Liberia. With buck of the country's population being involved in agricultural activities, during peak agricultural season, productivity increases with a corresponding increase in income levels for households. On the downside, agricultural output declines during the low agricultural season which yields low-income levels [43]. These natural occurrences continue to affect rural households' ability to access credit because of the unpredictability of repayment schedules. One of the key constraints that continue to affect the supply of finance in the rural market of Liberia is information asymmetry between lenders and borrowers. This often results in adverse selection and subsequent moral hazard since in fact, lenders are not willing to incur high costs for monitoring the projects of borrowers. banks' fears to expand their lending portfolios to the rural population premised on the growing statistics of non-performing loans. Evidently, the ratio of non-performing loans to total loans for Liberia's increased from 21.17 percent in 2020 to 22.41 in 2021 for commercial banks in Liberia [3]. This has narrowed the credit market when it comes to the flow of finance to the rural populace. Finally, social protection programs and coverage for the rural populace in Liberia are poor or ineffective due to the lack of coordination among them [44]. Adequate programs are not designed to tailor to the social protection needs of people found in this bracket and the Government of Liberia has not succeeded in efficiently allocating resources to address the welfare of its citizenry due to changing priorities, widespread corruption, and abuse of state resources.

Conclusion

A great deal of literature suggests that the global effort to achieve development in developing countries around the world has been greatly challenged by two well-entrenched forces: widespread poverty and inequality. As a way of surmounting these threats, several approaches or strategies have been explored and operationalized. One of such that continues to yield optimal results is financial inclusion. Financial inclusion has been unquestioningly viewed as a key tool in stimulating economic and financial development in developing countries where poverty and inequality are ubiquitous. It creates access to finance by those in the low-income bracket, thus engendering inclusive growth and equality. Liberia is a developing country with the devastating effect of prolonged civil war and two global pandemics as well as widespread poverty and unemployment. This presents a strong case for access to finance for the country's rural market as a means to support the livelihoods of rural dwellers. The study unearthed that the determinants of finance for Liberia's rural market include education, income

level, age, households' assets, and agriculture. The study concludes that access to finance for Liberia's rural market is limited by slow economic growth & lack of employment opportunities, poor public and private investments, structural unemployment few diversification opportunities, low income, seasonality in agriculture, imperfect information & supervision as well poor social protection & market failures. These gaps can be addressed by harnessing the National Financial Inclusion Strategy (NFIS) through strong policy formulation and robust implementation.

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Conflict of Interest

I write to categorically state that I do not have any personal relationship with any of the editors of the Publishing House. Also, I have no commercial, legal, or financial relationship with the publication business involving the Publishing House. I am only a bona fide student of Texila American University. As part of the partial requirements for a Ph.D, I am required to publish two articles.

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