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Consumption of Food Groups During Pregnancy and Adverse Pregnancy Outcomes among Women Attending Public Hospitals in Gambella Town, Southwest Ethiopia

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Abstract *Diets with limited food groups during pregnancy remain a significant predictor of maternal anemia, hypertensive disorders in pregnancy (HDP), preterm delivery (PTD), and low birth weight (LBW). Unbalanced dietary practices remain persistent in low- and middle-income countries, including Ethiopia. This study aimed to compare the risks of adverse pregnancy outcomes between pregnant women who consumed and did not consume specific food groups among women attending public hospitals in Gambella Town, Southwest Ethiopia. An institution-based prospective cohort study was conducted among 254 pregnant women enrolled and followed from July 25, 2024, to March 10, 2025, at public hospitals. Data were collected using a structured questionnaire administered by an interviewer. Food group consumption was assessed twice using a 24-hour dietary recall. Modified Poisson regression models were used to estimate risk ratios and 95% confidence intervals. Of the 254 enrolled women, 232 completed the follow-up (response rate: 91.3%). Lack of consumption of the other vitamin A-rich vegetables, fruit, roots, and tubers was significantly associated with a higher risk of low maternal hemoglobin (ARR = 1.959; 95% CI = 1.073–3.575, P = 0.006). However, HDP, PTD, and LBW were not associated with the consumption of any food groups. Lack of consumption of other vitamin A-rich vegetables, fruits, roots, and tubers was associated with a higher risk of low maternal hemoglobin. Improving antenatal nutrition counseling and education on consuming a variety of food groups, as well as addressing the social determinants that affect intake of food groups, is essential for enhancing pregnancy outcomes.*

Keywords *Adverse Pregnancy Outcomes, Consumption of Food Groups, Gambella, Southwest Ethiopia*

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Introduction

Suboptimal diets, such as those low in energy and micronutrients, increase the risk of complications during pregnancy and childbirth, weaken the immune system, cause poor fetal growth, and preterm delivery [1, 2]. Optimal dietary intake during preconception and pregnancy can enhance diet quality, gestational weight gain and lead to healthier birth outcomes [1]. Consuming at least five of the ten food groups is associated with greater micronutrient adequacy among women aged 15 to 49 than among those consuming fewer than five [3]. Consumption of maize foods provides limited amounts of lipids and micronutrients, such as vitamins C, A, and E, calcium, salt, and selenium, due to limited dietary diversity, lower nutrient bioavailability, and processing-related nutrient losses [4].

Plant-based foods, whole grains, and dietary fibers indicate carbohydrate quality [5]. Conversely, excessive intake of added sugar and a high sugar-content diet are associated with detrimental health effects [5]. Food groups with high carbohydrates also have detrimental health effects, while enriched and fortified staple foods, such as dairy products and grains, provide critical micronutrients such as calcium, vitamin D, potassium, and dietary fiber [5]. Dietary intake of starchy foods like rice and its byproducts, noodles, and flour products is linked to a higher risk of unfavorable pregnancy outcomes or adverse pregnancy outcomes (APOs), which include preterm delivery (PTD), low birth weight (LBW), maternal anemia, and hypertensive disorders in pregnancy (HDP) [6-9].

Anemia prevalence reached up to 65.9% in Ethiopia [10-15]. The incidence of low birth weight ranged from 9.6% to 41%, and preterm delivery from 9.1% to 38% [16, 17]. The incidence of hypertensive disorders in pregnancy was 6.82% [18].

The high magnitude of diet-associated non-communicable diseases (NCDs) in Ethiopia has been a significant contributor to high mortality and morbidity, posing considerable challenges in both maternal and newborn health, with significant regional and local variations, underscoring the need to understand the interplay between the consumption of food groups and their associated risks of adverse pregnancy outcomes. There is limited evidence on food group consumption and its association with adverse pregnancy outcomes in the Gambella Regional State of Ethiopia, despite more understanding in other regions. Therefore, this study aimed to compare individual food group consumption during pregnancy and examine associated risks of adverse pregnancy outcomes among women attending public hospitals in Gambella Town, Southwest Ethiopia.

Methods and Materials

Study Setting and Design

This institution-based prospective cohort study was conducted to compare the risks of HDP, PTD, LBW, and low maternal Hb levels between women with and without practices of consuming each food group during pregnancy among women attending public hospitals in Gambella Town, the capital of Gambella Regional State, located 766 km west of Addis Ababa. The town is in Ethiopia's Western Lowlands at 526 meters above sea level. It is divided into five smallest administrative units, namely Kebele 01, 02, 03, 04, and 05. According to the 2016 Ethiopian Fiscal Year (EFY) or 2023-2024 Gregorian Calendar (GC) population projection, an estimated population of 69,784, including 2,094 pregnant women, resided in the town. The women were enrolled from July 25, 2024, and followed up until March 10, 2025, at two public hospitals, Gambella Town Primary Hospital (GTPH) and Gambella General Hospital (GGH), as in the published articles [19, 20]. The women were followed prospectively to determine mothers'

usual practices of consuming at least one food item twice from each food group during pregnancy and associated risks of adverse pregnancy outcomes.

Study Population

As described in the published articles [19, 20], the source population comprised pregnant women who were permanent residents of Gambella Town (≥6 months). The target population included all permanent residents aged 15-49 years. The study population consisted of the target population who attended Antenatal Care (ANC) services at GTPH and GGH during the study period. The sample consisted of pregnant women selected from the study population based on predefined inclusion and exclusion criteria.

Inclusion and Exclusion Criteria

As described in the published articles [19, 20], pregnant women aged 15-49 who were permanent residents of Gambella Town and had a Gestational age (GA) between 12 and 27 completed weeks were eligible for inclusion. Additional inclusion criteria were no known hypertension or blood pressure (BP) < 140/90 mm Hg without any antihypertensive medication, a baseline maternal Hb ≥ 10.0 g/dl, willingness to attend routine ANC visits until delivery at the study hospitals, and provision of written informed consent. Pregnant women with BP<140/90 mm Hg and on any antihypertensive medication or known chronic hypertension under treatment, or those whose delivery was decided or planned outside the study hospitals (e.g., at home or in other facilities) were excluded from the study.

Sample Size Determination and Sampling Procedures

The sample size was determined using G*Power version 3.1.9.7, written by Franz Faul. To detect a true Relative Risk (RR) or difference in outcome proportions (P1-P2) between the exposed and unexposed groups, Fisher's exact test for two independent groups was used. The calculation assumed a 2-sided test with 85% power (Z 1-β=1.04); a 95% confidence level [Zα/2=1.96], and a type I error rate (α) of 5%. The proportion of inadequate DD practice among the exposed group (P1) was assumed to be 60.2%; the proportion of adequate DD practice among the unexposed group (P2) was 39.8%, yielding an absolute difference of 20.4% and an estimated relative risk of 1.51. An allocation ratio (N2/N1) of 0.66 was applied based on prior evidence among postpartum women in Gambella Town [21]. The DD findings from the postpartum women study were considered a good proxy for DD during pregnancy in this area. After accounting for a 10% non-response rate for potential loss to follow-up, a final sample size of 254 pregnant women was determined.

As described in Wie and colleagues' article [20], this study was conducted in two purposively selected hospitals in Gambella Town. The GTPH and the GGH were selected as the comprehensive ANC and delivery services centers on opposite sides of the Baro River. According to the 2015 EFY (2022-2023 G.C), the two hospitals' reports from the district health information software version 2 (DHIS2) indicated that 528 (71.6%) and 210 (28.4%) pregnant women were registered for their first ANC at GTPH and GGH, respectively. This suggested an average monthly enrollment of 44 and 18 pregnant women for the first ANC services in GTPH and GGH, respectively. Consequently, proportional sample size allocation, based on the number of pregnant women who attended the first ANC, was 182 and 72 for GTPH and GGH, respectively. A facility-based consecutive sampling was used to enroll all eligible pregnant women who attended ANC services at the respective hospitals until the required sample size for each hospital was achieved. Women were reminded regularly of the need to complete. The flow of participants was illustrated (Figure 1).

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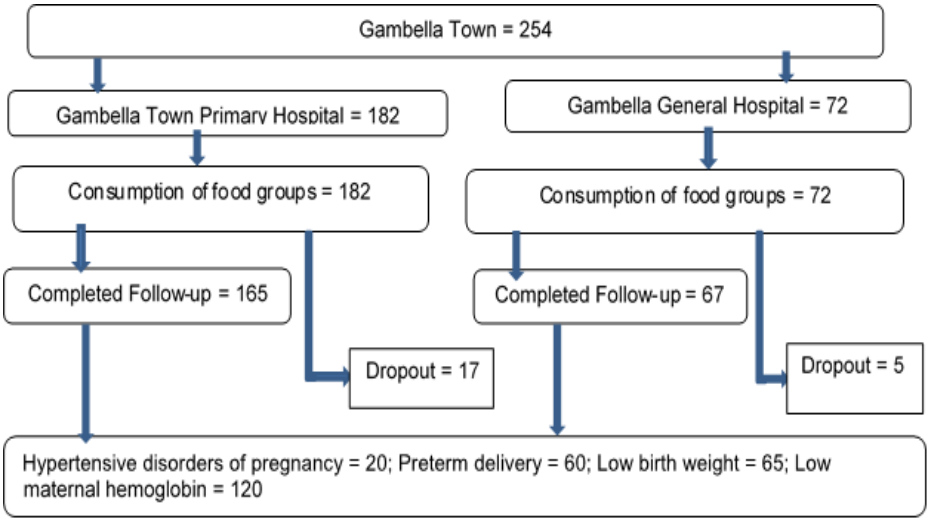

Figure 1. Cohort of Pregnant Women Enrolled and Followed up for Exposure in Public Hospitals in Gambella Town, Southwest Ethiopia, 2024-2025

Study Variables

Dependent Variable

The dependent variables included pregnancy outcomes, categorized as normal or adverse outcomes. APOs, such as HDP with BP ≥ 140/90 mm Hg with or without positive urine protein, including preeclampsia (PE) or eclampsia, superimposed preeclampsia (SPE), gestational hypertension (GH), chronic hypertension (CH) detected after enrollment, PTD with GA < 37 weeks at birth, LBW with weight < 2500 grams at birth, and low maternal Hb < 10.0 g/dl [20].

Independent Variables

The primary independent variable was consumption of food groups defined based on consumption of at least one food item twice from the same food groups such as grains; pulses (beans, peas and lentils); nuts and seeds; milk and milk products; meat, poultry and fish; eggs; dark green leafy vegetables; other vitamin A-rich fruits and vegetables; other vegetables; other fruits; fried and salty foods; sweet foods; sugar-sweetened beverages (SSBs); other beverages and foods; red palm oil; other oils and fats; and condiments and seasonings, as per Minimum Dietary Diversity for women (MDD-W) guide.

Other factors confounded the relationship between food group consumption and adverse pregnancy outcomes. These factors were sociodemographic, sociocultural, household socioeconomic status, and individual characteristics [19, 20]. The sociodemographic characteristics included location of residence in Gambella Town; ethnicity; religion; marital relationship; age of the pregnant woman and her partner; education level of a pregnant woman and her partner; occupation types for a woman and her partner; household size and family size; age at the time of her marriage; practices of polygamous marriage by husbands; husband's support of the household with food in kind or cash; number of relatives or visitors in the household; number of children under five years in the household; household income; per capita or average income; household food insecurity and access (HFIA); household economic status based on wealth index quintiles; ownership of seven durable assets [television (TV), fridge, phone, car, bicycle, cheap utensils ≤ 50 United States Dollar (USD) or ≤ 2,750 Ethiopian Birr (ETB), such as a chair, table, clock, watch, water cooker, radio, fan, or mixers, and expensive utensils ≥ 300 USD or ≥ 16,500 ETB, such as a washer, dryer, computer, motorbike, motorboat, air conditioner, or generator as adapted by Wie and his colleagues [19] from standard International

Wealth Index (IWI) scale described by Swits and Steendijk in their 2013 working paper. Other individual characteristics included gravidity; parity; newborn biological sex, acute infectious diseases during pregnancy (e.g., malaria, urinary tract infection (UTI), sexually transmitted infections (STIs), intestinal worms, intestinal parasites); acute non-infectious illnesses (e.g., dyspepsia or gastritis, excessive nausea or vomiting or hyperemesis gravidarum); regular physical activity or exercise or household chores for at least 30 minutes daily; slept under long lasting insecticide treated bed net (LLIN); ever utilized iron and folic acid supplements (IFAS) during pregnancy; dietary habits of taking coffee or tea immediately after meals, alcohol intake, smoking, and charcoal/soil intake during pregnancy as described by Wie and colleagues [19, 20]. Anthropometric indicators were also assessed, including maternal weight before and during pregnancy, height, body mass index (BMI), and mid-upper arm circumference (MUAC), as described by Wie and colleagues [19, 20].

Data Collection Instruments and Procedures

A structured data collection tool (questionnaire) was administered by an interviewer during data collection. This tool has five components: (I) Baseline characteristics (sociodemographics, sociocultural, household socioeconomic, individual characteristics); (II) MDD-W; (III) HFIA; (IV) Anthropometric, laboratory, and clinical measurements; and (V) Follow-up and outcomes assessments as described by Wie and colleagues [19, 20].

Gestational Age and Enrollment into the Study

Firstly, GA was determined using either the date of the last normal menstrual period (LNMP) or an obstetric ultrasound that confirmed a viable pregnancy. GA, in accordance with the World Health Organization (WHO), can be based on ultrasound before the 24th week of gestation [22]. Eligible participants were enrolled during their first and second ANC visits.

Baseline Characteristics Assessment

Baseline data were socio-demographics, socio-cultural characteristics, socioeconomic characteristics, and individual characteristics. The IWI scale was used for the household wealth index. This scale has 12 assets and 20 indicators. These indicators included ownership of consumer durable assets (7 indicators), housing quality characteristics (9 indicators, including floor quality, quality of toilet facilities, and number of rooms for sleeping), and households' access to two basic public utilities (4 indicators), such as access to quality potable water supply and electricity, as adapted by Wie and his colleagues [19] from the standard International Wealth Index (IWI) scale described by Swits and Steendijk in their 2013 working paper.

Assessment of Consumption of Food Groups

The consumption of each food group was assessed among women of reproductive age twice during enrollment and subsequent visits, one month apart, using two 24-hour (day and night) dietary recall assessments. The two assessments were preferred over a single dietary recall to ensure reliable data on mothers' usual dietary practices of consuming each food group during pregnancy. Foods eaten by pregnant women within 24 hours before the assessment were recorded as breakfast, lunch, dinner, mid-morning snacks, mid-afternoon snacks, and bedtime snacks, regardless of quantity and quality. The principal investigator (PI) ensured that each food item was classified into its appropriate food group according to the MDD-W guide [3]. The ten main food groups assessed included: Grains/cereals; pulses (beans, peas, and lentils); nuts and seeds; dairy (milk and milk products); meat, poultry, and

fish; eggs; dark green leafy vegetables; vitamin A-rich fruits and vegetables; other vegetables; and other fruits [3]. Additional food groups assessed included: Red palm oils; other source oils; fried, savory, and salty foods; sweet foods; sugar-sweetened beverages (SSB); other beverages and foods; condiments and seasonings, such as chili peppers, garlic, ginger root, bean paste, fermented bean paste, tomato paste, and other small food items as per the MDD-W guide [3]. These food groups were assessed for their potential relationships with the risk of adverse pregnancy outcomes. A food group was consumed when at least one food item from the group was eaten twice during two 24-hour dietary recall periods.

Household Food Insecurity Status Assessment

The food insecurity status of the households was assessed using nine standard questions from the Household Food Insecurity and Access Scale (HFIAS), developed by the Food and Nutrition Technical Assistance (FANTA) in 2007.

Anthropometry, Clinical Assessments, and Laboratory Tests

As described by Wie and colleagues [19, 20], maternal Hb concentration was measured in grams per deciliter (g/dl) using a HemoCue (Hb analyzer) to determine Hb level. Anthropometric measurements, including maternal height and weight, were collected using standard tools. Maternal height was measured with a stadiometer in the Frankfort standing position and recorded to the nearest 1 mm or 0.1 cm. The maternal weight was measured using a calibrated weighing scale and recorded to the nearest 0.1 kilogram. Calibration of the weight scale was done with an object of known weight. The newborn's weight was measured using an electronic weighing scale and recorded to the nearest 0.1 kilogram. A newborn's weight was measured as follows: the weight of dry linen was measured first. The reading of the dry, warm linen weight was recorded. Then the measurer reset the scale to zero (0). Then the newborn, without clothes, was placed on top of the linen, and the combined newborn and linen weight readings were obtained. Finally, the weight of the linen was subtracted from the weight of the linen plus newborn for the weight of the newborn and recorded to the nearest 100 g.

Mid-upper arm circumference was measured using MUAC tape or an armband, and the reading was to the nearest 0.1 cm. Blood pressure was measured with a digital BP measuring device, specifically an automatic sphygmomanometer. Cuffs were wrapped around the upper arm (left or right) at heart level after the subject rested for at least 5 minutes. Blood pressure was measured in millimeters of Mercury (mmHg) twice in a seated position at an interval of one to two minutes, and the average value of systolic blood pressure (SBP) in mmHg or diastolic blood pressure (DBP) in mmHg was recorded as per the procedure of Takagi and colleagues [23]. When high BP was detected, pregnant women's urine was checked for significant protein levels using a urine dipstick kit. Changes in color readings were compared against the standard. Proteinuria (protein in urine) was confirmed when a dipstick test result of a positive (1+) or higher was detected at least twice during the visit [24].

Follow-up Assessments

As described by Wie and colleagues [19, 20], pregnant women underwent at least three follow-up visits before the expected date of confinement (EDC) was reached at term (37 completed weeks to 41 completed weeks plus six days). The baseline characteristics, MUAC, weight, and height, were assessed once during enrollment. Consumption of each food group was assessed twice, one month apart. The Hb, BP, and urine protein were checked at every ANC visit. Blood pressure and urine protein were also checked during delivery and within

the first 24 hours after delivery. The newborn's weight was checked at delivery and within the first 24 hours after birth. Pregnancy outcomes were classified as normal pregnancy outcomes or APOs, such as low maternal Hb, HDP, PTD, and LBW. Maternal Hb levels were assessed during ANC follow-up after enrollment until the third trimester of pregnancy or just before delivery. The outcomes, such as presence or absence of PTD, LBW, low maternal Hb levels, and HDP, were assessed during ANC follow-up after enrollment, during delivery, and within 24 hours of delivery. HDP included GH, PE, SPE, and CH, reported but undetected at enrollment. Finally, pregnant women who dropped out or were lost to follow-up or transferred to other facilities before outcomes assessment or died from causes unrelated to the outcomes of interest were excluded from the analysis.

Data Quality Control

As described by Wie and colleagues [19, 20], the questionnaire was prepared in English, translated into Amharic and Nuer, and back-translated to English by blinded translators to ensure consistency and clarity. Discrepancies were reviewed and resolved through consensus. Six data collectors (midwives and nurses) with Bachelor of Science (BSc) degrees were recruited, along with two supervisors with Master of Science (MSc) degrees.

Data collectors and supervisors received training over three days covering eligibility, skip patterns, dietary recall assessment, follow-up procedures, ethics, and proper use of instruments (digital scales, stadiometers, MUAC tapes, HemoCue Hb analyzers, urine dipstick kits, and automated digital BP devices). They were also trained to use KoboCollect (Android software) for data entry and to assess dietary intake using MDD-W guidelines, portion size with household utensils (e.g., tablespoons, teaspoons, and cups), gram conversion, and food group classification based on the Ethiopian food-based dietary guideline.

Weight scales were calibrated daily. BP was measured twice to obtain average readings. Laboratory quality assurance procedures included cross-checking complete blood counts (CBCs), validating HemoCue Hb readings, and repeating urine protein tests. Questionnaire sections I and II were pre-tested on 10 pregnant women outside the ANC, Gynecology, and Obstetric units of the two hospitals to assess clarity, question sequence, and data collectors' competence. Feedback from the pre-test was incorporated before data collection. Data collectors were blinded to participants' exposure status (exposed and unexposed); they followed all participants until delivery to minimize bias. Supervisors and the PI conducted regular monitoring and cross-verification of ANC and laboratory records to ensure data quality.

Data Processing and Analysis

Data were collected electronically using KoboCollect version 2024.1.3 and exported to the Statistical Package for the Social Sciences (SPSS) version 25 for data transformation and analysis. Descriptive analyses were performed to summarize the study population and key variables using frequency distributions, percentages, means, and standard deviations. Categorical variables were presented using tables, while continuous variables were summarized using means with standard deviations (SD).

Bivariable modified Poisson regression was conducted to assess associations and identify potential predictors of HDP, low maternal Hb, PTD, and LBW. Risk Ratio (RR), along with the corresponding 95% Confidence Interval (CI), was calculated, and variables with $p < 0.25$, potential confounders, and clinically relevant variables were included in multivariable analysis.

Multivariable regression models with robust standard errors were employed to identify independent predictors while adjusting for confounders. An adjusted Risk Ratio (ARR), along with 95% CI, was calculated to quantify

the strength of associations. Statistical significance was declared at p-value < 0.05 and a 95% CI that excluded unity. Adequacy of models was assessed using deviance statistics or Pearson's chi-square goodness-of-fit tests. Multicollinearity was evaluated using the Variance Inflation Factor (VIF) ≤ 5.

Operational Definitions

Food Group Consumption: A food group was considered consumed when a pregnant woman ate at least one food item from that specific food group in an adequate quantity of at least 15 grams or 1 tablespoon for the 10 food groups of MDDS as per the guide of MDD-W of reproductive age group, or any amount for other food groups, on two occasions from 24 hours before enrollment into study until 24 hours before the second dietary recall assessments; otherwise, it was considered as not consumed food group even if food items were taken once during the study period [19].

Pregnancy outcomes: Any outcome, including either normal or any of the four diet-related APOs observed among pregnant women or newborns after enrollment in the follow-up until 24 hours after delivery [20].

Adverse pregnancy outcomes: The occurrence of at least one of four diet-related complications, such as hypertensive disorders in pregnancy, preterm delivery, low birth weight, or low maternal Hb less than 10.0 g/dl, that can potentially affect health outcomes among pregnant women and/or their newborns, after enrollment in the follow-up until 24 hours after delivery [20].

Hypertensive disorders in pregnancy: The occurrence or exacerbation of any of four clinical forms of hypertension for the first time after enrollment until 24 hours after delivery [20].

Low maternal hemoglobin: Maternal Hb concentration was considered low Hb < 10.0 g/dl or hematocrit <30.0% at any stage of pregnancy, as the risks of adverse health outcomes among mothers and newborns increased when the blood Hb level decreased below 10.0 g/dl [23].

Results

Socio-Demographics and Socio-cultural Characteristics

Of the 254 enrolled pregnant women, 194 were classified as exposed (inadequate DD) and 60 as unexposed (adequate DD). A total of 232 completed follow-ups (91.3% response rate), with 22 (8.7%) lost to home delivery (12), relocation (5), and loss of contact (5). Participants had a mean age of 24.24 years; most were married (97.8%), lived in Kebele 01 (60.3%), and were predominantly Nuer (58.2%) and Christians (95.7%). Most women had at least a secondary education (69.0%) and were homemakers (72.9%), while 45.4% of partners were employed (Table 1).

Table 1. Sociodemographics and Sociocultural Characteristics of Pregnant Women Attending Public Hospitals in Gambella Town, Southwest Ethiopia, 2024–2025

Variables	Number (n)	Percent (%)
Pregnant women age group		
16-23 years	112	48.3
24-38 years	120	51.7
Marital relationship		
Married and lived together	227	97.8
Others*	5	2.2
Partner's age group		
17-31 years	107	47.1
32-60 years	120	52.9

Residence location in Gambella Town		
Kebele 01	140	60.3
Kebele 02-05	92	39.7
Ethnic groups		
Nuer	135	58.2
Amhara	23	9.9
Oromo	23	9.9
Anuak	20	8.6
Others**	31	13.4
Religious groups		
Christianity***	222	95.7
Islam and Baba John	10	4.3
Pregnant women's educational level		
No formal class at the Primary level (Grades 1-8)	72	31.0
At least the secondary education level (Grades 9-12)	160	69.0
Partner's educational level		
No formal class at the secondary level (Grades 9-12)	83	36.6
At least a diploma or certificate level	144	63.4
Pregnant women's occupational types		
Homemakers	169	72.9
Employed (Government, UN, and NGOs)	30	12.9
Trading, Daily laboring, and Farming	33	14.2
Partner's occupational types		
Employed (Government, UN, and NGOs)	103	45.4
Trading, Daily laboring, Farming, and no formal Job	124	54.6
Family size or family members		
1-2 persons	72	31.0
3-11 persons	160	69.0
Number of children under 5 years of age among family members in the household		
No child under five	112	48.3
At least 1 child under five	120	51.7
Number of relatives/ visitors at home within the month of dietary assessment		
Less than 2 persons	105	45.3
2 persons and above	127	54.7
Household size (family and relatives/visitors) at home within the month of dietary assessment		

Less than 5 persons	110	47.4
5 persons and above	122	52.6
Partner's polygamy practices in the community		
Yes	40	17.9
No	184	82.1
Pregnant women in the age group at the time of their marriage		
14-17 years	63	27.2
18-28 years	169	72.8
Partner's support of the household with food, either in kind or cash		
Yes	189	83.3
No	38	16.7

*Notes: * Cohabiting, Separated, and Never lived together; ** Kambata, Tigre, Gurage, Gamo, Hadiya, Dawro, Kaffa, Cheka, Welayta, Oppo, and Shilluk; *** Protestant, Orthodox, Seventh-day Adventist, Church of God, Catholic, and Messianic Jewish*

UN United Nations; NGOs non-governmental Organizations

Household Socio-economics and Individual Characteristics

Most participants were multigravida (63.8%), with nearly one-third (32.8%) being multiparous. Based on MUAC, 19.0% of the pregnant women were undernourished, while 7.0% were overnourished before pregnancy. The majority of households (75.9%) were moderately to severely food-insecure, with only 24.1% food-secure and mildly food-insecure (Table 2).

Table 2. Household Socioeconomics and Individual Characteristics of Pregnant Women Attending Public Hospitals in Gambella Town, Southwest Ethiopia, 2024–2025

Variables	**Number (n)**	**Percent (%)**
Gravidity		
Primigravida	84	36.2
Multigravida	148	63.8
Parity		
Nulliparous and primiparous	156	67.2
Multiparous	76	32.8
Biological sex of the Newborn		
Female	120	51.7
Male	112	48.3
Fatness based on pre-pregnancy body mass index in kilograms per square meter.		
Normal (18.5-24.5)	117	63.2
Underweight (< 18.5)	55	29.7
Overnutrition (≥ 25.0)	13	7.0
Maternal fatness based on body mass index in kilograms per square meter		
Normal (18.0-24.5)	150	64.7
Underweight (< 18.5)	49	21.1
Overnutrition (≥25.0)	33	14.2
Maternal undernutrition based on mid-upper arm circumference below 23 cm		
Yes	44	19.0
No	188	81.0

Household average income or per capita income		
< 1250 Birr	88	37.9
≥ 1240 Birr	144	62.1
Household food insecurity level		
Food secure and mildly food insecure	56	24.1
Moderately and severely food insecure	176	75.9
Household wealth index quintiles.		
1st & 2nd quintiles (poorest 20% with the lowest wealth & poor)	105	45.3
3rd-5th quintiles (middle, rich, & richest 20% with the highest wealth)	127	54.7
Households with at least two sleeping rooms		
Yes	144	62.1
No	88	37.9
Had ever used iron and folic acid supplements for at least 90 days		
Yes	99	42.7
No	133	57.3
Physical activities, exercise, or household chores were conducted for at least 30 minutes daily.		
Yes	127	54.7
No	105	45.3
Slept under a long-lasting insecticide-treated bed net		
Yes	122	95.7%
No	10	4.3%
Malaria attack confirmed with laboratory tests.		
Yes	99	42.7
No	133	57.3
Had anemia in the past pregnancy		
Yes	41	17.7
No	191	82.3
Urinary tract and/or sexually transmitted infections		
Yes	46	19.8
No	186	80.2

Consumption of Food Groups during Pregnancy and Hypertensive Disorders in Pregnancy

After adjusting for potential confounders in this study, there was no significant difference observed in the risks of HDP between pregnant women with and without consumption of food items from food groups such as pulses (ARR = 0.623; 95% CI: 0.208–1.869; p = 0.398) and sugar sweetened beverages (ARR = 2.022; 95% CI: 0.771–5.303; p = 0.152) during pregnancy. The age group of pregnant women between 16 and 23 years showed a significantly reduced risk of hypertensive disorders of pregnancy (HDP), with an 88.5% decrease compared to the age group of 24 to 38 years (Adjusted Risk Ratio [ARR] = 0.115, 95% Confidence Interval [CI]: 0.023–0.581, P = 0.009). Additionally, women residing in Kebele 01 had an 86.9% lower risk of developing HDP compared to

those living in the other four Kebeles (02, 03, 04, and 05) in Gambella Town (ARR = 0.131, 95% CI: 0.024–0.720, P = 0.019). Furthermore, nulliparous women had a 2.1-fold higher risk of HDP compared to those who were at least primiparous (ARR = 3.136, 95% CI: 1.130–8.700, P = 0.028) in this study. (Table 3).

Table 3. Hypertensive Disorders in Pregnancy between Women with and without Consumption of Food Groups during Pregnancy among Women Attending Public Hospitals in Gambella Town, 2024–2025

Variables	Hypertensive Disorders in Pregnancy (n = 232)		RR (95%CI)	ARR (95%CI)
	Yes	No		
Pulses (beans, lentils, and peas) were consumed.				
No	10 (6.5%)	145 (93.5%)	0.50 (0.22–1.14)*	0.62 (0.21–1.87)
Yes	10 (13.0%)	67 (87.0%)	1	1
Sugar-sweetened beverages (SSBs) were consumed.				
Yes	10 (9.6%)	94 (90.4%)	1.23 (0.53–2.84)	2.02 (0.77–5.30)*
No	10 (7.8%)	118 (92.2%)	1	1
Pregnant women's age group				
16-23 years	6 (5.4%)	106 (94.6%)	0.46 (0.18–1.15)*	0.12 (0.02–0.58)**
24-38 years	14 (11.7%)	106 (88.3%)	1	1
Pregnant women's residence in Gambella Town				
Kebele 01	7 (5.0%)	133 (95.0%)	0.35 (0.15–0.85)**	0.13 (0.02–0.72)**
Kebele 02, 03, 04 & 05	13 (14.1%)	79 (85.9%)	1	1
Ethnic group origin				
Lowland	10 (6.4%)	147 (93.6%)	0.48 (0.21–1.10)*	2.15 (0.66–7.00)*
Highland	10 (13.3%)	65 (86.7%)	1	1
Pregnant women's educational level				
Informal to Primary	6 (8.3%)	66 (91.7%)	0.95 (0.38–2.38)	0.40 (0.11–1.50)*
Secondary and above	14 (8.8%)	146 (91.2%)	1	1
Parity				
Nulliparous	11 (11.5%)	85 (88.5%)	1.73 (0.75–4.02)*	3.14 (1.13–8.70)**
At least primiparous	9 (6.6%)	127 (93.4%)	1	1
Body mass index during the pre-pregnancy state				
Under & overnutrition	8 (6.8%)	109 (93.2%)	0.78 (0.28–2.14)	0.36 (0.12–1.11)*
Normal	6 (8.8%)	62 (91.2%)	1	1
Regular physical activity and exercise, or household chores, for at least 30 minutes daily.				
No	6 (5.7%)	99 (94.3%)	0.52 (0.21–1.30)*	3.26 (0.88–12.07)*
Yes	14 (11.0%)	113 (89.0%)	1	1
Household economic status using wealth index quintiles				
1st to 2nd Quintiles	13 (12.4%)	92 (87.6%)	2.25 (0.93–5.43)*	2.06 (0.69–6.16)*
3rd to 5th Quintiles	7 (5.5%)	120 (94.5%)	1	1

*Notes: * P-value < 0.25; ** P-value < 0.05; RR, risk ratio; ARR, adjusted risk ratio; CI, confidence interval*

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Consumption of Food Groups During Pregnancy and Low Maternal Hemoglobin

Among 232 pregnant women who completed the follow-up periods and delivered in the two hospitals in Gambella Town, 111 (56.6%) pregnant women did not consumed food items from vitamin A-rich roots, tubers, vegetables, and fruits developed low Hb level less than 10.0 g/dl during pregnancy and 9 (25.0%) pregnant women who consumed food items from vitamin A-rich roots, tubers, vegetables, and fruits developed low hemoglobin less than 10.0 g/dl during pregnancy.

A modified Poisson regression model with a log link and robust standard errors was used to compare the risk of low hemoglobin levels among pregnant women who consumed different food groups and those who did not. After adjusting for confounders, the risk of low maternal Hb level among pregnant women without consumption of food items from vitamin A-rich roots, tubers, vegetables, and fruits was 95.6% higher than among their counterparts (ARR = 1.959; 95% CI = 1.073–3.575, P = 0.006). There was no significant difference in risk of low Hb level < 10.0 g/dl between pregnant women with and without consumption of food items from food groups, such as pulses (ARR = 1.115; 95% CI = 0.797–1.539, P = 0.529); milk and milk products (ARR = 0.922; 95% CI = 0.660–1.287, P = 0.632); meats, poultry and fish (ARR = 0.915; 95% CI = 0.714–1.173, P = 0.485); dark green leafy vegetables (ARR = 0.869; 95% CI = 0.663–1.139, P = 0.310); other vegetables (ARR = 0.904; 95% CI = 0.701–1.166, P = 0.437), and other fruits (ARR = 1.968; 95% CI = 0.962–4.027, P = 0.064) in this study. The risk of low hemoglobin < 10.0 g/dl among pregnant women was significantly associated with residence in five kebeles of Gambella Town. Pregnant women living in Kebele 01 have a 77% higher risk of developing low hemoglobin (Hb) during pregnancy compared to those residing in other kebeles (02, 03, 04, and 05) in Gambella Town (Table 4).

Table 4. Low Maternal Hemoglobin between Women with and without Consumption of Food Groups during Pregnancy among Women Attending Public Hospitals in Gambella Town, 2024–2025

Variables	Low maternal Hb (n = 232)		RR (95%CI)	ARR (95%CI)
	Yes	No		
Pulses (beans, lentils, and peas) were consumed.				
No	88 (56.8%)	67 (43.2%)	1.37 (1.01–1.84)**	1.12 (0.80–1.54)
Yes	32 (41.6%)	45 (58.4%)	1	1
Milk and milk products were consumed.				
No	105 (52.2%)	96 (47.8%)	1.08 (0.73–1.59)	0.92 (0.66–1.29)
Yes	15 (48.4%)	16 (51.6%)	1	1
Meats, poultry, and fish were consumed.				
No	64 (51.2%)	61 (48.8%)	0.98 (0.76–1.26)	0.92 (0.71–1.17)
Yes	56 (52.3%)	51 (47.7%)	1	1
Dark green leafy vegetables were consumed.				
No	84 (47.7%)	92 (52.3%)	0.74 (0.58–0.95)**	0.87 (0.66–1.14)
Yes	36 (64.3%)	20 (35.7%)	1	1
Vitamin A-rich roots, tubers, vegetables, and fruits were consumed.				
No	111 (56.6%)	85 (43.4%)	2.27 (1.27–4.04)**	1.96 (1.07–3.58)**
Yes	9 (25.0%)	27 (75.0%)	1	1
Other vegetables were consumed.				

No	46 (49.5%)	47 (50.5%)	0.93 (0.72–1.20)	0.90 (0.70–1.17)
Yes	74 (53.2%)	65 (46.8%)	1	1
Other fruits were consumed.				
No	113 (57.1%)	85 (42.9%)	2.77 (1.42–5.42)**	1.97 (0.96–4.03)*
Yes	7 (20.6%)	27 (79.4%)	1	1
Pregnant women's residence in Gambella Town				
Kebele 01	88 (62.9%)	52 (37.1%)	1.81 (1.33–2.46)**	1.77 (1.04–3.03)**
Kebele 02, 03, 04 & 05	32 (34.8%)	60 (65.2%)	1	1
Ethnic group origin				
Lowland	90 (57.3%)	67 (42.7%)	1.43 (1.05–1.95)**	0.61 (0.34–1.08)*
Highland	30 (40.0%)	45 (60.0%)	1	1
Experienced excessive nausea and/or vomiting during pregnancy (Hyperemesis Gravidarum)				
Yes	44 (53.7%)	38 (46.3%)	1.06 (0.82–1.37)	1.10 (0.87–1.40)
No	76 (50.7%)	74 (49.3%)	1	1
Household food insecurity level				
Moderately and severely food insecure	90 (51.1%)	86 (48.9%)	0.96 (0.72–1.27)	0.76 (0.56–1.03)*
Food secure and mildly food insecure	30 (53.6%)	26 (46.4%)	1	1
Iron and folic acid supplements have been used as recommended by healthcare providers.				
No	82 (61.7%)	51 (38.3%)	1.61 (1.21–2.13)**	1.18 (0.89–1.56)*
Yes	38 (38.4%)	61 (61.6%)	1	1
Household Food Insecurity (FI) level				
Moderate & severe FI	90 (51.1%)	86 (48.9%)	0.96 (0.73–1.30)	0.80 (0.58–1.10)*
Food secure & mild FI	30 (53.6%)	26 (46.4%)	1	1

*Notes: * P-value < 0.25; ** P-value < 0.05; *** Church of God, Islam/Muslim, and Messianic Jewish; **** Orthodox, Catholic, and Baba John; ***** Nuer, Anuak, Oppo, Shilluk, and Burun; ****** Amhara, Oromo, Kambata, Gurage, Tigre, Gamo, Hadiya, Dawro, Kaffa, Cheka, and Welayta*

RR, risk ratio; ARR, adjusted risk ratio; CI, confidence interval

Consumption of Food Groups during Pregnancy and Preterm Delivery

The risk of PTD was not significantly different between pregnant women with and without consumption of food items from most food groups during pregnancy in this study. There was no significant difference in risk of PTD between pregnant women with and without consumption of food items from food groups, such as pulses (ARR = 0.905; 95% CI = 0.552–1.486, P = 0.694); milk and milk products (ARR = 0.783, 95% CI = 0.432–1.421, P = 0.421); meats, poultry and fish (ARR = 1.149; 95% CI = 0.707–1.868, P = 0.575); eggs (ARR = 1.039; 95% CI = 0.464–2.329, P = 0.926); dark green leafy vegetables (ARR = 1.069; 95% CI = 0.607–1.884, P = 0.816); vitamin A-rich roots, tubers, vegetables and fruits (ARR = 1.238; 95% CI = 0.633–2.420, P = 0.533); other vegetables (ARR = 0.893; 95% CI = 0.573–1.393, P = 0.619), and other fruits (ARR = 1.235; 95% CI = 0.586–2.602, P = 0.578) in this study (Table 5).

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Table 5. Preterm Delivery between Women with and without Consumption of Food Groups during Pregnancy among Women Attending Public Hospitals in Gambella Town, 2024–2025

Variables	Preterm delivery (n = 232)		RR (95%CI)	ARR (95%CI)
	Yes	No		
Pulses (beans, lentils, and peas) were consumed				
No	38 (24.5%)	117 (75.5%)	0.86 (0.55–1.34)	0.91 (0.55–1.49)
Yes	22 (28.6%)	55 (71.4%)	1	1
Milk and milk products were consumed				
No	51 (25.1%)	150 (74.6%)	0.87 (0.48–1.59)	0.78 (0.43–1.42)
Yes	9 (29.0%)	22 (71.0%)	1	1
Meats, poultry, and fish were consumed				
No	35 (28.0%)	90 (72.0%)	1.20 (0.77–1.87)	1.15 (0.71–1.87)
Yes	25 (23.4%)	82 (76.6%)	1	1
Eggs				
No	55 (25.7%)	159 (74.3%)	0.93 (0.43–2.02)	1.04 (0.46–2.33)
Yes	5 (27.8%)	13 (72.2%)	1	1
Dark green leafy vegetables were consumed				
No	47 (26.7%)	129 (73.3%)	1.15 (0.67–1.97)	1.07 (0.61–1.88)
Yes	13 (23.2%)	43 (76.8%)	1	1
Vitamin A-rich roots, tubers, vegetables, and fruits were consumed				
No	52 (26.5%)	144 (73.5%)	1.19 (0.62–2.30)	1.24 (0.63–2.42)
Yes	8 (22.2%)	28 (77.8%)	1	1
Other vegetables were consumed				
No	24 (25.8%)	69 (74.2%)	1.00 (0.64–1.56)	0.89 (0.57–1.39)
Yes	36 (25.9%)	103 (74.1%)	1	1
Other fruits were consumed				
No	53 (26.8%)	145 (73.2%)	1.30 (0.65–2.62)	1.24 (0.59–2.60)
Yes	7 (20.6%)	27 (79.4%)	1	1
Experienced a urinary tract infection and/or sexually transmitted infections				
Yes	8 (17.4%)	38 (82.6%)	0.62 (0.32–1.22)*	0.63 (0.32–1.25)*
No	52 (28.0%)	134 (72.0%)	1	1
Household Food Insecurity (FI) level				
Moderate & severe FI	41 (23.3%)	135 (76.7%)	0.69 (0.44–1.08)*	0.71 (0.44–1,14)*
Food secure & mild FI	19 (33.9%)	37 (66.1%)	1	1

*Notes: * P-value < 0.25; ** P-value < 0.05; RR, risk ratio; ARR, adjusted risk ratio; CI, confidence interval; Hb, hemoglobin.*

Consumption of Food Groups during Pregnancy and Low Birth Weight

The risk of LBW among newborns was not significantly different between pregnant women with and without the consumption of food items from most of the food groups during pregnancy. There was no significant difference in risk of LBW among newborns from pregnant women with and without consumption of food items from food groups, such as pulses (ARR = 1.293; 95% CI = 0.813–2.055, P = 0.277); milk and milk products (ARR = 1.371; 95% CI = 0.701–2.683, P = 0.357); meats, poultry and fish (ARR = 1.204, 95% CI = 0.785–1.845, P = 0.395); dark green leafy vegetables

(ARR = 1.026; 95% CI = 0.633–1.664, P = 0.917); vitamin A-rich roots, tubers, vegetables and fruits (ARR = 1.012; 95% CI = 0.547–1.873, P = 0.970), and other vegetables (ARR = 0.644; 95% CI = 0.407–1.018, P = 0.060). There was a significant difference in the risk of LBW with other maternal characteristics during pregnancy. The risk of LBW was 97.6% higher among newborns whose mothers were undernourished during pregnancy (ARR = 1.976; 95% CI = 1.334–2.925, P = 0.001). However, the risk of LBW was 47.9% lower among newborns whose mothers experienced excessive nausea or vomiting (hyperemesis gravidarum) at the early stage of pregnancy (ARR = 0.521; 95% CI = 0.313–0.867, P = 0.012) in this study (Table 6).

Table 6. Low Birth Weight between Women with and without Consumption of Food Groups during Pregnancy among Women Attending Public Hospitals in Gambella Town, 2024–2025

Variables	Low birth weight (n = 232)		RR (95%CI)	ARR (95%CI)
	Yes	No		
Pulses (beans, lentils, and peas) were consumed				
No	47 (30.3%)	108 (69.7%)	1.30 (0.81–2.07)	1.29 (0.81–2.06)
Yes	18 (23.4%)	59 (76.6%)	1	1
Milk and milk products were consumed				
No	58 (28.9%)	143 (71.1%)	1.28 (0.64–2.54)	1.37 (0.70–2.68)
Yes	7 (22.6%)	24 (77.4%)	1	1
Meats, poultry, and fish were consumed				
No	36 (28.8%)	89 (71.2%)	1.06 (0.70–1.61)	1.20 (0.79–1.85)
Yes	29 (27.1%)	78 (72.9%)	1	1
Dark green leafy vegetables were consumed				
No	49 (27.8%)	127 (72.2%)	0.97 (0.60–1.57)	1.03 (0.63–1.66)
Yes	16 (28.6%)	40 (71.4%)	1	1
Vitamin A-rich roots, tubers, vegetables, and fruits were consumed				
No	56 (28.6%)	140 (71.4%)	1.14 (0.62–2.10)	1.01 (0.55–1.87)
Yes	9 (25.0%)	27 (75.0%)	1	1
Other vegetables were consumed				
No	20 (21.5%)	73 (78.5%)	0.66 (0.42–1.05)*	0.64 (0.41–1.02)*
Yes	45 (32.4%)	94 (67.6%)	1	1
Gestational age was completed at birth				
Preterm	16 (26.7%)	44 (73.3%)	0.94 (0.58–1.52)	0.95 (0.60–1.50)
Term	49 (28.5%)	123 (71.5%)	1	1
Maternal blood hemoglobin level in the 3rd trimester or just before delivery				
< 10 g/dl	38 (31.7%)	82 (68.3%)	1.31 (0.86–2.00)*	1.32 (0.87–2.00)*
≥ 10 g/dl	27 (24.1)	85 (75.9%)	1	1
Pregnant woman's employment status				
No	54 (26.7%)	148 (73.3%)	0.73 (0.43–1.23)*	0.65 (0.41–1.04)*
Yes	11 (36.7%)	19 (63.3%)	1	1
Undernutrition status using mid-upper arm circumference < 23 cm				
Yes	20 (45.5%)	24 (54.5%)	1.90 (1.26–2.87)**	1.98 (1.33–2.93)**
No	45 (23.9%)	143 (76.1%)	1	1
Excessive nausea and/or vomiting experienced early during pregnancy				

Yes	15 (18.3%)	67 (81.7%)	0.55 (0.33–0.91)**	0.52 (0.31–0.87)**
No	50 (33.3%)	100 (66.7%)	1	1
Household economic status using wealth index quintiles				
1st to 2nd Quintiles	32 (30.5%)	73 (69.5%)	1.17 (0.78–1.77)	1.38 (0.92–2.05)*
3rd to 5th Quintiles	33 (26.0%)	94 (74.0%)	1	1

*Notes: * P-value < 0.25; ** P-value < 0.05; RR, risk ratio; ARR, adjusted risk ratio; CI, confidence interval*

Discussion

In this study, there was no significant difference in the risk of HDP between pregnant women who consumed food groups and those who did not. However, residence, maternal age, and parity were the significant predictors of HDP. Pregnant women residing in Kebele 01 experienced a substantially higher risk of HDP. The strong association between residence and adverse pregnancy outcomes, such as HDP and low maternal Hb, suggests an ethnic or racially based distribution of residences by kebeles in the town, with variation in genetics, socioeconomic status, and other social determinants, and disparities in this study setting. This finding is supported by several studies, which highlight that the global, regional, national, and local risks of HDP are explained by variations in genetics and other social determinants [25-27]. In this setting, there is an ethnic-based settlement by Kebeles, with possible variations in genetics, socioeconomic status, and other social determinants of health, which may explain differences in the risk of HDP by residential location. Targeted interventions, such as screening and close monitoring focusing on women from high-risk kebeles, could therefore help in reducing the impact of HDP.

Maternal age was also a significant determinant, with older mothers (24–38 years) being more likely to develop HDP than those younger than 16–23 years. This is inconsistent with evidence showing that adolescent pregnancies are associated with physiological immaturity, nutritional deficiencies, and limited ANC uptake, which increase susceptibility to hypertensive conditions [18, 28]. This finding reinforces the importance of not delaying the first pregnancy beyond the youth age group (age > 24 years). Parity demonstrated a well-established relationship with HDP. Nulliparous women had a markedly higher risk compared to those with prior births [29]. First pregnancies are known to pose a higher risk for preeclampsia and other hypertensive complications due to immunological factors, placental development dynamics, and lack of prior adaptation to pregnancy. This emphasises the need for close monitoring of first-time mothers during ANC visits. Strengthening ANC among younger and first-time expectant mothers for appropriate screening and counseling could be a key strategy for early detection and management of HDP.

This study identified two main predictors of low maternal hemoglobin levels: lack of intake of other vitamin A-rich vegetables, fruits, roots, and tubers, and residence in Kebele 01. Studies in low-resource settings reported that diets low in vitamin A-rich foods were associated with higher rates of anemia among pregnant women [30, 31]. This finding highlights the critical need for other vitamin A-rich vegetables, fruits, roots, and tubers during antenatal nutrition counselling. Disparity in risk of anemia was found with residential location by Kebeles in Gambella Town, with women in Kebele 01 experiencing a higher burden of low maternal Hb. This highlights the geographical and socioeconomic disparities in maternal dietary practices and anemia. Research shows that variations in anemia across different regions are

linked to differences in socioeconomic conditions, food security, and access to a variety of foods, as well as the availability and accessibility of maternal health care services [32-35]. This suggests that women in one area may face higher rates of poor sanitation, malaria exposure, or limited ANC, thereby contributing to lower maternal Hb. This finding suggests targeted community-based interventions, such as nutrition education, micronutrient supplementation, and strengthening ANC services, to address the disparities.

Maternal undernutrition was a significant predictor of LBW. The strong association between low MUAC < 23 cm and LBW aligns with extensive literature linking maternal undernutrition to intrauterine growth restriction (IUGR) [36-38]. Women with MUAC < 23 cm are more likely to have inadequate energy and micronutrient stores, limiting fetal growth and increasing the risk of LBW. This highlights the critical need for routine nutritional assessment during antenatal care and targeted interventions such as maternal supplementation with multiple micronutrients (MMNs) and counselling on balanced diets. An association was observed between excessive nausea and/or vomiting experienced in the early stage of pregnancy and LBW. It is inconsistent with findings in studies that demonstrated excessive nausea or vomiting was considered a risk factor for adverse birth outcomes due to poor maternal intake and dehydration [39, 40]. Possible explanations may include early management and care for nausea or vomiting since fetal weight gain peaks in the early third trimester. Pregnant women with nausea and/or vomiting early in pregnancy may receive more intensive medical attention, dietary counselling and guidance, and closer monitoring, which could mitigate the risk of LBW.

Conclusion

Lack of consumption of other vitamin A–rich vegetables, fruits, roots, and tubers was a significant independent determinant of a higher risk of low maternal hemoglobin levels. Residence in Kebele 01 was also a significant determinant of a higher risk of low maternal hemoglobin levels. Advanced maternal age (24-38 years), residing in Kebele 01, and being a first-time pregnant woman were found to be predictors of a higher risk of hypertensive disorders in pregnancy (HDP). These findings highlight the necessity for location-specific interventions, greater support for older and first-time pregnant women, and the reinforcement of antenatal care for the early detection and management of hypertension during pregnancy. Strengthening dietary counselling, improving access to diverse foods, and targeting geographically vulnerable women are critical steps to reducing risks of maternal anemia and HDP. Maternal undernutrition during pregnancy was a determinant of a higher risk of LBW. This finding underscores the critical role of screening for nutritional status during ANC. Interventions to improve maternal nutrition, particularly for women with low MUAC, remain essential. Additional studies are needed to investigate the consumption of various foods, sociodemographic factors, sociocultural influences, socioeconomic status, individual characteristics, and adverse pregnancy outcomes.

Data Availability

The datasets analyzed in this article can be obtained from the corresponding author upon request.

Conflict of Interest

The authors declare no conflicts of interest.

Ethics Approval

Ethical clearance and permission were granted by the Gambella Regional Health Bureau Ethical Review Committee, with reference number □□/9888/16 on 02 July 2024, to access data from the two hospitals. Written informed consent was obtained from all participants after telling them the purpose, risks, and benefits. Participants were also told of their right to refuse or withdraw at any time without affecting their services. The inclusion of high-risk groups, such as pregnant women aged 15-49 years, was declared. Finally, confidentiality was strictly maintained.

Author Contributions

The corresponding author played a pivotal role in the study's conception, design, data acquisition, analysis, interpretation, drafting of the manuscript, and critical revision for significant intellectual content. The corresponding author also submitted the manuscript to the journal and accepts full responsibility for the integrity and accuracy of the work. The co-authors' contributions included scientific guidance, critical review of the manuscript for intellectual content, final approval of the version to be published, and agreement to submit the manuscript to the current journal.

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