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Dietary Diversity Practices of Pregnant Women and Associated Factors among Women Attending Public Hospitals in Gambella Town, Southwest Ethiopia

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Abstract

Inadequate dietary diversity among pregnant women in Ethiopia remains a major public health concern, with approximately half of the women affected. Understanding context-specific dietary practices and associated factors is essential for effective intervention. This study assessed dietary diversity practices of pregnant women and their determinants among women attending public hospitals in Gambella Town, Southwest Ethiopia. An institution-based prospective cohort design was employed from July 25, 2024, to September 10, 2024, using a single-stage cluster sampling approach. Data were collected using an interviewer-administered questionnaire with KoboCollect software and analyzed in SPSS version 25. Dietary diversity was assessed twice using a 24-hour dietary recall. A modified Poisson regression model was applied, and statistical significance was declared at $p < 0.05$. All 254 participants completed the first follow-up, yielding a 100% response rate. The prevalence of inadequate dietary diversity practice was 76.4%. Factors significantly associated with being exposed included having at least one child under five years (ARR = 1.27; 95% CI: 1.03–1.57), lack of television in household (ARR = 1.19; 95% CI: 1.02–1.40), lack of antenatal care (ARR = 1.25; 95% CI: 1.02–1.53), gastritis (ARR = 1.29; 95% CI: 1.13–1.47), and meals or snacks frequency of only 1–4 times per day (ARR = 1.41; 95% CI: 1.17–1.69). The prevalence of inadequate dietary diversity practice was high. Strengthening nutrition education through mass media, improving antenatal nutrition counseling on meal frequency and diversity, and enhancing the screening and management of gastritis with smaller, more frequent meals were recommended.

Keywords: *Dietary Diversity, Gambella, Pregnant Women, Southwest Ethiopia.*

Introduction

Malnutrition among pregnant women remains a public health concern, largely driven by inadequate and poor-quality dietary practices during pregnancy [1-3]. Dietary diversity can be categorized as inadequate or adequate based on the number of food groups consumed [4]. The Minimum Dietary Diversity for Women (MDD-W) is a standardized Dietary Diversity (DD) indicator for women based on ten food groups [5]. It is used to assess dietary diversification and micronutrient adequacy at the population level among women aged 15-49 years [5]. It also reflects the quality of diets, based on micronutrient intake, for individual women who consume at least five of the ten defined food groups in a 24-hour recall period [5]. Accordingly, the MDD-W guide categorizes maternal DD as adequate DD and inadequate DD based on the Minimum Dietary Diversity Score (MDDS), which is obtained by

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summing up points scored for intake of foods in the ten food groups of MDD-W [5]. The MDDS ≥ 5 indicates adequate Minimum Dietary Diversity (MDD), whereas MDDS < 5 indicates inadequate MDD [5]. Consuming at least five of the ten food groups has been associated with higher micronutrient adequacy in women aged 15 to 49 compared to those consuming fewer than five [5]. Evidence showed that low maternal consumption of nutrient-dense foods such as nuts, poultry, and eggs, combined with high intake of refined grains and sugar-sweetened beverages, was associated with a lower prevalence (46.2%) of adequate MDDS ≥ 5 and a higher prevalence (53.8%) of inadequate MDDS < 5 [6]. Diets heavily reliant on maize-based foods (100 grams), which provide limited lipids and essential micronutrients, such as vitamins A, C, and E, calcium, iodine, and selenium, further contribute to poor nutritional status due to low dietary diversity, reduced nutrient bioavailability, and nutrient losses during processing [7]. Although plant-based foods, whole grains, and dietary fibers are indicators of carbohydrate quality, excessive consumption of refined carbohydrates and added sugars is associated with adverse health effects [8]. Although plant-based foods can improve health, they are not usually considered as a complex combination of nutrients and food elements [8]. In contrast, fortified and enriched staple foods, including dairy products and grains, provide essential micronutrients, such as calcium, vitamin D, potassium, and dietary fiber [8].

Inadequate dietary practices during pregnancy are more common than during other periods due to eating habits and dietary patterns associated with various factors [9, 10]. The prevailing habits in Ethiopia are predominantly characterized by the consumption of starchy foods and minimal intake of organ meats, which are believed to contribute to the persistence of nutritional deficiencies and the high prevalence of inadequate MDD [4]. The practice of inadequate MDD during pregnancy in Ethiopia ranged from 49.0% to 73.6% [2, 11-13]. The prevalence of low DD was 53.2%, and low food consumption was 19.7% in the East Gojjam Zone of the Amhara Region [14]. Inadequate MDD ranged from 39.8% to 72.6% among pregnant women with acute undernutrition and from 27.4% to 60.2% among those without acute undernutrition in Chinaksen District, Eastern Ethiopia [15]. Additionally, inadequate MDD was reported among 49.0% of pregnant women in Southwest Ethiopia [12] and 51.6% in Addis Ababa [11]. Overall, the combined prevalence of inadequate MDD practices among pregnant women in Ethiopia ranged from 53.0% to 56.6% [4, 16].

Dietary patterns and diversity during pregnancy have both positive and negative effects on the risk of unfavorable pregnancy outcomes and complications for both mothers and fetuses [17, 18]. Poor dietary quality, diversity, and malnutrition during pregnancy are associated with numerous complications and adverse outcomes, such as Hypertensive Disorders of Pregnancy (HDP), Preterm Delivery (PTD), Low Birth Weight (LBW), and maternal anaemia [17-21]. Undernutrition, low-quality diets, or suboptimal diets with low energy and micronutrients during pregnancy have been linked to unfavourable or adverse pregnancy outcomes, poor fetal growth, PTD, poor infant survival, and an increased risk of chronic diseases later in life [6, 22]. These unfavorable pregnancy outcomes for mothers and their newborns are referred to as Adverse Pregnancy Outcomes (APOs). These include PTD, LBW, Diabetes Mellitus (DM), Small-for-Gestational-Age (SGA), HDP, placental abruption, and pregnancy loss [17, 18]. Maternal anaemia with adverse effects, defined as a haemoglobin (Hb) concentration below 10.0 g/dl at any stage of pregnancy, is strongly associated with adverse maternal and fetal outcomes, including intrauterine growth retardation and preterm birth [23]. As such,

maternal anemia is considered one of the key diet-related APOs [23].

Appropriate nutritional interventions and adequate dietary intake during the preconception period and pregnancy can enhance the quality of a diet, resulting in optimal gestational weight gain (GWG) and favorable birth outcomes [6]. Diet-related problems during pregnancy can lead to complications such as anemia and other adverse pregnancy outcomes, affecting both mothers and their newborns [24, 25]. These nutrition-linked complications, including maternal mortality, perinatal mortality, PTD, LBW, and hypertension, continue to pose serious public health challenges in Ethiopia [26]. The persistently high burden of inadequate dietary diversity, the increasing prevalence of diet-associated Non-Communicable Diseases (NCDs) such as HDP, anemia, LBW, and PTD, highlight significant regional and local disparities in Ethiopia [4, 26].

These findings underscore the urgent need to understand and address the complex relationships between dietary practices, associated factors, and pregnancy-associated outcomes. Despite this need, evidence on dietary diversity practices during pregnancy, associated factors, and risks of adverse pregnancy outcomes remains limited in the study area. There has been no previous study conducted in the Gambella Regional State and Gambella Town on dietary diversity practices during pregnancy and their associated factors. Therefore, this study aimed to assess the burden of dietary diversity practices during pregnancy and associated factors among pregnant 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 determine exposure status based on the average MDDS among pregnant women attending public hospitals in Gambella Town, the capital city of Gambella Regional State. Gambella Town or Gambella City Administration is situated 766 km west of Ethiopia's capital, Addis Ababa. It is located in the Western Lowlands of Ethiopia, at an elevation of 526 meters above sea level along the banks of the Baro River. It is administratively organized into five kebeles (the smallest administrative unit or sub-district level), namely Kebele 01, 02, 03, 04, and 05. Based on projections from the 2007 Ethiopian Population and Housing Census, the town has an estimated total population of 69,784, with 34,194 males and 35,590 females [27]. During the 2016 Ethiopian Fiscal Year (corresponding to 2023-2024 Gregorian Calendar (G.C.), approximately 2,094 pregnant women were estimated to reside in the town. This study was conducted from July 25, 2024, to September 10, 2024, at Gambella Town Primary Hospital (GTPH) and Gambella General Hospital (GGH), the only public hospitals providing comprehensive antenatal and delivery services in the town.

Study Population

Pregnant women who were permanent residents of Gambella Town (those who had lived there for at least 6 months) were considered the source population. The target population included all pregnant women aged 15 to 49 who were permanent residents. The study population consisted of all pregnant women of reproductive age who attended Antenatal Care (ANC) services at GTPH and GGH during the study period. The sample was pregnant women selected from the study population based on predefined inclusion and exclusion criteria. The sampled participants were followed prospectively and assessed twice, yielding two groups: the exposed and unexposed groups. The exposed group comprised pregnant women who consumed inadequately diverse diets of less than five of the ten food groups twice or an average intake of less than five food groups over the two 24-

hour dietary recall periods, while the unexposed group included pregnant women who consumed adequately diverse diets of five or more food groups twice or an average intake of five or more food groups over two 24-hour recall periods, as per the MDD-W guide [5].

Inclusion and Exclusion Criteria

Pregnant women aged 15-49 who were permanent residents of Gambella Town and had a Gestational Age (GA) between 12 and 27 completed weeks at enrollment were eligible for inclusion. Additional inclusion criteria included having no known hypertension [Blood Pressure (BP) < 140/90 mm Hg without taking any antihypertensive medication], a baseline maternal Hb level ≥ 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 while 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 the G*Power 3.1.9.7 computer program written by Franz Faul to detect a true Relative Risk (RR) or a difference in outcome proportions (P_1-P_2) between the exposed and unexposed groups using Fisher's exact test for two independent groups. 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 in the exposed group (P1) was assumed to be 60.2%, while the proportion of adequate DD practice among the exposed group (P_2) was of 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 [28]. The DD findings from postpartum women were considered a good approximation proxy for DD during pregnancy, as this study represented the only available evidence using the ten food groups recommended by the MDD-W guide. After accounting for a 10% non-response rate to compensate for potential loss to follow-up, a final sample size of 254 pregnant women was determined.

Gambella Town has two hospitals, the GTPH and the GGH, which served as the study sites. According to District Health Information Software 2 (DHIS2) data records, 528 (71.6%) and 210 (28.4%) pregnant women were registered for their first ANC at GTPH and GGH, respectively, during the 2015 Ethiopian Fiscal Year (2022-2023). This indicated average monthly enrollment of 44 and 18 pregnant women at first ANC visits in GTPH and GGH, respectively. Consequently, proportional sample allocation, based on the size of pregnant women attended at ANC, was 182 and 72 for GTPH and GGH, respectively. A single-stage cluster sampling technique was employed, with each hospital considered a primary sampling unit. All eligible pregnant women attending ANC services at the respective hospitals were consecutively enrolled with inclusion criteria and informed written consent, until the required sample size for each hospital was reached. This cohort study's sampling procedures and participants' flow were illustrated schematically (Figure 1).

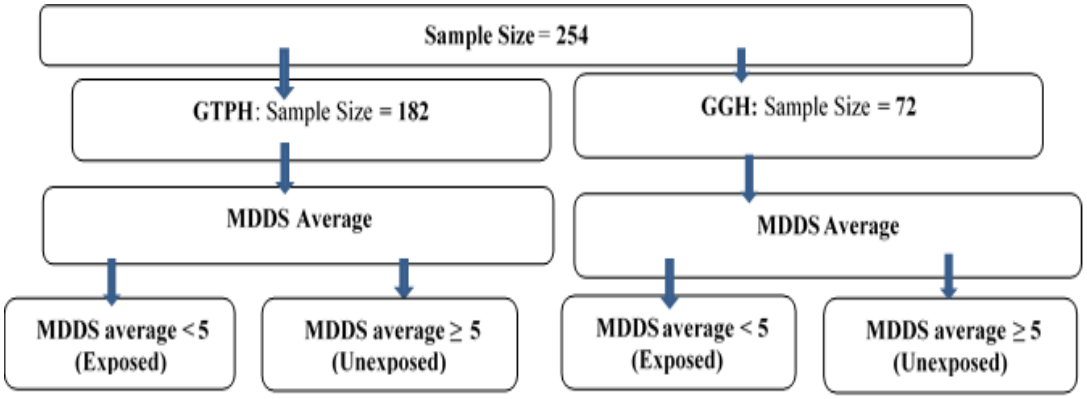

Figure 1. The Cohort of Pregnant Women Enrolled and Followed up for Exposure in Public Hospitals in Gambella Town, Southwest Ethiopia, 2024.

Study Variables

Dependent Variable

The dependent variable was DD practices during pregnancy, categorized as inadequate DD practice (exposed group) and adequate DD practice (unexposed group) based on the MDDS.

Independent Variables

Socio-demographic characteristics assessed included location of residence in Gambella Town; ethnicity; religion; marital relationship; age of the pregnant woman and her partner; education level of the pregnant woman and her partner; occupation types for a woman and her partner; family size or family members, such as pregnant woman, her partner, other wives of the husband, and their children).

Sociocultural characteristics included food taboos; cultural beliefs against weight gain during pregnancy; meal-sharing practices with a pregnant woman; family members and close relatives support for meal-sharing practices; age at the time of her marriage; practices of polygamous marriage by partner; partner's support of the household with food in kind or cash; number of children under five years in the household; number of relatives or visitors (non-family members who lived or stayed as a household within a month of dietary data collection); household size or number of household members (family members, relatives, guests, or visitors who lived or stayed as a household within a month of dietary data collection).

Household socio-economic characteristics included household income; per capita or average income; household food insecurity status based on the Household Food Insecurity and Access Scale (HFIAS); household economic status based on wealth index quintiles; ownership of seven durable assets [television (TV), fridge, phone, car, bicycle, cheap utensils, such as a chair, table, clock, watch, water cooker, radio, fan, or mixers with price ≤ 50 United States Dollar (USD) or ≤ 2,750 Ethiopian Birr (ETB), and expensive utensils, such as a washer, dryer, computer, motorbike, motorboat, air conditioner, or generator with price ≥ 300 USD or ≥ 16,500 ETB [29].

Individual characteristics assessed included gravidity; parity; ANC services in the past; Postnatal Care (PNC) services in the past; delivery in the health facilities in the past; nutrition counseling or education provided by health care providers in the past; 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); physical activity or exercise or household chores for at least 30 minutes daily; habits of taking coffee or tea

immediately after meals, alcohol intake, smoking, and charcoal/soil intake during pregnancy; frequencies of meals and snacks daily during pregnancy; dietary knowledge and attitudes/behaviours. Anthropometric indicators assessed included maternal weight before and during pregnancy, height, Body Mass Index (BMI), and Mid-Upper Arm Circumference (MUAC).

Data Collection Instruments and Procedures

Data were collected using an interviewer-administered structured questionnaire with five sections. These included: (I) Baseline characteristics, comprising socio-demographics, socio-cultural, household socio-economic, and individual characteristics; (II) MDD-W; (III) HFIAS; (IV) Anthropometry, laboratory, and clinical measurements; and (V) Follow-up and outcome assessments.

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 confirming a viable pregnancy. In accordance with WHO recommendations, GA estimation was based on LNMP and urine Human Chorionic Gonadotropin (HCG) levels, or on an ultrasound examination, conducted before the 24th week of gestation [30]. Eligible participants were enrolled during their first and second ANC visits, corresponding to gestational ages between 12 completed weeks and 27 weeks plus six days. Pregnant women outside this gestational age window were not eligible for enrollment.

Baseline Characteristics Assessment

Baseline data included comprehensive information on sociodemographics, sociocultural, and individual characteristics. The household wealth index was adopted from the International Wealth Index (IWI) scale using 12 assets with 20 indicators. These indicators included ownership of consumer durable assets (seven indicators), housing quality characteristics (nine indicators, including floor quality, quality of toilet facilities, and number of rooms for sleeping), and households' access to two basic public utilities or services (four indicators), such as access to quality potable water supply and electricity [29].

Minimum Dietary Diversity Score Assessment

The MDDS assessment among women of reproductive age was conducted using two 24-hour (day and night) recall periods of at least one month apart for foods consumed or dietary intake of all foods eaten by pregnant women. Pregnant women were asked to complete a list of foods they consumed as meals (breakfast, lunch, dinner), and snacks (mid-morning snacks, mid-afternoon snacks, and bedtime snacks) 24 hours before the dietary recall assessment. The quantities of all food items and drinks consumed were estimated and recorded using the adapted DD checklist provided to data collectors during dietary recall assessments. A threshold of ≥ 15 g (one tablespoonful of food items) of food consumed was counted as 1, and extremely small amounts (< 15 g) of each food item eaten were ignored (recorded as 0), according to the MDD-W guide [5]. The data collectors or the Principal Investigator (PI) determined which food groups the food items eaten or drunk belonged to according to the MDD-W guide [5]. Eating at least 15 g of each food item from the food groups recommended by the MDD-W guide earned 1 point; otherwise, 0 points were given. Therefore, points ranged from 0 to 10 for each of the 10 food groups. The 10 food groups assessed from each woman included (1) Grains (cereals), white roots and tubers, and plantains; (2) pulses (beans, peas, and lentils); (3) nuts and seeds; (4) dairy (milk and milk products); (5) meat, poultry, and fish; (6) eggs; (7) dark green leafy vegetables; (8) vitamin A-rich fruits, and

vegetables, roots and tubers; (9) other vegetables; and (10) other fruits [5]. Some common foods, such as chili peppers, garlic, ginger root, bean paste, fermented bean paste, tomato paste, and other small food items added for flavor, were not included in the MDDS as per the MDD-W guide [5]. However, these food groups were assessed to understand their relationships with the risks of adverse pregnancy outcomes in this study. The MDDS assessment was conducted twice during enrollment and subsequent visits at least one month apart. The final MDDS for each participant was calculated as the average of the two MDD scores, providing more reliable data on the usual dietary practices than a single dietary recall assessment.

Household Food Insecurity Status Assessment

The food insecurity status of the households was determined using nine standard questions from the HFIAS, developed in 2006 by the Food and Nutrition Technical Assistance (FANTA) for developing countries [31].

Anthropometry, Clinical Assessments, and Laboratory Tests

Maternal Hb concentration was measured in grams per deciliter (g/dl) using a HemoCue (Hb analyzer) to determine anemia status. Anthropometric data, including maternal height and weight, were collected using anthropometric tools. A stadiometer was used to measure height in the Frankfort (standing) position, recorded to the nearest 1 mm or 0.1 cm. Maternal weight was measured using a scale and recorded to the nearest 0.1 kilogram. This was done after calibration of the weight scale with an object of known weight. The newborn's weight was measured using an electronic weight measuring scale and recorded to the nearest 100 grams or 0.1 kilogram. A newborn's weight was measured as follows: First, the weight of dry and warm linen was measured before measuring the newborn's weight. Then the reading of the dry warm linen weight was recorded. Then the measurer pressed the zero (0) button on the scale once to neutralize the reading to zero. 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 that of the newborn for the weight of the newborn and recorded to the nearest 100 g (0.1kg).

Mid-upper arm circumference was measured using MUAC tape or armband, and the reading was to the nearest 0.1 cm or 1 mm. Blood pressure was measured using a digital BP measuring device (automatic sphygmomanometer) with a cuff wrapped around the upper arm (left or right) at heart level after resting for 5 minutes or more. 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 [32]. When high BP was detected, the urine protein level was checked for the presence of significant protein using urine protein measuring kits or urine dipstick kits with color change readings to compare against the standard. This was a qualitative measurement of color changes compared with a standardized level of protein and recorded level readings, plus (+) or minus (-). Proteinuria (protein in urine) was confirmed from spot urine or urine collected at the time of visit with dipstick test results of a positive (1+) or more detected at least twice at six hours apart [33].

Follow-up Assessments

The first ANC contact is recommended at the 12^{th} gestational week [33]. Subsequent contacts are also recommended at gestational weeks 20, 26, 30, 34, 36, 38, and 40 to reduce perinatal mortality and improve women's experience of ANC, as outlined in the Ethiopian Federal

Ministry of Health (FMOH) ANC 2020 protocol [33]. Each participant underwent at least three follow-up visits before the expected date of normal delivery 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. The Hb, BP, and urine protein were checked at every ANC visit. BP and urine protein were also checked during delivery and within the first 24 hours after delivery. The newborn's weight was checked during delivery and within the first 24 hours after delivery. The assessments for MDDS were conducted twice during enrollment and at the first subsequent visit. Based on the average MDDS, the DD practices of pregnant women were classified as inadequate DD practice (exposed) when the average MDDS was less than five and adequate DD practice (unexposed) when the average MDDS was greater than or equal to five. Then, pregnant women were grouped into two groups: the exposed and the unexposed. The exposed group had inadequate DD practice (MDDS average < 5), and the unexposed group had adequate DD practice (MDDS average ≥ 5).

Data Quality Control

The questionnaire was prepared in English and then translated into two languages, Amharic and Nuer, spoken by most residents of Gambella Town. Finally, it was translated back into English by two other translators, who were blinded to the original English version, to check the questionnaire's consistency and clarity. Discrepancies were reviewed and resolved through consensus. Six data collectors (midwives and nurses) with a minimum qualification of a Bachelor of Science (BSc) degree were recruited, along with two supervisors with a Master of Science (MSc) degree.

All data collectors and supervisors received comprehensive training over three consecutive days. The training covered study objectives, eligibility and enrollment criteria, questionnaire administration, skip patterns, dietary recall assessment, follow-up procedures, and ethical considerations. Particular emphasis was placed on standardized measurement techniques, calibration procedures, and the correct use of data collection instruments. Data collectors were trained and mentored in the proper use of anthropometric and clinical instruments, including digital weight scales, stadiometers, MUAC tapes, HemoCue Hb analyzers, urine dipstick kits, and automatic digital BP devices. They were also trained to use KoboCollect (Android software) for data collection. To ensure accurate dietary assessment, data collectors were trained in operational definitions of food groups, portion-size estimation using common household utensils (e.g., tablespoons, teaspoons, cups), and conversion of portions to approximate gram equivalents, following the MDD-W guide. The Ethiopian food-based dietary guideline (FBDGs) was used to enhance understanding of dietary assessment terminology and food group classification. Detailed discussions were held to standardize the classification of food groups and portion-size estimation for MDDS calculations.

To maintain measurement accuracy, data collectors were instructed to calibrate weight scales daily using objects of known weights before commencing measurements. Blood pressure was measured twice with automated devices, and the average of the two readings was recorded. Laboratory quality assurance was maintained through routine checks conducted by laboratory professionals. Urine protein testing was performed using dipstick kits, and Complete Blood Count (CBC) analyses were randomly cross-checked daily at each laboratory unit. Hemoglobin measurements obtained using the HemoCue analyzer were periodically validated through random hematocrit or Hb assessments using CBC machines to ensure consistency and accuracy.

Questionnaire sections, such as I and II, were pre-tested among 10 pregnant women who were

admitted or attended healthcare services in other units, rather than the ANC unit, Gynecology, and Obstetric wards of the two hospitals. The pre-test aimed to assess clarity, sequence of questions, and competence of data collectors. Feedback from the pre-test was reviewed, and necessary modifications were made before the actual data collection. To minimize information bias, data collectors were blinded to participants' exposure status (exposed and unexposed and followed all participants uniformly until delivery for outcome assessment.

Supervisors closely monitored data collection activities at each hospital to ensure adherence to standardized procedures. The PI conducted daily reviews of submitted data through the Kobo Toolbox server to verify completeness and consistency. Food item classifications into appropriate food groups were routinely cross-checked. The PI conducted weekly supervisory visits to both hospitals. Data quality was further ensured through cross-verification of ANC and laboratory records using participants' unique medical record numbers.

Data Processing and Analysis

Data were collected electronically using KoboCollect 2024.1.3 and exported to the Statistical Package for the Social Sciences (SPSS) 25 from International Business Machines (IBM) Corporation, Armonk, NY, USA, 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 and graphical displays, while continuous variables were summarized using means with standard deviations (SD).

Dietary diversity was classified using the average MDDS from two dietary assessments. Participants with an average MDDS < 5 were categorized as having inadequate dietary diversity (exposed group), whereas those with an average MDDS ≥ 5 (adequate dietary diversity) or the unexposed group. A chi-square test or Fisher's exact test was used to check for the differences in proportions of pregnant women between exposed and unexposed groups at p-value < 0.05. The chi-square test of independence or Fisher's exact test was also used to assess the independence relationship between categorical independent variables and dependent variables (exposed and unexposed groups) at a p-value < 0.05.

For associations between independent variables and dietary diversity practices, bivariate analyses using log-binomial regression were used to identify significant factors (predictors) of the dietary diversity practices. Risk Ratios (RR), along with corresponding 95% Confidence Interval (CI), were estimated in bivariable analyses using log-binomial regression. In the bivariable analyses, all predictors with p-values < 0.25, potential confounders, and clinically/epidemiologically relevant variables were selected for the final model. A multivariable Poisson regression model with a log link and robust standard error was employed to identify independent predictors (factors associated with dietary diversity practices), while adjusting for other predictors and potential confounders. An Adjusted Risk Ratio (ARR) or an Adjusted Relative Risks (ARR), along with 95% CI, was calculated to quantify the strength of associations. Statistical significance was defined as p-value < 0.05 and a 95% CI excluding unity (1). Model adequacy was assessed using deviance statistics or Pearson's chi-square goodness-of-fit test. The final model was considered a good fit to the data when the deviance or Pearson chi-square statistic to the model's Degrees of Freedom (DF) ratio approximated 1, as assessed using a Poisson regression model with robust standard errors. Multicollinearity among independent variables was evaluated using the Variance Inflation

Factor (VIF) ≤ 5, indicating no serious multicollinearity.

Operational Definitions

Food group consumption: A food group was consumed when a pregnant woman ate at least one food item twice from that individual food group in an adequate quantity of at least 15 grams or 1 tablespoon for the ten food groups of MDDS as per the MDD-W of reproductive age group (15-49 years) guide, or any amount twice for other food groups, on 24 hours before enrollment into study and 24 hours before the second dietary recall assessments; otherwise, it was considered as not consumed food group even if food items were eaten once during the study period.

Dietary diversity practices: Referred to the consumption of at least twice for food items from at least five or fewer food groups in the 24-hour recall period out of ten food groups as per the MDDS for women of reproductive age group (15-49 years) guide.

Inadequate dietary diversity practice (exposed): Referred to inadequate dietary diversity practice based on MDDS average less than five out of ten or consumption of less than five of the ten food groups at least twice, as per the MDD-W guide.

Adequate dietary diversity practice (unexposed): Referred to adequate dietary diversity practice based on the MDDS average of at least five out of ten or consumption of at least five of the ten food groups at least twice, as per the MDD-W guide.

Results

Dietary Diversity Practices

A total of 254 pregnant women were enrolled and followed up for DD practices, resulting in a 100% response rate. The mean of the MDDS average plus or minus SD was 4.11 ± 0.90. The mean of the average MDDS < 5 was 3.72 ± 0.61, while the mean of the average MDDS ≥ 5 was 5.38 ± 0.51. An independent samples t-test was performed to compare the mean difference in MDDS between pregnant women with inadequate DD practices (exposed) and those with adequate DD practices (unexposed). The average MDDS ≥ 5 was 5.38 with SD of 0.51, and the average MDDS < 5 was 3.72 with SD of 0.61; t (115.696) was -20.906 with p-value < 0.001. The mean difference in MDDS between the two groups was -1.65 with a 95% CI from -1.81 to -1.49.

A Z-test for column proportions of the chi-squared test of independence was used to compare the difference in proportions between pregnant women who were exposed and unexposed. A total of 194 (76.4%) pregnant women had inadequate DD practices (exposed), while 60 (23.6%) pregnant women had adequate DD practices (unexposed). The difference in proportions of pregnant women between those with inadequate DD practices (average MDDS < 5) and those with adequate DD practices (average MDDS ≥ 5) was statistically significant at p-value < 0.001 (Table 1).

Table 1. A Z-Test for Column Proportion of Pregnant Women between Exposed and Unexposed among Women Attending Public Hospitals in Gambella Town, Southwest Ethiopia, 2024

Variable	Dietary diversity practices (n = 254)		Total
	Inadequate (exposed)	Adequate (unexposed)	
Minimum dietary diversity scores average			
MDDS average ≥ 5	0a (0.0%)	60b (100%)	60 (23.6%)
MDDS average < 5	194a (100%)	0b (0.0%)	194 (76.4%)
Total	**194 (100%)**	**60 (100%)**	**254 (100%)**

Notes: *a, b, each subscript letter denotes a subset of categories of dietary diversity practices during pregnancy whose column proportions do not differ significantly from each other at the p-value 0 .05 level.*

Abbreviation: *MDDS minimum dietary diversity scores.*

Pregnant women with average MDDS < 5 had inadequate DD practices (exposed group), while those with average MDDS ≥ 5 had adequate DD practices (unexposed group). Among the ten food groups consumed by pregnant women, food items from the grains and cereals group were consumed by 191 (98.5%) and 60 (100%) exposed and unexposed women, respectively. While 54 (27.8%) of exposed pregnant women consumed pulses (mature beans, lentils, and peas), 29 (48.3%) of unexposed pregnant women consumed pulses. Among pregnant women, 79 (40.7%) of exposed women consumed meat, poultry, and fish, while 38 (63.3%) of unexposed women consumed meat, poultry, and fish. A total of 110 (56.7%) of exposed pregnant women consumed other vegetables, while 45 (75.0%) of those who were unexposed consumed other vegetables. A total of 39 (20.1%) of exposed women consumed dark green leafy vegetables, while 23 (38.3%) of unexposed women consumed them. While 23 (11.9%) of exposed women consumed milk and milk products, 13 (21.7%) of unexposed women did so as well. About 20 (10.3%) of exposed women consumed vitamin A-rich vegetables, fruits, roots, and tubers, while 17 (28.3%) of unexposed women consumed foods from the group. While 15 (7.7%) of exposed women consumed other fruits, 21 (35.0%) of unexposed women consumed food items from this group. The least consumed food items were from food groups such as nuts and seeds and eggs, which were consumed by 5 (2.6%) and 9 (4.6%) exposed women, respectively (Figure 2).

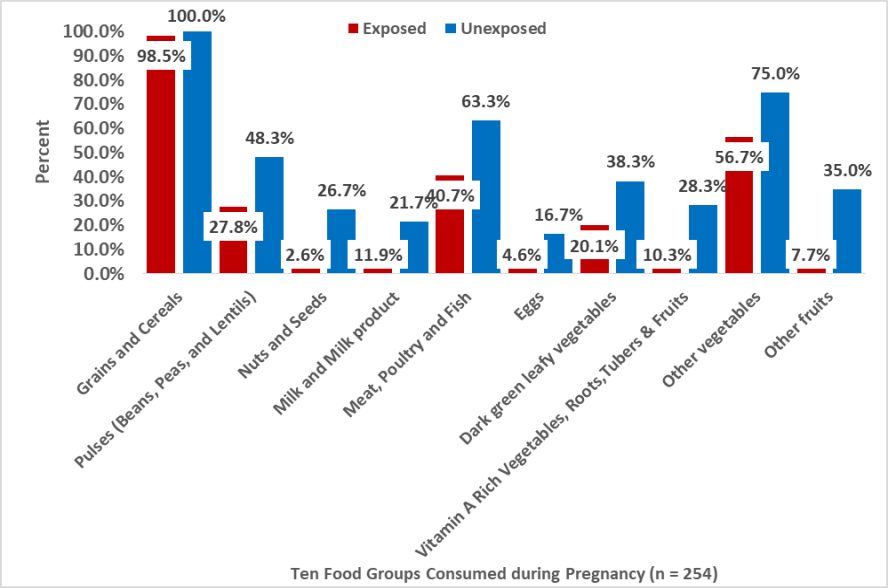

Figure 2. The Ten Food Groups Consumed in the Last 24 hours Recall Periods among Exposed and Unexposed Pregnant Women Attending Public Hospitals in Gambella Town, Southwest Ethiopia, 2024

Food Group Consumption

Among 254 pregnant women who consumed different food items from each of the food groups at least twice in the last 24 hours of dietary recall assessments (during enrollment and follow-up), 253 (99.6%) women consumed other oils including animals, seeds and fruits sources, 251 (98.8%) women consumed grains and cereals, 245 (96.5%) women consumed condiments and seasonings, 155 (61.0%) women consumed other vegetables, 117 (46.1%) women consumed meat, poultry and fish. The Sugar-Sweetened Beverages (SSB) were consumed by 113 (44.5%) women, 83 (32.7%) women consumed pulses (mature beans, lentils, and peas), and 62 (24.4%) women consumed dark green leafy vegetables. The least consumed food groups among

pregnant women during pregnancy included eggs consumed by 19 (7.5%), nuts and seeds consumed by 21 (8.3%), milk and milk products consumed by 36 (14.2%) vitamin A rich vegetables, fruits, roots, and tubers consumed by 37 (14.2%), and other fruits consumed by 36 (14.2%) women (Figure 3).

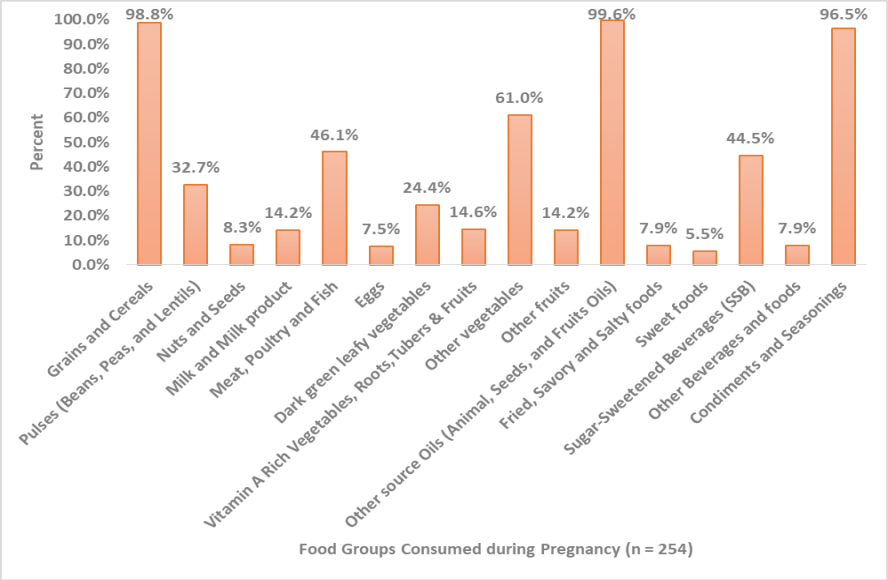

Figure 3. Food Groups Consumed Twice in the Last 24 hours of Dietary Recall Periods among Pregnant Women Attending Public Hospitals in Gambella Town, Southwest Ethiopia, 2024

Sociodemographic Characteristics

In this study, the mean age of the pregnant women was 24.24 ± 4.36. The mean age of the partner was 32.47 ± 6.94. The mean family size was 3.55 ± 1.54. Ninety-six (78.6%) pregnant women in the age groups of 16–23 years practiced inadequate DD, and 98 (73.7%) pregnant women in the age groups of 23–38 years had inadequate DD practices. One hundred eighty-nine (75.9%) pregnant women who practiced inadequate DD were married and lived together with their partner, and 5 (100%) pregnant women who practiced inadequate DD were others (separated, cohabiting, and never lived together with their partner). Protestants were the predominant believers among pregnant women (58.3%), and Nuer were 122 (82.4%) pregnant women with inadequate DD practices. Pregnant women with no formal class and those with primary education (Grade 1-8) had inadequate DD practices of 81.3%, while those women with a first degree or above had inadequate DD practices of 72.2%. Pregnant women who were homemakers were 138 (75.4%) exposed, and those employed by the government, the United Nations (UN), and Non-governmental Organizations (NGOs) were 25 (71.4%) exposed women (Table 2).

Table 2. Sociodemographic Characteristics of Exposed and Unexposed during Pregnancy among Women Attending Public Hospitals in Gambella Town, Southwest Ethiopia, 2024

Variables	**Dietary diversity practices**	
	Inadequate (exposed)	**Adequate (unexposed)**
Pregnant women's age group		
16-23 years	96 (78.7%)	26 (21.3%)
24-38 years	98 (74.2%)	34 (25.8%)
Marital relationship		

Married and lived together as a couple	189 (75.9%)	60 (24.1%)
Others*	5 (100%)	0 (0.0%)
Partner's age group		
17-31 years	92 (78.6%)	25 (21.4%)
32-60 years	97 (73.5%)	35 (26.5%)
Pregnant women's residence location in Gambella Town		
Kebele 01	126 (81.3%)	29 (18.7%)
Kebele 02	8 (72.7%)	3 (27.3%)
Kebele 03	12 (57.1%)	9 (42.9)
Kebele 04	9 (69.2%)	4 (30.8%)
Kebele 05	39 (72.2%)	15 (27.8%)
Ethnicity		
Nuer	122 (82.4%)	26 (17.6%)
Amhara	20 (74.1%)	7 (25.9%)
Oromo	19 (76.0%)	6 (24.0%)
Anuak	12 (57.1%)	9 (42.9%)
Kambata	4 (40.0%)	6 (60.0%)
Tigre	4 (57.1%)	3 (42.7%)
Others**	13 (81.2%)	3 (18.8%)
Religious groups		
Protestant	114 (77.0%)	34 (23.0%)
Orthodox	28 (65.1%)	15 (34.9%)
Seventh-day Adventist and Church of God	40 (81.6%)	9 (18.4%)
Others***	12 (85.7%)	2 (14.3%)
Pregnant women's educational level		
No formal class and primary level (Grades 1-8)	65 (81.3%)	15 (18.7%)
Secondary education level (Grades 9-12)	83 (74.8%)	28 (25.2%)
Diploma or certificate level	33 (73.3%)	12 (26.7%)
First degree and above	13 (72.2%)	5 (27.8%)
Partner's educational level		
No formal class and primary level (Grades 1-8)	23 (79.3%)	6 (20.7%)
Secondary level (Grades 9-12)	41 (67.2%)	20 (32.8%)
Diploma or certificate level	26 (74.3%)	9 (25.7%)
First degree and above	99 (75.9%)	25 (24.1%)
Pregnant woman's occupation type		

Homemaker	138 (75.4%)	45 (24.5%)
Employed by the government, the UN, and NGOs	25 (71.4%)	10 (28.6%)
Trading	20 (83.3%)	4 (16.7%)
Daily laboring and farming	11 (91.7%)	1 (8.3%)
Partner's occupation type		
Employed by the government, the UN, and NGOs	85 (73.3%)	31 (26.7%)
Trading	27 (79.4%)	7 (20.6%)
Daily laboring and farming	77 (77.8%)	22 (22.2%)
Family size or family members, such as a pregnant woman, partner, other wives, and their children		
3-11 Members	136 (78.2%)	38 (21.8%)
1- 2 Members	58 (72.5%)	22 (27.5%)

Notes: ** Cohabiting, Separated & Never lived together; ** Gamo, Hadiya, Dawro, Gurage, Kefa, Cheka, Welayta, Oppo, Shilluk, and Burun; *** Catholic, Islam/Muslim, Messianic Jewish, and Baba John*

Abbreviations*: UN United Nations; NGOs non-governmental organizations*

Sociocultural Characteristics

The mean age at marriage was 18.74 ± 2.25. The mean household size was 6.22 ± 5.39, and the mean number of legal wives among partners was 1.22 ± 0.52. The food items and non-food items prohibited (tabooed) during pregnancy in the community included non-scale fishes such as Teleostei and mudfish, honey, senafiche, telba or linseeds/flaxseeds, sweet potatoes, yogurt, gomen, ice cream, and alcoholic beverages. Only 11 (4.3%) women reported that there were taboos during pregnancy in their community. The reasons provided by community for avoidance of those items during pregnancy included abortion reported by 6 (54.6%) women for items such as honey, Sena fiche and telba, linseeds/flaxseeds, sweet potatoes, yogurt and gommen, religious beliefs against items reported by 4 (36.4%) women for non-scale fishes, and the coating on the newborn's head reported by 1 (9.1%) woman for ice cream. A total of 7 (63.6%) women reported that community leaders were responsible for reinforcing the taboos, while 4 (36.4%) women reported that religious leaders reinforced the practices. A total of 215 (84.6%) pregnant women reported no child marriage practices in their community; they reported that minimum accepted age for legal marriage ranged from 18 years and above, while 32 (12.6%) pregnant women reported that child marriage practices existed, with 31 (12.2%) women who reported that age ranged from 15 to 17 years was the minimum accepted age for legal marriage, and 7 (2.8%) women did not have any information in their community. A total of 150 (59.0%) pregnant women reported that there were no community beliefs against weight gain during pregnancy; 23 (9.1%) reported beliefs against weight gain in their community; and 81 (31.9%) had no idea about the community's perception of weight gain during pregnancy. Thirty-two (91.3%) pregnant women accepted and practised meal-sharing, 4 (1.6%) practised against their will, and 18 (7.1%) rejected the practices (Table 3).

Table 3. Sociocultural Characteristics of Exposed and Unexposed during Pregnancy among Women Attending Public Hospitals in Gambella Town, Southwest Ethiopia, 2024

Variables	Dietary diversity practices	
	Inadequate (exposed)	Adequate (unexposed)
Prohibition (taboo) of food and non-food items during pregnancy in the community		
Yes	5 (45.5%)	6 (54.5%)
No	189 (77.8%)	54 (22.2%)
Beliefs against weight gain during pregnancy in the community		
Yes	14 (60.9%)	9 (39.1%)
No	120 (80.0%)	30 (20.0%)
Meal-sharing practices or eating together with pregnant women in the community		
Yes	180 (76.3%)	56 (23.7%)
No	14 (77.8%)	4 (22.2%)
Pregnant women's acceptance and practices of meal-sharing		
Yes	179 (77.2%)	53 (22.8%)
No	15 (68.2%)	7 (31.8%)
Family members or close relatives' influence on meal-sharing with pregnant women		
Yes	174 (76.3%)	54 (23.7%)
No	6 (75.0%)	2 (25.0%)
Age group in years at the time of the pregnant woman's marriage		
14-17 years	51 (72.9%)	19 (27.1%)
18-28 years	143 (77.7%)	41 (22.3%)
Partner's polygamy practices in the community		
Yes	36 (80.0%)	9 (20.0%)
No	153 (75.0%)	51 (25.0%)
Partner's support for the household with food, either in cash or in kind		
No	33 (78.6%)	9 (21.4%)
Yes	156 (75.4%)	51 (24.6%)
Children aged under five years among family members who lived in the same home as a household		
≥ 1 child	105 (79.5%)	27 (20.5%)
0 child	89 (73.0%)	33 (27.0%)
Relatives/visitors who lived for at least 24 hours as a household within a month of dietary assessments		
≥ 2 Persons	116 (81.1%)	27 (18.9%)
< 2 Persons	78 (70.3%)	33 (29.7%)
Household size or members who lived for at least 24 hours within a month of dietary assessments		
≥ 5 Persons	111 (81.6%)	25 (18.4%)
< 5 Persons	83 (70.3%)	35 (29.7%)

Household Socioeconomic Characteristics

Households within the 1st, 2nd, 3rd, 4th, and 5th levels of wealth index quintiles were 33 (86.8%), 52 (67.5%), 42 (82.4%), 40 (80.0%), and 27 (71.1%), respectively, among the exposed. Households with food security, mild food insecure, moderate food insecure, and severe food insecure were 38 (73.1%), 6 (85.7%), 15 (93.8%), and 135 (75.4%), respectively, among the exposed (Table 4)

Table 4. Household Socioeconomic Characteristics of Exposed and Unexposed during Pregnancy among Women Attending Public Hospitals in Gambella Town, Southwest Ethiopia, 2024

Variables	Dietary diversity practices (n = 254)	
	Inadequate (exposed)	Adequate (unexposed)
Household monthly income in Ethiopian birr		
< 6000.00 birr	92 (78.6%)	25 (21.4%)
≥ 6000.00 birr	102 (74.5%)	35 (25.6%)
Household monthly average income or per capita income		
< 1250.00 birr	81 (79.4%)	21 (20.6%)
≥ 1250.00 birr	113 (74.3%)	39 (25.7%)
Household food insecurity level		
Food secure	38 (73.1%)	14 (26.9%)
Mildly food insecure	6 (85.7)	1 (14.3%)
Moderately food insecure	15 (93.8%)	1 (6.2%)
Severely food-insecure	135 (75.4%)	44 (24.6%)
Household wealth indexes quintiles		
1st quintile (poorest 20% with the lowest wealth)	33 (86.8%)	5 (13.2%)
2nd quintile (poor)	52 (67.5%)	25 (32.5%)
3rd quintile (middle)	42 (82.4%)	9 (17.6%)
4th quintile (rich)	40 (80.0%)	10 (20.0%)
5th quintile (richest 20% with the highest wealth)	27 (71.1%)	11 (28.9%)
Household ownership of a television		
No	82 (88.2%)	11 (11.8%)
Yes	112 (69.6%)	49 (30.4%)
Household ownership of a refrigerator (fridge)		
No	122 (82.4%)	26 (17.6%)
Yes	72 (67.9%)	34 (32.1%)
Household ownership of a home or a mobile phone		
No	43 (79.6%)	11 (20.4%)
Yes	151 (75.5%)	49 (24.5%)
Household ownership of a car		
No	189 (76.8%)	57 (23.2%)
Yes	5 (62.5%)	3 (37.5%)
Household ownership of a bicycle		
No	186 (76.8%)	56 (23.2%)
Yes	8 (66.7%)	4 (33.3%)
Household ownership of cheap utensils with a price less than or equal to 50 USD or 2,750 ETB		

No	25 (69.4%)	11 (30.6%)
Yes	169 (77.5%)	49 (22.5%)
Household ownership of expensive utensils with a price greater than or equal to 300 USD or 16,500 ETB		
No	165 (75.3%)	54 (24.7%)
Yes	29 (82.9%)	6 (17.1%)
Quality of the household latrine		
Traditional pit latrine, hanging toilet, or no toilet	18 (90.0%)	2 (10.0%)
Public toilet, improved pit latrine	164 (75.2%)	54 (24.8%)
Private flush toilet	12 (75.0%)	4 (25.0%)
Quality of the household floor		
Earth, dung	31 (88.6%)	4 (11.4%)
Cement, concrete, raw wood	152 (75.2%)	50 (24.8%)
Parquet, carpet, tile, or ceramic	11 (64.7%)	6 (35.3%)
Household number of sleeping rooms		
0 or 1 sleeping room	66 (69.5%)	29 (30.5%)
2 sleeping rooms	24 (88.9%)	3 (11.1%)
3 more sleeping rooms	104 (78.8%)	28 (21.2%)
Household access to a quality potable water supply		
Unprotected well, borehole, spring, surface water	7 (63.6%)	4 (36.4%)
Tap, protected well, tanker truck.	186 (77.8%)	53 (22.2%)
Bottled water, or water piped.	1 (25.0%)	3 (75.0%)
Household access to the electric power supply		
Yes	150 (81.5%)	34 (18.5%)
No	44 (62.9%)	37.1%)

Abbreviation: *USD United States dollar; ETB Ethiopian birr*

Individual Characteristics

The mean gravidity of pregnant women was 2.36 ± 1.46. The mean weight of pregnant women at enrollment was 59.32 ± 8.96. The mean dietary knowledge and attitude was 12.71 ± 3.19, and the median was 13.0. Forty (83.3%) undernourished pregnant women had inadequate DD practices, while 8 (16.7%) undernourished pregnant women had adequate DD practices. A total of 154 (74.8%) women with normal nutritional status had inadequate DD practices, and 52 (25.2%) women with normal nutritional status had adequate DD practices. Seventy-two (77.4%) pregnant women with no previous ANC had inadequate DD practices, while 122 (75.8%) pregnant women with previous ANC had inadequate DD practices. Pregnant women who experienced epigastric burning sensation (dyspepsia) or gastritis had inadequate DD practices in 92 (87.6%) cases, while 102 (68.5%) pregnant women with no signs of dyspepsia or gastritis had inadequate DD practices. Seventy-four (82.2%) pregnant women with excessive nausea or vomiting during pregnancy had inadequate DD practices, while 120 (73.2%) pregnant women with no nausea or vomiting had inadequate DD practices. One hundred thirteen (77.4%) women with unfavorable dietary knowledge and attitudes during pregnancy had inadequate DD practices, while 81 (75.0%) counterparts had inadequate DD practices (Table 5).

Table 5. Individual Characteristics of Exposed and Unexposed during Pregnancy among Women Attending Public Hospitals in Gambella Town, Southwest Ethiopia, 2024

Variables	Dietary diversity practices (n = 254)	
	Inadequate (exposed)	Adequate (unexposed)
Gravidity ever experienced (number of pregnancies)		
Primigravida	69 (76.7%)	21 (23.3%)
Multigravida	125 (76.2%)	39 (23.8%)
Parity ever experienced (number of births at or beyond 28 completed weeks)		
Nulliparous	74 (72.5%)	28 (27.5%)
Primiparous and above	120 (78.9%)	32 (21.1%)
Antenatal care services that were provided in the most recent pregnancy		
No	72 (77.4%)	21 (22.6%)
Yes	122 (75.8%)	39 (24.2%)
Postnatal care services that were provided after the most recent delivery		
No	145 (74.4%)	50 (25.6%)
Yes	49 (83.1%)	10 (16.9%)
Delivered in the health facilities in the past, the most recent delivery		
No	82 (78.8%)	22 (21.2%)
Yes	112 (74.7%)	38 (25.3%)
Had nutrition counseling or education provided by healthcare providers before pregnancy		
No	131 (72.8%)	49 (27.2%)
Yes	63 (85.1%)	11 (14.9%)
History of adverse pregnancy outcomes, such as anemia, preterm, and/or low birth weight		
Yes	37 (77.1%)	11 (22.9%)
No	157 (76.2%)	49 (23.8%)
History of anemia in the most recent pregnancy or delivery in the past		
Yes	34 (77.3%)	10 (22.7%)
No	160 (76.2%)	50 (23.8%)
History of preterm delivery and/or low birth weight in the most recent delivery in the past		
Yes	6 (85.7%)	1 (14.3%)
No	187 (76.0%)	59 (24.0%)
Family history of Diabetes Mellitus and/ or hypertensive disorders in pregnancy		
Yes	2 (33.3%)	4 (66.7%)
No	123 (77.8%)	35 (22.2%)
Bleeding via the birth canal during pregnancy		
Yes	13 (86.7%)	2 (13.3%)
No	181 (75.7%)	58 (24.3%)
Dyspepsia or gastritis during pregnancy		
Yes	92 (87.6%)	13 (12.4%)
No	102 (68.5%)	47 (31.5%)

Excessive nausea and/or vomiting in the first and second trimesters of pregnancy		
Yes	74 (82.2%)	16 (17.8%)
No	120 (73.2%)	44 (26.8%)
Malaria attacks that were confirmed with laboratory tests during pregnancy.		
Yes	81 (76.4%)	25 (23.6%)
No	113 (76.4%)	35 (23.6%)
Urinary tract and/or sexually transmitted infections during pregnancy		
Yes	37 (77.1%)	11 (22.9%)
No	157 (76.2%)	49 (23.8%)
Intestinal parasites and/or intestinal worms during pregnancy		
Yes	4 (100%)	0 (0.0%)
No	190 (76.0%)	60 (24.0%)
Regular physical activities or household chores for at least 30 minutes daily during pregnancy		
No	98 (84.5%)	18 (15.5%)
Yes	96 (69.6%)	42 (30.4%)
Frequencies of eating regular meals and snacks per day during pregnancy		
1-4 times	144 (86.2%)	23 (13.8%)
5-6 times	50 (57.5%)	37 (42.5%)
Preferred to coffee/tea immediately after meals, smoking, alcohol, soil, or charcoal		
Yes	100 (76.9%)	30 (23.1%)
No	94 (75.8%)	30 (24.2%)
Dietary knowledge and attitude/behaviour during pregnancy		
Unfavorable (scored < 70%)	113 (77.4%)	33 (22.6%)
Favorable (scored ≥ 70%)	81 (75.0%)	27 (25.0%)

Dietary Diversity Practices during Pregnancy and Associated Factors

A modified Poisson regression model was employed to explore the factors associated with inadequate DD practices in this study. Model fit was acceptable with a deviance to DF ratio of 0.395, a Pearson chi-square to DF ratio of 0.257, Likelihood Ratio χ^2 of 36.783, DF of 21, and p-value of 0.018. Pregnant women who lived in a household with at least one child under five years of age had a 26.8% higher risk of inadequate DD practices compared with those who lived in a household with no child under five years of age (ARR = 1.268, 95% CI = 1.025–1.569, P = 0.029). Pregnant women who did not attend ANC in the past had a 24.7% higher risk of inadequate DD practices when compared with their counterparts (ARR = 1.247, 95% CI = 1.016–1.532, P = 0.035). Pregnant women from households without a TV had a 19.2% higher risk of inadequate DD practices than those with a TV (ARR = 1.192, 95% CI = 1.019–1.395, P = 0.029). Furthermore, pregnant women with dyspepsia or gastritis during pregnancy had a 28.8% higher risk of inadequate DD practices compared to their counterparts (ARR = 1.288, 95% CI = 1.132–1.466, P < 0.001). Mothers who ate 1–4 times for regular meals and snacks per day during pregnancy had a 40.9% higher risk of inadequate DD practices compared to those whose frequency of eating regular meals

and snacks daily was between 5–6 times per day (ARR = 1.409, 95% CI = 1.172–1.694, P < 0.001) (Table 6).

Table 6. Factors Associated with Dietary Diversity Practices during Pregnancy among Women Attending Public Hospitals in Gambella Town, Southwest Ethiopia, 2024

Variables	Dietary diversity practices (n = 254)		RR (95%CI)	ARR (95%CI)
	Inadequate (Exposed)	Adequate (Unexposed)		
Pregnant women's age group				
16-23 years	96 (78.7%)	26 (21.3%)	1.06 (0.92–1.22)	0.94 (0.79–1.11)
24-38 years	98 (74.2%)	34 (25.8%)	1	1
Pregnant women's religious group				
SDA and others***	50 (84.7%)	9 (15.3%)	1.15 (0.99–1.31)**	1.08 (0.93–1.25)
Protestant and others****	144 (73.8%)	51 (26.2%)	1	1
Partner's educational level				
Below a diploma level	64 (71.1%)	26 (28.9%)	0.91 (0.77–1.05)*	0.89 (0.75–1.06)*
Diploma level and above	125 (78.6%)	34 (21.4%)	1	1
Number of children aged under five years among family members who lived in the household				
At least one child under five	105 (79.5%)	27 (20.5%)	1.09 (0.95–1.26)*	1.27 (1.03–1.57)**
No child under five	89 (73.0%)	33 (27.0%)	1	1
Number of household size (family and relatives/visitors who lived together for at least 24 hours)				
≥ 5 Persons	111 (81.6%)	25 (18.4%)	1.16 (1.01–1.35)**	1.11 (0.91–1.36)
< 5 Persons	83 (70.3%)	35 (29.7%)	1	1
Parity (number of births that occurred beyond 28 weeks of completed gestational age)				
Nulliparous and primiparous	130 (76.5%)	40 (23.5%)	1.00 (0.87–1.17)	1.17 (0.97–1.42)*
Multiparous	64 (76.2%)	20 (23.8%)	1	1
Household monthly average income or per capita income				
< 1250 birr	98 (81.7%)	22 (18.3%)	1.07 (0.93–1.22)	0.89 (0.74–1.06)*
≥ 1250 birr	96 (71.6%)	38 (28.4%)	1	1
Household wealth index quintiles				
1st to 2nd quintiles	85 (73.9%)	30 (26.1%)	0.94 (0.82–1.08)	0.96 (0.79–1.15)
3rd to 5th quintiles	109 (78.4%)	30 (21.6%)	1	1
Household with a television				
No	82 (88.2%)	11 (11.8%)	1.27 (1.12–1.44)**	1.19 (1.02–1.40)**
Yes	112 (69.6%)	49 (30.4%)	1	1
Household with a refrigerator (fridge)				
No	122 (82.4%)	26 (17.6%)	1.21 (1.05–1.43)**	1.11 (0.94–1.32)*
Yes	72 (67.9%)	34 (32.1%)	1	1
Households with two rooms or more for sleeping				
Yes	128 (80.5%)	31 (19.5%)	1.16 (1.00–1.37)*	0.81 (0.63–1.03)*
No	66 (69.5%)	29 (30.5%)	1	1
Household with access to a public electric power utility				
Yes	150 (81.5%)	34 (18.5%)	1.30 (1.09-1.61)**	1.13 (0.93-1.36)*

No	44 (62.9%)	26 (37.1%)	1	1
Household food insecurity level				
Moderate and severe FI	165 (76.7%)	50 (23.3%)	1.03 (0.89–1.25)	0.97 (0.80–1.16)
Food secure and mild FI	29 (74.4%)	10 (25.6%)	1	1
Antenatal care services that were provided in the most recent pregnancy				
No	72 (77.4%)	21 (22.6%)	1.02 (0.88–1.17)	1.25 (1.02–1.53)**
Yes	122 (75.8%)	39 (24.2%)	1	1
Had nutrition counseling or education provided by healthcare providers before pregnancy				
.No	76 (72.4%)	29 (27.6%)	0.86 (0.75–0.98)**	1.11 (0.95–1.31)*
Yes	49 (83.1%)	10 (16.9%)	1	1
Malaria attacks that were confirmed with laboratory tests during pregnancy				
Yes	89 (78.1%)	25 (21.9%)	1.00 (0.87–1.15)	0.96 (0.84–1.11)
No	105 (75.0%)	35 (25.0%)	1	1
Urinary tract and/or sexually transmitted infections during pregnancy				
Yes	37 (77.1%)	11 (22.9%)	1.01 (0.83–1.18)	1.15 (0.95–1.38)*
No	157 (76.2%)	49 (23.8%)	1	1
Dyspepsia or gastritis during pregnancy				
Yes	92 (87.6%)	13 (12.4%)	1.28 (1.12–1.46)**	1.29 (1.13–1.47)**
No	102 (68.5%)	47 (31.5%)	1	1
Dietary knowledge and attitudes/behaviour during pregnancy				
Unfavorable (< 70%)	115 (78.8%)	31 (21.2%)	0.97 (0.84–1.11)	1.02 (0.88–1.18)
Favorable (≥ 70%)	79 (73.1%)	29 (26.9%)	1	1
Regular physical activities or household chores for at least 30 minutes daily during pregnancy				
No	97 (84.3%)	18 (15.7%)	1.21 (1.06–1.40)**	1.11 (0.95–1.31)*
Yes	96 (69.6%)	42 (30.4%)	1	1
Frequencies of eating regular meals and snacks during pregnancy				
1-4 times per day	144 (86.2%)	23 (13.8%)	1.50 (1.24–1.82)**	1.41 (1.17–1.69)**
5-6 times per day	50 (57.5%)	37 (42.5%)	1	1

Notes: ** P-value < 0.25; ** P-value < 0.05; *** Church of God, Islam/Muslim, and Messianic Jewish; **** Orthodox, Catholic, and Baba John.*

Abbreviations: *SDA seven-day Adventist; RR risk ratio; ARR adjusted risk ratio; CI confidence interval; FI food insecure.*

Discussion

This study aimed to assess dietary practices during pregnancy and their associated factors among pregnant women. A higher proportion (76.4%) of pregnant women had inadequate dietary diversity practices compared to only 23.6% of women with adequate dietary diversity practices. The proportion of pregnant women who consumed various food items from each of the ten food groups used for MDDS estimation was lower among women unexposed compared to exposed women in this study. The finding of low prevalence of adequate dietary diversity practices among women in this study was consistent with findings from studies in low and middle-income countries [34]. The findings in the previous study have shown that the majority of pregnant women in the reproductive age group (15-49 years) had inadequate dietary diversity, with a mean of four food groups consumed [34]. This review study also indicated that over 66% of women consumed inadequately diversified diets or diets with less than five food groups on average [34]. Previous studies conducted in Ethiopia have also revealed that the prevalence of inadequate dietary diversity practices was over

fifty percent [2, 4, 11-13, 16]. This finding suggests that over 50% of women are exposed to dietary inadequacies by consuming fewer than five food groups during pregnancy.

This study also revealed several factors that were significantly associated with inadequate dietary diversity practices, including sociocultural, household socioeconomic, and individual characteristics. These factors were associated cumulatively with a 19–41% increased risk of inadequate dietary diversity practices. Pregnant women who lived in households with at least one child under five years of age among family members who lived together as a household had a higher risk of inadequate dietary diversity practices during pregnancy compared to women from households without children under five years among family members of the households. The risk of exposure to inadequate dietary diversity increased among women who had lived in households with at least one child under five years old, among family members. Although similar evidence is limited, previous studies' findings suggest that households with multiple members face greater economic strain, affecting the dietary diversity and quality of household diets [16, 28]. There are several reasons for this to happen in this study setting. The presence of more young children may imply household shifts in resources to young children and compromise the quality of maternal diets. This may be because most cultural practices prioritize young children for food and care in this setting. It may also be because maternal caring for more children interferes with the time they need for their own care and feeding practices.

Pregnant women who did not attend ANC services in their most recent pregnancy were more likely to experience inadequate dietary diversity practices than those who had attended ANC. Past ANC service attendance in the most recent pregnancy was found to be protective against inadequate dietary diversity practices among pregnant women in this study. Similarly, previous studies in Ethiopia have shown that nutrition counselling and education have been linked to adequate dietary diversity practices during ANC, due to improvements in nutrition services through counselling or education on dietary supplements during pregnancy [28, 35]. This finding suggests a critical need for appropriate ANC nutrition counselling and education on adequate and quality diets for pregnant women.

Households' lack of TV was associated with a higher risk of inadequate dietary diversity practices among pregnant women in this study. Women from households without television were practicing inadequate dietary diversity. This finding is consistent with previous studies that highlight the roles of household assets and underlying household socioeconomic status on household dietary diversity [28]. Similarly, a previous study has shown that household ownership of a TV is associated with higher household income and access to nutrition and food-related information [36, 37]. This finding suggests nutrition and health communication play a crucial role in household socioeconomic determinants in maternal dietary diversity practices.

Meal frequency during pregnancy was significantly associated with dietary diversity practices during pregnancy. Pregnant women who consumed 1–4 meals and snacks per day had a significantly increased risk of inadequate diversity practices compared to those whose meal and snack frequencies were 5-6 times daily during pregnancy. This finding was consistent with previous studies linking meal frequency to improved dietary diversity practices [28, 35, 36]. Previous studies conducted in Ethiopia have shown that maternal dietary habits and healthy eating patterns are associated with adequate dietary diversity [2, 4, 9, 11, 12, 38]. This finding suggests that women's dietary habits and daily eating patterns, including consuming fewer than five meals and snacks during pregnancy, are critical maternal and individual characteristics that

predispose women to inadequate dietary diversity practices.

Pregnant women with dyspepsia or gastritis during pregnancy had an increased risk of inadequate dietary diversity practices. Pregnant women with dyspepsia or gastritis during pregnancy were significantly more likely to practice inadequate dietary diversity than their counterparts. A previous study has shown that nausea and or vomiting and food aversion during pregnancy have been associated with inadequate dietary diversity practices [39, 40]. This finding is probably due to the fact that gastrointestinal disorders reduce appetite, cause food aversions, and limit intake of certain food groups during early pregnancy, resulting in inadequate dietary diversity practices. This finding highlights the need for targeted screening, nutritional counselling, and management of gastritis or dyspepsia with smaller, more frequent meals during pregnancy.

This study model diagnostics indicate an acceptable fit, suggesting that predictors improve model performance and contribute to relevant explanatory power. Although this study employed a follow-up (longitudinal) study and two dietary recall assessments to ascertain the usual dietary diversity practices during pregnancy, some limitations were present. First, seasonality might affect the results as dietary diversity data were collected between July and September, a period when some food items, including mangoes, are not readily available in Gambella Town. Secondly, there was an ethnic-based conflict in the Gambella regional state and Gambella Town during the study period, which could also restrict movement within and outside the town. This might reduce household socioeconomic activities, could affect accessibility and availability of certain foods at the household and individual levels, and negatively limit maternal dietary diversity. Thirdly, the assessment of dietary intake was conducted based on the 24-hour recall method, which might not accurately reflect past feeding experience due to recall bias.

Conclusion

A higher proportion of women had inadequate dietary diversity practices during pregnancy. Pregnant women who consumed fewer than five out of ten food groups were exposed to less diverse diets than their counterparts. A higher proportion of women were exposed during pregnancy in this study. The study also identified several independent predictors of inadequate dietary diversity practices among pregnant women, such as having under-five children among family members in the household, lack of ANC attendance in the past, household not owning a television, dyspepsia or gastritis during pregnancy, and eating fewer than five meals and snacks per day during pregnancy. These findings show the multifactorial nature of dietary diversity practices among pregnant women. The findings have important implications for the maternal nutrition program. The study also highlights important targets for policymakers and planners in public health interventions during pregnancy. Maternal nutrition and dietary interventions should prioritize households with young children, promote quality of ANC counselling, enhance household-focused nutrition education, and address gastrointestinal symptoms through screening and management with smaller, more frequent meals during pregnancy. Nutrition counselling by health workers during ANC should focus on increasing meal frequency as a simple and cost-effective strategy to improve dietary diversity practices during pregnancy. Future studies should further explore the connections among factors such as sociodemographics, sociocultural and socioeconomic factors, individual maternal characteristics, and dietary diversity practices, using a longitudinal design that accounts for seasonality and provides broader geographical coverage in the Gambella Regional State.

Data Sharing Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Disclosure

The authors declare no conflicts of interest in this work.

Ethics Approval and Consent

This study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was granted by the Research Review Committee of the Gambella Regional Health Bureau on July 02, 2024, and a letter of permission was submitted to the GGH and GTPH before the start of data collection. Written informed consent was obtained from each participant after they received comprehensive information about the study's purpose, procedures, potential risks, and benefits. Pregnant women of reproductive age group (15-49 years) were eligible for participation, including those younger than 18 years, as this age group is recognized as being at increased risk for APOs. Participation was entirely voluntary, and participants were informed of their right to refuse participation or withdraw from the study at any time without any consequences for the care or services they received at the study hospitals. Confidentiality and anonymity were strictly maintained throughout all stages of the study.

Author Contributions

The corresponding author made substantial contributions to the conception and design of the study, data acquisition, analysis, interpretation of data, drafting of the manuscript, and critical revision for important 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 agreeing to submit the manuscript to the current journal.

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