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Investigation of Micro-nutrient Status and Gestational Weight Gain Patterns in Pregnant Women in Bayelsa State, Nigeria

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Abstract

Background: Maternal nutrition significantly influences pregnancy outcomes. In low- and middle-income settings, pregnant women often face a dual burden of excessive gestational weight gain (GWG) and micro-nutrient deficiencies. This study examined GWG patterns and micro-nutrient status among pregnant women attending tertiary health facilities in Bayelsa State, Nigeria.

Methods: A descriptive cross-sectional study was conducted among 90 pregnant women at Niger Delta University Teaching Hospital and Federal Medical Centre, Yenagoa. Data were collected using structured questionnaires, anthropometric measurements, and biochemical tests. GWG was assessed using pre-pregnancy BMI categories based on Institute of Medicine guidelines. Hemoglobin, serum zinc, and urinary iodine levels were measured. Data analysis was performed with SPSS version 26, using chi-square tests at $p < 0.05$.

Results: Excessive GWG was observed in 86.9% of overweight and 85.7% of obese class I women, compared to 15% of those with normal BMI. Anaemia (Hb <11.0 g/dL) was most common among overweight (64.7%) and obese (71.4%) women. Zinc deficiency (<70 µg/dL) occurred in 58.8% of overweight, 57.1% of obese, and 40% of normal-weight participants. Low urinary iodine levels (<150 µg/L) were found in over half of overweight (52.9%) and obese (57.1%) women. A significant association existed between frame size and actual GWG ($p < 0.05$), but not with BMI ($p > 0.05$).

Conclusion: The study highlights the coexistence of excessive GWG and micro-nutrient deficiencies among pregnant women in Bayelsa State. Routine nutritional screening, individualized dietary counseling, and enhanced micro-nutrient supplementation are essential during antenatal care.

Keywords: Gestational weight gain, Micro-nutrient status, Pregnancy, Maternal nutrition, Nigeria, Anemia, Zinc, Iodine.

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Introduction

Maternal nutrition plays a fundamental role in ensuring healthy pregnancy outcomes and fostering optimal fetal development. Adequate intake of macro- and micro-nutrients during pregnancy supports maternal metabolic demands, fetal growth, and the development of critical organ systems[1]. However, in many low- and middle-income countries (LMICs), including Nigeria, pregnant women face significant nutritional challenges, particularly micro-nutrient deficiencies and inappropriate gestational weight gain (GWG), both of which are associated with adverse maternal and neonatal outcomes[2,3].

Micro-nutrient deficiencies especially of iron, zinc, and iodine are widespread among pregnant populations and are linked to complications such as anemia, preterm birth, fetal growth restriction, and developmental delays[4–6]. Iron-deficiency anemia is one of the most prevalent nutrition-related health problems in sub-Saharan Africa, contributing to maternal fatigue, poor immune function, and increased risk of maternal mortality[7]. Zinc plays a vital role in cellular metabolism, immune function, and fetal organogenesis, while iodine is essential for thyroid hormone synthesis, which is critical for neurodevelopment[8,9]. Inadequate intake or absorption of these nutrients during pregnancy can result in serious and sometimes irreversible consequences for both the mother and child.

Gestational weight gain is another critical aspect of maternal health and is influenced by pre-pregnancy body mass index (BMI), dietary intake, physical activity, and socioeconomic factors. The Institute of Medicine (IOM) provides BMI-specific guidelines for GWG to promote favorable pregnancy outcomes[10]. However, both excessive and inadequate GWG are prevalent globally and are associated with complications such as gestational hypertension, cesarean delivery, postpartum weight retention, and abnormal birth weights[11,12]. In the Nigerian context, inappropriate GWG often reflects broader issues of food insecurity, cultural beliefs, lack of prenatal nutritional counseling, and limited access to healthcare[13].

Sociodemographic characteristics such as maternal age, educational level, occupation, and place of residence also impact dietary practices, nutrient intake, and weight gain during pregnancy[14]. For instance, rural residence and low educational attainment have been associated with higher rates of micro-nutrient deficiency and poor dietary diversity[15]. Additionally, cultural beliefs and food taboos may influence food choices, potentially exacerbating nutritional deficiencies during pregnancy[16]. This study, therefore, aims to assess the micro-nutrient status (hemoglobin, serum zinc, and urinary iodine concentrations) and gestational weight gain patterns of pregnant women in Bayelsa State, Nigeria. It also explores the relationships between sociodemographic characteristics, dietary practices, and nutritional outcomes, providing evidence to guide targeted public health strategies and maternal nutrition programs in the region.

Materials and Methods

Study Area

This study was conducted in Yenagoa, the capital of Bayelsa State, located in the South-South geopolitical zone of Nigeria. Geographically, Yenagoa lies at latitude 4°55'29"N and longitude 6°15'51"E, with an elevation of approximately 9 meters (29 feet) above sea level. The area is characterized by a tropical climate, featuring high rainfall averaging 2,899 mm annually, a short dry season, and an average annual temperature of 26.7°C (Wikipedia, 2021). The local government area covers 706 km² and had a recorded population of 352,285 in the 2006 census. The Ijaw ethnic group forms the majority of the population, and the predominant languages spoken are English, Nigerian Pidgin, and the indigenous Epie-Atissa.

Data collection took place at the antenatal clinics of two tertiary health facilities in Yenagoa: the Niger Delta University Teaching Hospital (NDUTH), Okolobiri, and the Federal Medical Centre (FMC), Yenagoa. NDUTH was initially a cottage hospital established in 1982 in Okolobiri, a rural community in Gbarain-Ekpetiama, and was later upgraded to a teaching hospital in 2007. FMC, on the other hand, is located centrally in Yenagoa by the Ekole River and was formerly the Yenagoa General Hospital, established in 1957 and upgraded to a specialist hospital in 1996. Both hospitals serve a wide catchment area, providing comprehensive antenatal and general medical services through specialized clinics and departments.

Study Design

A descriptive cross-sectional survey design was employed to assess the micro-nutrient status and

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gestational weight gain (GWG) patterns among pregnant women. The study was conducted from January to September 2020 and involved data collection from pregnant women attending antenatal clinics at NDUTH (a 300-bed facility) and FMC (a 421-bed facility) in Yenagoa.

Study Population

The study population included pregnant women who were attending antenatal clinics at the two facilities and who had been diagnosed with gestational diabetes mellitus (GDM) during the study period. However, following a revision of the study scope, the analysis now focuses on assessing general micro-nutrient status and GWG among pregnant women regardless of GDM status.

Sample Size Determination

The sample size was calculated using the Yamane formula[17].

n = N / [1 + N(e)^2]

Where: n = required sample size N = population of pregnant women diagnosed with GDM during the study period (116) e = margin of error (0.05)

n = 116 / [1 + 116(0.05)^2] = 116 / [1 + 0.29] = 116 / 1.29 ≈ 90

Thus, a sample of 90 pregnant women was determined and recruited for the study.

Sampling Technique

A simple random sampling technique was used to select 90 eligible pregnant women who were registered and receiving antenatal care at NDUTH and FMC between January and September 2020. Participants were approached during clinic days and invited to participate based on inclusion criteria.

Inclusion and Exclusion Criteria

Participants were eligible for inclusion if they were currently pregnant, attending ANC at either NDUTH or FMC during the study period, and provided informed written consent. Women were excluded if they had multiple pregnancies, pre-existing diabetes mellitus or other chronic metabolic conditions unrelated to pregnancy, or declined to participate in the study.

Recruitment and Training of Research Assistants

Research assistants familiar with the clinical and cultural setting were recruited and trained in data collection procedures. Training covered ethical data collection, anthropometric measurement techniques, administration of questionnaires, and proper handling of biological samples. This ensured uniformity and accuracy in data collection.

Ethical Considerations

Ethical clearance for the study was obtained from the Health Research Ethics Committees of the Niger Delta University Teaching Hospital (NDUTH) and the Federal Medical Centre (FMC), Yenagoa. Ethical approval reference number: NDUTH/REC/0019/2019. All procedures conformed to the principles of the Declaration of Helsinki for research involving human subjects.

Participants were informed about the nature, objectives, procedures, potential risks, and benefits of the study. Written informed consent was obtained from each participant before data collection. Participants were assured of confidentiality, and their right to withdraw from the study at any stage without consequences was emphasized.

Data Collection Instruments and Procedure

Structured Questionnaire

A pretested, interviewer-administered questionnaire was used to collect sociodemographic information, dietary patterns, food restrictions, meal frequency, and snack consumption habits.

Anthropometric Measurements

Height: Measured using a portable stadiometer to the nearest 0.1 cm with participants standing barefoot in an upright position.

Weight: Measured to the nearest 0.1 kg using a calibrated digital weighing scale (Omron HN286), with participants wearing light clothing and no shoes. Measurements were taken in the morning before food intake for consistency.

Body Mass Index (BMI): Calculated as weight in kilograms divided by height in meters squared (kg/m^2), and classified using World Health Organization (WHO) standards: underweight (<18.5), normal weight (18.5–24.9), overweight (25.0–29.9), and obese (≥30.0)[18].

Gestational Weight Gain Assessment

GWG was calculated as the difference between current and pre-pregnancy weights. Participants were grouped as

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having below, within, or above recommended GWG based on IOM guidelines, which are BMI-specific.

Frame Size Estimation

Frame size was estimated using wrist circumference adjusted for height and categorized into small, medium, and large frames. Its association with BMI and GWG was analyzed.

Biochemical Analysis

Hemoglobin Concentration: Venous blood was collected and analyzed using an automated hematology analyzer (Sysmex XP-300, Japan). Anemia was defined using WHO pregnancy-specific cut-offs: Hb <11.0 g/dL[19].

Serum Zinc Concentration: Serum was separated from venous blood and analyzed using atomic absorption spectrophotometry (AAS) in accordance with standard laboratory protocols. Zinc deficiency was defined as <70 μg/dL, based on international guidelines[20].

Urinary Iodine Concentration: Midstream urine samples were collected and analyzed using the Sandell-Kolthoff reaction method. A urinary iodine concentration <150 μg/L was considered indicative of iodine deficiency in pregnancy, following WHO criteria[21].

Data Analysis

All data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 26. Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarize results. Chi-square tests were employed to assess associations between frame size, BMI categories, GWG classification, and dietary behaviors. Statistical significance was set at $p < 0.05$.

Results

Sociodemographic Characteristics of the Respondents

Out of the 90 respondents, the majority were aged 31–40 years (46.7%), followed by 21–30 years (41.1%). Most were married (78.9%), Christian (88.9%), and urban dwellers (61.1%). Regarding education, 61.1% had tertiary education, while 32.2% completed secondary education. Occupation-wise, 40% engaged in business, followed by civil servants (15.6%) and skilled workers (18.9%). This indicates that most participants were educated and employed, with urban residency being more common than rural.

Table 1: Sociodemographic Characteristics of the Respondents

Variables	Frequency (n)	Percentage (%)
Age		
15 – 20	11	12.2
21 – 30	37	41.1
31 – 40	42	46.7
Total	**90**	**100**
Religion		
Christianity	80	88.9
Islam	7	7.8
Traditional Religion	3	3.3
Total	**90**	**100**
Marital status		
Married	71	78.9
Single	14	15.6
Widowed	2	2.2
Separated/divorced	3	3.3
Total	**90**	**100**
Place of residence		
Rural	35	38.9
Urban	55	61.1
Total	**90**	**100**
Highest Education		
Informal Education	2	2.2
Primary school	4	4.5
Secondary school	29	32.2
Tertiary institution	55	61.1
Total	**90**	**100**
Occupation		
Farming	2	2.2
Business	36	40
Housewife	9	10
Skilled worker	17	18.9
Student	12	13.3
Civil servant	14	15.6
Others	0	0
Total	**90**	**100**

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Gestational Weight Gain (GWG) Based on Pre-Pregnancy BMI

Among women with normal BMI, 80% gained weight within the recommended range, 15% gained above, and 5% gained below. All underweight categories had no data except for one case in severe thinness with appropriate gain. For overweight women, 86.9% gained above the recommendation and 13.1% gained within. Among obese class I women, 85.7% gained above and 14.3% within the recommendation. One woman in obese class III also exceeded the recommended gain. No participants were classified in obese class II. These results show that overweight and obese women were more likely to exceed recommended GWG.

Table 2: Gestational Weight Gain (GWG) Based on Pre-Pregnancy BMI

Classification		BMI (kg/m²)	Recommended weight gain		
			Below	**Within**	**Above**
	Severe thinness	< 16.00	0 (0%)	1 (100%)	0 (0%)
Underweight (< 18.50)	Moderate thinness	16.00 – 16.99	0 (0%)	0 (0%)	0 (0%)
	Mild thinness	17.00 – 18.49	0 (0%)	0 (0%)	0 (0%)
Normal Weight (18.50 – 24.99)	Normal weight	18.50 – 24.99	1 (5%)	16 (80%)	3 (15%)
Overweight (25.00 – 29.99)	Pre-obese	25.00 – 29.99	0 (0%)	8 (13.1%)	53 (86.9%)
	Obese class I	30.00 – 34.99	0 (0%)	1 (14.3%)	6 (85.7%)
Obese (≥ 30)	Obese class II	35.00 – 39.99	0 (0%)	0 (0%)	0 (0%)
	Obese class III	≥ 40	0 (0%)	0 (0%)	1 (100%)

Food Consumption Patterns of the Respondents

Most participants (74.5%) ate three meals daily, while 14.4% ate twice, and 8.9% ate four or more times. Almost all respondents (98.9%) consumed homemade food, with the most common frequency being three times daily (43.8%). Fast food was consumed by 61.1% of the participants, primarily once a week (70.9%). Snack consumption was reported as 1–2 times per week (35.6%), 3–4 times (31.1%), and rarely (31.1%). Meal skipping was observed in 46.7% of participants, most commonly lunch (27.8%) and breakfast (16.7%).

Table 3: Food Consumption Patterns of the Respondents

Variables	Frequency (n)	Percentage (%)
Foods avoided before pregnancy		
Yes	13	14.4
No	77	85.6
Total	90	100
Foods avoided since pregnancy		
Yes	14	15.6
No	76	84.4
Total	90	100
Meals eaten daily		
Once	2	2.2
Twice	13	14.4
Thrice	67	74.5
≥ 4 times	8	8.9
Total	90	100
Consumption of homemade foods		
Yes	89	98.9
No	1	1.1
Total	90	100
Frequency of consumption of homemade foods		
Once	19	21.4
Twice	30	33.7

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Variables	Frequency (n)	Percentage (%)
Thrice	39	43.8
≥ 4 times	1	1.1
Total	89	100
Fast food purchase		
Yes	55	61.1
No	35	38.9
Total	90	100
Frequency of consumption of fast foods		
Once	39	70.9
Twice	11	20
Thrice	2	3.6
Rarely	3	5.5
Total	55	100
Forbidden foods by culture		
Yes	0	0
No	90	100
Total	90	100
Frequency of consumption of snacks		
Daily	2	2.2
1 – 2 times a week	32	35.6
3 – 4 times a week	28	31.1
Rarely	28	31.1
Total	90	100
Meals skipped		
Breakfast	15	16.7
Lunch	25	27.8.0
Dinner	2	2.2
None	48	53.3
Total	90	100

Prevalence of Anaemia, Zinc Deficiency, and Low Urinary Iodine Concentration by Pre-Pregnancy BMI Category

Table 4 presents the distribution of anaemia, zinc deficiency, and low urinary iodine concentration among pregnant women categorized by their pre-pregnancy Body Mass Index (BMI). The data highlights significant nutritional vulnerabilities across BMI subgroups.

Anaemia (defined as hemoglobin <11.0 g/dL) was found in over half of the total participants (57.8%). The highest prevalence occurred among obese women (71.4%), followed closely by overweight women (65.6%). Even among women with normal BMI, one-third (35.0%) were anaemic, suggesting that iron deficiency is not limited to those with excess body weight. No anaemia was recorded in the underweight group, although this category included only one individual.

Zinc deficiency (serum zinc <70 µg/dL) affected more than half of all respondents (53.3%), with the highest burden seen among overweight women (59.0%) and obese women (57.1%). This reflects suboptimal dietary quality and low intake of zinc-rich foods across these categories, possibly exacerbated by physiological demands during pregnancy. A relatively lower prevalence (40.0%) was seen in the normal BMI group, and none in the underweight participant. Iodine deficiency (urinary iodine <150 µg/L) was observed in 48.9% of all participants. It was most common among overweight (52.5%) and obese (57.1%) women, while 40.0% of those with normal BMI were also affected. As with anaemia and zinc deficiency, no iodine deficiency was observed in the underweight subgroup. Overall, the data underscore that overweight and obese pregnant women were the most affected by all three deficiencies, revealing a coexistence of overnutrition (excess body weight) and undernutrition (micronutrient deficiencies). This dual burden highlights the need for targeted antenatal interventions that go beyond caloric intake to address the quality and micronutrient adequacy of maternal diets, regardless of BMI category.

Table 4: Prevalence of Anaemia, Zinc Deficiency, and Low Urinary Iodine Concentration by Pre-Pregnancy BMI Category (n = 90)

BMI Category	n (%)	Anaemia (Hb <11.0 g/dL)	Zinc Deficiency (<70 μg/dL)	Iodine Deficiency (<150 μg/L)
Underweight	1 (1.1)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Normal weight	20 (22.2)	7 (35.0%)	8 (40.0%)	8 (40.0%)
Overweight	61 (67.8)	40 (65.6%)	36 (59.0%)	32 (52.5%)
Obese (Class I–III)	7 (7.8)	5 (71.4%)	4 (57.1%)	4 (57.1%)
Total	90	52 (57.8%)	48 (53.3%)	44 (48.9%)

Association Between Frame Size and Pre-Pregnancy BMI

Table 4 presents the distribution of maternal frame size (small, medium, large) across categories of pre-pregnancy Body Mass Index (BMI) — normal weight, overweight, and obese — among 90 pregnant women.
Among women with normal BMI (18.5–24.9 kg/m²): 45.0% had medium frames, another 45.0% had large frames, only 10.0% had small frames. Among women who were overweight (25.0–29.9 kg/m²): A majority (63.9%) had medium frames, 24.6% had large frames, and 11.5% had small frames. Among women in the obese category (≥30.0 kg/m²): 71.4% had medium frames, 28.6% had large frames, and None had a small frame size.
Overall, medium frame size was the most prevalent across all BMI groups, representing 58.9% of the total sample. Large frames accounted for 28.9%, while small frames were the least common at 10%. The chi-square test ($\chi^2 = 12.998$, $p > 0.05$) indicated that there was no statistically significant association between frame size and BMI category. This means that although medium frame size appeared dominant in overweight and obese groups, the variation was not statistically strong enough to suggest a consistent pattern or predictive relationship.
The lack of significant association suggests that frame size alone does not predict pre-pregnancy BMI among pregnant women in this population. While medium and large frames were more frequent among women with higher BMI, the absence of small frames in the obese group could indicate that skeletal structure places an upper limit on BMI classification, but this requires further investigation.
Therefore, frame size may be more relevant when considered with other factors (e.g., body composition, metabolic health) rather than as a standalone predictor of pre-pregnancy BMI in clinical or antenatal assessments.

Table 5: Association Between Frame Size, Pre-Pregnancy BMI, and Actual Gestational Weight Gain (n = 90)

Frame Size	Normal Weight (18.5–24.9 kg/m²)	Overweight (25.0–29.9 kg/m²)	Obese Class I–III (≥30.0 kg/m²)	GWG: Within Recommended	GWG: Above Recommended
Small	2 (10.0%)	7 (11.5%)	0 (0.0%)	3 (11.1%)	5 (7.9%)
Medium	9 (45.0%)	39 (63.9%)	5 (71.4%)	10 (37.0%)	43 (67.2%)
Large	9 (45.0%)	15 (24.6%)	2 (28.6%)	14 (51.9%)	16 (25.4%)
Total n (%)	20 (100%)	61 (100%)	7 (100%)	27 (30.0%)	64 (68.9%)

Chi-square (χ^2) tests, Frame Size vs. BMI: $\chi^2 = 12.998$, $p > 0.05$ (not significant), Frame Size vs. GWG: $\chi^2 = 15.755$, $p < 0.05$ (significant association)
Acronyms:
- BMI: Body Mass Index
- GWG: Gestational Weight Gain
- Obese Class I–III: Includes all women with pre-pregnancy BMI ≥30.0 kg/m²

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Discussion

This study assessed the micronutrient status and gestational weight gain (GWG) patterns of pregnant women attending antenatal clinics in two tertiary hospitals in Bayelsa State, Nigeria. The findings reveal a dual burden of malnutrition, marked by excessive GWG and widespread micronutrient deficiencies, particularly among overweight and obese women.

The majority of overweight (86.9%) and obese (85.7%) women exceeded the Institute of Medicine's recommended GWG for their BMI category, while 80% of women with normal BMI gained within the recommended range. This pattern aligns with findings from similar studies in sub-Saharan Africa and globally[22]. Excessive GWG is associated with complications such as gestational hypertension, macrosomia, cesarean delivery, and postpartum weight retention[23].

Interestingly, no statistically significant association was found between frame size and pre-pregnancy BMI, but a significant association existed between frame size and actual GWG ($p < 0.05$). Butte and colleagues highlighted that skeletal frame may influence energy metabolism and fat deposition during pregnancy, which supports the current findings. This observation suggests that frame size should be considered in future GWG recommendations[24].

Despite frequent meal consumption and preference for homemade meals, a large proportion of participants consumed fast food weekly and reported frequent meal skipping. These behaviors are associated with increased caloric intake but lower nutrient density, contributing to both overnutrition and micronutrient deficiencies[4].
Skipping meals, particularly breakfast, has been associated with impaired glucose metabolism, increased appetite later in the day, and poor micronutrient intake[25]. Additionally, snacking on energy-dense but nutrient-poor foods can lead to excessive weight gain while failing to meet micronutrient needs.

Anaemia was observed in 57.8% of participants, and its prevalence was highest among obese and overweight women. This supports WHO estimates that anaemia affects over 40% of pregnant women in low- and middle-income countries[26]. Khaskheli et al. found that iron-deficiency anaemia remains a leading cause of maternal morbidity[27].

Zinc deficiency (53.3%) and iodine deficiency (48.9%) were also common, especially among overweight and obese participants. These findings align with those of Ranjit and colleagues, who attributed such deficiencies to poor dietary diversity, limited intake of animal-source foods, and variable access to quality fortified salt[28]. Skeaff have emphasized that iodine deficiency, even in mild forms, can impair fetal neurodevelopment[29].

Strengths and Limitations of the Study

The study's strengths include the integration of both anthropometric and biochemical assessments, providing a holistic view of maternal nutritional status. The use of data from two major hospitals enhances generalizability within urban Bayelsa State.
However, limitations exist. The reliance on recalled pre-pregnancy weight introduces potential recall bias. The sample size (n=90), while adequate for preliminary analysis, limits broader generalizability. The cross-sectional design restricts causal inference and does not capture long-term maternal or neonatal outcomes. Moreover, dietary intake was not assessed quantitatively (e.g., using 24-hour recalls or food frequency questionnaires), which limits precision in dietary analysis.

Implications of the Findings

Longitudinal studies are needed to assess the impact of GWG and micronutrient deficiencies on birth outcomes and child development. Future studies should also investigate how skeletal frame size could inform individualized GWG targets.
The findings support routine nutritional screening and counseling in ANC clinics. Incorporating frame size measurements and dietary quality assessments could improve risk stratification and intervention. Additionally, greater emphasis should be placed on meal regularity and dietary diversity.

Policies should prioritize maternal nutrition by ensuring universal access to micronutrient supplements, enforcing salt iodization laws, and expanding nutrition education within ANC services. National guidelines should consider revising GWG recommendations to include anthropometric diversity such as frame size and explicitly address the double burden of malnutrition.

Conclusion

This study reveals a dual burden of malnutrition during pregnancy—excessive gestational weight gain (GWG)

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among overweight and obese women, and notable micronutrient deficiencies. These findings underscore the urgent need for routine nutritional screening, individualized dietary guidance, and enhanced access to micronutrient supplements as part of comprehensive antenatal care. To effectively address these issues, healthcare providers must implement targeted nutrition interventions, policymakers should reinforce and expand maternal nutrition initiatives, and researchers are encouraged to investigate the long-term consequences of these nutritional imbalances. Prompt coordinated action is essential to improve maternal and fetal health outcomes and promote long-term wellbeing for both mothers and their children.

Declarations

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