Dietary Diversity and Micronutrient Adequacy of Pregnant Women Attending Antenatal Clinic in Asaba Specialist Hospital (Ash), Delta State, Nigeria

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ABSTRACT

Background: : High quality and optimum Dietary Diversity Score (DDS) is a proxy indicator for measuring nutrient adequacy because this could facilitate a healthy child birth outcome.

Objectives: *This research assessed the dietary diversity and micronutrient adequacy of pregnant women in Asaba Specialist Hospital (ASH), Delta State, Nigeria.*

Methodology: *A cross-sectional survey which employed convenience sampling of 382 pregnant women from Asaba Specialist Hospital. The respondents satisfied the inclusion criteria (across all gestation periods). A structured questionnaire was used to gather data on sociodemographic attributes and a day 24-hour dietary recall for micronutrient intake, adequacy and dietary diversity score. Using regression analysis, statistically significant effects (p<0.05) of age and number of children on DDS were found*

Results: *Most (78.0%) of the pregnant women were married, under 30 years of age (74.1%), educated to tertiary level (62.6%), and Christians (90.1%). The majority (79.0%) had a high dietary diversity score and most were found in cereals and grains, with a mean DDS of 10.02±1.72. Micronutrients (Calcium, vitamin A, C, and folate) intake was inadequate. Vitamin A and DDS had a weak positive correlation (r=.274, p<0.05), whereas vitamin B1, B2, and folate were negatively correlated with DDS (r = -.261 and -.259, p<0.05) respectively..*

Conclusion: *Despite a high dietary diversity score, inadequacy of some key micronutrient intakes such as folates and Vitamin A was identified among pregnant women. Maternal dietary habits and fetal health outcomes in this population can be improved by nutritional interventions.*

Keywords: Dietary diversity, Pregnant women, Micronutrient Adequacy

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Introduction

Pregnancy is a critical period marked by the development of the foetus in the uterus. Adequate prenatal care, including sufficient micronutrient intake such as folate is essential during this time (1). Micronutrient deficiencies are problems of public health significance in Nigeria, Kenya, and South Africa respectively (2) but of more concern is the occurrence among pregnant women in Nigeria because of the likely implication on the outcome of the pregnancy. Folate is a vital nutrient, and its deficiency is a common concern among pregnant women, often due to inadequate dietary intake (1). The need for folate increases significantly during pregnancy, particularly during periods of rapid fetal growth (1). Insufficient folate levels have been associated with serious health issues such as neural tube defects, preterm delivery, low birth weight, preeclampsia, and restricted fetal growth (1). Also, Iron Deficiency Anemia (IDA) (3), Vitamins A, C, and E deficiencies in southwestern Nigeria with consequent negative outcomes (4), and zinc deficiency in Katsina State (5) have been reported.

However, high-quality, and optimal diversified diets are known to be the ideal vehicle for ensuring an adequate supply of micronutrients (6). nonetheless, in southwestern Nigeria, a study assessed the dietary diversity and micronutrient intake of adult women which shows that the women residing in that community consume diets with low diversity and inadequate micronutrients (7). Also, some biochemical studies in Nigeria revealed that there was a significant deficiency of vitamin C in pregnant women (8) of which dietary diversification is proposed as an intervention.

Diversified diet during pregnancy play a crucial role as it affects pregnancy and birth outcomes (9). The importance of dietary diversity in pregnancy enhances the required support for fetal growth and development, and maternal health (10), while it fosters micronutrient adequacy and overall diet quality (11). However, adverse outcomes, such as maternal anaemia, low birth weight, preterm delivery, intrauterine growth restriction, and increased risk of maternal and neonatal mortality (12,9) are evident in pregnant women with low dietary diversity and nutrient intake. It must not be left unsaid that many pregnant women in low- and middle-income countries (LMICs) face multiple challenges to achieving adequate dietary diversity and nutrient intake (13) of which Nigeria is affected. Limited studies in southeastern Nigeria on dietary diversity and micronutrient intake of pregnant women is an identified gap. This therefore, provides the need for this study; to assess the dietary diversity score and micronutrient adequacy of pregnant women attending antenatal clinic in Asaba Specialist Hospital (ASH), Delta State, Nigeria.

MATERIALS AND METHODS

This study was conducted in Asaba Specialist Hospital (ASH), Oshimili North Local Government Area (LGA), , Delta State, Nigeria.

Study Design

The study was a hospital-based cross-sectional study conducted on a sample size of 382 pregnant women selected from Asaba Specialist Hospital (ASH), in Asaba, Delta State.

Eligibility/Inclusion criteria:

It includes pregnant women aged 18 to 49, who are proficient in reading and speaking English, and also in any gestation period.

Exclusion criteria

Pregnant women diagnosed with chronic health conditions (e.g., diabetes, HIV/AIDS), also taking regular medications other than prenatal vitamins and folic acid, and with multiple gestations.

Sampling Technique and Recruitment

A convenience sampling comprising 382 pregnant women attending an antenatal clinic at the hospital was enrolled in the study. The hospital was chosen since it is the main referral hospital in the community. The study population included pregnant women attending Antenatal Clinic at the hospital and consented to participate.

Data collection

Recruitment and data collection occurred between April and May 2022. Pregnant women completed structured interviewer-administered, and standardized questionnaires on socio-demographic characteristics, while a day twenty-four (24) hour recall was used for dietary diversity, and dietary intake (14) as administered by trained interviewers in the hospital (15). Memory aids such as food models and pictures were used to assist the pregnant women recall all foods eaten and beverages taken in the previous 24 hours before the interview. Information from the one day 24 hour recall was recorded in the 12 food groups in the dietary diversity questionnaire (16).

Dietary diversity score

The dietary diversity score was based on a 24-hour recall of pregnant women. The guidelines for the 12 food groups were used (16) . Foods were categorised into 12 groups based on FANTA recommendations as follows: (i) cereals, (ii) vegetables, (iii) fruits, (iv) meat, (v) egg, (vi) fish and other seafood, (vii) legumes, nuts, and seeds, (viii) milk and milk products, (ix) oil and fats, (x) sweets, (xi) spices, condiments and beverage, and (xii) tubers and roots. Commonly consumed foods in the area were incorporated into each food group.

The response categories were "Yes" if at least one food item in a group was consumed and this was scored one (1) point. However, where a food item was not consumed in a group, a zero (0) point was given representing "No". Dietary diversity was obtained by summing the number of food items consumed in each group separately. The total score was calculated, and this ranged from 0-12. Terciles of DDS were used to classify the pregnant women into low (≤4), medium (5-8), and high (9-12) (16). Mean scores were also calculated for each of the food groups.

Micronutrient Intake and Adequacy

The micronutrient intake of the pregnant women was measured using the quantitative multiple-pass 24-h dietary recall method. The five-step multiple-pass method starts with the quick uninterrupted listing of foods by the interviewee, proceeds to probing for forgotten foods list and collecting the time and occasion, then a comprehensive description of foods and amounts eaten is gathered in the detailed cycle, and ends with a final probe review (17). Dietary data from the 24-h recalls were analyzed with NutriSurvey 2007 software (17). Local single food items were added to the database from the Nigerian food composition tables by (18). Dietary intake of the pregnant women was compared to the Recommended Dietary Allowances (RDAs) (19)

In addition, the average key micronutrient intakes were analyzed for the pregnant women. The micronutrient inadequacy represents the proportion of mothers not meeting 2/3rd of the RDA for key micronutrients while adequacy is otherwise (17)

Statistical analysis

Frequencies were calculated for demographic characteristics and DDS. Bivariate analyses were conducted to examine the associations between DDS and micronutrient intake. Regression analysis was employed between Socio-demographic factors and DDS. Statistical Product and Service Solution (SPSS) for Windows version 20 was used to perform all statistical analysis. A p-value of less than 0.05 was accepted as statistically significant.

Ethical Consent

Ethical clearance for the study was obtained from the Asaba Specialist Hospital Ethical Committee (REF: ASH:240/22). Oral and written consents were obtained from the pregnant women before their enrollment in the study having explained the study objectives to them. Also, confidentiality and anonymity were assured. Respondents were informed that participation was voluntary and that they could terminate their participation any time they wished.

RESULTS

Table 1 provides the respondent's demographics in the conducted study. A significant proportion of the pregnant women (74.1%) were under 30 years old, and a smaller percentage (25.7%) were over 30. As for marital status, 18.8% of respondents were single, 2.1% were divorced, and 1.0% were widowed, with 78.0% married. They ranged widely in terms of educational background: 2.1% had only completed elementary school, 8.9% had finished primary school or its equivalent, 26.4% had attended secondary school, and 62.6% had a bachelor's degree or above. About 16.0% of the distribution worked full time, 17.5% as civil servants, 45.3% as independent contractors, 9.9% as housewives, and 11.3% as unemployed people. The Igbos make up 59.7% of the population, and the Yorubas made up 17.5%. Religiously, 90.1% identified as Christians, while 9.9% identified as Muslims. Family sizes varied, with 16.2% having no children, 71.2% having 1-3 children, 11.3% having 4-6 children, and 1.3% having over 6 children. Last, the income distribution showed that 42.4% earned ≤ 30,000 Naira (approximately USD 20), 40.8% earned between 31,000 and 90,000 Naira, 14.4% earned between 91,000 and 180,000 Naira, and 2.4% earned above 180,000 Naira.

Table 3 illustrates the mean values (±SD) for various nutritional variables alongside their Recommended Dietary Allowance (RDA), Percentage RDA, p-values, and correlation coefficients (R) with the Dietary Diversity Score (DDS).

Vitamin A intake, with a mean of 410.73±192.0 μg/d, corresponds to 53.34% of the RDA (770), showing a significant association (p = .034**). Vitamin C, averaging 30.46±29.94 mg/d, represents 35.84% of the RDA (85) but lacks statistical significance (p = .632). Vitamin B1 and B2 intakes, with means of 1.60±1.80 mg/d and 1.46±1.13 mg/d respectively, exceed their RDAs (1.4), displaying significant associations (p = .044** and p = .046**). Vitamin B3, Folate, Vitamin B12, Calcium, Zinc, and Iron also exhibit varying degrees of adherence to RDAs, with Folate intake showing a significant association (p = .015**).

Correlation coefficients with DDS reveal potential relationships. Notably, Vitamin A, Vitamin B1, and Vitamin B2 show positive correlations (R = .274, -.261, and -.259 respectively), indicating a potential link between higher intakes and dietary diversity. Conversely, Folate, demonstrates a negative correlation (R = -.312), suggesting a potential inverse relationship.

While these findings shed light on the nutritional status of the studied population, it's crucial to note the varying degrees of adherence to RDAs and the correlations with DDS. These provide valuable insights into the dietary habits and potential nutritional gaps among pregnant women.

Table 1. Socio-demographic and economic characteristics of pregnant mothers (n = 382)

Variables	N	%
Age (Years)		
≤ 30	283	74.1
> 30	99	25.9
Marital Status		
Married	298	78.0
Single	72	18.8
Divorced	8	2.1
Widowed	4	1.0
Educational Level		
Less than primary school	8	2.1
Primary school or equivalent	34	8.9
Secondary school	101	26.4
Bachelor's degree or higher	239	62.6
Occupation		
Employed full-time	61	16.0
Civil servant	67	17.5
Self-employed	173	45.3
Housewife	38	9.9
Unemployed	43	11.3
Ethnicity		
Igbo	296	77.5
Yoruba	67	17.5
Hausa	19	5.0
Religion		
Christianity	344	90.1
Islam	38	9.9
No of Children		
None	62	16.2
1–3	272	71.2
4–6	43	11.3
Above 6	5	1.3
Income (Naira)		
≤ 30,000 (~20 USD)	162	42.4
31,000–90,000	156	40.8
91,000–180,000	55	14.4
> 180,000	9	2.4
Total	**382**	**100.0**

The mean dietary diversity of the various food groups is shown in Table 2. Cereals had the highest mean dietary diversity (0.98±0.23), followed by eggs (0.95±0.22), fish and other seafood (0.94±0.23), milk and its derivatives (0.91±0.28), and fish and other seafood. Fruits (0.76±0.43), vegetables (0.66±0.48), and tubers and roots (0.65±0.48) had the lowest mean dietary diversity. The highest mean dietary diversity is observed in cereals (0.98±0.23), followed by eggs (0.95±0.22), fish and other seafood (0.94±0.23), and milk and its products (0.91±0.28). The lowest mean dietary diversity is observed in tubers and roots (0.65±0.48), fruits (0.76±0.43), and vegetables (0.66±0.48). The overall mean dietary diversity score is 10.02±1.72.

Table 2. Mean dietary diversity of the different food groups

Food groups	Mean (±) SD
Cereals	0.98±0.23
Vegetables	0.66±0.48
Spices, condiments and beverages	0.87±0.34
Oils and fats	0.86±0.34
Fish, and other sea foods	0.94±0.23
Legumes, nuts and seeds	0.88±0.33
Tubers and roots	0.65±0.48
Fruits	0.76±0.43
Meat	0.89±0.31
Sweets	0.68±0.47
Milk and milk products	0.91±0.28
Eggs	0.95±0.22
Total	10.02±1.72

Figure 1a shows that the majority (78.8%) of the respondents have high DDS, while 21.2% have medium DDS, although none of the respondents have low DDS.

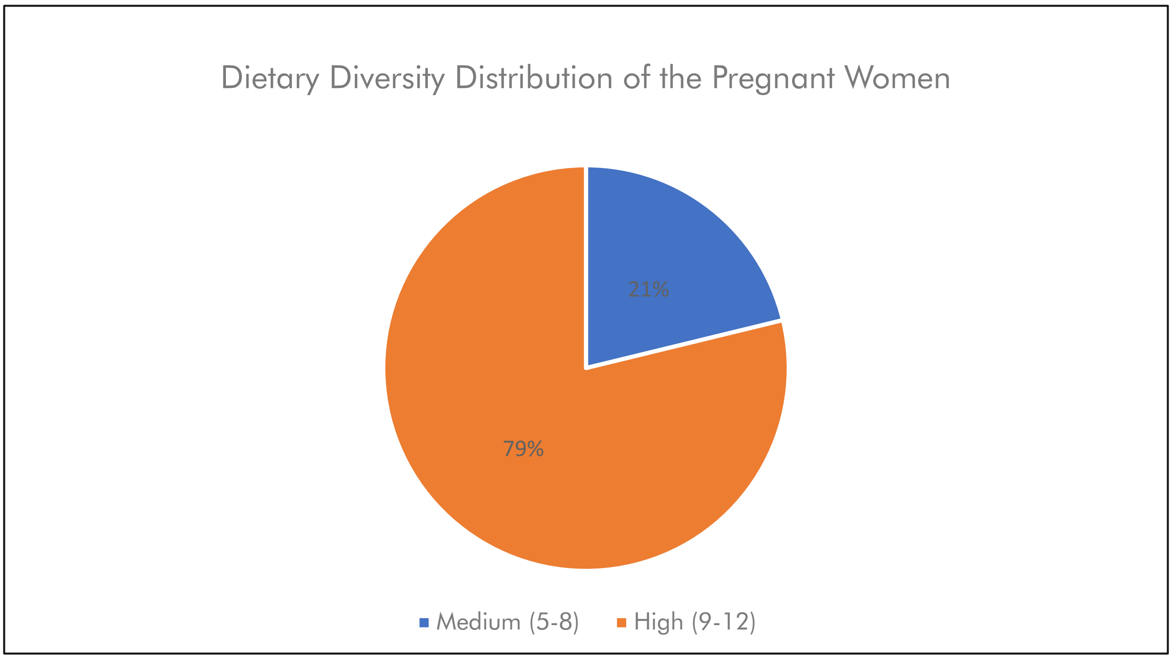

Figure 1a: Dietary Diversity Distribution of the Pregnant Women

Figure 1b shows that higher income is associated with high DDS

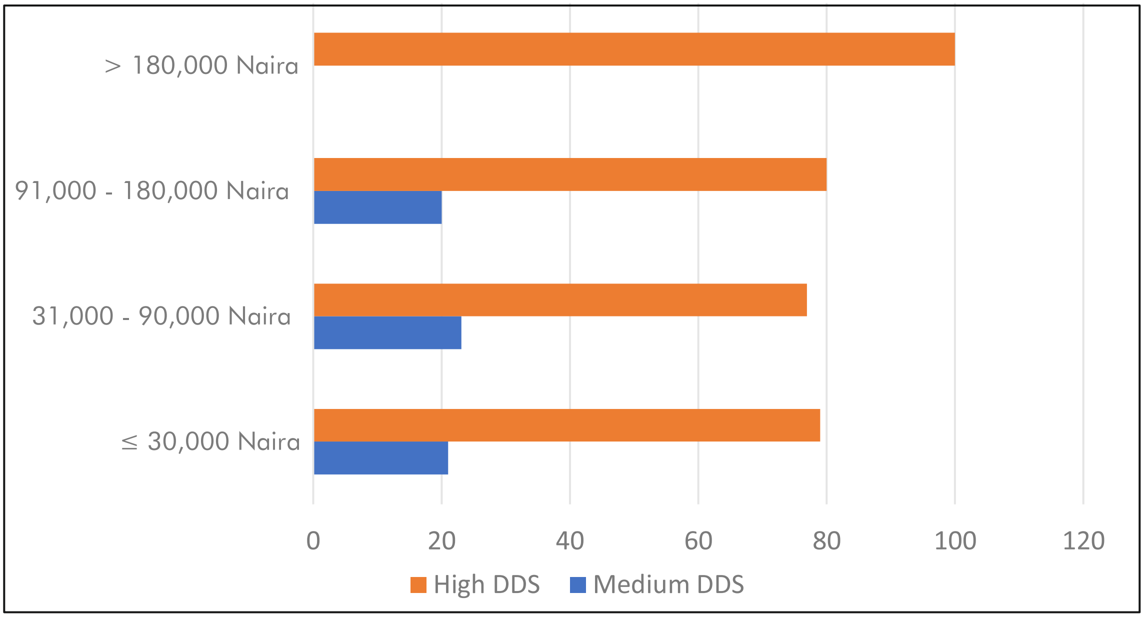

Figure 1b: Association between Household monthly income and DDS (p<0.05)

Table 3. Relationship between DDS and Micronutrient intake/adequacy of the pregnant mothers

Variables	Mean±SD	RDA	Percentage RDA (Adequacy)	DDS Correlation p-value	R
Vitamin A (µg/d)	410.73±192.0	770	53.34	.034**	.274
Vitamin C (mg/d)	30.46±29.94	85	35.84	.632	.063
Vitamin B1 (mg/d)	1.60±1.80	1.4	114.29*	.044**	.261
Vitamin B2 (mg/d)	1.46±1.13	1.4	105*	.046**	.259
Vitamin B3 (mg/d)	15.12±18.52	18	84.06*	.152	.187
Folate (µg/d)	297.42±331.08	600	49.57	.015**	.312
Vitamin B12 (µg/d)	2.30±2.73	2.6	88.46*	.240	.154
Calcium (mg/d)	588.04±474.85779	1000	58.80	.914	.014
Zinc (mg/d)	19.28±14.70142	11	175.36*	.832	.028
Iron (mg/d)	23.73 ±15.11754	27	87.89*	.590	.071

Adequate; ** Significance p<0.05; Dietary Reference Intake (19)

In Table 4, the hypothesis tests if the sociodemographic and economic characteristics have a significant effect on their DDS. The dependent variable, DDS, regressed based on predicting sociodemographic and economic characteristics. To test hypothesis H1, sociodemographic characteristics (age and number of children) significantly predict their DDS, $F(141.90, 1469.25) = 3.96$, $p < 0.05$, which indicates that the sociodemographic characteristics (age and number of children) play a significant role in shaping their dietary diversity ($b = 11.15$, $p < 0.05$). The result clearly shows the positive effect of sociodemographic characteristics (age and number

Table 4. Summary of the regression statistics for the predictors of DDS

Variables	Coefficient	Std. error	R^2	F	t-statistics	probability
Constant	11.62	1.160			10.02	000
Age	0.09	0.021			4.30	0.00*
Ethnicity	0.01	0.094			0.10	0.92
Monthly income	-3.67	0.001			0.84	0.40
Marital status	0.08	0.198			0.42	0.68
Educational level	-0.06	0.159	0.09	3.96	0.39	0.70
Occupation	0.07	0.100			0.71	0.48
No of Children	-0.34	0.084			-4.17	0.00*

*Significant at $p<0.05$.

of children). The R2 = 0.09 shows that the model explains 9% of the variance in DDS.

DISCUSSION

This section discusses the findings of the study according to the objectives respectively.

In this study, a larger proportion of the respondents are Igbos, and this is because the study was conducted in an Igbo-speaking community. Most of the respondents in the study were aged 30 years or younger and married. This is like other Nigerian studies amongst women of reproductive age (7, 19) and some other West and East African countries (20, 22, 23). In addition, over half of the respondents were Christians, and it might be because the area was Christian-dominated. It is worthy of note that a considerable percentage of the women earned less than the set minimum wage per month in Nigeria and this disagrees with the result of (7) who reported about two-thirds living on the minimum wage. The findings imply that a good number of pregnant women live below the poverty line (less than $1.9 daily) (24).

The present study revealed that the mean DDS was ten which is about eighty-percent of the 12 food groups (25). The finding is closely related to studies done in Kenya (26) and Northern Ghana (27), where their mean DDS are 6.84 and 6.81 of 9 food groups, respectively. The study showed that most respondents had good dietary diversity and it could be attributable to the season the study was conducted. The study also revealed a good consumption of cereals and their products, and this is in line with the study of (26), which reported high consumption of food items from grains and grain products by almost all respondents. It further agrees with other reports that concluded that the diets of pregnant women are predominantly cereal-based (28-30). The DDS also reveals that almost all respondents consumed fish and meat products, which is a diversion from the result of (26, 31), who reported that only 27.5% of the total respondents had consumed animal-source foods.

Despite the high Dietary Diversity Score (DDS) observed among pregnant women with low earning capacity, our study reveals inadequate intake of crucial micronutrients, particularly vitamin A and folate, falling below the Recommended Dietary Allowance (RDA). This paradoxical finding aligns with studies (32-35) identifying these as common micronutrient deficiencies in Nigerian women of reproductive age and during pregnancy.

The discrepancy between high DDS and low micronutrient intake suggests that dietary diversity alone may not guarantee adequate micronutrient consumption. This could be attributed to the overreliance on affordable, carbohydrate-rich staples with low micronutrient density (36), even when diets appear diverse.

This finding is particularly concerning, given the critical roles of vitamin A and folate in pregnancy. Vitamin A is essential for embryonic development, including eyes, heart, and lungs (37), and supports fetal growth and maternal metabolism (38-40). Folate is crucial for neural tube development in early pregnancy (41).

It is important to add that vitamin A and folates are found more in fruits and vegetables (42), yet their mean consumption is a little above average in our study. It is worthy of note that, despite the intake as identified by dietary diversity, the quantity consumed was inadequate as compared to the RDA for this vulnerable group. It is expected that more of fruits and vegetables should be consumed because of increased demand for micronutrients (43), interestingly, this was not the case.

Further to this, Delta state, Nigeria is poised to be blessed with vegetables and fruits (44) but despite the supposed good news, our result does not reflect it because of the level micronutrients consumption among pregnant women. A almost convincing reason for the low consumption could be the season (45) this study was conducted. For instance, the likes of Mangoes, Pawpaw, and Watermelons have their peak seasons between June and August yearly (46), of which we collected our data between April and May. So, it likely would be the reason for their fruit consumption rate.

In addition, vegetables such as pumpkin leaves, bitter leaves, and okro are good sources of vitamin A and folates (47), although found more in pumpkin and bitter leaves (1), which are available all year round in the study location (48). However, this was not reflected in their nutrient intake which could probably be due to food taboos during pregnancy, limited understanding of the importance of vegetables during pregnancy (49), and Pica (cravings for non-food items or unhealthy foods leading to reduced vegetable intake) (25, 45). Although, nutrient deficiencies like iron or zinc are proven to affect appetite and food choices, which could be one of the possible reasons for their vegetable and fruit consumption. However, it would not have been so because their iron and zinc intake were adequate which is in close agreement with similar studies conducted amongst women of reproductive age in the Southwest of Nigeria (7, 32, 33). The relationship between dietary diversity and micronutrient intake is complex and influenced by various factors. Research has shown that dietary diversity scores are indeed associated with micronutrient intake, with a higher score indicating a lower risk of inadequacy (50). This somewhat agrees with the present study, where there exists a statistically significant positive correlation between DDS and vitamin A intake. Emphasis must be placed on consuming nutrient-dense foods to maximize the intake of essential nutrients without excessive caloric intake (51). In this case, there exists a weak and statistically significant correlation ($p<0.05$) between the mentioned micronutrients and DDS. This appears contrary to the common knowledge of positive relationships between the two (52, 53). Although a seeming slant to common knowledge was observed (54), who found a weak but positive correlation between dietary diversity and nutrient adequacy, unlike the present study. A negative statistically significant correlation suggests that as one variable is increasing, the other is decreasing, which would be contrary to the common knowledge of positive association. Maternal age and the number of children had a statistically significant effect on their DDS. This agrees with other studies from developing countries where there exists an association between diet diversity and socio-demographic and economic variables (7, 55, 56).

CONCLUSION

This study revealed a paradoxical situation where some pregnant women in Oshimili North Local Government Area in Delta State, Nigeria, demonstrated high dietary diversity yet suffer from inadequate intake of crucial micronutrients, particularly vitamin A and folate. Despite the region's abundance of vegetables, seasonality, financial constraints and food preferences appear to influence dietary choices, leading to an overreliance on affordable, carbohydrate-rich staples with low micronutrient density. The study also revealed that there is a relationship between dietary diversity and micronutrient intake in pregnancy.

Recommendations

Based on our findings, we recommend implementing targeted nutritional interventions that emphasize the importance of micronutrient-rich foods within a diverse diet. Nutritional education programs should be enhanced to address cultural food preferences and promote the consumption of locally available, micronutrient-rich vegetables. Additionally, policymakers should consider fortification programs or targeted supplementation for essential micronutrients, particularly vitamin A and folate, for pregnant women at risk of deficiencies.

REFERENCES

1. Cruz-Rodríguez, J., Díaz-López, A., Canals-Sans, J., and Arija, V. (2023) Maternal vitamin B12 status during pregnancy and early infant neurodevelopment: The ECLIPSES study. Nutrients, 15(6), 1529.
2. Harika, R., Faber, M., Samuel, F., Kimiywe, J., Mulugeta, A., and Eilander, A. (2017) Micronutrient status and dietary intake of iron, vitamin A, iodine, folate and zinc in women of reproductive age and pregnant women in Ethiopia, Kenya, Nigeria and South Africa: a systematic review of data from 2005 to 2015. Nutrients, 9(10),

1096.
3. Babah, O.A., Akinajo, O.R., Beňová, L., Hanson, C., Abioye, A.I., Adaramoye, V.O., ... and Larsson, E.C. (2024) Prevalence of and risk factors for iron deficiency among pregnant women with moderate or severe anaemia in Nigeria: a cross-sectional study. BMC pregnancy and childbirth, *24*(1), 39.
4. Joseph, G.U., Oyediran, O.T., Oladiti, R.A., and Iyanda, A.A. (2024) Birth Weight and Third-trimester Maternal Vitamins A, C, and E Levels. Asian Journal of Research in Medical and Pharmaceutical Sciences, *13*(1), 1-8.
5. Abdurrahman, A., Haladu, H., Oloyede, T.W., Shehu, J.S., Obi, O.L., and Rasheed, F.A. (2024) Zinc Deficiency among Pregnant Women at a Tertiary Hospital in Katsina. Tropical Journal of Obstetrics and Gynaecology, *42*(1), 17-22.
6. Martin-Prével, Y., Allemand, P., Wiesmann, D., Arimond, M., Ballard, T., Deitchler, M., ... and Moursi, M. (2015) Moving forward on choosing a standard operational indicator of women's dietary diversity. FAO. 226 p. ISBN: 978-92-5-108883-8
7. Ilo, J., Onabanjo, O., and Hamzat, A. (2023) Dietary diversity and micronutrient intake of adult women in Ogun State, Nigeria (Case study). Egyptian Journal of Nutrition, 38(3), 13-21.
8. Nwagha, U.I., and Ejezie, F.E. (2005) Serum ascorbic acid levels during pregnancy in Enugu, Nigeria. International Journal of Medicine and Health Development, 10(1), 43-45.
9. Aliwo, S., Fentie, M., Awoke, T., and Gizaw, Z. (2019) Dietary diversity practice and associated factors among pregnant women in North East Ethiopia. BMC research notes, 12, 1-6.
10. Wondmeneh, T.G. (2022) Dietary diversity practice and its influencing factors among pregnant women in Afar region of Ethiopia: mixed method study. BMC Pregnancy and Childbirth, 22(1), 291.
11. Tafasa, S.M., Darega, J., Dida, N., and Gemechu, F.D. (2023) Dietary diversity, undernutrition and associated factors among pregnant women in Gindeberet district, Oromia, Ethiopia: a cross-sectional study. BMC nutrition, *9*(1), 115.
12. Ndem, B.N., Akwiwu, E.C., Akpan, P.A., Akpotuzor, J.O., Bassey, I.E., Isong, I.K., and Onukak, E.E. (2021) Timely accessing of antenatal care and prevalence of vitamin B12 and folate deficiencies among pregnant women in a Nigerian population. New Zealand Journal of Medical Laboratory Science, *75*(1), 12-15.
13. Azene, A.G., Aragaw, A.M., Wubetie, H.T., Wassie, G.T., Tsegaye, G.W., Derebe, M.A., and Mitiku, H.D. (2021) Dietary diversity among pregnant women and associated factors in Ethiopia: systematic review and meta-analysis. PloS One, 16(6), e0251906.
14. Thompson F, Byers T. (1994) Dietary assessment resource manual. The Journal of Nutrition.;124(11 suppl):2245S-2317S
15. Food and Agriculture Organization of the United Nations (2018) Dietary Assessment: A Resource Guide to Method Selection and Application in Low Resource Settings. Rome. FAO.
16. Hussein, F.M., Ahmed, A.Y., and Muhammed, O.S. (2018) Household food insecurity access scale and dietary diversity score as a proxy indicator of nutritional status among people living with HIV/AIDS, Bahir Dar, Ethiopia, 2017. PloS One, *13*(6), e0199511.
17. Abou-Rizk, J.; Jeremias, T.; Nasreddine, L.; Jomaa, L.; Hwalla, N.; Tamim, H.; Frank, J.; Scherbaum, V. (2021) Anemia and Nutritional Status of Syrian Refugee Mothers and Their Children under Five Years in Greater Beirut, Lebanon. International Journal of Environmental Research and Public Health. 18, 6894. https://doi.org/10.3390/ijerph18136894
18. Nigeria Food Composition Table/Database. Available online: http://nigeriafooddata.ui.edu.ng/ (accessed on 20 May 2020)
19. Oyewole, O.O., Nkanga, E.A., Oyerinde, I.E., Akintoye, O., Asekun-Olarinmoye, I., and Alabi, Q.K. (2023) Factors affecting anemia in pregnancy women in Ibeju-Lekki, Lagos State, Nigeria. INQUIRY: The Journal of Health Care Organization, Provision, and Financing, 60, 00469580231159961.
20. Darboux, A.J., Agueh, V., and Santos, R.Y.

(2022) Assessment of the nutritional status and dietary intake of women of childbearing age in the city of Comè, Benin. Pan African Medical Journal, 41(1).
21. Meyers, L.D., Hellwig, J.P., and Otten, J.J. (eds). (2006) Dietary Reference Intakes: The Essential Guide to Nutrient Requirements. Institute Of Medicine. National Academies Press. https://books.google.com.ng/url?client=ca-print-nap&format=googleprint&num=0&id=dYZZTgjDeccC&q=http://www.nap.edu/catalog.php%3Frecord_id%3D11537&usg=AOvVaw0CA75U4DkjiBS9Sx12eS75&source=gbs_buy_r
22. Woldegebriel, A.G., Gebrehiwot, G.G., Desta, A.A., Ajemu, K.F., Berhe, A.A., Woldearegay, T.W., and Bezabih, N.M. (2020) Determinants of anemia in pregnancy: findings from the Ethiopian health and demographic survey. Anemia.(1), 2902498.
23. Weldekidan, F., Kote, M., Girma, M., Boti, N., and Gultie, T. (2018) Determinants of anemia among pregnant women attending antenatal clinic in public health facilities at Durame Town: unmatched case control study. Anemia.(1), 8938307.
24. Statista (2024). Monthly minimum wage in Nigeria from 2018 to 2024. https://www.statista.com/statistics/1119133/monthly_minimum_wage_in_nigeria/
25. Swindale, A., and Bilinsky, P. (2005) Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide. Washington, DC: Food and Nutrition Technical Assistance Project (FANTA), Academy for Educational Development. http://www.fantaproject.org/
26. Kiboi, W., Kimiywe, J., and Chege, P. (2017) Determinants of dietary diversity among pregnant women in Laikipia County, Kenya: a cross-sectional study. BMC Nutrition, 3, 1-8.
27. Saaka, M., and Osman, S.M. (2013) Does household food insecurity affect the nutritional status of preschool children aged 6–36 months?. International Journal of Population Research, pp.1-12), 304169.
28. Jayawardena, R., Byrne, N.M., Soares, M.J., Katulanda, P., Yadav, B., and Hills, A.P. (2013) High dietary diversity is associated with obesity in Sri Lankan adults: an evaluation of three dietary scores. BMC public health, 13, 1-8.
29. Ali, F., Thaver, I., and Khan, S.A. (2014) Assessment of dietary diversity and nutritional status of pregnant women in Islamabad, Pakistan. Journal of Ayub Medical College Abbottabad, 26(4), 506-9.
30. Ekesa, B.N., Blomme, G., and Garming, H. (2011) Dietary diversity and nutritional status of pre-school children from Musa-dependent households in Gitega (Burundi) and Butembo (Democratic Republic of Congo). African Journal of Food, Agriculture, nutrition and development, 11(4).
31. Acham, H., Oldewage-Theron, W.H., and Egal, A.A. (2012) Dietary diversity, micronutrient intake and their variation among black women in informal settlements in South Africa: a cross-sectional study. International Journal of Nutrition and Metabolism, 4(2), 24-49.
32. Amoda, O.S., Oladosu, G.S., Olajide, B.R., Onabanjo, O.O., and John, E.P. (2022) Nutritional status and adequacy of selected micronutrients of civil servants in Ogun state, Nigeria. Nigerian Journal of Nutritional Sciences, 43(2), 41-50.
33. Oladoyinbo, C.A., Ugwunna, U.M., and Ekerette, N.N. (2017) Dietary diversity and nutrient intake adequacy among women in Iwo Local Government Area, Osun State Nigeria. African Journal of Food, Agriculture, Nutrition and Development, 17(4), 12641-12656.
34. Muthayya, S., Rah, J.H., Sugimoto, J.D., Roos, F.F., Kraemer, K., and Black, R.E. (2013) The global hidden hunger indices and maps: an advocacy tool for action. PloS one, 8(6), e67860.
35. Ojofeitimi, E.O., Ogunjuyigbe, P.O., Sanusi, R.A., Orji, E.O., Akinlo, A., Liasu, S.A., and Owolabi, O.O. (2008) Poor dietary intake of energy and retinol among pregnant women: implications for pregnancy outcome in Southwest Nigeria. Pakistan Journal of Nutrition, 7(3), 480-4.
36. Blakstad, M.M., Mosha, D., Bellows, A.L., Canavan, C.R., Chen, J.T., Mlalama, K., ... and Fawzi, W.W. (2021) Home gardening improves dietary diversity, a

cluster-randomized controlled trial among Tanzanian women. Maternal & Child Nutrition, 17(2), e13096.
37. Quadro, L., and Spiegler, E.K. (2020) Maternal-Fetal Transfer of Vitamin A and its impact on mammalian embryonic development. Sub-celular biochemistry, 95, 27-55. https://doi.org/10.1007/978-3-030-42282-0_2
38. McCauley, M.E., van den Broek, N., Dou, L., and Othman, M. (2015) Vitamin A supplementation during pregnancy for maternal and newborn outcomes. Cochrane Database of Systematic Reviews, (10).
39. Haider, B.A., Sharma, R., and Bhutta, Z.A. (2017) Neonatal vitamin A supplementation for the prevention of mortality and morbidity in term neonates in low and middle income countries. Cochrane Database of Systematic Reviews, (2).
40. Ota, E., da Silva Lopes, K., Middleton, P., Flenady, V., Wariki, W. M., Rahman, M. O., ... and Mori, R. (2020) Antenatal interventions for preventing stillbirth, fetal loss and perinatal death: an overview of Cochrane systematic reviews. Cochrane Database of Systematic Reviews, (12).
41. Thiamin, R., and Acid, P. (1998). Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline: A Report of the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes and its Panel on Folate, Other B Vitamins, and Choline and Subcommittee on Upper Reference Levels of Nutrients, Food and Nutrition Board, Institute of Medicine. National Academy of Sciences. ISBN: 0-309-59725-0, 592 pages. http://www.nap.edu/catalog/6015.html
42. Chungchunlam, S.M., and Moughan, P.J. (2023) Comparative bioavailability of vitamins in human foods sourced from animals and plants. Critical Reviews in Food Science and Nutrition, 1-36.
43. Rahmatullayev, Y., and Buranova, G. (2023) Study Of Micronutrient Status Of Pregnant Women In Rural Conditions. Science and innovation, 2(5), 234-237.
44. Dada T, Otitoloju K, Adjonu R, Crockett J, and Nwose U. Nutritional and medicinal values of common green leafy vegetables consumed in Delta state, Nigeria: A review. International Journal of Community Medicine and Public Health. 2021 May 1;8(5):2564-71
45. Stadlmayr, B., Trübswasser, U., McMullin, S., Karanja, A., Wurzinger, M., Hundscheid, L., ... and Sommer, I. (2023). Factors affecting fruit and vegetable consumption and purchase behavior of adults in sub-Saharan Africa: A rapid review. Frontiers in Nutrition, *10*, 1113013.
46. Takeshima, H., Yamauchi, F., Balana, B., Adeyanju, D., Edeh, H., Kadjo, D., ... and Olanipekun, C. I. (2023). Innovations for inclusive and sustainable growth of domestic food value chains: Fruits and vegetables value chains in Nigeria scoping report. International Food Policy Research Institute (IFPRI) Google Book.
47. Ashaolu, T.J., and Adeyeye, S.A.O. (2022) African Functional Foods and Beverages: A Review. Journal of Culinary Science & Technology, 22(1), 142–177. https://doi.org/10.1080/15428052.2022.2034697
48. Sawyer, W.E., Jacob, D.E., Ogidi, O.I., Izah, S.C., and Popoola, A.M. (2023) Threats and conservation strategies of common edible vegetables that possess pharmacological potentials in Nigeria. In Herbal Medicine Phytochemistry: Applications and Trends (pp. 1-35). Cham: Springer International Publishing.
49. Abere, M., and Azene, A.G. (2023) Food Taboo and associated factors among pregnant women attending antenatal clinics at Bahir Dar City, North West Ethiopia, 2021: cross-sectional study. Scientific Reports, 13(1), 7790.
50. Chakona, G, and Shackleton, C. (2017) Minimum dietary diversity scores for women indicate micronutrient adequacy and food insecurity status in South African towns. Nutrients.28;9(8):812.
51. Drewnowski, A, and Almiron-Roig, E. (2009) 11 Human perceptions and preferences for fat-rich foods. Fat detection: Taste, texture, and post ingestive effects.14;23:265.
52. Rajpal, S., Kumar, A., Alambusha, R., Sharma, S., and Joe, W. (2021) Maternal dietary diversity during lactation and

associated factors in Palghar district, Maharashtra, India. PLoS One. 29;16(12):e0261700
53. Meng, L, Wang, Y., Li, T., Loo-Bouwman, C.A, Zhang Y, Man-Yau Szeto I. (2018) Dietary diversity and food variety in Chinese children aged 3–17 years: are they negatively associated with dietary micronutrient inadequacy?. Nutrients.5;10(11):1674.
54. Ngala, S.A. Evaluation of dietary diversity scores to assess nutrient adequacy among rural Kenyan women (Doctoral dissertation, Wageningen University).
55. Taruvinga, A., Muchenje, V, Mushunje A. (2013) Determinants of rural household dietary diversity: The case of Amatole and Nyandeni districts, South Africa. International Journal of Development and Sustainability.;2(4):2233-47.
56. Tarasuk, V, McIntyre, L, and Li, J. (2007) Low-income women's dietary intakes are sensitive to the depletion of household resources in one month. The Journal of nutrition.1;137(8):1980-7.