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Assessment of the Dietary Supplements Effects on Maternal Underweight in Nigeria

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Abstract

Maternal underweight continues to rise and, if not properly managed, will lead to increased mortality. This contradicts the United Nations Sustainable Development Goal of reducing maternal mortality by 2050. Therefore, this study aimed to determine the probable effect of dietary supplements on maternal underweight in Nigeria. This study employed probit estimation using the maximum likelihood technique in 2022, with the 2018 Nigeria Demographic Health Survey data as the basis for analysis. The results showed a statistically significant effect of dietary supplements on maternal underweight in Nigeria. The likelihood of dietary supplements impacting maternal underweight was approximately 0.4% lower, on average, for mothers who took dietary supplements compared to those who took non-dietary supplements. That is, maternal underweight could be reduced significantly if mothers were consuming the required dietary supplements during their reproductive ages. This study concludes that the head of household age, wealth index, and mothers' education level are likely to reduce maternal underweight. In contrast, household size is unlikely to have this effect when mothers take dietary supplements, with a very strong effect.

Keywords: dietary supplement, maternal underweight, probit model

Introduction

Dietary supplements are oral dietary ingredients such as iron, folic acid, and vitamins formulated in capsules, syrups and tablets, components and other domestic diets that are edible to improve one's dietary deficiencies according to the United States Food and Drug Administration, under the Dietary Supplement Health and Education Act of 1994.[1] The need for dietary supplements would not be undermined during pregnancy to support changes in maternal tissue, metabolism, and global fetal growth and development. Moreover, every pregnant woman needs an average increase in energy of about 300 kcal per day during pregnancy, as well as adequate protein, vitamins, and minerals such as iron, folic acid, and calcium for her healthy living.[2]

Dietary supplements are essential components of a balanced diet that should be accessible, safe, affordable, and sustainable, along with essential dietary services and positive dietary practices that are key to optimal healthy living and well-being.[3,4] The need for dietary supplements for women is related to nutritional status, health, and fetal development; while in African countries such as Nigeria and Tanzania, pregnant women face deficiencies of dietary supplements during pregnancy, resulting in adverse health effects for both mother and child.[5] There is an urgent call to increase the nutritional needs of every pregnant mother to meet the energy, protein, and micronutrient needs for the normal growth and development of maternal tissues and her unborn child during pregnancy and breastfeeding.[6]

It is well argued that the possibility of pregnant women meeting their needed daily diets through domestic feedings without dietary supplements is unattainable since malnutrition among pregnant women in Africa was 23.5% in 2019.[7] However, poor diets and dietary supplements deficiency before, during, and after pregnancy are contributing factors leading to a serious maternal health problem such underweight that will result in poor pregnancy outcomes.[8,9] The numerous health implications of malnutrition among women in Africa prompted Nigeria to develop a national food and

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nutrition policy plan through a multi-stakeholder process. This policy plan was produced by the Nigerian National Planning Commission in 2001 to mitigate the adverse impacts of malnutrition in the country. However, the policy has not yielded significant outcomes in improving the nutritional status of the country due to inadequate implementation.[10]

Maternal underweight has become a global health economic concern, particularly in low- and middle-income countries (LMICs), including Nigeria. The impact of malnutrition could be reported as underweight, predominantly among women, with its consequences including anemia and a high risk of maternal and infant morbidity.[11] It is obvious that women face financial constraints, mostly in LMICs, which may prevent them from meeting the daily dietary supplement intake needed to address maternal health issues such as underweight and anemia.[12]

Underweight is a health condition causing the mother's body mass index to fall below 18.5kg/m^2 by lowering the mother's immune system in the age range of 15-49 years and creating a niche for other diseases, causing the death of approximately 462 million women with their offspring.[13] Underweight is multifaceted with different causes and determinants across geographic settings, household environment, education, cultural practices, biological factors, and poor dietary practices, among others.[14-16] Proper diet and dietary supplementation before, during, and after pregnancy may reduce the risk of maternal underweight, hemorrhagic disease of the newborn, and congenital abnormalities in the fetus.[17]

In Nigeria, underweight has become a health threat mostly faced by women, particularly pregnant women; if not properly managed through improved diets and dietary supplements, it could lead to maternal and infant mortality.[18] However, the level of dietary supplement consumption among Nigerian women was highly disappointing according to the 2013 National Demographic and Health Survey (NDHS) report, revealing 15% underweight among women aged 15–49 years in 2003, while it was 11% in 2013, exposing little improvement over a decade. Undernutrition is evident among women, with 13% of the rural and 10% of the urban population.[18] Maternal mortality rate in Nigeria is unabated due to health factors such as maternal underweight, caused mainly by food shortages and poor diets. It is well documented that the lifetime risk of maternal death for pregnant or childbearing mother is 1 in 30 women.[19] Being underweight as a result of malnutrition causes about 8% of economic hardship for a country through direct productivity losses and losses as a result of poor cognition and increased school dropout rates, causing Africa and Asia to lose 11% of their gross domestic product each year as a result of malnutrition.[20]

Even though mothers are more likely to face health problems, such as underweight, due to poor diet and dietary supplements before, during, and after pregnancy, occasioned by a high poverty rate in the country, because of their low socioeconomic status, there have been few empirical studies assessing the effect of dietary supplements on maternal underweight in Nigeria. This study then attempted to fill the existing literature gap in Nigeria. In this thematic area, research has been conducted worldwide, but none in Nigeria. A study to investigate the prevalence of underweight and its associated risk factors among women of reproductive age in Ethiopia found that the likelihood of underweight was higher among young women living in rural areas. They recommended robust context-based awareness-raising on how to prevent underweight among women living in rural areas.[21] Previous studies examining the prevalence and associated factors of maternal health risks, including underweight, overweight, and obesity among women of childbearing age (WCA) in South and Southeast Asia, found that underweight was higher among poor, young, and rural WCA lacking adequate diets and dietary supplements.[22-30] A cross-sectional study on WCA in Nepal found that the underweight prevalence decreased from 25.3% to 16.9% although it remained a threat among women without dietary supplements. Their findings suggest that sociodemographic and household environmental factors are associated with maternal underweight, regardless of dietary supplements.[31]

Furthermore, this study utilized the recent national data. It generated marginal effects of all the variables used to control for endogeneity, which most studies did not observe, thus pushing the boundaries of knowledge beyond what already exists. Another study in Nigeria focused on improved household environments.[11] Therefore, this study utilized fruits as one of its control variables to estimate their effect on reducing maternal underweight, given the agrarian nature of the country studied. This study would add to the growing literature on the effects of dietary supplements and maternal underweight at the national and regional levels in Africa. This is essential because the United Nations Sustainable Development Goal 3 aims to achieve good health and well-being for all by 2030, which can be accomplished by ensuring the availability and subsidization of dietary supplements for women who fall short of the required daily intake. Studies on this thematic area of research are still limited at the national and regional levels, and that necessitated this study in Nigeria, as a giant African country, to determine the effects of dietary supplements on maternal underweight by utilizing Nigeria NDHS data produced by the World Bank, and logistic modeling technique was used in the analysis.

Method

This quantitative study utilized a cross-sectional design to determine the probable effects of dietary supplements on maternal underweight in Nigeria. The 2018 Nigeria NDHS data were used since they provide the updated estimates of basic demographic and health indicators through a survey sample. The sampling frame used for the 2018 NDHS was the population and housing census of the Federal Republic of Nigeria. The primary sampling units, called "clusters," for the 2018 NDHS were defined based on enumeration areas from the 2006 census framework.

An econometric package (Stata 13) was used to run the analysis. A two-stage stratified sampling technique was employed to select households in each of the 36 states and the Federal Capital Territory (FCT), stratified into urban and rural areas, by dividing the sample into 74 strata. In the first stage, 1,400 enumerated areas were selected from the sample strata, comprising 580 urban areas and 820 rural areas with probability proportional to the size of the enumerated area.

In the second stage, approximately 30 households were selected from each cluster through the same systematic probability sampling, resulting in a total sample size of 42,000 households. A total of 41,820 households were selected for underweight screening, targeting WCA (15-49 years). The inclusion criteria were all WCA who were either permanent residents or visitors in the sample household the evening before the survey. Women who were unable to provide their consent and were outside the age of WCA were excluded.

This study was based on the social determinants of maternal health framework, developed to analyze health inequities caused by various determinants, which could be categorized as structural and intermediary determinants according to the Commission on Social Determinants of Health (CSDH).[32] The structural determinants are clearly those producing health inequities by introducing social stratification in society based on class, sex, ethnicity, income, education, and occupation. Meanwhile, the intermediary determinants include factors influencing individual-level health outcomes such as material circumstances, biological factors, and health systems.[33] To estimate the model, a logistic (probit) model was utilized.[34] Instead, the dependent variable addressing this objective was underweight, which was binary, and the logistic regression addressed the heteroscedasticity problem inherent in linear probability models.

$$underweight_i = \beta_0 + \beta Supplements + \theta SEFACTORS + \lambda Demographics + \varphi geopolitcal + \alpha rural + \mu_i \ldots 3.1$$

Model 1. Dietary Supplements and Maternal Underweight in Nigeria

Notes: Underweight = takes the value of 1 if underweight has been observed and 0 if otherwise.
Supplement = vector of various dietary supplements taken by WCA; **SEFACTORS** = vector of socioeconomic factors which includes wealth index, education level, occupation, and ethnicity; **Demographics** = vector of demographic characteristics which includes age of mother, age of household head, and sex of household head; **geopolitical** = vector of geopolitical indicator variables (Northwest, Northeast, North Central, Southeast, Southwest and South-South); **rural** = takes the value of 1 if the woman lives in rural area and 0 if otherwise; **μ** = random error term that is assumed to be homoscedastic and normally distributed if probit estimation is to be employed or follows logistic distribution if logit estimation is to be employed.

The dichotomous model specified in equation (Model 1) would be estimated as a probit model, estimating the probability of the occurrence of the dependent variable given its covariates. The probit model followed the normal cumulative density function and was estimated by the method of maximum likelihood. The results of the probit model would be interpreted by computing the marginal effects of each variable, and this marginal effect was the probability that a woman was exposed or not exposed to the desired health outcome (underweight) given the supplement.

Results

This study employed descriptive statistics (Table 1) to examine the data features and nature of the variables in the probit model. In that vein, this study examined the mean, standard deviation, and minimum and maximum values of the model variables. Table 1 displays the descriptive statistics for variables with 41,821 observations. Key descriptive statistical measures, such as central tendency (mean) and dispersion (standard deviation), indicate disparities across most variables. For instance, household size (with a mean of 6.568 and a standard deviation of 3.893) was more dispersed than other variables.

Furthermore, variables such as the household head's age, age range, wealth, and residence exhibit higher distributions across means and wider gaps between minimum and maximum values. The underweight group, who were educated and also consumed supplements and fruits, exhibited lower distributions across means and less dispersed values, with a mean of zero and a standard deviation of one, respectively. Thus, approximately 40% of the women

observed were underweight, showing a low prevalence of underweight among WCA.

Table 1. Descriptive Statistics of the Model Variables

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Underweight	41,821	0.040	0.196	0	1
Age	41,821	3.499	1.935	1	7
Education	41,821	1.263	1.044	0	3
Wealth	41,821	3.025	1.385	1	5
Residence	41,821	1.594	0.491	1	2
Supplements	41,821	0.374	0.484	0	1
Fruits	41,821	0.412	0.492	0	1
Household size	41,821	6.568	3.893	1	37

Source: Author's computation from available data using STATA 13

Table 2 presents the results of the probit model stated on the method section by computing the marginal effects of dietary supplements on maternal underweight in Nigeria. The findings indicated a statistically significant likelihood of maternal age, education level, and wealth impacting maternal underweight among mothers on dietary supplements compared to mothers who were not. The likelihood of maternal age, education level, wealth, and ethnicity impacting maternal underweight was approximately 0.8, 0.6, 0.6, and 0.2% lower on average among mothers on dietary supplements, respectively, at a higher significance level (1%). The likelihood of dietary supplements and fruits impacting maternal underweight was approximately 0.4 and 0.4% lower on average for mothers on dietary supplements, respectively, and was statistically significant at the 10% level.

The likelihood of household size impacting maternal underweight is approximately 0.2% higher on average for mothers on dietary supplements, also statistically significant at the 1% level. For these regions, the likelihood of mothers from the North-Eastern, Northwest, and Southwest being underweight averaged approximately 0.2, 0.7, and 0.9% for mothers taking dietary supplements. It was statistically significant at the 1% and 10% levels, respectively. The likelihood of mothers from the Southeast being underweight averaged approximately 1% for mothers taking dietary supplements, with a significant level of 5%.

Table 2. Assessment of the Effects of Dietary Supplements on Maternal Underweight

Variable	Underweight	Marginal Effect	Underweight	Marginal Effect
Underweight				
Age	-0.111***	-0.00833***	-0.105***	-0.00779***
	(0.000)	(0.000)	(0.000)	(0.000)
Education	-0.0760***	-0.00572***	-0.0478**	-0.00354**
	(0.000)	(0.000)	(0.003)	(0.003)
Wealth	-0.0764***	-0.00575***	-0.0658***	-0.00487***
	(0.000)	(0.000)	(0.000)	(0.000)
Residence	-0.0327	-0.00246	-0.0262	-0.00194
	(0.253)	(0.253)	(0.373)	(0.373)
Region	-0.00402	-0.000302		
	(0.642)	(0.642)		
Supplements (d)	-0.0465	-0.00346	-0.0552*	-0.00403*
	(0.056)	(0.054)	(0.024)	(0.023)
Fruits (d)	-0.0496*	-0.00371*	-0.0419	-0.00308
	(0.040)	(0.039)	(0.085)	(0.083)
Household size	0.0223***	0.00168***	0.0186***	0.00138***
	(0.000)	(0.000)	(0.000)	(0.000)
Ethnicity	-0.00145***	-0.000109***	-0.00174***	-0.000129***
	(0.000)	(0.000)	(0.000)	(0.000)
Northeast			0.238***	0.0203***
			(0.000)	(0.000)
Northwest			0.0861*	0.00664*
			(0.031)	(0.038)
Southeast			-0.142**	-0.00958**
			(0.007)	(0.003)
South-South			-0.0288	-0.00209
			(0.571)	(0.563)
Southwest			0.113*	0.00906*
			(0.018)	(0.028)
r2_p	0.0442	0.0442	0.0500	0.0500
Ll	-6689.2	-6689.2	-6648.7	-6648.7
Correctly classified	96.02%	96.02%	96.02%	96.02%
N	41821	41821	41821	41821

Notes: Marginal effects; *p*-values in parentheses; (d) for discrete change of dummy variable from 0 to 1; *p-value <0.05, **p-value <0.01, ***p-value < 0.001

Table 3 reports maternal body mass index based on dietary supplements generated by STATA 13. The report indicated that 13.3% of mothers not taking dietary supplements and 8.7% of mothers taking dietary supplements were underweight, resulting in a total of 11.3% mothers being underweight. The results also showed that 61.1% of mothers not taking dietary supplements maintain a normal weight, while 59.1% taking dietary supplements maintain a normal weight, indicating that 60.5% of mothers have a normal weight. In aggregate, 18.4% of mothers in this study were overweight. However, 16.5% were overweight due to factors other than dietary supplements, while 20.8% were overweight due to dietary supplement intake. In addition, out of the 9.8% of obese mothers, 9% did not take dietary supplements, and 10.8% did.

Table 3. Maternal Body Mass Index Based on Dietary Supplements

Body Mass Index Computed	No Supplement (%)	Taking Supplement (%)	Total (%)
Underweight	1,123 (13.3)	548.7 (8.7)	1,671.7 (11.3)
Normal	5,163.5 (61.1)	3,749.2 (59.7)	8,912.7 (60.5)
Overweight	1,396 (16.5)	1,307 (20.8)	2,703 (18.4)
Obese	763.7 (9.0)	678.6 (10.8)	1,442.3 (9.8)
Total	8,446.2 (100.0)	6,283.6 (100.0)	14,729.8 (100.0)

Test of Significance: Pearson: Uncorrected Chi^2 (3) = 115.6733 Design-based F (2.98, 3,908.52) = 24.9424 p-value <0.001.

Discussion

This study's findings indicated a statistically significant likelihood that maternal age, education level, and wealth impact maternal underweight among mothers who took dietary supplements compared to those who did not. The likelihood that maternal age impacted maternal underweight was approximately 0.8% lower on average among mothers taking dietary supplements. These results were highly significant at the 1% level, suggesting that age influenced maternal body mass on dietary supplements.

This study also revealed that an increase in maternal age will decrease the likelihood of maternal underweight by 0.8%, holding other factors constant. This result was in contrast with findings in Nepal, which established a higher prevalence of underweight among women of reproductive age.[31] On the other hand, the likelihood that education impacted maternal underweight was 0.6% lower on average, meaning that an increase in maternal education level decreased the likelihood of maternal underweight by 0.6%. Again, this was highly significant, at the 1% level, suggesting that higher maternal education increases her knowledge of the health needs of dietary supplements to control maternal health problems, such as underweight in Nigeria, when other factors are met. This study's results showed that education level improves maternal health awareness and their dietary supplement intakes in Nigeria. The results also confirmed the findings in Nepal on education, suggesting that mothers with a low education level are more vulnerable to underweight.[11,31]

Another variable reducing a mother's likelihood of being underweight was wealth index. The results showed a statistically significant negative effect on maternal underweight in Nigeria at the 1% level, meaning that a percentage increase in wealth index reduces the likelihood of maternal underweight by approximately 0.5%. This result suggested that a higher wealth index corresponded to greater purchasing power for mothers to buy dietary supplements that could improve their health and address maternal health issues, including underweight.

This study's results showed that wealth improves the mothers' chances of taking dietary supplements for better health conditions. Also, the likelihood of women from affluent households going for regular medical checks was higher compared to women from poor households. The results affirmed the findings in Vietnam, India, and Tanzania regarding wealth index, suggesting that the poorest mothers are more likely to be underweight due to their financial inability to consume appropriate food and dietary supplements.[11,28,35]

This study's findings revealed that residence and region had negative and insignificant effects on maternal underweight in Nigeria. It suggests that residence (location) had a reduced effect on maternal weight among mothers who took dietary supplements, although it was not statistically significant, compared to those who did not. A mother's residence and region reduced the effect of maternal underweight when taking dietary supplements. However, they did not show any difference compared to mothers who did not take dietary supplements in Nigeria. On the other hand, fruit itself showed a weak effect on maternal underweight, at the 10% level, indicating a probable 0.4% lower effect of fruit on maternal underweight compared to mothers not taking dietary supplements. This condition suggested that fruit supplement intake may help mothers maintain a healthy balance (weight) by boosting the immune system for a healthier maternal life in Nigeria.

The household size variable showed a statistically significant positive impact on maternal underweight in Nigeria. This study's findings indicated that a 1% increase in household size increased the likelihood of maternal underweight by 0.2% at the 1% significance level for mothers who took dietary supplements compared with those who did not. This claim is particularly evident in Nigeria and several other sub-Saharan African countries with high poverty rates due to declining household income.[36]

This study's results showed that an increase in the household size is likely to decrease the chance of mothers headed by the household having a good diet or receiving dietary supplements. This finding was consistent with the study on family size.[11] When mothers were among the poorest groups, they were more likely to adopt risky coping strategies, compromising their diet quality. Again, ethnicity had a statistically significant lower effect on maternal underweight at the 1% significance level. Hence, a one-point increase in mothers from any ethnic group in Nigeria reduced maternal underweight by 0.01% for mothers on dietary supplements alone. This finding was significant because maternal underweight was not sensitive to ethnicity.

Regarding the regional impact of dietary supplements on maternal underweight in Nigeria, this study showed that the Northeast, Northwest, Southeast, and Southwest regions had statistically significant effects. In contrast, the country's South-South region was the only region that did not show a statistically significant effect of dietary supplements on maternal underweight. While the Northwest and Southwest regions showed weak statistically significant effects at the 10% level of significance, the Northeast and Southeast regions showed highly significant effects at the 1% level.

This study's finding of improved dietary patterns in the Northern region could be a result of the 2013 and 2017 campaigns to improve access to micronutrients, health facility accessibility, nutrition counseling, and dietary diversity for the Northern region, which stemmed from the scale-up of donor-supported community-based maternal and child nutrition and food security interventions in Northern Nigeria.[37] These results suggested that the impact of dietary supplements on maternal underweight may be more likely due to factors beyond the scope of this study, such as environmental impacts, rather than regional impacts.

The report under this study suggested that more mothers who maintained a normal weight did not rely on dietary supplements. Furthermore, a greater proportion of mothers relying on dietary supplements might be overweight and obese. This study could identify solutions to the prevalence of maternal underweight due to malnutrition among WCA in Africa. It demonstrates the potential to achieve the United Nations Sustainable Development Goal 3 in Africa through the provision of dietary supplements and educating every woman about the importance of supplements in both their own life and those of their children. However, the data used in this study were not clinically validated, which limited this study, due to their secondary nature, making them publicly available through the Nigeria Demographic and Health Survey repository. This study suggests areas for further research, such as dietary supplements and the influence of environmental factors on maternal underweight.

Conclusion

Empirical results of the effect of dietary supplements on maternal underweight in Nigeria indicate that the age of the head of the household, the wealth index, and the mother's education level may contribute to the reduction of maternal underweight when consuming dietary supplements. However, a large family size will trigger maternal underweight when dietary supplements are not available. Fruit consumption has a weak effect on reducing maternal underweight when combined with dietary supplements. This study recommends that all stakeholders in the health industry collaborate with the government at all levels (regional and national) to provide dietary supplements through voluntary donations and also educate every WCA about the importance of dietary supplements in their lives before, during, and after pregnancy.

Abbreviations

LMICs: low- and middle-income countries; NDHS: Nigeria Demographic Health Survey; WCA: Women of childbearing age.

Ethics Approval and Consent to Participate

The study did not seek ethical approval because it was a secondary analysis of publicly accessible Nigeria Demographic and Health Survey data. However, the 2018 Nigeria Demographic and Health Survey protocol was reviewed and approved by the National Health Research Ethics Committee of Nigeria and the International Coaching Federation Institutional Review Board. Informed consent was gathered from participants before interviews or biomarker tests were granted.

Competing Interest

The authors declare that they have no competing interests.

Availability of Data and Materials

The data is available online in the 2018 Nigeria Demographic and Health Survey repository; https://dhsprogram.com.

Authors' Contribution

CJC and UAC wrote the first and subsequent drafts of the manuscript, with comments from NAO, IAM, and UMO. CJC and UAC conceptualized and designed the study. IAM and CJC conducted data analysis and interpretation, while NSU, UMO, and UAC did the introduction and conducted the empirical literature review. All authors read and approved the final manuscript.

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