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Effect of nutritional status of pregnant women on birth weight of newborns at Butajira Referral Hospital, Butajira, Ethiopia

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Abstract

Back ground: Maternal nutritional status influences the developmental environment of the fetus which consequently affects the birth weight of the newborn. However, the association between maternal nutritional factors and birth weight is complex and is not well characterized in Ethiopia.

Objective: To assess the effect of maternal anthropometry and biochemical profile on birth weight of babies at Butajira Referral Hospital, Butajira, Ethiopia.

Methods and materials: Laboratory-based cross-sectional study was conducted among 337 pregnant women at the hospital. Socio-demographic and obstetric characteristics were collected using pre-tested questionnaires. Blood sample was collected from each pregnant women for determination of total serum protein, total serum cholesterol and hemoglobin level. However, maternal dietary habits were not assessed in this study.

Results: A total of 337 pregnant women were involved in the study. The mean (standard deviation) birth weight of the newborns was 3.14 ± 0.46 kg. After adjusting for different maternal factors, parity ($p = 0.013$), hemoglobin level ($p = 0.046$), pre-pregnancy body mass index ($p < 0.001$) and weight gain during pregnancy ($p < 0.001$) were positively associated with birth weight of the newborns, while the associations with total protein ($p = 0.822$) and total cholesterol ($p = 0.423$) were not significant.

Conclusion: This study has shown that nutritional status of pregnant women as indicated by maternal anthropometry and hemoglobin level was associated with birth weight of the baby. Therefore, nutritional status of the pregnant women should be improved to reduce the risk of low birth weight.

Keywords

Anthropometric indicators, biochemical profile, birth weight

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Introduction

Maternal nutritional and metabolic factors affect the developmental process of the fetus which consequently influence the birth weight of the newborn.[1] During pregnancy, many physiological and metabolic functions are changed to a great extent.[2] Pregnant women need adequate energy and nutrients to meet the increased nutritional demands for growth of the fetus and to satisfy the increased body demands of the mother.[3] Poor maternal nutritional status has been related to different adverse birth outcomes including intrauterine

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growth restriction and low birth weight (LBW), which can have lifelong consequences for development.[4–6] Thus, improving maternal nutritional status before conception and during pregnancy are essential to improve birth weight of newborns.[7] However, the association between maternal nutrition and birth outcome is influenced by different factors. Thus, understanding the relationship between maternal nutrition and birth outcomes is important to prevent adverse birth outcomes including LBW.[6]

During pregnancy, the fetus is entirely dependent on maternal nutrients intake and store, mainly fats and protein. Thus, inadequate intake of fat and protein leads to poor nutrient availability to the fetus.[7] In addition, maternal nutrient intake of protein and fat have strong influence on fetal growth and birth outcome.[4] Result from biochemical studies showed that maternal blood lipid concentrations in late pregnancy were associated with newborn anthropometry. The elevated serum lipids during pregnancy are essential for optimal development of the fetus.[8–11]

Poor fetal growth results not only from a deficiency of protein and lipids but also from low maternal hemoglobin concentration during pregnancy.[4,6] Maternal hemoglobin level during pregnancy has greatly influenced the neonatal anthropometry especially the birth weight of newborn.[4] If a woman's diet does not contain enough iron to meet the increased nutritional requirement during pregnancy, it may cause the mother to prone for nutritional deficiency anemia.[12] The maternal anemia during pregnancy is a major public health problem, and it can lead to fetal growth retardation which results in reduced birth weight of the neonates.[13]

Maternal anthropometries during pregnancy including weight, height, body mass index (BMI) and total maternal weight gain have also strong association with fetal growth and birth weight.[7] Pregnancy BMI and gestational weight gain were the most important determinants of birth weight.[14,15] When there is appropriate maternal height and weight, there will be a better growth of the fetus and also better birth outcome.[4]

Birth weight has long been a concern of different clinical investigations and a target for public health intervention. In particular, considerable attention has been focused on the causal determinants of LBW, in order to identify potential risk factors. There are only few published reports in Ethiopia that assessed the birth weight of newborns. Even the available studies did not address and bring together the broader picture of multiple nutrient deficiencies. Therefore, this study was designed to investigate the effect of maternal nutritional status on offspring's birth weight.

Materials and methods

Study setting and design

This study was conducted in Butajra Referral Hospital, which is located in Butajira, Southern Ethiopia. Laboratory-based cross-sectional study was conducted to assess the effect of nutritional status of pregnant mothers on birth weight of babies. The study was conducted from 5 May to 6 July, 2018.

Study population and sampling techniques

The participants of this study were pregnant mothers who meet the inclusion criteria. All pregnant women were eligible for inclusion in the study if they were between the age of 18 and 37 years, those with singleton term pregnancy (37–42 weeks) in labor and those who were volunteered to participate in the study. Pregnant women with history of taking tobacco, alcohol and drug abuse, history of chronic diseases, diagnosed as antepartum hemorrhage, oligohydramnios, fetal anomaly and still birth were excluded from this study.

The required sample size for this study was calculated using statistical formula for single population proportion by taking the prevalence of LBW as 27%,[16] 95% confidence interval and 5% marginal error. Hence, a total of 337 pregnant women who fulfill the eligibility criteria and gave birth during study period were consecutively recruited in the study until the sample size was filled.

Data collection procedures and definition of variables

Before the data collection, ethical approval was obtained from Institutional Review Board (IRB) of Wolkite University, Wolkite, Ethiopia. Then, written informed consent was obtained from all study participants. Socio-demographic characteristics and obstetrics information of the pregnant women were collected on a face-to-face interview using pre-tested questionnaires. The data were collected by trained midwives at delivery ward.

After collection of socio-demographic characteristics and obstetrics data, anthropometric measurements were carried out using appropriate measuring instruments. Accordingly, measurements of height were made without shoes to the nearest 0.1 cm using erect height measuring device. Weight was measured using a weighing scale with light clothes and without shoes to the nearest 0.1 kg. Maternal BMI was then calculated using height and weight (weight in kilograms divided by height in square meters). Based on BMI cutoffs developed by the World Health Organization (WHO), it was categorized into three levels as underweight (BMI, <18.5), normal weight (BMI, 18.5–24.99) and overweight (BMI, >25).[17] According to 2009 Institute of Medicine guidelines, women were classified as having low, recommended or high gestational weight gain based on the pre-pregnancy BMI.[18]

Maternal venous blood, approximately 8 mL, was collected before delivery by experienced laboratory technician with appropriate aseptic techniques. Immediately after collection, 5 mL of the blood sample was transferred to tubes for the preparation of serum. Serum was separated by centrifugation process at 3500 r/min for 10 min. One-milliliter aliquots of serum samples were obtained by centrifugation and

Table 1. Socio-demographic characteristics of pregnant women attending delivery room of Butajira Referral Hospital, Butajira, Ethiopia, 2018 (n = 337).

Variables	n (%)
Age (years)	
⩽27	187 (55.5)
⩾28	150 (44.5)
Religion	
Muslim	178 (52.8)
Orthodox	81 (24)
Protestant	36 (10.7)
Catholic	42 (12.5)
Residence	
Urban	110 (32.6)
Rural	227 (67.4)
Educational level	
Illiterate	33 (9.8)
Primary school	144 (42.7)
High school	77 (22.8)
Certificate and above	83 (24.6)
Occupational status	
Employed	80 (23.7)
Self-employed	55 (16.3)
Unemployed	202 (59.9)

stored at 2°C–8°C prior to processing. The serum samples were analyzed for the estimation of total protein and total cholesterol. Total protein was assayed using Biuret method[19] and total cholesterol was assayed using cholesterol oxidase/peroxidase colorimetric (ENDPOINT) method.[20]

Measurements of total cholesterol and total protein were performed on ECHO XPC automatic chemistry analyzer (Edif instruments, Italy). The hemoglobin level of pregnant women was determined from the whole blood using Sysmex XT 2000i hematology analyzer. The WHO categories of anemia for pregnant women were used for this study. Anemia was defined as hemoglobin concentration less than 11 g/dL. It was further classified into mild (10–10.9 g/dL), moderate (7–9.9 g/dL) and severe (<7 g/dL).[21]

The newborn weight was measured soon after birth using a standard beam balance by trained personnel. Based on the birth weight, neonates were classified as LBW (<2500 g), normal birth weight (2500–4000) and macrosomia (>4000 g).[22,23]

Data quality control

To ensure good quality of data, standard procedures and safety precautions were followed during sample collection and all other laboratory procedures. The accuracy of chemistry analyzer and hematology analyzer was controlled by running quality control samples. Before the actual data collection, training was given for data collectors. The questionnaires were pretested and the necessary corrections were undertaken. The collected data were checked daily for completeness and consistency. In addition, double data entry was done to avoid data entry errors.

Statistical analysis

All statistical analyses were performed using SPSS version 20. Descriptive statistics were used to describe the socio-demographic characteristics of the study participants. Univariate linear regression analyses were performed to explore associations between maternal factor variables and the outcome of newborn birth weight. Multiple linear regressions analysis was also performed to explore independent effects of maternal factors. The variables that were statistically significant in the multiple linear regression models were reported as the best predictors of newborn birth weight. The results of the analysis were presented with texts and tables. A p value < 0.05 was considered to be significant.

Results

Socio-demographic characteristics

A total of 337 pregnant women were involved in this study. The mean age of the pregnant women was 26 ± 5 years, within the age range of 18–37 years. Majority of the pregnant women were Muslims followed by Orthodox Christian. On the basis of educational status, about 144 pregnant women had primary school education and majority of them were unemployed by occupation. Of the study participants, 227 were rural residents (Table 1).

Obstetrical characteristics of mothers

In this study, about 138 (40.9%) of the women were nulliparous and 126 (37.4%) were multiparous. About 114 (33.8%) of the pregnant women were primigravida, 67 (19.9%) were second gravid, 57 (16.9%) were third gravid, 49 (14.5%) were fourth gravid and grand multigravidity was found in 50 (14.8%) women. Majority of multiparous women live in rural areas and also most of gravida one women were rural residents (Table 2). The newborns in our study had a mean birth weight of 3.14 ± 0.46 kg. About 320 (95%) of them belonged to normal birth weight and the remaining 17 (5%) belonged to LBW.

Anthropometric characteristics of the pregnant women

In this study, the mean weight and height of pregnant women were 64.08 ± 7.31 kg and 157.71 ± 4.27 cm, respectively. On the basis of pre-pregnancy BMI, 29 (8.6%), 280 (83.1%) and 28 (8.3%) pregnant women had BMI (kg/m^2) value of <18.5, 18.5–24.9 and ⩾25, respectively. Overall, the mean pre-pregnancy BMI of the study participants was 25.72 ± 2.59 kg/m^2. The study also revealed that the mean weight gain of the mothers was 9.99 ± 2.29 kg, within the weight gain range of 4–16 kg. Based on the pre-pregnancy BMI, 164 (48.7%)

Table 2. Distribution of parity and gravidity by residence of pregnant women attending delivery room of Butajira Referral Hospital, Butajira, Ethiopia, 2018 (n = 337).

Variables	Residence		Total
	Rural	Urban	n (%)
Parity			
Nulliparous	82 (24.3)	56 (16.6)	138 (40.9)
Primiparous	35 (10.4)	19 (5.6)	54 (16)
Multiparous	93 (27.6)	33 (9.8)	126 (37.4)
Grand multiparous	17 (5)	2 (0.6)	19 (5.6)
Gravidity			
One	64 (19)	50 (14.8)	114 (33.8)
Two	47 (13.9)	20 (5.60	67 (19.9)
Three	41 (12.2)	16 (4.7)	57 (16.9)
Four	35 (10.4)	14 (4.2)	49 (14.5)
⩾Five	40 (11.9)	10 (3)	50 (14.8)

Table 3. Mean anthropometric and biochemical parameters of pregnant women attending delivery room of Butajira Referral Hospital, Butajira, Ethiopia, 2018 (n = 337).

Measurements	Mean (SD)
Height (cm)	157.71 (4.27)
Weight (kg)	64.08 (7.31)
Weight gain during pregnancy (kg)	9.99 (2.29)
Pregnancy body mass index (kg/m^2)	25.72 (2.59)
Pre-pregnancy body mass index (kg/m^2)	21.73 (2.51)
Hemoglobin (g/dL)	11.89 (1.41)
Total cholesterol (mg/dL)	185.29 (24.06)
Total protein (g/dL)	5.89 (0.87)

SD: standard deviation.

women had gestational weight gain within the recommended range. The remaining 151 (44.8%) and 22 (6.5%) women had low and high gestational weight gain, respectively (Table 3).

Biochemical profile of the study participants

Table 3 also illustrates the result of maternal blood sample analysis. The mean (± standard deviation (SD)) maternal hemoglobin level was 11.91 ± 1.39 g/dL. Based on hemoglobin concentration, about 72 (21.4%) mothers had anemia with 79.2% (57/72) mild and 20.8% (15/72) moderate anemia. Severe anemia was not found in this study. Moreover, the mean total serum cholesterol level of the mothers was 185.29 ± 24.06 mg/dL. Total cholesterol level less than 200 mg/dL was recorded in 73% of women while 24.3% and 2.7% of women had cholesterol level between 200 and 239 mg/dL and above 239 mg/dL, respectively. Maternal blood sample analysis also revealed that the mean total serum protein level was 6.22 ± 4.33 g/dL, with 80.1% and 19.6% of women having total protein level less than 6.7 g/dL and between 6.7 and 8.7 g/dL, respectively.

Association of maternal factors with birth weight of newborns

In univariate linear regression analysis, birth weight was significantly associated with parity, maternal BMI, weight gain during pregnancy, hemoglobin level, total cholesterol level and total protein level. Bivariate associations were further analyzed using multiple linear regression models to investigate the independent predictors of newborn birth weight. The maternal factors—age, residence, educational status, hemoglobin level, total cholesterol level, total protein level, pre-pregnancy BMI and weight gain during pregnancy—were entered simultaneously into a multiple regression model. After adjusting for these factors, parity, hemoglobin level, pre-pregnancy BMI and weight gain during pregnancy remained significant predictors of offspring's birth weight ($p < 0.05$; Table 4).

Discussion

LBW is a major public health problem, and it is associated with increased risk of newborn morbidity and mortality.[24] The birth weight of the newborn is an indicator of the mother's nutritional status.[25,26] Hence, the objective of this study was to assess the effect of maternal nutritional status as indicated by maternal anthropometry and biochemical profile on the birth weight of the newborns.

This study revealed that the biochemical profile of pregnant women as indicated by hemoglobin level, total cholesterol and total protein level were positively associated with birth weight of the newborn. However, there was no significant association between birth weight and total cholesterol level, which is in line with studies conducted by Misra et al.[27] and Geraghty et al.[8] who found no significant association between maternal serum total cholesterol and infant birth weight. Similarly, the positive association between birth weight and maternal total protein was not significant. In line with this finding, a previous study that assessed maternal protein intake during pregnancy reported that protein intake in the second trimester or later showed no significant association with birth weight of the newborns.[28]

In this study, statistically significant positive association was found between maternal hemoglobin level and birth weight of the baby. In line with this finding, several studies[24,26,29,30] showed that with increasing maternal hemoglobin level, the incidence of LBW was decreased. Hence, mothers with lower hemoglobin level during pregnancy had an increased risk of delivering LBW babies. In conformity with this result, studies done by earlier researchers[29–31] showed that anemia during pregnancy was associated with a significantly increased risk of LBW. The rate of delivery of babies with LBW was significantly higher in the anemic mothers as compared to non-anemic mothers.[32] Reduced levels of hemoglobin lead to abnormal placental angiogenic

Table 4. Univariate simple and multiple linear regression model examining the associations between maternal risk factor variables and birth weight (kg) as an outcome in Butajira Referral Hospital, Butajira, Ethiopia, 2018 (n = 337).

Maternal factors	Simple regression model				Multiple regression model			
	Beta coefficient	SE	95% CI for beta coefficient	p-value	Beta coefficient	SE	95% CI for beta coefficient	p-value
Parity	0.190	0.050	0.091 to 0.289	**<0.001**	0.137	0.055	0.029 to 0.245	**0.013**
Hgb	0.088	0.017	0.053 to 0.122	**<0.001**	0.035	0.018	0.001 to 0.070	**0.046**
Total cholesterol	0.004	0.001	0.002 to 0.006	**0.01**	0.001	0.001	−0.001 to 0.003	0.423
Total protein	0.088	0.029	0.032 to 0.144	**0.02**	0.007	0.029	−0.050 to 0.064	0.822
Pre-pregnancy BMI	0.045	0.010	0.026 to 0.064	**<0.001**	0.043	0.010	0.023–0.064	**<0.001**
Weight gain	0.080	0.010	0.06 to 0.100	**<0.001**	0.072	0.011	0.052–0.093	**<0.001**

Hgb: hemoglobin; BMI: body mass index; SE: standard error; CI: confidence interval.
Numerical data in bold indicate statistical significance ($p < 0.05$). Multiple regression model is controlled for maternal age, residence and educational level.

development, limiting the availability of oxygen to the fetus and consequently causing potential restriction of intrauterine growth and LBW.[33]

This study revealed that maternal anthropometry including pre-pregnancy BMI and total weight gain during pregnancy showed significant positive association with birth weight of newborns. Similar to our findings, several studies[4,7,26] reported that maternal anthropometric parameters such as height, weight, BMI and gestational weight gain have strong association with birth weight of the baby. When the maternal height and weight is appropriate, the better is the growth of the fetus and better is the birth outcome.[4] Women with normal BMI before pregnancy promised a better outcome for pregnancy itself and also for the outcome of baby birth.[34] Our result also agrees with previous study on pregnancy which reported that birth weight was lower for infants of mothers with inadequate weight gain.[35]

This study also revealed that parity was significantly associated with birth weight of the baby and primiparous mother had a higher risk of delivering LBW babies. Concurrent with this result, other studies[24,36] showed that primiparous mothers were shown to be at particular risk of delivering LBW babies. This might be due to limited uterine capacity in the first pregnancy. Physiological changes that occur during the first pregnancy increase uterine efficiency in the subsequent pregnancy.[36–38] A lower birth weight among first-born infants could be a consequence of biological immaturity as compared to later-born infants.[39]

This study assesses the effect of maternal nutritional status during pregnancy on birth weight of newborns. However, this study still had some limitations. The study did not include information on dietary nutrition intake of pregnant mothers. Another limitation is that the study did not include all trimester pregnancy and the subjects were not observed longitudinally. Furthermore, the sample size was estimated based on the prevalence of LBW which gave rise to small sample size. This small sample may limit the generalization of the study. However, efforts were made to ensure that the study participants were representative of the general population. Thus, further large-scale studies using other maternal parameters are required to elucidate the relationship between maternal nutritional status and birth weight of the newborns. Despite these limitations, this study provides valuable information about the relationship of maternal anthropometry and biochemical profile with the birth weight of the babies.

Conclusion

This study has shown that nutritional status of pregnant women as indicated by maternal anthropometry and biochemical profile was associated with birth weight of the baby. Baby born to poorly nourished mother has a lower body weight as compared to the baby of better nourished mothers. Hence, the pregnant mother's diet must contain adequate and balanced nutrients to decrease the percentage of LBW babies. Therefore, different strategies such as intensive health education should be planned and carried out to improve the nutritional status of the pregnant women and to reduce the risk of LBW.

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Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

Ethical approval was obtained from Institutional Review Board (IRB) of Wolkite University. The IRB had reviewed the study protocol and approved with ethical approval reference number IRB/78/2010. Then, letter of cooperation to conduct the study was obtained from Butajira Referral Hospital clinical director office.

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Informed consent

Data were collected after obtaining written informed consent from all study participants and confidentiality was maintained throughout the study.

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