Early-pregnancy Body Mass Index and Gestational Weight Gain are important Maternal Markers of Low Birth Weight in Harar town, Eastern Ethiopia

Dereje Nemomsa[1], Firehiwot Mesfin[2], Melake Damena[3], and Fekede Asefa[3,4*]

[1]Federal Police Commission Referral Hospital, Addis Ababa, Ethiopia
[2]School of Nursing, College of Health and Medical Sciences, Haramaya University, P.O. Box: 235, Harar, Ethiopia
[3]School of Public Health, College of Health and Medical Sciences, Haramaya University, P.O. Box: 235, Harar, Ethiopia
[4]Center for Midwifery, Child and Family Health, Faculty of Health, University of Technology Sydney, NSW, Australia

Abstract

Background: A baby's birth weight is an indicator of a new-born's health, and it is highly associated with maternal weight before pregnancy and gestational weight gain. Although there are plenty of studies on low birth weight in Ethiopia, none has addressed the effect of gestational weight gain on low birth weight. The aim of this study was to assess the factors associated with low birth weight in Harar town, Eastern Ethiopia.

Methods: We conducted a cross sectional study on 411 women who started antenatal care follow-up before 16 weeks of gestation and presented to health facility to give birth. Primary data were collected using a structured questionnaire and maternal weight and new-born's birth weight were measured. Maternal weight and height at early pregnancy, and the number of antenatal care visits were abstracted from the antenatal care registration. Logistic regression was used to identify the factors associated with low birth weight. The level of significance was declared at a p value of <0.05.

Results: The proportion of low birth weight was 12.7% (95% CI: 9.7-16.1). Ninety-six percent of the low birth weight babies were born to women who gained insufficient gestational weight and 46.2% of the underweight women (at early pregnancy) had new-born babies with low birth weight. Low birth weight was more likely to occur among those who earned a monthly income of <$50 as compared to ≥$50 [Adjusted odds ratio (AOR)=5.4;95% CI (0.2, 13.7)]; antenatal care visits < 4 times compared to ANC visit ≥4 times [AOR=3.7; 95% CI (1.4, 9.5)]; age < 20 years [AOR=4.4;95% CI (1.5, 12.8)] and mother's age ≥30 years [AOR=3.9;95% CI (1.4, 10.9)] compared to mother's age 20 to 29 years; inadequate gestational weight gain (GWG) compared to adequate GWG [AOR=7.6;95% CI (3.4, 12.4)]; underweight compared to normal weight (at early pregnancy) [AOR=4.0; 95% CI (1.4,12.2)], gestational age <37 weeks compared to ≥37 weeks [AOR=8.9;95% CI (4.4, 27.0)]; and primipara compared to multi-paras [AOR=3.4;95% CI (1.4, 9.5)].

Conclusion: The proportion of babies with low birth weight was minimal compared to the national magnitude. Almost all the low birth weight babies were born to women who gained inadequate gestational weight and who were underweight at early pregnancy. The pregnant women should be counselled on appropriate weight management during their prenatal visits.

Key words: *Low birth weight, underweight, gestational weight gain, body mass index, Haramaya University*

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Introduction

According to the World Health Organization (WHO), infants with a birth weight less than 2,500g are classified as low birth weight (LBW) (WHO, 2004). LBW is an important indicator of reproductive health and general health status of a population (Ryan *et al.*, 2000). It directly or indirectly contributes 60% to 80% of all the neonatal deaths (WHO, 2011). Globally, about 20.6 million LBW infants are born each year, with more than 95% of them being born in low-income countries (WHO, 2004; WHO, 2011). Evidence from the Ethiopian Central Statistics Agency (CSA) showed that the proportion of babies with low birth weight in the country was 21%, which is one of the highest in the world (CSA and ICF, 2012).

An infant's birth weight is determined by the amount of growth during pregnancy, gestational age, infant's and the mother's genetic make-up, lifestyle, and overall health (Wilcox, 2001; Wardlaw *et al.,* 2005). Inadequate GWG, in combination with low pre-pregnancy weight, is associated with high rate of pre-mature birth and small for gestational-age infants (Institute of Medicine, 2009). LBW is one of the most important health indices in the growth, development and survival of a baby (Zenebe *et al.,* 2014). Although

*Corresponding author; Email: sinboona@gmail.com

there are many studies on low birth weight in Ethiopia (Assefa *et al.,* 2012; Zenebe *et al.,* 2014; Gebremedhin *et al.,* 2015; Gebremedhin *et al.,* 2015; Abdo *et al.,* 2016), none of these has investigated the association between gestational weight gain and low birth weight. Hence, this study aimed at assessing the factors associated with LBW in Harar town.

Materials and Methods

Study setting and period

We conducted this study in Harar, the capital city of the Harari Regional State, Eastern Ethiopia. According to the Regional Health Bureau, the health service coverage of the region is 100%, with two public hospitals, one Federal police hospital, one army (Federal Defence) hospital, two private general hospitals, one fistula hospital, eight governmental Health Centres, 16 Health posts and one NGOs clinic that provides health care services. Health workers per 1000 population ratio is 2.8. The study was conducted from 14th of January to 25th of July 2014.

Study design and participants

We conducted a cross-sectional study design. The pregnant women who started ANC follow-up during their first trimester and who presented to health facilities of Harar town to give birth were included in the study. The women with twin pregnancies were excluded from the study.

The sample size was estimated with Open Epi Version 2.3 by considering the proportion of women who gained gestational weight according to the recommendation of United States Institute of Medicine (IOM) (p=0.55) (Latifa, et al. 2013), 5% marginal error with 95% confidence level, and 10% non-response rate. The final sample size was 418. All the pregnant women who gave birth and fulfilled the above criteria were included in the study. The women were selected from three hospitals, one family guidance association model clinic, and one health centre.

Measurements and data quality control

LBW was the outcome variable. The predictor variables considered were socio-demographic characteristics, dietary pattern, early pregnancy Body Mass Index (BMI), physical activity, parity, gestational age, ANC follow up, and GWG. Total GWG is the difference between the last measured weight recorded before delivery and the first measured weight in the first trimester. It is categorized according to IOM recommendations as a normal weight gain of 12.5 – 18 kg for underweight women, 11.5 – 16 kg for women of normal weight, 7 – 11.5 kg for overweight women, and 5 – 9 kg for obese women. Likewise, it is categorized as an inadequate weight gain for each woman who gained less than the recommended level, and an excessive weight gain for each woman who gained more than the recommended level (Institute of Medicine, 2009). Adequate physical activity was measured according to the recommendation of American College of Sports Medicine that pregnant women should do at least a half-an-hour of physical exercise at most, if not all, days of the week (Nelson *et al.,* 2007).

We hired midwives working in the delivery rooms of the selected health facilities to collect data from the mothers. They were trained for two days before collecting data on the objectives and methodology of the study and the questionnaire was discussed in detail. The primary data were collected by midwives through face-face interview using a pre-tested structured questionnaire. The data were checked for completeness by supervisors and/or the principal investigator on daily basis.

The data collectors measured the weight of the mother before delivery (upon arrival to health facility) and the birth weight immediately following the delivery. The last maternal weight and height were measured by a digital weight scale with minimum clothing and using a height measuring board. The participant's first weight was measured in the first trimester, which was used as a proxy for pre-pregnancy weight, because a reliable maternal pre-pregnancy weight is rarely available and the total weight gain in the first trimester of pregnancy is usually small (Institute of Medicine, 2009). These weights (early pregnancy weights) were abstracted from ANC registration.

Data processing and analysis

Data were entered using EpiData Version 3.0 and analysed using SPSS Version 20. Frequencies, mean, and standard deviations were computed. Crude and adjusted odds ratios were used to determine the presence of an association between explanatory variables and LBW. The degree of association between LBW and independent variables were also measured using odds ratio, along with 95% of the confidence intervals and a p-value < 0.05. The factors with p-value of ≤ 0.2 in the binary logistic regression age, educational status, estimated monthly income, frequency of feeding per day, fruit and vegetable consumption, egg and meat consumption, previous history of LBW, early pregnancy BMI, gestational age,

parity, numbers of ANC visits and gestational weight gain were included in the multivariable logistic regression.

Ethical considerations

The study protocol was approved by Institutional Health Research Ethical Review Committee (IHRERC) of the College of Health and Medical Sciences, Haramaya University. An official letter of co-operation was sent to each health institution in the region. Relevant information about the study was given to the participants, including the purpose and procedures, potential risks and benefits, voluntary participation, the right to withdraw from the interview and confidentiality. Written informed consent was obtained from each participant.

Results

Soci o-demographic characteristics

Out of the 418 participants sampled for the study, 411 were interviewed, giving a response rate of 98.3%. Nearly one third of the participants (30.9%) were between the ages of 26-30 years, with a mean age of 25.18 (SD ±5.01) years. Most of the respondents (94.6%) were married and 25.8% of the total were illiterate. The predominant religion of the study population was Muslim 55.2% and 52.6% of the participants were housewives (Table 1).

Eating habits, physical activity and obstetric history of the respondents

During their current pregnancy, 83.5% of the respondents had less than three meals per day 81.5% ate fruit and vegetables; 79.1% ate meat at least once per week, and 91.7% consumed eggs at least once per week. Only 34.8% were engaged in physical exercise at least once per week during their current pregnancy. Among the respondents, 84.7% had no previous history of abortion, and 96.4% had no previous history of stillbirth. Of those who had previous history of birth (193), 88.6 % had no previous history of LBW, and 90.2% had no previous history of pre-term birth. In addition, 86.1% of the respondents gave birth at or after 37 weeks of gestation. Slightly more than half of the respondents (51.8%) had ANC follow up of greater or equal to four times and 53% of them were primipara (Table 2).

Table 1. Socio-demographic characteristics of the study participants in Harar town, 2014 (n=411)

Variable	Frequency	Percent
Age		
20 and less	90	21.9
21-25	145	35.3
26-30	127	30.9
31-35	38	9.2
>35	11	2.7
Marital status		
Married	389	94.6
Single	18	4.4
Divorced and widowed	4	1
Educational status		
Illiterate	106	25.8
Primary and secondary	237	57.7
College and above	68	16.5
Occupation		
Housewife	216	52.6
Employed	108	26.3
Merchant	49	11.9
Farmer	23	5.6
Others**	15	3.6
Ethnicity		
Oromo	181	44.1
Amhara	128	31.1
Gurage	42	10.2
Harari	35	8.5
Others*	25	6.1
Religion		
Muslim	227	55.3
Christian	181	44.0
Wakefata ***	3	0.7
Residential area		
Urban	333	81.0
Rural	78	19.0
Monthly income		
≤$50	88	21.4
>$50	323	78.6

* Others – Tigre, Somali, Walayita, Argoba; ** daily laborer, students; *** Traditional religion

Table 2. Eating habits, physical activity and obstetric history of the study participants in Harar town, 2014 (n=411)

Variable	Frequency	Percent
Frequency of meals per day		
Less three times	343	83.5
Three and above	68	16.5
Fluid drunk per week		
Milk	237	57.6
Alcohol	6	1.5
Coffee	94	22.9
Others*	74	18.0
Frequency of eating veg. and fruit per week		
Consumes at least once	335	81.5
Does not consume	76	18.5
Frequency of eating meat per week		
Consumes at least once	325	79.1
Does not consume	86	20.9
Frequency of eating egg per week		
Consumes at least once	377	91.7
Does not consume at all	34	8.3
Physical activity per week		
At least once/week	143	34.8
Not at all	268	65.2
Abortion History		
Yes	63	15.3
No	348	84.7
LBW history **(193)**		
Yes	22	11.4
No	171	88.6
Still birth history		
Yes	15	3.6
No	396	96.4
Preterm history (193)		
Yes	19	9.8
No	174	90.2
Parity		
Primipara	218	53.0
Multipara	193	47.0
Gestational age		
<37 weeks	54	13.1
≥37weeks	357	86.9
Number of ANC visit		
< 4	198	48.2
≥ 4	213	51.8

* Others are soft drinks and tea

Early pregnancy BMI, GWG and Birth weight

Nearly three quarters of the respondents (296, 72%) had a normal BMI (18.5-24.9kg/m2) at the early pregnancy stage. The majority of the new-born babies (348, 87.3%) had a birth weight of ≥2.5 kg. However, 12.7% (95% CI: 9.7-16.1) of the new-borns were LBW (<2.5 kg). The overall mean birth weight was 3.16 (SD±0.52) kg, while it was 3.04 (±0.48kg) and 2.64 (±0.47kg) among the women who gained inadequate gestational weight and who were underweight in early pregnancy, respectively (Table 3).

Table 3. Mean birth weight in relation to early pregnancy BMI and gestational weight gain in Harar town, 2014 (n=411)

Variables	Frequency (%)	Mean birth weight	SD
GWG			
Below recommendation	285(69.3)	3.04kg	±0.48kg
Within recommendation	115(28)	3.40kg	±0.49kg
Above recommendation	11(2.7)	3.65kg	±0.56kg
Total	411(100)	3.16kg	±0.52kg
Early pregnancy BMI			
<18.5kg/m^2	39(9.5)	2.64 kg	±0.47kg
18.5-24.9 kg/m^2	296(72)	3.13kg	±0.44kg
25-29.9kg/m^2	60(14.6)	3.46kg	±0.54kg
≥30 kg/m^2	16(3.9)	3.73kg	±0.59kg

Almost all the LBW babies (96.2%, 50 of 52) were born to women who gained inadequate gestational weight. Only 3.8% (2 of 52) of the LBW babies were born to mothers who gained the recommended gestational weight. All the women who gained gestational weight above the recommendation gave birth to babies with the normal birth weight. Forty-six percent of the women who were underweight in early pregnancy gave birth to LBW babies, while only 5% of the overweight women gave birth to LBW babies (Fig 1)

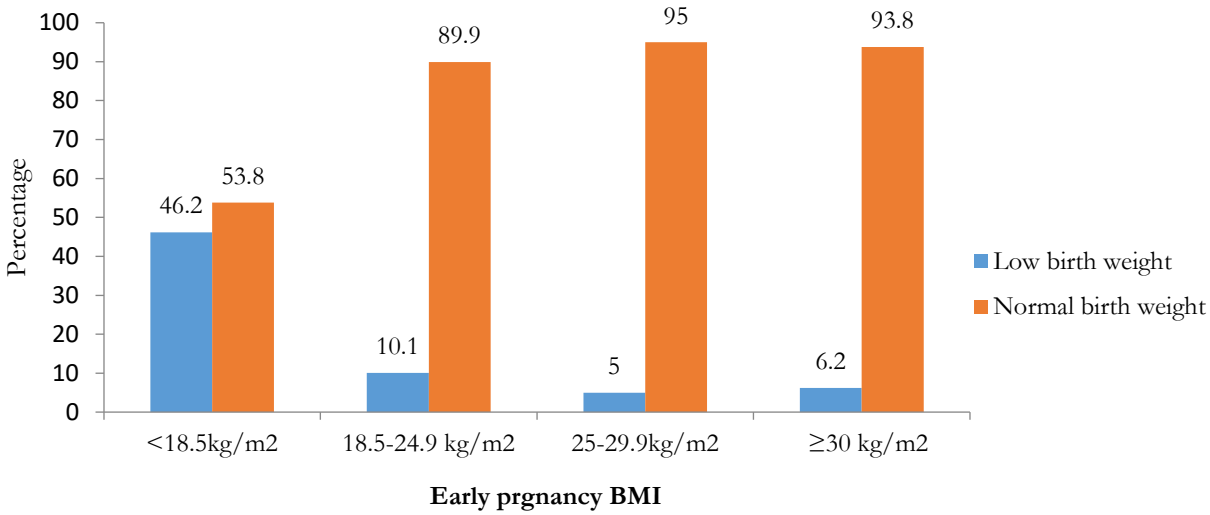

Figure 1. Early pregnancy BMI and low birth weight in Harar town, June 2014, Eastern Ethiopia (n= 411)

Factors associated with LBW

Low birth weight was more likely to occur in women with an early-pregnancy BMI of <18.5 kg/m2 [AOR=4.0; 95% CI: (1.44, 12.16)] than women with a normal BMI. The women who gained inadequate gestational weight [AOR=7.60; 95% CI :(3.35, 12.40)] were more likely to have a LBW baby than those who gained adequate gestational weight. In addition, LBW was significantly associated with the mother aged less than twenty years [AOR=4.40; 95% CI:(1.53, 12.80)] and aged thirty or above [AOR=3.90; 95% CI:(1.40, 10.90)], less than four ANC visits [AOR=3.70; 95% CI:(1.40, 9.50)], primiparity [AOR=3.40; 95% CI:(1.30, 9.90)], gestational age less than 37 weeks [AOR=8.90; 95% CI:(3.60, 22.00)] and monthly income less than $50 [AOR=5.40; 95% CI:(2.15, 13.70)] (Table 4).

Discussion

In this study, the proportion of LBW was 12.7%. Almost all the LBW babies were born to women who gained inadequate gestational weight and were underweight in early pregnancy. In addition, low monthly income (<$50), attending ANC visit for < 4 times, maternal age of less than 20 years or 30 years and older, gestational age <37 weeks and being primipara were the significant predictors of LBW.

The proportion of babies with LBW was lower than that was found by the studies conducted in different parts of Ethiopia. Studies conducted in Jimma zone revealed a prevalence of 22.5% (Tema, 2006) and 18.4% (Gebremariam, 2005), in East Hararghe 28.3% (Assefa *et al.,* 2012), and in Gondar 17.4% (Zenebe *et al.,* 2014). The overall estimates of LBW in Ethiopian, according to DHS results, is 21%, and of the study area (Harari Regional state) is 19.4% (CSA and ICF, 2012). One explanation is that the finding of the DHS was obtained by maternal subjective assessment of the size of the baby at birth while we measured birth weight objectively. In addition, our study subjects were only those who had ANC follow up, and these women may have different characteristics regarding the determinants of LBW; these might be underestimated the proportion of LBW in our study. However, our finding is similar with results from a study in Tanzania, which was 13.6% (Siza, 2008) and higher than those of a study in Lesotho (5.2%) (Mathule *et al.,* 2005). This variation may be due to the study area and participant's socio-economic differences.

Entering pregnancy underweight and experiencing inadequate weight gain during pregnancy are the factors associated with LBW. The odds of LBW were 4 times more likely in women who were underweight in early pregnancy than normal weight women. This was also observed in the study in Tanzania (Siza, 2008), where LBW was 2.6 times more likely in women who were underweight than women who were of normal weight. Several other studies also support this finding (Godhia *et al.,* 2012; Munim and Maheen, 2012; Association of State Public Health Nutritionists, 2013).

Table 4. Associated factors determining birth weight at health facilities in Harar town, 2014 (n=400)

Variable	Birth weight			
	<2.5 kg	≥ 2.5 kg	**COR(95% CI)**	**AOR(95% CI)**
Age(years)				
20-29	22(8.4)	239(91.6)	1.00	1.00
<20	16(34)	31(66)	5.6(2.66,11.80)***	4.4(1.53,12.80)**
>29	14(15.2)	78(84.8)	1.9(0.95,3.90)	3.9(1.4,10.90)**
Educational status				
Illiterate	12(12.5)	84(87.5)	1.8(0.60,5.30)	1.2(0.22,6.50)
Primary & secondary	35(14.8)	201(85.2)	2.1(0.82,5.80)	2.5(0.57,11.00)
College & above	5(7.4)	63(92.6)	1.00	1.0
Estimated monthly Income				
>$50	22(7.1)	290(92.9)	1.0	1.00
≤ $50	30(34.1)	58(65.9)	6.8(3.67,12.60)***	5.4(2.15,13.70)***
Frequency of meals/day				
≥3 times	3(4.8)	60(95.2)	1.00	1.00
<3times	49(14.5)	288(85.5)	3.4(1.10,11)*	1.9(0.40,8.90)
Fruit and veg. consumption/ week				
At least once	38(11.7)	288(88.3)	1.00	1.00
Not at all	14(18.9)	60(81.1)	1.7(0.90,3.40)	1.6(0.60,3.89)
Egg consumption/week				
At least once	42(11,4)	325(88.6)	1.00	1.00
Not at all	10(32.3)	23(69.7)	3.4(1.49,7.50)*	2.4(0.63,8.80)
Meat consumption/ week				
At least once	32(10.1)	284(89.9)	1.00	1.00
Not at all	20(23.8)	64(76.2)	2.7(1.50,5.00)**	1.9(0.65,5.70)
Early pregnancy				
BMI(kg/m2)				
Normal	30(10.2)	263(89.8)	1.00	1.00
Underweight	18(47.4)	20(52.6)	7.9(3.73,16.50)***	4(1.44,12.16)**
Overweight and obese	4(5.8)	65(94.2)	0.5(0.15,1.75)	2.6(0.50,14.00)
Gestational age				
≥37weeks	25(7.2)	321(92.8)	1.00	1.00
<37weeks	27(50)	27(50)	13(6.50,25.00)***	8.9(3.60,22.00)***
Parity				
Multipara	16(8.5)	172(91.5)	1	1.00
Primipara	36(17)	176(83)	2(1.2,4.00)*	3.4(1.30,9.90)*
ANC visit				
≥4	8(3.9)	197(96.1)	1.00	1.00
<4	44(22.6)	151(77.4)	7(3.3,16.00)***	3.7(1.40,9.50)**
Weight gain(kg)				
Within recommended	2(1.7)	113(98.3)	1.00	1.00
Below recommended	50(17.5)	235(82.5)	12(2.87,20.42)**	7.6(3.35,12.40)*

*p< 0.05, ** p <0.01***, p <0.001

Likewise, the pregnant women who experienced inadequate weight gain were 7.6 times more likely to give birth to LBW as compared with those who gained the recommended weight, as documented by other research (Munim and Maheen, 2012, Latifa *et al.,* 2013, Association of State Public Health Nutritionists, 2013). This is probably due to the fact that mothers with a history of poor nutrition before conception and underweight women tend to retain some of the weight gained in pregnancy for their own needs, and consequently, the growing baby may have reduced access to the nutrients needed for growth and development. In this regard, our study showed 89.7% of the underweight women gained gestational weight below the recommended level. In fact, the foetus is one of the components of weight change during pregnancy and as a result, low gestational weight gain may result in a low birth weight.

The women who had ANC follow up for less than 4 times were more likely to give birth to LBW babies as compared with the mothers with ANC follow up visits of 4 or more times. A study in Tanzania also reported that LBW among the mothers who did not have ANC follow up was 28%, while it was 13% among the mothers who had ANC follow up (Siza, 2008) and in

Ethiopia (Assefa *et al.,* 2012) in which the odds of LBW were 1.6 times more in the mothers with no ANC follow up. Similarly, an Indian study also reported that the mothers with a single ANC visit had six times more risk of giving birth to a LBW baby than those who had more than 4 ANC visits (Negi *et al.,* 2006). This might be the result of the women who attended ANC receiving advice on a balanced diet, the need for proper nutrition during pregnancy and weight management.

The results of the present study also revealed that birth weight is significantly influenced by gestational age. Babies who has been born before 37 weeks of gestational age were 9 times more likely to be LBW as compared to babies born at or after 37 weeks. This finding is in agreement with the one found in Jimma (Tema, 2006), in which LBW was 60% in the women who gave birth before 37 weeks and it was found to be 42% in a Tanzanian study (Siza, 2008). This might be because the baby was born before reaching the optimal time at which the highest maternal weight gain occurs, which affects birth weight or it could be due to the effect of intrauterine growth restriction.

Parity was positively associated with birth weight. The odds of LBW were 3.7 times more in primipara than in multipara. This is consistent with the finding of a study in India, in which primipara mothers had 3 times more risk of delivering LBW babies than multiparas (Negi *et al.,* 2006). A possible explanation for the lower birth weight among first-born babies could be that lower parity is associated with inadequate GWG (Hill *et al.,* 2016), which predicts LBW (Nyaruhucha *et al.,* 2006). Similarly, mothers who were less than 20 years of age or more than 29 years old were 4.4 and 3.9 times odds to give birth to LBW babies than mothers aged between 20-29 years were. This is also consistent with the findings from a Japanese study, in which the odds of LBW babies were 8 times more likely in the women who were less than 18 years of age (Louangpradith *et al.,* 2010) compared with the older mothers. Moreover, in our findings low birth weight babies were also common in older age mothers, which is in line with the study report from India (Negi *et al.,* 2006). This is probably because adolescent girls may have increased nutritional requirements to complete their own growth as well as the foetus. In older women, however, the reason might be due to other factors such as chronic disease.

Low family income was also a predictor of low birth weight; the odds of LBW among the women who had an estimated family income of <$50 a month was 13.9 times more to occur as compared to women who earned ≥$50 a month . Similar findings were also observed in different studies such as one in Ethiopia (Assefa *et al.,* 2012), in which LBW was two times more likely in women from poor family incomes, and in Japan (Louangpradith *et al.,* 2010), where LBW was 14 times odds in women with a low family income, than their counterparts. Low income could adversely affect food and nutrition security, thus increasing the risks for poor pregnancy outcomes.

This study has some limitations. As the weight gain recommendations were from developed countries, there are a number of contextual factors that limit its applicability in low-income setting. Early pregnancy BMI was taken before or at 16 weeks of gestation, at which time there might have been an increase or decrease in gestational weight. Gestational age estimation was done by asking the women's last menstrual period that could produce some measurement error. This study could be generalizable only for women who started ANC follow-up before 16 weeks of gestation and presented to health care facilities to give birth.

Conclusion

In this study, the proportion low birth weight was lower compared to the national magnitude. Almost all LBW babies were born to the women who gained inadequate gestational weight. The mean birth weight of the babies of the women who gained inadequate gestational weight and were underweight at early pregnancy was lower than the overall mean birth weight of the babies in the study population. Being underweight in early pregnancy and inadequate gestational weight gains significantly increased the likelihood of LBW. In addition, being primipara, age <20 and ≥30 years also increased the odds of LBW. It is recommended that the issue of appropriate weight management should be included in prenatal consultations. There is also the need to develop guidelines on gestational weight gain to optimize pregnancy and birth outcomes.

Conflict of Interest

The authors would like to declare that they have no competing interest.

Authors' Contributions

DN has conceived the study, overall design and execution, performed data collection and statistical analysis. FA has critically revised the design of the study, data collection techniques and helped the

statistical analysis and drafted the manuscript. FM and MD have critically revised the design of the study, data collection techniques and helped the statistical analysis.

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