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Determinants of Low Birth Weight Among Newborns Delivered at Public Hospitals in Bale Zone, Southeastern Ethiopia: Unmatched Case-Control

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Abstract: *Background:* A birth weight of less than 2500 grams is known as low birth weight. Globally more than 20 million newborns are born with low birth weight each year, over 96.5% of these occur in low-income nations, which causes for newborn morbidity and mortality. Therefore, this study aimed to identify determinants of low birth weight among newborns delivered at public hospitals of Bale zone, southeastern, Ethiopia, 2022. *Methods:* A hospital-based unmatched case-control study design was conducted among total of 342 mothers of the newborns (114 cases and 228 controls) from July to October, 2022 at public hospitals of Bale zone. Mothers who gave live birth to newborns weighing less than 2500g were included in the study as cases, and birth weight between 2500g and 4000g were considered as controls. Consecutive and systematic random sampling was used to select cases and controls, respectively. Collected data was entered by Epidata software version 4.6.1, and analyzed by Statistical Package for Social Sciences version 26. Variable having P-value < 0.25 in bi-variable logistic regression was entered into a multi-variable logistic regression. Finally, significance was declared at p-value < 0.05. *Result:* From a total of 354 sampled populations, 342 newborns (114 cases and 228 controls) were included, which made the study respondents rate 96.6% for both cases and controls. Birth interval ≤ 2 years AOR =2.6, 95% CI: (1.32–4.98), Continuous consuming of coffee-milk/tea-milk immediately after meals AOR=3.8, 95% CI: (1.51-9.69), being rural dweller mother AOR=5.0, 95% CI: (2.54-9.86), having separated kitchen AOR=0.3, 95% CI: (0.13-0.59), and MUAC <23cm AOR=2.4, 95% CI: (1.18-4.85), were identified determinants of low birth weight. *Conclusion:* Birth interval < 2 years, Continuous consuming of coffee-milk/tea-milk immediately after meals, rural residence, having separated kitchen, and MUAC <23cm were determinants of low birth weight. Therefore, intervention should focus on screening and treatment of mothers with malnutrition, promotion of family planning, improving meal pattern, and promotion of separated kitchen.

Keywords: Bale Zone, Determinants, Ethiopia, Low Birth Weight, Newborn, Public Hospitals

1. Introduction

World Health Organization (WHO) defines low birth weight (LBW) as a birth weight of less than 2500 g (up to and including 2499 g) [1]. An infant's birth weight is the first weight measured after birth, ideally within the first few hours after birth, before significant postnatal weight loss has occurred. The weight of a newborn at birth is an important measure of mother nutrition and fetal health [2]. Globally, more than 20 million newborns are born with LBW each year [3]; Over 96.5% of these occur in low-income nations. LBW affects approximately 5.7 million African newborns [2], and Ethiopia accounts for 13% of this total [4]. According to Ethiopian Demographic and Health Surveys (2016), 11–13% of all newborns in Ethiopia are born to LBW [4].

Low birth weight could be caused by preterm labor osr intrauterine growth restriction [2, 5]. Also, long-term maternal malnutrition, young mother age at pregnancy, family income level, infections, pregnancy related problems, family educational level and occupational status, insufficient prenatal care during pregnancy, behavioral determinants related to smoking and chewing, and physically demanding job during pregnancy are all common causes of LBW newborns mainly among low-income countries mothers [2, 6–9].

LBW is a well-known cause of newborn morbidity and mortality, with long-term effects such as nutritional and developmental deficits [10, 11]. It can predict a child's health throughout his or her life and can lead to a variety of chronic conditions later in life, including ischemic heart disease, stroke, hypertension, diabetes, metabolic syndrome, cancer, dementia, osteoarthritis, and poor cognitive development [11–14]. Furthermore, it may result in poor academic performance and behavior [15].

In comparison to a baseline set in 2006–2010, there is a policy target to reduce the number of LBW live births by 30% globally at the end of 2025 [16]. Similarly, Ethiopia has been implementing globally recommended strategies to reduce LBW of newborns. Despite efforts to lower the prevalence of LBW around the world, it remains a global public health issue, particularly in Sub-Saharan Africa [3]. In Ethiopia, LBW has huge public health issue as its causes are not fully recognized. As a result, this study aimed to identify the determinants of low birth weight among newborns delivered at public hospitals of Bale zone, which used to develop urgent and long-term intervention for consequence of low birth weight in study area.

2. Method and Materials

2.1. Study Design, Period, and Setting

We have conducted a hospital based unmatched case-control study at all five public hospitals (Goba, Robe, Dello Mena, Goro and Madda Walabu) in the Bale zone, from July to October, 2022. Robe is capital town of Bale zone, which is located 430 km southeast of Addis Ababa, the capital city of Ethiopia. The zone had 12 districts and two town administrations. Bale zone has a total population of 1,302,023 peoples (49 % females and 51 % males), 141,187 female reproductive age group (15-49 Years), with 45,180 pregnant mothers, and 3,765 estimated of deliveries/month according to the Bale zone health office report of December, 2021 [17]. Currently, the zonal population has been served by three general hospitals, one district hospital, and one referral hospital, 63 health centers, 252 health posts, and 107 private and 9 NGO clinics.

2.2. Source Population and Study Population

All newborns/mothers pair who delivered at public hospitals of Bale zone were used as source populations. Selected newborns/mothers pairs who delivered at five public hospitals of Bale zone, and which the data actually collected from, were used as study populations. Cases were those live singleton term newborns with birth weight less than 2500 grams, and Controls were live singleton term newborn with birth weight between 2500grams and 4000grams. Those mothers who were very unwell or had communication challenges, and who had a congenital abnormality, were excluded from the study because it is known risk determinants for low birth weight. A mother with recognized medical conditions such as diabetes and hypertension were excluded from the study, because they are known risk determinants for birth overweight.

2.3. Sample Size Determination

The sample size was calculated using Epi info version 7.2.0.1, and the double population proportion formula was used, by taking into account the proportion of rural mothers among controls (24.8%) and the odds ratio of 2.1 [9], as well as the confidence level of 95%, power of 80%, and case to control ratio of 1:2. The overall sample size was 354 participants after considering for 10% non-response rate (118 cases and 236 controls). Cases were selected by consecutive sampling, and controls were sampled by systematic random every five interval from the mothers of newborns.

2.4. Sampling Technique

This study was conducted in all (five) of the Bale zone's hospitals. The number of newborn/mother pairs surveyed from each hospital was proportionally allocated based on the expected number of deliveries in the study period.

It was estimated using the number of deliveries in the last year similar two months in each institution, which was taken from each hospital's delivery registration books. As a result, each hospital's sample was computed by multiplying the average number of newborns delivered per two months in each hospital by a total sample size (354), then dividing by the total number of newborns delivered per two months at all hospitals (1304) (Figure 1). From 1304 deliveries per two months (for five hospitals), 129 were cases and 1175 were controls. Then, cases were selected by consecutive sampling, and controls were obtained by systematic random sampling by taking newborn/mother pairs every five interval (1175/236 = 5), and the first participant for control was selected by lottery method, that third participant was first control in each hospital from which the cases were drawn.

The weights of all live term singleton newborns during the study period were measured. Based on the case definition, those live term newborns birth weight less than 2500 g were included in the study as cases, and newborns birth weight between 2500 g to 4000g were considered as controls.

2.5. Operational Definitions

Low birth weight is a weight of less than 2,500 g (up to and including 2,499 g) irrespective of the gestational age [1]. Cases were those live singleton term newborns with birth weight less than 2500 grams. Controls were live singleton term newborns with birth weight between 2500grams and 4000grams. Anemia in pregnancy was defined by hemoglobin (Hb) level <11g/dl adjusted at sea level altitude based on WHO criteria [18].

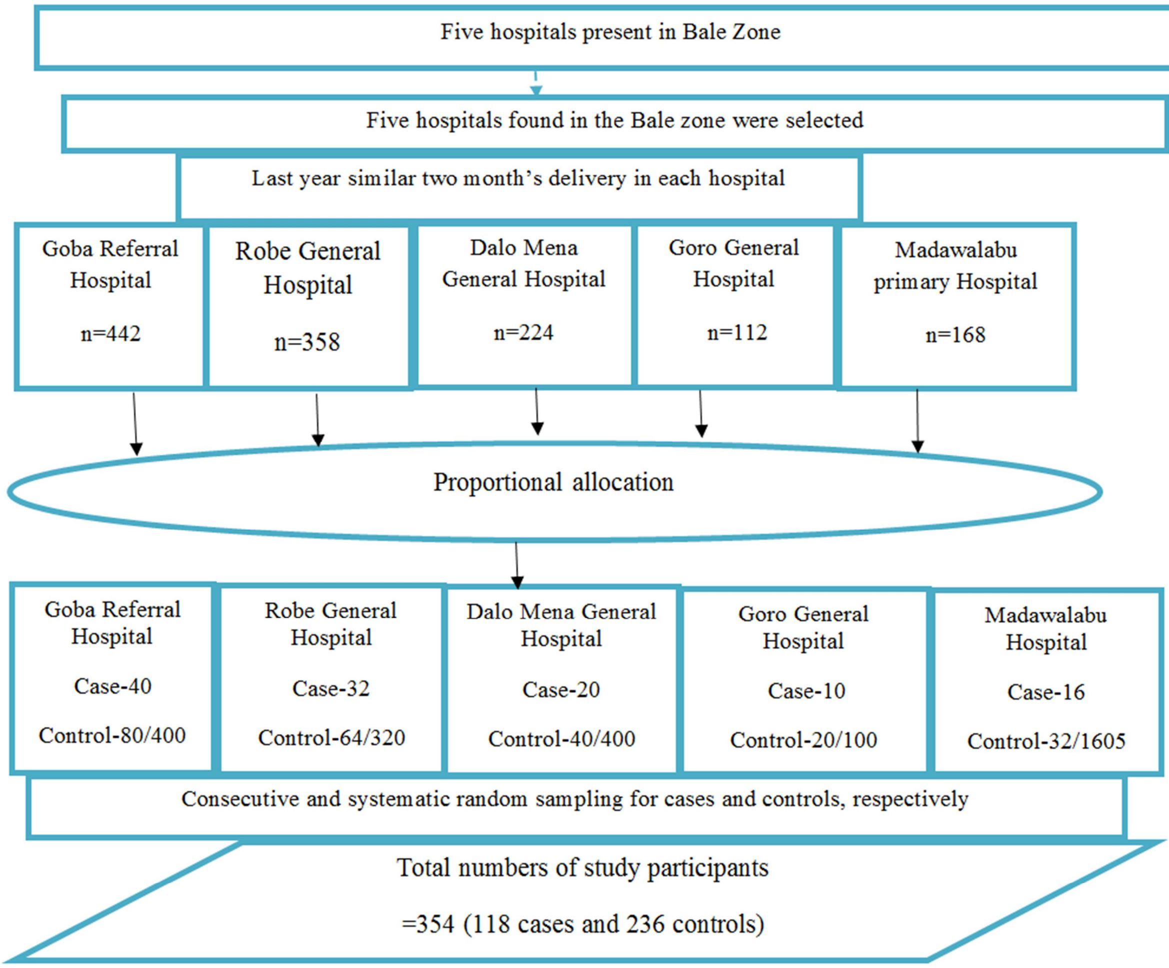

Figure 1. *Schematic representation of sampling procedure for newborn delivery at public hospitals of Bale zone from July to October, 2022.*

2.6. Data Collection Tool and Procedure

The data was collected by interviewing the mothers, observing medical records and measuring the anthropometric of the mothers and the newborns using semi-structured and pretested questionnaires. The interview and anthropometric measurements were conducted by 8 trained midwives working in delivery rooms of five public hospitals and with 5 supervisors. Height measurement of mother was undertaken with a measuring tape.

The respondents were asked to remove footwear, hair accessories that could make bias in measurement. A ruler was placed on top of their heads, and the reading was taken from the top of the ruler at eye level. Height was then read and recorded to the nearest 0.1 cm. To reduce intra-individual error, height was measured twice and the mean value was used for analysis. Data for birth weight was recorded using the metric scale (in grams) and measured within 1–2 hours after delivery. MUAC of mothers was measured by MUAC tape and rounded to the nearest 0.1cm. The serum hemoglobin level of mothers was extracted from their medical records since the hemoglobin level test is routinely done for all mothers who come for delivery services. During data collection, birth weight was confirmed by weighing the baby using the metric scale (in grams). Documented evidence on the child health card or verbally from the mother was only be used if the baby is ill. The questionnaire was adapted from a demographic health survey [19], and different study conducted in Ethiopia [9, 13, 20].

2.7. Data Quality Control and Management

The questionnaire was first prepared in English and translated to local language (Afaan Oromo), and back to English to check for language consistency by an independent translator.

The data collection instrument was pre-tested on 5% of the sample size, with 18 subjects (6 cases and 12 controls) at Gindhir general hospital in East Bale zone, before actual data collection was made. The pre-test was used to check for language clarity, appropriateness of data collection tools, time estimation and for the necessary adjustment. The weighing balanced scale was checked and adjusted to zero before weighing the next newborn.

Training concerning data collection tool and data collection process was given for both data collectors and supervisors. During data collection, supervision was conducted by supervisors and principal investigators for the quality of data. Finally, all the collected data was also checked by the supervisors and investigators for its completeness and accuracy. Consistency was examined through a random selection of questionnaires.

2.8. Data Processing and Analysis

Before analysis, data was coded and cleaned. Identified errors during this time were adjusted after a review of the original data using the code numbers. Data was entered using Epi-data version 4.2.1 and analyzed using SPSS 26 statistical software. Socio-demographic profiles of variables frequency distribution, summary measures such as mean and standard deviation was calculated for cases and controls. When frequencies become smaller than expected, variables were re-categorized or merge of the levels was done.

Determinants associated with LBW were identified using bi-variable and multivariable logistic regression models. Independent determinants that showed near to statistically significant association (p-value less than 0.25) in the bivariable logistic regression were considered as candidate variables for the multivariable logistic regression.

Before final multivariable analysis, the level of Multicollinearity was checked using standard error. In final multivariable analysis, goodness of fit was checked by Hosmer Lemeshow, and fitted for the data with the P-value 0.624. In a multivariable regression, P-value < 0.05 was considered statistically significant and finally, result was presented in the form of tables and graphs.

3. Result

3.1. Sociodemographic-Related Characteristics of Study Participants

In this study, from a total of 354 sampled populations, 342 newborns (114 cases and 228 controls) were included which made the study respondents rate 96.6% for both cases and controls. About 32 (28.1%) of the cases and 175 (76.8%) of the controls were males. The mean birth weight of the newborn was 2898 ± 584 g (gram) with the minimum and maximum birth weight of new-born 1600 g and 3900 g, respectively. The gestational age of the new-born was ranged from 37 to 40 weeks with a mean of 37.76 weeks. The mean height of the respondent was 158.99cm (Table 1).

3.2. Mothers Obstetric Related Determinants

About 83 (72.8%) mothers of cases and 29 (12.7%) mothers of controls had a history of low birth weight, and also 9 (7.9%) mothers of cases and 12 (5.3%) controls had a history of stillbirth. With regard to their pregnancy intention, 94 (82.5%) mothers of cases and 55 (24.1%) mothers of controls had unintended pregnancy. About 49 (43%) of the case group mothers had nutritional counseling during pregnancy, whereas from the controls group mothers, 134 (58.8%) of them had nutritional counseling during pregnancy (Table 2).

3.3. Environmental Sanitation and Hygiene Related Determinants

With regard to latrine, only 15 (13.2%) of cases and 210 (92%) of controls mother have their own latrine in their village. And also, among latrine owner, 4 (26.7%) of case and 148 (70.5%) of control were continuously using latrine. Two (1.8%) of cases and 39 (17.1%) of control had separated hand washing facility, also 60 (52.6%) of cases and 195 (85.5%) of control had separated kitchen for cooking (Table 3).

3.4. Determinants Associated with Low Birth Weight

Bivariate logistic regression was done for each independent variable. Multi-variate analysis was done for those variables with a p value < 0.25 in the bivariate logistic regression after adjusting of covariate. Fitness of the model was also assessed. The result of multiple logistic regressions showed that the odds of being rural reside mothers was 5 times higher among cases (low birth weight newborns) than among controls (normal birth weight newborns) as compared to being urban reside mothers (AOR = 5.0, 95% CI: (2.54.9.86)) (Table 4).

The birth interval less than or equal to 2 years between pregnancy was 3 times more among mothers of cases than among controls when compared with birth interval greater than two years (AOR = 2.6, 95% CI: (1.32-4.98)) (Table 4). The odds of taking coffee-milk/tea-milk immediately after meals within 30 minutes was 4 times higher among mothers of the cases than among mothers of the controls when compared with not taking coffee-milk/tea-milk immediately after meals within 30 minutes (AOR = 3.8, 95% CI: (1.51-9.69)) (Table 4). The probability of having MUAC of < 23 cm was 2 times higher among mothers of the cases than among mothers of the controls as compared to having MUAC ≥ 23 cm (AOR = 2.4, 95% CI: (1.18- 4.85)) (Table 4). The odds of having separated kitchen were 70% times less likely among cases than among controls as compared to those haven't separated kitchen for cooking (AOR = 0.3, 95% CI: (0.13,0.59)) (Table 4).

Table 1. *Shows frequency distribution of Socio-demographic characteristics among cases and controls groups in public hospitals of Bale zone, from July to October, 2022. (N=342).*

Variable	Categories	Cases, n=114 Frequency (%)	Controls, n=228 Frequency (%)
Age of mother	<20	32 (28.1%)	4 (1.8%)
	20-34	78 (68.4%)	181 (79.4%)
	≥35	4 (3.5%)	43 (18.8%)

Variable	Categories	Cases, n=114 Frequency (%)	Controls, n=228 Frequency (%)
Head of household	Father	73 (64.0%)	224 (98.2%)
	Mother	41 (36.0%)	4 (1.8%)
Residence	Rural	73 (64%)	43 (18.9%)
	Urban	41 (36%)	185 (81.1%)
Family size in number	≤5	84 (73.7%)	79 (34.6%)
	>5	30 (27.3%)	149 (66.4%)
Sex of newborn	Male	32 (28.1%)	175 (76.8%)
	Female	82 (71.9%)	53 (23.2%)
Deciding on resource mobilization	Father	73 (64.0%)	10 (4.4%)
	Mother	28 (24.6%)	4 (1.7%)
	Both	13 (11.4%)	214 (93.9%)

Table 2. *Shows frequency distribution of mothers' obstetrics related characteristics among cases and controls groups in public hospitals of Bale zone, from July to October, 2022. (N=342).*

Variable	Category	Cases, n=114 Frequency (%)	Controls, n=228 Frequency (%)
History of LBW	Yes	82 (71.9%)	36 (15.8%)
	No	32 (28.1%)	192 (84.2%)
History of still birth	Yes	9 (7.9%)	12 (5.3%)
	No	105 (92.1%)	216 (94.7%)
History of abortion	Yes	14 (12.3%)	14 (6.1%)
	No	100 (87.7%)	214 (93.9%)
Birth interval	≤2 yrs	62 (54.4%)	66 (28.9%)
	>2 yrs	52 (45.6%)	162 (71.1%)
Anemia	Yes	38 (33.4%)	6 (2.6%)
	No	76 (67.6%)	222 (87.4%)
MUAC	<23cm	92 (80.7%)	123 (53.9%)
	≥23cm	22 (19.3%)	105 (46.1%)
ANC on recent pregnancy	Yes	55 (48.2%)	209 (91.7%)
	No	59 (51.8%)	19 (8.3%)
Dietary counseling	Yes	49 (43.0%)	133 (58.3%)
	No	65 (57.0%)	95 (41.7%)
Taking tea/ coffee-milk after meals	Yes	103 (90.4%)	157 (68.9%)
	No	11 (9.6%)	71 (31.1%)

Abbreviation: MUAC, mid-upper arm circumstance; Cm, centimeter; yrs, years.

Table 3. *Shows frequency distribution of environmental sanitation and hygiene related characteristics among cases and controls groups in public hospitals of Bale zone, from July to October, 2022. (N-342).*

Variable	Categories	Cases, n=114 Frequency (%)	Controls, n=228 Frequency (%)
Latrine availability	Yes	15 (13.2%)	209 (91.7%)
	No	99 (86.8%)	19 (8.3%)
Continuous utilization of latrine	Yes	4 (26.7%)	148 (70.8%)
	No	11 (73.3%)	62 (29.2%)
Use water treatment method	Yes	29 (25.4%)	112 (49.1%)
	No	85 (74.6%)	116 (50.9%)
Separated hand washing facility	Yes	4 (3.5%)	43 (18.9%)
	No	110 (96.5%)	185 (81.1%)
Separated kitchen	Yes	60 (52.6%)	195 (85.5%)
	No	54 (47.4%)	33 (14.5%)

4. Discussion

It's critical to recognize the determinants that lead to low-birth-weight outcomes, in order to make changes in the prevention of low birth weight for newborns. This study showed that, the odds of low birth weight was higher among mothers of rural dwellers, when compared to urban dwellers mothers. This finding was in line with study done in Ethiopia [9, 21]. This could be due to poor availability of healthcare facilities and maternal health services utilization in rural dwelling that put mothers to have low birth weight newborns. However, this finding does not line up with study done in another region of Ethiopia [21]. This discrepancy may be due to difference in sociocultural primarily related to food taboos, and other geographical determinants primarily related to this study area that covers mostly safety net program served postural community, conjoined with food insecurity resulted from climate change a year before study period.

Table 4. *Shows bi-variables and multi-variable logistics regression analysis of low birth weight among newborns delivered at public hospitals of Bale zone, from July to October, 2022. (N=342).*

Variables with category		Cases, n=114	Controls, n=228	COR (95% CI)	AOR (95% CI)
Residence	Rural	73 (64%)	43 (18.9%)	7.7 (4.62,12.71)	5.0 (2.54,9.86) **
	Urban	41 (36%)	185 (81.1%)	1	1
History of LBW	Yes	82 (71.9%)	36 (15.8%)	13.7 (7.95,23.50)	0.9 (0.21,4.26)
	No	32 (28.1%)	192 (84.2%)	1	1
History of abortion	Yes	14 (12.3%)	14 (6.1%)	2.1 (0.98,4.66)	1.7 (0.56,5.28)
	No	100 (87.7%)	214 (93.9%)	1	1
Birth interval	≤2 years	62 (54.4%)	66 (28.9%)	2.9 (1.84,4.67)	2.6 (1.32,4.98) *
	> 2 years	52 (45.6%)	162 (69.1%)	1	1
MUAC	<23cm	92 (80.7%)	123 (45.2%)	3.6 (2.10,6.08)	2.4 (1.18,4.85) *
	≥23cm	22 (19.3%)	105 (54.8%)	1	1
Recent pregnancy ANC	Yes	55 (48.2%)	209 (91.7%)	1	1
Follow up	No	59 (51.8%)	19 (8.3%)	11.8 (6.50,21.42)	1.3 (0.65,3.76)
Dietary counseling	Yes	49 (43.0%)	133 (58.3%)	1	1
	No	65 (57.0%)	95 (41.7%)	1.9 (1.18-2.93)	1.7 (0.86,3.24)
Continuous consuming of coffee-	Yes	103 (90.4%)	157 (68.9%)	4.2 (2.14,8.38)	3.8 (1.51,9.69) *
milk/tea-milk immediately after meals	No	11 (9.6%)	71 (31.1%)	1	1
Separated Kitchen	Yes	60 (52.6%)	195 (85.5%)	0.2 (0.11,0.32)	0.3 (0.13,0.59) **
	No	54 (47.4%)	33 (14.5%)	1	1

AOR=Adjusted odds ratio, COR=Crude odds ratio, CI=Confidence interval; MUAC, mid upper arm circumstance; cm, centimeter; LBW, low birth weight; *=statistically significant at p-value < 0.05; **=statistic ally significant at p-value < 0.001, and 1=reference group

The finding of this study also revealed that, the odds of giving birth to low-birth-weight newborn was higher among mothers of MUAC < 23 cm, when compared to mothers of MUAC ≥ 23cm. This result was in line with research done in other part of Ethiopia [23–25]. This could be because of inter-generational continuum of starvation; if a mother was malnourished throughout pregnancy, the likelihood of delivering a newborn with low birth weight is significant.

The result of this study also showed that, low birth weight of newborns was positively associated with a birth interval between consecutive pregnancies. Risk of low birth weight was higher among mothers who had birth interval less than or equal to two years than mothers who had greater than two years. This finding is consistent with research done in Ethiopia [13], and in Nepal, Iran, and Qatar [13, 25, 26] where mother of birth interval less than or equal to 2 years had more risk to deliver low birth weight newborns. This could be as a result of iron depletion brought on by repeated pregnancies and blood loss during pregnancy, delivery, and the postpartum period. Mothers who become pregnant soon after giving birth are vulnerable to anemia, which could ultimately lead to low birth weight for the newborns.

This study results again revealed that, drinking tea-milk or coffee-milk instantly after meals was associated with newborns having a low birth weight. In comparison to mothers who did not drink tea-milk or coffee-milk immediately after meals during their current pregnancy, mothers who did so had higher risk of having newborns with low birth weight. This finding is agreement with study from Norway and Ethiopia that found a positive association between tea/coffee consumption and low birth weight [28, 29]. This may be because drinking tea-milk or coffee-milk instantly after eating meals can interfere with iron absorption [28, 30], which causes the pregnant mother to consume insufficient amounts of iron-rich foods, which ultimately leads to low birth weight for the newborns [32].

In consistent with study conducted in Ethiopia [13, 32], and in other areas [33–35], this study revealed that, the risk of low birth weight was higher among mothers who had no separated kitchen for cooking when compared to mothers having separated kitchen for cooking. This could be due to indoor air pollution conjoined with different smoky type of fuels from same living room leads to respiratory tract infections, long-lasting bronchitis and chronic obstructive lung diseases, as incomplete burning of biomass can have carbon monoxide that combines with hemoglobin to form carboxyhaemoglobin made reduced conveyance of oxygen with suffocation to developing fetus tissues, and finally could leads to low birth weight of newborns [36, 37]. However, a Malawian study based on DHS data found no association between living room biomass fuel exposure and low birth weight [38]. This discrepancy may be a result of the length of exposure, state of ventilation of the room, and types of fuels used for cooking like electricity could make the differences.

5. Limitation of the Study

This study could be affected by recall bias because it was retrospective and could be susceptible to social desirability bias.

6. Conclusion

Rural residency, maternal malnutrition as determined by MUAC less than 23cm, continuously drinking coffee-milk/tea-milk instantly within 30 minutes after meals, haven't separated kitchen for cooking, and birth interval of less than or equal to two years between pregnancies were all found to be independent and significant determinants of low birth weight in this study.

Ethics approval and consent to participate: Ethical clearance was obtained from ethical review committee (ERC) of Salale University College of health Sciences and a supportive letter was obtained from Bale zonal health department and administration body. Finally official letter was submitted to each respective hospital. After explaining the objectives of the study, informed written consent was obtained from mothers, and for the mothers' age 15-18 years the ethical issue was addressed with informed written assent by asking for permission to interview from the parents/guardians of participants.

During anthropometric measurement the privacy of the participants was kept. The confidentially of information was guaranteed by using codes instead of names. Furthermore, interview of respondents was conducted in places with no interference from other people. Respondents have the right not to participate or withdraw from the study at any time during interview.

Abbreviations

ANC: Antenatal care
LBW: Low Birth weight
MUAC: Mid upper arm circumstances
SPSS: Statistical Package for Social Sciences
WHO: World Health Organization.

Availability of Data and Materials

The data used to support the findings of this study will be made available from the corresponding author upon a reasonable request.

Authors' Contributions

TDW, KG, and AL were involved in idea creation, proposal development, supervising data collection, data analysis, and interpreting results. MM, AS and AHG were involved in editing, supervision, and guiding during the whole research proposal development and research result writing, while TDW and AHG contributed to the manuscript preparation. All the authors read and approved the manuscript.

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Conflicts of Interest

There are no conflicts of interest regarding publication of this paper.

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