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Burden and Predictors of Fetal Growth Restriction in a Tertiary Hospital in Hawassa, Southern Ethiopia: A Cross-Sectional Study

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Abstract

Background:

Fetal growth restriction (FGR) has an adverse impact on fetal, neonatal, and adult life and is a significant cause for perinatal morbidity and mortality, particularly in low- and middle-income countries. Evidence from tertiary care settings in Ethiopia using standardized diagnostic criteria remains limited. This study aimed to assess the burden of FGR at birth and its associated factors.

Methods:

An institution-based cross-sectional study was conducted from April to September 2024 among 358 women who gave birth at Hawassa University Comprehensive Specialized Hospital. A systematic sampling technique was applied to select the required samples. Data was collected through interviews and medical record reviews. Binary and multivariable logistic regression analyses were used to identify factors independently associated with fetal growth restriction.

Results:

The magnitude of fetal growth restriction was 22.6% (95% CI: 15.5–29.7). After controlling for potential confounding variables women who were unable to read and write (AOR = 8.06; 95% CI: 2.01–32.31), pre-pregnancy BMI < 18.5 kg/m² (AOR = 7.63; 95% CI: 2.30–25.29), hypertensive disorders of pregnancy (AOR = 3.27; 95% CI: 1.13–9.50), and preterm delivery (AOR = 2.85; 95% CI: 1.31–6.20) predicted fetal growth restriction.

Conclusion:

Low maternal educational status, pre-pregnancy BMI < 18.5 kg/m², hypertensive disorders of pregnancy, and preterm delivery were independently associated with fetal growth restriction. These findings highlight the need for targeted antenatal interventions focusing on maternal nutrition and hypertension management.

Introduction

Fetal growth restriction (FGR) remains a major public health and clinical challenge worldwide, particularly in low- and middle-income countries(1). FGR is defined as the failure of a fetus to achieve its full genetically determined growth potential due to pathologic etiologies, primarily placental dysfunction(2). Currently, the International Federation of Gynecology and Obstetrics (FIGO 2021) and the Society for Maternal-Fetal Medicine (SMFM 2023) define fetal growth restriction (FGR) as either an estimated fetal weight (EFW) <10th percentile for gestational age or an abdominal circumference (AC)

<10th percentile for gestational age, along with one or more abnormal Doppler findings in the umbilical, uterine, and middle cerebral arteries (2, 3). Globally, FGR contributes significantly to perinatal morbidity and mortality, including stillbirth, neonatal death, and long-term adverse health outcomes such as neurodevelopmental complications, metabolic syndrome, and cardiovascular disease later in life(4).

The burden of FGR is disproportionately high in sub-Saharan Africa and South Asia due to maternal malnutrition, limited access to quality antenatal care, and a high prevalence of pregnancy-related complications(5). FGR affects an estimated 23.8% of newborns globally, corresponding to approximately 30 million births each year, with nearly 75% occurring in low- and middle-income countries(1). Evidence from studies conducted in Ethiopia, Malawi, Romania, and Serbia, as well as the 2021 FIGO report, indicates that FGR is associated with multiple maternal, placental, and healthcare-related factors. These include maternal smoking, malaria infection during pregnancy, short maternal stature, maternal anemia, reduced placental size, inadequate antenatal care (ANC) utilization, low maternal educational attainment, hypertension in the current pregnancy, and low maternal body mass index (BMI < 18.5 kg/m²) (2, 6–9).

In Ethiopia, perinatal mortality was estimated to be nearly 33 in 1000 live births according to the Ethiopian Demographic and Health Survey in 2016 report(10). In developing countries, FGR is a leading cause of perinatal mortality, only second to prematurity(6). Despite the limited number of studies conducted in Ethiopia, a study from the Gondar Zone reported an FGR prevalence of 23.5%(6). In contrast, a community- and facility-based study carried out in Hawassa town in 2017, which examined the prevalence of adverse birth outcomes among women delivering in public health institutions, documented a markedly lower prevalence of FGR (0.5%)(11). The low estimate likely reflects reliance on birth weight alone and composite outcomes, leading to underestimation of FGR in general health facilities. Therefore, updated hospital-based evidence using standardized criteria is needed to characterize FGR in tertiary care settings.

Therefore, this study aimed to estimate the prevalence of FGR by applying the FIGO 2021 diagnostic criteria and the WHO growth curves and to examine associated factors at the Hawassa University Comprehensive Specialized Hospital (HUCSH). The findings will aid in advancing evidence-based clinical practice and contribute to the development of targeted interventions to reduce the burden of FGR in similar resource-limited settings.

Methods

Study design and participants

An institution-based cross-sectional study was carried out from April 01 to September 30, 2024, in Hawassa University Comprehensive Specialized Hospital, Hawassa town, Sidama National Regional State, Southern Ethiopia. The study was conducted in the department of obstetrics and gynecology. The study was conducted among pregnant women who visited the hospital for delivery and recruited

voluntary and consenting participants using a systematic sampling technique during the study period. The study excluded mothers with Intrauterine Fetal Death (IUFD), lethal congenital anomalies, and multifetal gestation. Ethical clearance was obtained from the Institutional Review Board of Hawassa University College of Medicine and Health Sciences, with reference number IRB/341/15. A formal approval letter was obtained from the college's ethical review committee. Informed consent was obtained from each participant.

Sample size determination and sampling technique

The sample size was determined using two approaches. First, the single population proportion formula was used to estimate the prevalence of FGR. The proportion of FGR was drawn from a previous study conducted in Gondar, Ethiopia, which reported a FGR prevalence of 23.5% (6). Second, the sample size needed to identify factors associated with FGR was calculated using Epi Info version 7 by considering BMI < 18.5 as a key exposure variable using an estimated AOR = 2.13 (95% CI:1.72–3.83), with 80% power and 5% significance level, which yielded 358 participants(6). This sample size was chosen to conduct this study. In addition, a sampling interval of (K) value of 5 was computed as the total number of deliveries at HUCSH during the study period (Average delivery (300) times 6 months) divided by the sample size.

Variables and measurement

After reviewing relevant literature, a structured interviewer-administered questionnaire and a medical record review checklist were developed to collect data. The questionnaire assessed socio-demographic characteristics, maternal history, and obstetric factors, while clinical and fetal data, including gestational age, ultrasound findings, doppler measurements, and pregnancy-related diagnoses, were extracted from medical records. Data collection was performed by using a smartphone through kobo-tool box, and interviews were conducted after delivery. FGR was diagnosed based on documented ultrasound findings by senior residents or a consultant gynecologist, using an estimated fetal weight (EFW) or abdominal circumference (AC) below the 10th percentile for gestational age, along with abnormal umbilical artery doppler findings, as recorded in the patient's chart. Four data collectors were trained for two days, and close supervision was maintained during data collection. All checklists were double-checked for consistency and completeness.

In this study, FGR was the dependent variable, and exploratory analysis was conducted to determine factors associated with FGR. Independent variables were categorized into three primary groups according to prior research: sociodemographic factors, maternal characteristics, and obstetric factors(6).

Operational definitions

Fetal growth restriction (FGR): in a single gestation with an early milestone (early ultrasound done before 24 weeks or reliable last normal menstrual period), FGR is defined as an EFW or an AC of < 10th percentile for the given gestational age according to the WHO weight-to-gestational age distribution table, and one or more abnormal umbilical artery doppler waveforms. For women who have unknown gestational age, clinical estimation of gestational age is determined by femur length/abdominal circumference (FL/AC) ≥ 23.5% with a combination of one or more of the abnormal umbilical artery doppler waveform (2, 12, 13).

Abnormal umbilical artery doppler waveform: one of the following abnormal doppler ultrasound findings, Raised Pulsatility Index (PI) above 95th centile, Absent End-Diastolic velocity (AEDV), and Reversed End-Diastolic velocity (REDV) (13).

Gestational age (GA): is the age of the current pregnancy, described in weeks, and it is calculated from the last normal menstrual period (LNMP) or from an early ultrasound, which is done before 24 weeks of pregnancy(12).

Prematurity: delivery after 28 weeks but before 37 weeks of gestational age(14).

Term pregnancy: delivery within gestational age 37 to 42 completed weeks(15).

Maternal Body Mass Index (BMI): calculated by using the formula weight in kg/height in m^2(16).

Data analysis

Data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS), version 26. The normality of continuous variables was assessed using appropriate statistical tests. Descriptive statistics were employed to summarize participants' socio-demographic characteristics, maternal factors, and obstetric history. Binary logistic regression analyses were performed to identify candidate variables associated with the outcome of interest. Variables with a p-value ≤ 0.25 in the binary logistic regression were subsequently included in a multivariable logistic regression model to control for potential confounding. The strength of associations was reported using odds ratios (ORs) with corresponding 95% confidence intervals (CIs). Statistical significance was determined at a two-sided alpha level of 0.05.

Result

Socio-demographic characteristics of the respondents

The study included 358 participants seeking delivery services at HUCSH, achieving a 100% response rate. The participants' mean (SD) age was 26.8(4.9) years, with 50.8% between the ages of 30 and 34 years. Regarding educational status, 43% had completed primary education, and 11.5% had no formal

education. Most participants were married (94.4%), and over half (52%) were employed. The majority of the participants (91.9%) came from urban areas (Table 1).

Table 1
, Socio-demographic characteristics of women who attended delivery in HUCSH, April 1- September 30, 2024 (N = 358)

Characteristics	Frequency (%)
Current maternal age (year)	
15–19	33 (9.2)
20–24	38 (10.6)
25–29	76 (21.2)
30–34	182 (50.8)
> 35	29 (8.1)
Marital status	
married	338 (94.4)
single	20 (5.6)
Maternal occupation	
Unemployed	172 (48.0)
Employed	186 (52.0)
Place of residency	
Urban	329 (91.9)
Rural	29 (8.1)
Total Family Size	
≥ 5	77 (21.5)
≤ 4	281 (78.5)
Total family income per month (Birr)	
< 5000	81 (22.6)
5000–10000	148 (41.3)
10000–15000	73 (20.4)
> 15,000	56 (15.6)
Maternal educational status	
unable to read and write	41 (11.5)
primary education	154 (43.0)

Characteristics	Frequency (%)
secondary education	124 (34.6)
college and above	39 (10.9)

Maternal characteristics of respondents

Among mothers who participated in this study, 28 (7.9%) had chronic illness, and chronic hypertension was found to be the most common chronic illness (35.7%). There were 116 (32.4%) participants who were overweight, 13 (3.6%) were obese, and 21(5.9%) were underweight based on pre-pregnancy BMI. Of the total study participants, 341(95.3%) were non-reactive for HIV, and 346(96.6%) were non-reactive for VDRL **(**Table 2**)**.

Table 2
, Maternal characteristics of women who attended delivery in HUCSH, April 1- September 30, 2024(N = 358)

Characteristics	Frequency (%)
Maternal chronic illness	
No	330 (92.2)
Yes	28 (7.8)
Maternal drug intake during pregnancy	
No	326 (91.1)
Yes	32 (8.9)
Maternal BMI (pre-pregnancy)	
< 18.5	21 (5.9)
18.5–24.9	208 (58.1)
25-29.9	116 (32.4)
> 30	13 (3.6)
Maternal current MUAC	
< 23	151 (42.2)
≥ 23	207 (57.8)
Maternal coffee consumption (Cups per Day)	
No	63 (17.6)
1–2	211 (58.9)
≥ 3	84 (23.5)
Maternal weight gain after pregnancy (Kgs)	
< 10	170 (47.5)
10–17	169 (47.2)
> 17	19 (5.3)
Maternal HIV status	
Non-Reactive	341 (95.3)

BMI: body mass index, MUAC: middle-upper arm circumference, VDRL: Venereal Disease Research Laboratory test, HIV: human immunodeficiency virus

Characteristics	Frequency (%)
Maternal chronic illness	
Reactive	17 (4.7)
Maternal VDRL status	
Non-reactive	346 (96.6)
Reactive	12 (3.4)
Maternal hemoglobin level (g/dl)	
< 11	51 (14.2)
> 11.1	307 (85.8)

BMI: body mass index, MUAC: middle-upper arm circumference, VDRL: Venereal Disease Research Laboratory test, HIV: human immunodeficiency virus

Obstetric factors of respondents

Out of 358 study participants, nearly 72% were multigravida, 249 (69.6%) were term deliveries, and 109(30.4%) were preterm. For 264 (73.7%) of participants, an early milestone was recorded and used to calculate gestational age. Among study participants, 72(20.1%) had hypertensive disorders of pregnancy, and 65(18.2%) had a previous bad obstetrics history. Most respondents, 342(95.5%), had ANC follow-up during the current pregnancy, and 26 (7.3%) had malaria attack during the index pregnancy **(**Table 3**).**

Table 3
, Obstetric characteristics of women who delivered at HUCSH, April 1- September 30, 2024(N = 358)

Characteristics	Frequency	Percent
Is there a diagnosis of FGR (N = 358)		
No	277	77.4
Yes	81	22.6
Doppler US of the umbilical artery among FGR(N = 81)		
PI ≥ 95	63	77.8
AEDV	13	16
REDV	5	6.2
Gravidity (N = 358)		
Primigravidae	99	27.7
Multigravida	259	72.3
Gestational age at delivery (N = 358)		
Preterm (< 37)	109	30.4
Term (≥ 37)	249	69.6
Was there an early milestone for the calculation of GA (from U/S or LNMP) (N = 358)		
No	94	26.3
Yes	264	73.7
Interpregnancy interval from last delivery (for multigravidas) (N = 259)		
≤ 2 years	80	22.3
2–5 years	121	33.8
≥ 5 years	58	16.2
Hypertensive disorder of pregnancy during current pregnancy (N = 358)		
Yes	74	20.7
No	284	79.3
Previous bad obstetrics history (N = 358)		
Yes	65	18.2
No	293	81.8

Characteristics	Frequency	Percent
Is there a diagnosis of FGR (N = 358)		
ANC during current pregnancy(N = 358)		
No	16	4.5
Yes	342	95.5
Ultrasound estimated fetal weight (kg) (N = 358)		
< 2.5	110	30.7
≥ 2.5	248	69.3
Current obstetric complications other than PIH (N = 284)		
No Complications	89	31.3
oligo/anhydramnios	101	35.6
APH	38	13.4
PROM	20	7
Others	36	12.7
History of infertility treatment(N = 358)		
Yes	3	0.8
No	355	99.2
Malaria Attack in current pregnancy(N = 358)		
No	332	92.7
Yes	26	7.3
Excessive nausea and vomiting in current pregnancy (N = 358)		
No	286	79.9
Yes	72	20.1
Mode of delivery (N = 358)		
vaginal delivery	203	56.7
cesarean delivery	154	43.0

FGR: Fetal growth restriction, GA: gestational age, APH: antepartum hemorrhage PIH: Pregnancy-induced hypertension, PROM: Premature rupture of membrane

Abnormal umbilical artery doppler waveform: abnormal doppler ultrasound finding, Raised Pulsatility Index (PI) above 95th centile, Absent End-Diastolic velocity (AEDV), and Reversed End-Diastolic

Characteristics	Frequency	Percent
Is there a diagnosis of FGR (N = 358)		
velocity (REDV)		

Prevalence of FGR

The magnitude of FGR among pregnant women who delivered at HUCSH in this study was 81(22.6%) (95% CI: 15.5–29.7). Regarding the doppler findings, 63(77.8%) had Pulsatility Index (PI) above 95th centile, 13(16%) had Absent End-Diastolic velocity (AEDV), and 5(6.2%) had Reversed End-Diastolic velocity (REDV).

Factors associated with FGR

Multivariable logistic regression analyses were performed to identify factors associated with FGR among pregnant women who delivered at HUCSH. After controlling for potential confounding, women who were unable to read and write had more than eight times higher odds of delivering FGR when compared with those who had a college education (AOR = 8.06; 95% CI: 2.01–32.31). Similarly, mothers with pre-pregnancy BMI < 18.5 kg/m² were nearly eight-fold more likely to have FGR (AOR = 7.63; 95% CI: 2.30–25.29) compared to women with normal BMI. Several obstetric variables showed significant associations with FGR. Preterm delivery was associated with nearly threefold higher odds of FGR compared to term delivery (AOR = 2.85; 95% CI: 1.31–6.20), and hypertensive disease of pregnancy was associated with three times higher odds of FGR compared to pregnant women with normal blood pressure (AOR = 3.27; 95% CI: 1.13–9.50). Maternal age, gestational age, early ultrasound confirmation, ANC follow-up, maternal anemia level, and HIV status did not predict FGR in the adjusted model. (Table 4)

Table 4. Result of multivariate logistic regression analysis of factors associated with FGR among women who delivered at HUCSH

Variable Category	COR (95% CI)	AOR (95% CI)	p-value
Maternal Educational Status			
College and above	1	1	–
Secondary education	0.84 (0.34–2.05)	1.20 (0.38–3.80)	0.756
Primary education	0.75 (0.31–1.82)	1.13 (0.36–3.52)	0.834
Unable to read and write	**6.69 (2.64–16.97)**	**8.06 (2.01–32.31)**	**0.004**
Pre-pregnancy BMI (kg/m²)			
18.5–24.9	1	1	–
<18.5	**6.49 (2.48–16.99)**	**7.63 (2.30–25.29)**	**0.001**
25–29.9	0.37 (0.19–0.74)	0.45 (0.18–1.10)	0.080
≥30.0	1.42 (0.46–4.36)	0.88 (0.26–2.97)	0.837
Gravidity			
Multigravida	1	1	–
Primigravida	1.78 (1.03–3.06)	1.88 (0.82–4.32)	0.136
Gestational Age at Delivery			
Term (≥37 weeks) 1		1	–
Preterm (<37 weeks)	**2.56 (1.51–4.35)**	**2.85 (1.31–6.20)**	**0.008**
Early Ultrasound for GA Confirmation			
Yes	1	1	–
No	1.18 (0.49–2.85)	0.92 (0.35–2.41)	0.862
Hypertensive Disorder of Pregnancy			
No	1	1	–
Yes	**6.99 (4.00–12.22)**	**3.27 (1.13–9.50)**	**0.028**
Obstetric Complications (excluding PIH)			
None	1	1	–
Oligo/anhydramnios	3.89 (2.17–6.96)	1.60 (0.57–4.50)	0.375
Other complications [a]	0.90 (0.42–1.91)	0.85 (0.34–2.12)	0.731
Maternal Age (years)			

25–29	1	1	–
15–19	1.30 (0.49–3.44)	1.45 (0.45–4.65)	0.535
20–24	1.45 (0.59–3.56)	1.60 (0.55–4.66)	0.389
30–34	1.07 (0.55–2.09)	1.12 (0.48–2.62)	0.795
≥35	2.14 (0.85–5.41)	2.05 (0.68–6.21)	0.203
Maternal MUAC (cm)			
≥23	1	1	–
<23	1.37 (0.83–2.25)	1.25 (0.65–2.40)	0.500
ANC follow-up			
Yes	1	1	–
No	1.15 (0.36–3.67)	0.95 (0.22–4.10)	0.945
Maternal Anemia			
≥11 g/dL	1	1	–
<11 g/dL	1.70 (0.89–3.26)	1.45 (0.64–3.29)	0.374
Maternal HIV Status			
Non-Reactive	1	1	–
Reactive	1.94 (0.70–5.36)	1.60 (0.45–5.71)	0.468

Abbreviations: COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval; BMI, body mass index; MUAC, mid-upper arm circumference; ANC, antenatal care; PIH, pregnancy-induced hypertension.

Footnotes:

1. Bold value indicates statistical significance ($p < 0.05$).

a. Other complications: APH and PROM

Discussion

In the present study, we found a prevalence of FGR 22.6% among women who delivered at HUCSH, Hawassa, Ethiopia. This finding aligns with studies conducted in various regions, including Gondar-Ethiopia (23.5%), Uganda (21.8%), Malawi (20.3%), and Pakistan (24.4%)(6, 7, 17, 18). In addition, it is estimated that from 3% to 9% of pregnancies in the developed world and up to 25% of pregnancies in low- and middle-income countries are affected by FGR(19). However, studies from countries such as

Nigeria (4.3%), India (3.6%), and Romania (5.13%) have reported much lower prevalence rates than in the present study. (8, 20, 21). This disparity may be attributed to differences in diagnostic criteria of FGR, variations in study design, and socioeconomic characteristics.

Maternal educational status plays a critical role in shaping health-related behaviors, including dietary practices, utilization of antenatal care services, and adherence to recommended prenatal guidelines. Higher levels of maternal education are associated with improved access to health information and greater understanding of pregnancy-related risks and preventive measures, which contribute to healthier pregnancies and better neonatal outcomes. Consequently, improved newborn care and fetal growth are expected among women with higher educational attainment. In the present study, mothers who were unable to read and write had an approximately eightfold higher likelihood of delivering infants with fetal growth restriction compared with mothers who had attained higher levels of education. This finding is supported by previous studies conducted in Northwest Ethiopia, Indonesia, and Pakistan(6, 18, 22).

Maternal factors associated with FGR may have a direct or indirect relationship with the nutritional status of the mothers(23). Maternal BMI of less than 18.5 kg/m2 and MUAC less than 23 cm were used as evidence of maternal malnutrition, and these are associated with FGR(24). Low maternal BMI, resulting from chronic low energy intake, can be effectively addressed through dietary supplementation during pregnancy, which has been shown to improve pregnancy outcomes and reduce perinatal mortality(25, 26). BMI of less than 18.5 kg/m2 was associated with FGR in the present study, and this finding is in line with studies conducted in Northwest Ethiopia, the Democratic Republic of Congo, and Nigeria(6, 27, 28).

Hypertension in pregnancy induces fibrinoid degeneration of arteriolar media with resultant intimal thickening and decreased luminal diameter(29). It causes reduced permeability of essential nutrients across the placental barrier to the fetus and has, therefore, been implicated as a causal factor for FGR(30). This study showed that women who had hypertensive disease of pregnancy were three times more likely to give birth to babies with FGR, similar to studies conducted in Uganda, Nigeria, and India (17, 21, 28, 31). The association between FGR and preterm birth is biologically plausible. Elevated placental corticotropin-releasing hormone and increased fetal stress can promote early activation of labor through hormonal and prostaglandin pathways(32). In addition, conditions such as placental insufficiency and intrauterine infections can cause FGR as well as spontaneous preterm birth(33). These shared mechanisms can explain the association of growth restriction and preterm delivery. In this study, preterm delivery was associated with nearly threefold higher odds of FGR compared to term delivery, and this finding is consistent with studies conducted in Romania, the USA, and a case-control study from various European countries (8, 34, 35).

Strengths and Limitations

This study applied standardized diagnostic criteria for fetal growth restriction (FGR), incorporating both US assessments and umbilical artery Doppler findings, thereby enhancing diagnostic accuracy.

Nevertheless, several limitations should be acknowledged. First, the single-center, hospital-based design limits the generalizability of the findings to the wider community. Second, the cross-sectional design and exploratory nature of the analysis preclude inference regarding causal and temporal relationships. Third, reliance on the LNMP is susceptible to recall bias. Finally, US measurements may be affected by interobserver variability, potentially introducing measurement imprecision. Collectively, these limitations underscore the need for large-scale, population-based studies in the same setting. Despite these constraints, the present study provides valuable baseline data to inform future research.

Conclusion

The magnitude of FGR at Hawassa University Comprehensive Specialized Hospital was 22.6%. Low maternal educational status, pre-pregnancy BMI < 18.5 kg/m², hypertensive disorders of pregnancy, and preterm delivery were independently associated with FGR. These findings highlight the need for targeted antenatal interventions focusing on maternal nutrition, hypertension management, and enhanced obstetric care to reduce the burden of FGR.

Abbreviations

AC Abdominal Circumference

AEDV Absent End Diastolic Velocity

BMI Body Mass Index

EFW Estimated Fetal Weight

FIGO International Federation of Gynecology and Obstetrics

FGR Fetal Growth Restriction

FL Femur Length

GA Gestational Age

HUCSH Hawassa University Comprehensive Specialized Hospital

LNMP Last Normal Menstrual Period

MUAC Middle Upper Arm Circumference

PI Pulsatility Index

REDV Reversed End Diastolic Velocity

SMFM Society for Maternal-Fetal Medicine

VDRL Venereal Disease Research Laboratory

WHO World Health Organization

Declarations

Ethical approval

Prior to data collection, ethical clearance was obtained from the Institutional Review Board of Hawassa University College of Medicine and Health Sciences (Ref.No:IRB/341/15). A formal approval letter was obtained from the college's ethical review committee. The data collectors explained the significance of the study and the secure data management and privacy protocol before obtaining informed consent from each participant. No individuals under the age of 16 were included in this study.

Consent for publication:

Not applicable

Competing Interests:

The authors have no competing interests to declare that are relevant to the content of this article.

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Author Contribution

Mihiretu Tesfamariam, and Sisay Degefa contributed to the study conception and design. Material preparation and data collection were performed by Temesgen Teklu. The first draft of the manuscript was written by Sisay Degefa. Mihiretu Tesfamariam supervised the study, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data Availability

The datasets used during the current study are available from the corresponding author on reasonable request

References

1. Kleijer ME, Dekker GA, Heard AR. Risk factors for intrauterine growth restriction in a socio-economically disadvantaged region. J Matern Fetal Neonatal Med. 2005;18(1):23–30.
2. Melamed N, Baschat A, Yinon Y, Athanasiadis A, Mecacci F, Figueras F, et al. FIGO (international Federation of Gynecology and obstetrics) initiative on fetal growth: best practice advice for screening, diagnosis, and management of fetal growth restriction. Int J Gynaecol Obstet Off Organ Int Fed Gynaecol Obstet. 2021;152(1Suppl 1):3–57.
3. SMFM. Maternal Fetal Medicine. J Obstet Gynaecol Res. 2023;49(S1):90–9.
4. Gidi NW, Goldenberg RL, Nigussie AK, McClure E, Mekasha A, Worku B, et al. Comparison of neonatal outcomes of small for gestational age and appropriate for gestational age preterm infants born at 28–36 weeks of gestation: a multicentre study in Ethiopia. BMJ Paediatr Open. 2020;4(1):e000740.
5. Sharma D, Shastri S, Sharma P. Intrauterine Growth Restriction: Antenatal and Postnatal Aspects. Clin Med Insights Pediatr. 2016;10:CMPed.S40070.
6. Tesfa D, Tadege M, Digssie A, Abebaw S. Intrauterine growth restriction and its associated factors in South Gondar zone hospitals, Northwest Ethiopia, 2019. Arch Public Health Arch Belg Sante Publique. 2020;78:89.
7. Verhoeff FH, Brabin BJ, van Buuren S, Chimsuku L, Kazembe P, Wit JM, et al. An analysis of intra-uterine growth retardation in rural Malawi. Eur J Clin Nutr. 2001;55(8):682–9.
8. Bucur-Grosu ML, Avasiloaiei A, Popa IV, Păduraru L, Dimitriu DC, Socolov D et al. Involvement of Maternal and Socioeconomic Risk Factors in the Incidence of Fetal Growth Restriction in a Large Maternity Hospital in Romania. Children [Internet]. 2025 Jan 28 [cited 2026 Jan 17];12(2). Available from: https://www.mdpi.com/2227-9067/12/2/152
9. Milosavljevic J, Pejcic A, Arsenijevic P, Dimitrijevic A, Milosavljevic M, Macuzic IZ, et al. Factors associated with fetal growth restriction and small for gestational age newborns. Ginekol Pol. 2023;94(8):645–53.
10. CSA/Ethiopia CSA, Ethiopia Demographic ICF, Health Survey. 2016. 2017 Jul 1 [cited 2026 Jan 17]; Available from: https://dhsprogram.com/publications/publication-fr328-dhs-final-reports.cfm
11. Tsegaye B, Kassa A. Prevalence of adverse birth outcome and associated factors among women who delivered in Hawassa town governmental health institutions, south Ethiopia, in 2017. Reprod Health. 2018;15(1):193.
12. WHO. WHO recommendations on antenatal care for. a positive pregnancy experience [Internet]. [cited 2026 Jan 18]. Available from: https://www.who.int/publications/i/item/9789241549912

13. Baschat AA, Su EJ, Galan HL. Fetal Growth Restriction. In: Gabbe's Obstetrics: Normal and Problem Pregnancies, Ninth Edition [Internet]. Elsevier; 2024 [cited 2026 Jan 14]. pp. 557–581.e3. Available from: https://pure.johnshopkins.edu/en/publications/fetal-growth-restriction-6/
14. WHO. Preterm birth [Internet]. [cited 2026 Jan 19]. Available from: https://www.who.int/news-room/fact-sheets/detail/preterm-birth
15. ACOG. Definition of Term Pregnancy [Internet]. [cited 2026 Jan 19]. Available from: https://www.acog.org/clinical/clinical-guidance/committee-opinion/articles/2013/11/definition-of-term-pregnancy
16. Gandhi S, Chauhan K, Rajan P, Wanjari M, Sangoi L, Sangoi R. Impact of maternal body mass index on pregnancy outcomes among Indian women. Bioinformation. 2024;20(10):1257.
17. Mutumba J, Kayondo M, Ssebanenya J, Abaatyo J, Mutesasira S, Akandwanaho G, et al. Prevalence and factors associated with small for gestational age births among women delivering at a tertiary hospital in South-Western Uganda: a cross-sectional study. BMC Pregnancy Childbirth. 2025;26(1):12.
18. Fikree FF, Berendes HW. Risk factors for term intrauterine growth retardation: a community-based study in Karachi. Bull World Health Organ. 1994;72(4):581–7.
19. Damhuis SE, Ganzevoort W, Gordijn SJ. Abnormal Fetal Growth: Small for Gestational Age, Fetal Growth Restriction, Large for Gestational Age: Definitions and Epidemiology. Obstet Gynecol Clin North Am. 2021;48(2):267–79.
20. Olusanya BO. Intrauterine growth restriction in a low-income country: Risk factors, adverse perinatal outcomes and correlation with current WHO Multicenter Growth Reference. Early Hum Dev. 2010;86(7):439–44.
21. Dr. Rozy Pravinchandra Ahya DrJU. Cross Sectional Study To Assess Perinatal Outcome Of Intrauterine Growth Restriction Babies Delivered In Jehangir Hospital, Pune, Maharashtr [Internet]. [cited 2026 Jan 14]. Available from: https://ijlbpr.com/htmlissue.php?id=1455
22. Hastuti L, Litasari A, Kardiatun K, Mardiyani R, Rahmawati A, Jais S. Factors associated with the incidence of low birth weight in Pontianak City, Indonesia. Med J Malaysia. 2024;79(6):757–63.
23. Scott KE, Usher R. Fetal malnutrition: its incidence, causes, and effects. Am J Obstet Gynecol. 1966;94(7):951–63.
24. Lechtig A. Predicting risk of delivering low birthweight babies: which indicator is better? J Trop Pediatr. 1988;34(1):34–41.
25. WHO. Physical status: the use of and interpretation of anthropometry, report of a WHO expert committee [Internet]. [cited 2026 Jan 22]. Available from: https://www.who.int/publications/i/item/9241208546
26. Ceesay SM, Prentice AM, Cole TJ, Foord F, Weaver LT, Poskitt EM, et al. Effects on birth weight and perinatal mortality of maternal dietary supplements in rural Gambia: 5 year randomised controlled trial. BMJ. 1997;315(7111):786–90.

27. Landis SH, Lokomba V, Ananth CV, Atibu J, Ryder RW, Hartmann KE, et al. Impact of maternal malaria and under-nutrition on intrauterine growth restriction: a prospective ultrasound study in Democratic Republic of Congo. Epidemiol Infect. 2009;137(2):294–304.
28. Adebami OJ, Oyedeji GA, Owa JA, Oyelami OA. Maternal factors in the etiology of fetal malnutrition in Nigeria. Pediatr Int Off J Jpn Pediatr Soc. 2007;49(2):150–5.
29. Resnik R, Creasy RK, Iams JD, Lockwood CJ, Moore T, Greene MF. Creasy and Resnik's Maternal-Fetal Medicine: Principles and Practice E-Book. Elsevier Health Sciences; 2008. p. 1301.
30. Lewis SH, Perrin EVDK, Perrin EVDK. Pathology of the Placenta. Churchill Livingstone; 1999. p. 442.
31. Accrombessi M, Zeitlin J, Massougbodji A, Cot M, Briand V. What Do We Know about Risk Factors for Fetal Growth Restriction in Africa at the Time of Sustainable Development Goals? A Scoping Review. Paediatr Perinat Epidemiol. 2018;32(2):184–96.
32. Majzoub JA, McGregor JA, Lockwood CJ, Smith R, Taggart MS, Schulkin J. A central theory of preterm and term labor: putative role for corticotropin-releasing hormone. Am J Obstet Gynecol. 1999;180(1 Pt 3):S232–241.
33. Gibbs RS, Eschenbach DA. Use of antibiotics to prevent preterm birth. Am J Obstet Gynecol. 1997;177(2):375–80.
34. Gilbert WM, Danielsen B. Pregnancy outcomes associated with intrauterine growth restriction. Am J Obstet Gynecol. 2003;188(6):1596–9. discussion 1599–1601.
35. Zeitlin J, Ancel PY, Saurel-Cubizolles MJ, Papiernik E. The relationship between intrauterine growth restriction and preterm delivery: an empirical approach using data from a European case-control study. BJOG Int J Obstet Gynaecol. 2000;107(6):750–8.