Factors associated with small-for-gestational-age births among preterm babies born <2000 g: a multifacility cross-sectional study in Ethiopia

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INTRODUCTION

Objectives This study aimed to determine the prevalence of small-for-gestational-age (SGA) and appropriate-for-gestational-age (AGA); compare variations in multiple risk factors, and identify factors associated with SGA births among preterm babies born <2000 g.

Design Cross-sectional study.

Setting The study was conducted at five public hospitals in Oromia Regional State and Addis Ababa City Administration, Ethiopia.

Participants 531 singleton preterm babies born <2000 g from March 2017 to February 2019.

Outcome measures Birth size-for-gestational-age was an outcome variable. Birth size-for-gestational-age centiles were produced using Intergrowth-21st data. Newborn birth size-for-gestational-age below the 10th percentile were classified as SGA; those>10th to 90th percentiles were classified as AGA; those>90th percentiles, as large-for-gestational-age, according to sex. SGA and AGA prevalence were determined. Babies were compared for variations in multiple risk factors.

Results Among 531 babies included, the sex distribution was: 55.44% males and 44.56% females. The prevalences of SGA and AGA were 46.14% and 53.86%, respectively. The percentage of SGA was slightly greater among males (47.62%) than females (44.30%), but not statistically significant. The prevalence of SGA was significantly varied between pre-eclamptic mothers (32.42%, 95% CI 22.36% to 42.22%) and non-pre-eclamptic mothers (57.94%, 95% CI 53.21% to 62.54%). Mothers who had a history of stillbirth (adjusted OR (AOR) 2.96 95% CI 1.04 to 8.54), pre-eclamptic mothers (AOR 3.36, 95% CI 1.95 to 5.79) and being born extremely low birth weight (AOR 10.48, 95% CI 2.24 to 49.02) were risk factors significantly associated with SGA in this population.

Conclusion Prevalence of SGA was very high in this population in the study area. Maternal pre-eclampsia substantially increases the risk of SGA. Hence, given the negative consequences of SGA, maternal and newborn health frameworks must look for and use evidence on gestational age and birth weight to assess the newborn’s risks and direct care.

INTRODUCTION

Worldwide, an estimated 20.5 million live births (nearly 15% of all births) were born with low birth weight (LBW) in 2015.1–3 Greater than 17% of all LBW babies were born in Asia, whereas Africa accounted for closely 14% of all LBW babies, more in Eastern and Western Africa.3 LBW, (defined as birth weight <2500 g irrespective of gestational age), consists of preterm births or small-for-gestational-age (SGA) births or both.4 SGA, which is usually a proxy indicator for intrapartum growth restriction (IUGR), is described as birth weight below the 10th centile for gestational age and gender of a given reference population.2–8 In areas with a high percentage of SGA, SGA is more probably to be a consequence of IUGR rather than being constitutionally small.9 SGA can be the result of genetic factors or due to placental, fetal and maternal and demographic factors.10

The global prevalence of SGA accounts for one-third of LBW.11–13 Using data from the Neonatal Research Network database, the prevalence of SGA was 9% among babies born very LBW of <1500 g and gestational age between 25 and 30 weeks.12 In low-income countries, a greater proportion of LBW is due to SGA than preterm.13–15 Nearly one in five neonates born in low-income countries is SGA.15 Of the 23.3 million babies born SGA in resource-limited settings in 2012,
around 11.2 million were born term and not LBW, and 10.7 million were born term and LBW whereas 1.5 million were born preterm. The prevalence of SGA is highest in South Asia and Sahelian countries of Africa. In Sahelian countries of Africa, 25.5% of all births were SGA (23.5% term SGA and 2% preterm SGA) and 12.3% were preterm births. Preterm-SGA babies have the highest mortality risk.

About 60% of the neonatal mortalities in poor-resource settings are related to LBW due to SGA or preterm birth or both. SGA remains as a public health agitation worldwide, although nutrition levels have improved over the last 30 years. Previous studies have suggested that babies born SGA have a higher risk of morbidity and mortality. In low-income and middle-income countries, 21.9% of all neonatal deaths occur among babies born SGA. Small birth size due to preterm birth or SGA, or both is the major threat for more than 80% of newborn deaths and upsurges the risk of growth failure and other diseases. Success in reducing neonatal and child death in these countries may depend on addressing the problem of SGA.

Kangaroo Mother Care (KMC, described as extended skin-to-skin contact of the baby with the mother/guardians for as much as possible through day and night, and exclusive breastfeeding or breast milk feeding), is one of the interventions for regulating deaths among LBW newborns. KMC has the capacity to decrease death by closely 40% in LBW babies <2000 g. This is the population served by the KMC. The WHO ‘Every Newborn Action Plan’ contains the goal of scaling up KMC to 75% of newborns with birth weight <2000 g by 2025. To help the realisation of these goals and aims, a multifacility implementation research project was conducted in Ethiopia among LBW babies <2000 g with the aim to produce a model that could result in a high KMC coverage. The detail is found elsewhere. This study is part of this large initiative research project.

Currently, there is a scarcity of evidence about SGA births among babies born <2000 g in Ethiopia. Information, for example, being born SGA is essential from a clinical and social perspective since it indicates a link with negative consequences, for instance, neonatal mortality, low childhood growth and chronic diseases in adulthood. In addition, the prevalence of SGA varies considerably based on the choice of birthweight-for-gestational age reference population and growth standard charts. Therefore, this study aimed to compute the prevalence of SGA, and appropriate-for-gestational-age (AGA) (≥10 to 90th percentile) using Intergrowth-21st reference data; and compare variations in risk factors (eg, baby sex, maternal pre-eclampsia and maternal age); and identify factors associated with SGA births among preterm babies born <2000 g recruited from five study hospitals in Ethiopia.

METHODS
Study design and setting
This cross-sectional study was employed in Oromia Regional State and Addis Ababa City Administration, Ethiopia. Four Districts (Tiyo, Munesa, Limuna Bilbilo and Adami Tullu) from Oromia Regional State and Akaki-Kality Sub-City Adm from Addis Ababa City were considered (figure 1). This study was embedded within a KMC research initiative in Ethiopia. It was based at five hospitals (one in each district/subcity): Assela Teaching and Referral Hospital, Kersa Primary Hospital, Bekoji Primary Hospital, Batu General Hospital and Tirunesh-Beijing General Hospital, since hospitals have neonatal intensive care units (NICU) that are used as treatment and referral centres for KMC in the respective districts/subCity.

Participants and sample size calculation
Since this study was embedded within the existing KMC research initiative study, it was conducted among preterm babies born <2000 g (eligible for KMC). All singleton preterm live birth newborns, who were <2000 g at birth and who could have been born or admitted to the study base hospitals from 1 March 2017 to 29 February 2019, were included. Births that took place in health centres and private hospitals in the study area were also included. We only included birth weight if the measurement was made within 72 hours of birth. The exclusion criteria were newborns whose gestational age could not be established either by last menstrual period (LMP) (or mother’s report) or first-trimester ultrasound; multiple births; large for gestational age (LGA) births; and newborns with congenital abnormality and those who died immediately after live birth, but before the birth weight was measured. However, we included everyone during the study period (n=531) who fulfil the inclusion criteria using cluster random sampling method, the minimum sample size was calculated using single population proportion formula by considering SGA prevalence of 50% (since no prior study), 5% margin of error and 90% level of confidence.

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n = \frac{Z_{\alpha/2}^2 \cdot p(1-p)}{d^2} = \frac{1.65^2 \cdot 0.5 \cdot (1-0.5)}{0.05^2} = 270
\]
Adding 10% non-response rate and 1.5 for clustering effect, the final sample size becomes 446.

Outcome variable definitions
The study considered size-for-gestational-age as an outcome variable. Birth size-for-gestational-age was categorized according to the new Intergrowth-21st data,\(^{27}\) considering cut-off points in percentiles according to international standards, where newborns weighing below the 10th percentile were classified as SGA; those >10th to 90th percentiles, classified as AGA; those >90th percentiles, as LGA, according to sex.

Exposure variables
The following exposure variables were considered based on prior studies of risk factors:\(^{28–30}\):

- Maternal sociodemographic characteristics—mother age at birth (categorised as <20 years, 20–24 years, 25–29 years, 30–34 years and ≥35 years; mothers age <20 years and ≥35 years have been found to have an increased risk of SGA), mother’s education, mother’s marital status, mother’s occupation, average monthly family income and family size (<5 and ≥5).
- Neonatal factors—sex of the newborn (male/female, female is reference category), birth weight (categorised as extremely LBW/ELBW (<1000g), very LBW/VLBW (a term used to describe babies who are born weighing less than 1500g) and 1500–1999g –this group is found to have a lower risk of SGA), birth interval (first born, <3 years and ≥3 years),
- Maternal factors—gravidity, parity (primiparous mothers have an elevated risk of SGA), history of abortion and stillbirth, place of birth, mode of delivery, maternal infection (like malaria) and maternal pre-eclampsia defined as mothers with a systolic blood pressure ≥140 mm Hg or diastolic blood pressure of ≥90mm Hg on two distinct measurements taken at least 4–6 hours apart with previously normal readings.\(^{31,32}\)

Data collection procedures
Interviews were conducted by trained health professionals with mothers after delivery using a structured questionnaire (online supplemental file 1) specially designed for the study and some other data were obtained from records (newborns and mothers). Gestational age was determined by either ultrasound examination or the patient’s LMP. Trained health professionals carried out gestational age assessments. Birth weight was extracted from delivery registers. Newborns were weighed unclothed, using digital weighing scales (Seca, Hamburg, Germany) that are routinely calibrated.\(^{33}\) Maternal clinically pertinent situations occurring during childbirth were assessed. Written informed consent was obtained from mothers/caregivers of neonates in the study hospitals. Interview was conducted with the mother during enrolment to KMC/NICU to collect the baseline maternal and neonatal characteristics.

Data quality assurance
A pretested questionnaire was used to refine the questionnaire design (ie, to identify problems in the language, structure, logic and flow). Calibration of the weighing scale was made to improve the validity of the study. Instruments and techniques used in all centres were standardised, that is, equipment and training were given.

Statistical analysis
Data were collected using the REDCap data management system. Data entered into the REDCap system were checked by the coordinating unit at Addis Ababa University, Black Lion Hospital for completeness and accuracy. Statistical analysis of data was performed using STATA V.14 software. Birthweight-for-gestational age centiles were produced for each live-born singleton newborn, using sex-specific Intergrowth-2st newborn size standard.\(^{27}\) The overall and stratified percentage of newborns that were SGA and AGA was determined. The \(\chi^2\) test was used to show the relationships between risk factors (baby sex, maternal pre-eclampsia and age at birth) and SGA, and AGA. A \(p<0.05\) was used to determine the occurrence of a significant difference. A multivariable logistic regression model was carried out to ascertain factors related to SGA. To fit the model, AGA births were treated as a reference category. Multicollinearity was checked using variance inflation factors (>10 taken as the existence of collinearity). The variables selected for the model did not show a multicollinearity problem. Both crude OR and adjusted OR (AOR) were reported along with 95% CIs. A \(p<0.05\) was considered significant.

Patient and public involvement
Patients and/or the public were not involved in the design or development of the study.

RESULTS
Description of the study population
Out of 1092 eligible newborns, 531 (48.63%) fulfilled the inclusion criteria and were included in the analysis, as indicated in figure 2. Just 561 were excluded because 128 (11.72%) missed their gestational age at birth, 302 (27.66%) were twins and triplets 101 (9.25%) were...

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term births and 30 (2.74%) were LGA births. The study comprised 531 singleton preterm newborns born <2000 g.

Sociodemographic characteristics of participants

Baseline characteristics are shown in Table 1. The mean maternal age at birth was 25.88 (SD±5.24) years. The majority (35.59%) of the newborn’s mother’s age was 25–29 years old, followed by 30–34 years (17.33%). One hundred and twenty-nine (24.29%) of the mothers were illiterate, and 210 (39.55%) of the mothers completed primary school (grades 1–8). Nearly 30% of the mothers completed secondary school (grades 9–12) while 26 (4.90%) attended college. Nearly all 492 (92.66%) of the mothers were married, while only 35 (6.59%) were single and 4 (0.75%) were divorced/widowed. Sixty-three per cent of the women were housewives by occupation followed by farmers, 47 (8.85%). Greater than 69% of the mothers had <5 family size (Table 1).

Obstetric and clinical characteristics of mothers

More than half (54.42%) of the women were pregnant for the first time, while 34.62% and 10.96% of the mothers were multigravida and grand multigravida, respectively (Table 2). Nearly two-thirds (60.38%) of the mothers were primiparous while only 7.62% of the mothers had ≥5 births; around 17% had a history of abortion and 3.94% had a history of stillbirth. A greater proportion of the women (76.46%) delivered at government hospitals while 4.71% delivered at home whereas 16.95% and 1.88% delivered at health centres/health posts and private hospitals/clinics, respectively (Table 3). The majority (85.88%) were spontaneous vaginal deliveries, 3.77% were assisted vaginal deliveries, and caesarean sections accounted for 10.36% of the deliveries. Around 16% (84/531) of the women had pre-eclampsia/eclampsia, 9% of the women had an antepartum haemorrhage, 5% of the women had postpartum haemorrhage and 3% of the women had HIV/AIDS. Only two mothers had anaemia, one mother had premature rupture of membrane and the other two mothers had retained placenta.

### Table 1 Baseline characteristics of mothers who participated in the study (Oromia regional state and Addis Ababa City administration, Ethiopia, 2017–2019, (n=662))

| Variables                  | No (percentage) |
|----------------------------|-----------------|
| Mother age at birth (years)|                |
| <20 years                  | 44 (8.29)       |
| 20–24 years                | 165 (31.07)     |
| 25–29 years                | 189 (35.59)     |
| 30–34 years                | 92 (17.33)      |
| ≥35 years                  | 39 (7.34)       |
| Missing                    | 2 (0.38)        |
| Mother’s education         |                |
| No education               | 129 (24.29)     |
| Primary (grades 1–8)       | 210 (39.55)     |
| Secondary (grades 9–12)    | 166 (31.26)     |
| College                    | 26 (4.90)       |
| Mother’s marital status    |                |
| Single                     | 35 (6.59)       |
| Married                    | 492 (92.66)     |
| Divorced/widowed           | 4 (0.75)        |
| Mother’s occupation        |                |
| Farmers                    | 47 (8.85)       |
| Housewife                  | 337 (63.47)     |
| Professional work          | 31 (5.84)       |
| Sales and services         | 28 (5.27)       |
| Skilled labourers          | 36 (6.78)       |
| Unemployed                 | 12 (2.26)       |
| Unskilled labourers        | 40 (7.53)       |
| Family size                |                |
| <5                         | 368 (69.30)     |
| 5+                         | 157 (29.57)     |
| Missing                    | 6 (1.13)        |

### Table 2 Current and past obstetric and clinical characteristics of participating mothers (Oromia regional state and Addis Ababa City administration, Ethiopia, 2017–2019, (n=662))

| Variables                  | No (percentage) |
|----------------------------|-----------------|
| Gravidity (n=520)          |                |
| Primigravida               | 283 (54.42)     |
| Multigravida (IIIV)        | 180 (34.62)     |
| Grand multi-gravida        | 57 (10.96)      |
| Parity (n=525)             |                |
| Primiparous                | 317 (60.38)     |
| Multiparous (2–4)          | 168 (32.00)     |
| Grand multiparous          | 40 (7.62)       |
| History of abortion (n=528)|                |
| Yes                        | 88 (16.67)      |
| No                         | 440 (83.33)     |
| History of stillbirth (n=507)|              |
| Yes                        | 20 (3.94)       |
| No                         | 487 (96.06)     |
| Place of birth(n=531)      |                |
| Home                       | 25 (4.71)       |
| Government hospitals all type | 406 (76.46)  |
| Health centre/health post  | 90 (16.95)      |
| Private hospitals and clinics | 10 (1.88)   |
| Mode of delivery (n=661)   |                |
| Spontaneous vaginal delivery| 456 (85.88)   |
| Assisted vaginal delivery  | 20 (3.77)       |
| Caesarean section          | 55 (10.36)      |
| Pre-eclampsia              | 84 (15.82)      |
| Antepartum haemorrhage     | 9 (1.69)        |
| Postpartum haemorrhage     | 5 (0.94)        |
| Others*                    | 8 (1.51)        |
| *HIV/AIDS=3, anaemia=2, premature rupture of membrane=1, retained placenta=2. |
Gestational ages and birthweight distributions

Gestational ages and birthweight distributions by sex are shown in Table 3. Just 1.69%, 36.91%, 10.17% and 51.22% of the newborns were born under 28 gestational weeks, between 28 and <32 gestational weeks, and between 32 and <34 gestational weeks, and between 34 and <37 gestational weeks, respectively. The average gestational age was 33.04 (SD±2.22) weeks. Two hundred and ninety-four (55.37%) of the newborns were boys while 237 (44.63%) were girls. There was a slightly higher fraction of male against female births at parallel gestational weeks, however, there was no statistically significant difference in the overall distribution of gestational age by sex (χ²=1.88, p=0.39). Overall, males weighed more than females, but not significant (t=0.94, p=0.17). The combined mean birth weight was 1589.82 (SD±290.34) g. The average birth weight for males was 1600.35 (SD±295.70) g while for females it was 1576.76 (SD±283.63) g (Table 3). There was an overall mean difference of 23.59 g between males and females.

Prevalence of SGA stratified by multiple risk factors

Overall, 245 out of 531 babies were born SGA which gives a prevalence of SGA 46.14% (95% CI 41.84% to 50.48%). The prevalence of AGA was 53.86% (95% CI 49.51% to 58.16%) (Table 4). The prevalence of SGA was slightly higher among male (47.62%, 95% CI 42.42% to 52.83%) than female (44.63%, 95% CI 37.88% to 50.88%) newborns even though not statistically significant. Nearly 3% and 30% of the babies were born with extremely LBW, and very LBW, respectively, while the rest 67.30% of the babies were born weighing between 1500 and 1999 g. The prevalence of SGA was significantly different (p=0.002) among the three categories of newborn birth weight. Just about half of the newborns (49.54%) were admitted to NICU. There was no significant difference between babies who stayed at NICU and those who did not for the SGA prevalence. The prevalence of SGA was 45.41% (95% CI 39.28% to 51.66%) among babies who stayed at NICU while it was 46.84% (95% CI 40.76% to 52.99%) among those who did not stay at NICU.

The prevalence of SGA was nearly similar among the age distribution of the newborn mothers. The prevalence of SGA was 43.18% (95% CI 28.35% to 58.97%), 44.24% (95% CI 36.53% to 52.17%), 46.56% (95% CI 39.29% to 53.34%), 50.00% (95% CI 39.39% to 60.61%) and 48.72% (95% CI 32.41% to 65.22%) among newborns whose mothers age at birth was <20 years, 20–24 years, 25–29 years, 30–34 years and ≥35 years, respectively. SGA babies had a difference in maternal risk factors (ie, maternal pre-eclampsia). The prevalence of SGA was significantly varied between pre-eclamptic mothers (32.42%, 95% CI 22.36% to 43.22%) and non-pre-eclamptic mothers (57.94%, 95% CI 53.21% to 62.54%) (Table 4).

After multiple variable adjustments in the multivariable logistic regression model, three risk factors were found to be associated with SGA births (Table 5). The odds of being born SGA were greater in the newborn of mothers who had a history of stillbirth. Babies of mothers who had history of stillbirth had three times greater risk of having SAG babies than AGA babies (AOR 2.96 95% CI 1.04 to 8.54). The risk of SGA was nearly three times higher (AOR 3.36, 95% CI 1.95 to 5.79) in babies born after pre-eclampsia than in non-pre-eclampsia pregnancies. The odds of being SGA were 10 times more likely (AOR 10.48, 95% CI 2.24 to 49.02) among babies who were born extremely LBW compared with babies born between 1500 and 1999 g. The rest of the factors became non-significant in the adjusted model (Table 5).

**DISCUSSION**

This study aimed to estimate the prevalence of SGA and identify risk factors associated with SGA births among singleton preterm live-born babies born <2000 g. The estimated prevalence of SGA in newborns was very high (46.14%). The higher prevalence of SGA in this study could be the population studied, restricted to live-born singleton preterm babies born <2000 g. The higher prevalence could be also, as explained by Gautam Paudel et al, maternal undernutrition, maternal infections and lower antenatal care contact. The higher prevalence can be due to short maternal stature; it was indicated that globally about 35% of SGA might be connected to short maternal stature. Could be due to maternal pathological conditions—pre-eclampsia. Previous studies mentioned that pre-eclampsia is considerably linked to SGA. Women with pre-eclampsia had higher prevalence of SGA (specifically preterm-SGA) compared with those without, as

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**Table 3** Birthweight distributions by sex and gestational age for preterm live-born singleton newborns, (Oromia regional state and Addis Ababa City, Ethiopia, 2017–2019

| Gestational age category in weeks | Boys | Birth weight | Girls | Birth weight |
|----------------------------------|------|--------------|-------|--------------|
| Extremely preterm (<28 weeks)    | 7 (2.38) | 972.86 (203.69) | 2 (0.84) | 1000 (0.00) |
| Very preterm (28 to <32 weeks)   | 107 (36.39) | 1506.56 (319.71) | 89 (37.55) | 1425.55 (282.67) |
| Moderate preterm (32 to <34 weeks)| 30 (10.20) | 1703 (172.79) | 24 (10.13) | 1619.38 (191.79) |
| Late preterm (34 to <37 weeks)   | 150 (51.02) | 1676 (242.99) | 122 (51.48) | 1688.14 (237.94) |
| Overall                          | 294 (100.0) | 1600.35 (295.70) | 237 (100.0) | 1576.76 (283.63) |
prior studies established. This advocates that poor birth outcomes like SGA (preterm-SGA) should be taken into consideration in Ethiopia.

The prevalence of SGA was slightly greater for male newborns than females. This could be due to the occurrence of male excess among preterm births. The presence of a male excess is probably due to, as explained by Zeitlin et al., greater weight at lower gestation and higher vulnerability to pregnancy complications. Comparatively larger fetal weight and size of males might somehow persuade early commencement of labour, as a result, shorter gestation.

Furthermore, the male preterm newborns were more probably fulfilling the preterm SGA criteria, as the weight standard for males is greater than for females. The estimated birthweight values varied across the reference population. The mean birthweight values of males were greater than females.

Numerous risk factors associated with SGA births were examined in this study. Risk factors, such as history of stillbirth, maternal pre-eclampsia and being born ELBW, significantly increased the risk of SGA births. Higher maternal education was associated with a reduced risk of SGA births. Studies were done in Nepal and India indicated that a mother’s education lowered the risk of SGA births. SGA was significantly associated with mothers who had previous history of stillbirth. The risk of SGA birth was significantly increased among neonates whose mothers had previous history of stillbirth, which agrees with results from other studies.

Maternal pre-eclampsia was another risk factor linked with a higher risk of SGA birth. Mothers with pre-eclampsia show closely threefold increase in SGA birth compared with healthy mothers. The link between SGA and pre-eclampsia is biologically reasonable, providing that proteinuria could be a marker for vascular damage, and restricted maternal blood flow to the uterus could result in fetal hypoxia and growth restriction.

The limitations in this study may include that the nutritional status of the women in late pregnancy and diabetic status of mother were not assessed and we failed to correlate these with SGA status of newborns. Moreover, the use of dates of LMP in assessing gestational age was also another limitation. The following factors may lead to errors (over-estimation of SGA) while calculating the gestational age from the LMP: irregularity of the menstruation cycle, difficulty to recall the LMP, and oral contraceptive use. There may be some interobserver inconsistency; however, we believe that this to be a minor source of misclassification since extensive training was given to data collectors to follow a standard protocol using accurate scales that were calibrated regularly. Exclusion of newborns who died before being weighed could as well lower the

| Characteristics                   | SGA, n (%)  | AGA, n (%)  | Total, n (%) | P value |
|-----------------------------------|-------------|-------------|--------------|---------|
| Sex of baby                       |             |             |              |         |
| Male                              | 140 (26.37) | 154 (29.00) | 294 (55.37)  | 0.45    |
| Female                            | 105 (19.77) | 132 (24.86) | 237 (44.63)  |         |
| Newborn birth weight (grams)      |             |             |              |         |
| <1000                             | 15 (2.82)   | 2 (0.38)    | 17 (3.20)    | 0.002   |
| 1000–1499                         | 72 (13.56)  | 86 (16.20)  | 158 (29.76)  |         |
| 1500–1999                         | 158 (29.76) | 198 (37.29) | 356 (67.04)  |         |
| NICU admission                    |             |             |              |         |
| Yes                               | 119 (22.41) | 143 (26.93) | 262 (49.34)  | 0.743   |
| No                                | 126 (23.73) | 143 (26.93) | 269 (50.66)  |         |
| Maternal age at birth             |             |             |              |         |
| <20 years                         | 19 (3.58)   | 25 (4.71)   | 44 (8.29)    | 0.901   |
| 20–24 years                       | 73 (13.75)  | 92 (17.33)  | 165 (31.07)  |         |
| 25–29 years                       | 88 (16.57)  | 101 (19.02) | 189 (35.59)  |         |
| 30–34 years                       | 46 (8.66)   | 46 (8.66)   | 92 (17.33)   |         |
| ≥35 years                         | 19 (3.58)   | 20 (3.77)   | 39 (7.34)    |         |
| Missing                           | 0 (0.00)    | 2 (0.38)    | 2 (0.38)     |         |
| Maternal pre-eclampsia            |             |             |              |         |
| Yes                               | 57 (10.73)  | 27 (5.08)   | 84 (15.82)   | 0.001   |
| No                                | 188 (35.40) | 259 (48.78) | 447 (84.18)  |         |
| Overall total                     | 245 (46.14) | 286 (53.86) | 531 (100)    |         |

AGA, appropriate-for-gestational-age; NICU, neonatal intensive care unit; SGA, small-for-gestational-age.
The prevalence of SGA since those newborns might have died owing to one or both of those conditions. Another limitation was sampling only from five hospitals. Even so, our study covers wide-ranging pregnancy and birth-size data.

The data were limited to <2000 g (which may introduce selection and/or sampling biases), which limit us not to compare our study prevalence with other studies. This may trigger us to have further interest/future work to

| Characteristics | SGA, n (%) | AGA, n (%) | COR | 95% CI for COR | 95% CI for AOR |
|-----------------|------------|------------|-----|---------------|---------------|
|                 | Lower      | Upper      |     |               |               |
|                 | Lower      | Upper      |     |               |               |
| Mother educational status |           |            |     |               |               |
| No education    | 69 (12.99) | 60 (11.30) | 1.48| 0.95          | 2.31          |
| Primary         | 92 (17.33) | 118 (22.22)| 1.00| 0.68          | 1.45          |
| Secondary and above (ref.) | 84 (15.82) | 108 (20.34)| 1.00| 0.93          | 4.21          |
| Age of mother (n=529) |           |            |     |               |               |
| < 20 years      | 19 (3.59)  | 25 (4.73)  | 0.87| 0.45          | 1.70          |
| 20–24 years     | 73 (13.80) | 92 (17.39) | 1.15| 0.59          | 2.05          |
| 30–34 years     | 46 (8.70)  | 46 (8.70)  | 1.00| 0.69          | 1.82          |
| ≥35 years       | 19 (3.59)  | 20 (3.78)  | 1.09| 0.55          | 2.17          |
| 25–29 (ref.)    | 88 (16.64) | 101 (19.09)| 1.00| 1.00          | 1.00          |
| Avg monthly income |           |            |     |               |               |
| ≥5              | 80 (15.24) | 77 (14.67) | 1.35| 0.93          | 1.97          |
| <5 (ref.)       | 160 (30.48)| 208 (39.62)| 1.00| 1.00          | 1.00          |
| History of stillbirth (n=507) |           |            |     |               |               |
| Yes             | 13 (2.56)  | 7 (1.38)   | 2.25| 0.89          | 5.75          |
| No (ref.)       | 220 (43.39)| 267 (52.66)| 1.00| 1.00          | 1.00          |
| Maternal pre-eclampsia |           |            |     |               |               |
| Yes             | 57 (10.73) | 27 (5.08)  | 2.91| 1.77          | 4.77          |
| No (ref.)       | 188 (35.40)| 258 (48.78)| 1.00| 1.00          | 1.00          |
| Birth interval  |            |            |     |               |               |
| <3 years        | 49 (9.23)  | 56 (10.55) | 1.14| 0.73          | 1.77          |
| ≥3 years        | 53 (9.98)  | 44 (8.29)  | 1.57| 0.99          | 2.47          |
| First born (ref.) |         |        | 1.00| 1.00          | 1.00          |
| Sex             |            |            |     |               |               |
| Male            | 140 (26.37)| 154 (29.00)| 1.14| 0.81          | 1.61          |
| Female (ref.)   | 105 (19.77)| 132 (24.86)| 1.00| 1.00          | 1.00          |
| Birth weight (gram) |       |      |     |               |               |
| <1000           | 15 (2.82)  | 2 (0.38)   | 9.39| 2.12          | 41.71         |
| 1000–1499       | 72 (13.56) | 86 (16.20)| 1.05| 0.72          | 1.53          |
| 1500–1999 (ref.) |         |        | 1.00| 1.00          | 1.00          |
| Admitted to NICU|            |            |     |               |               |
| Yes             | 119 (22.41)| 149 (29.30)| 0.94| 0.67          | 1.61          |
| No (ref.)       | 126 (23.73)| 143 (26.93)| 1.00| 1.00          | 1.00          |
| Having RDS      |            |            |     |               |               |
| Yes             | 196 (36.91)| 210 (39.55)| 0.69| 0.46          | 1.04          |
| No (ref.)       | 49 (9.23)  | 76 (14.31)| 1.00| 1.00          | 1.00          |

AGA, appropriate-for-gestational-age; AOR, adjusted OR; COR, crude OR; NICU, neonatal intensive care unit; RDS, Respiratory Distress Syndrome; SGA, small-for-gestational-age.
CONCLUSION

The percentage of SGA in this study was very high. Maternal pre-eclampsia considerably increases the risk of SGA in babies born <2000 g. Being born ELBW, having history of stillbirth and maternal pre-eclampsia, is associated with SGA births. The birth weight of the newborns should be improved. Additional nutritional supplementation is very essential during pregnancy to decrease SGA and increase placental weight. Pre-eclamptic mother should be given a due emphasis, (early diagnosis).

REFERENCES

1. Blencowe H, Krasevec J, de Onis M, et al. National, regional, and worldwide estimates of low birthweight in 2015, with trends from 2000: a systematic analysis. Lancet Glob Health 2019;7:e649–60.
2. WHO/UNICEF. Prematurity and low birth weight. WHO/UNICEF, 2009.
3. WHO. UNICEF-WHO low birthweight estimates: levels and trends 2000-2015. World Health Organization, 2019.
4. Lee ACC, Katz J, Blencowe H. National and regional estimates of term and preterm babies born small for gestational age in 138-income and middle-income countries in 2010. Lancet Glob Health 2013;1:e26–36.
5. de Onis M, Habicht JP. Anthropometric reference data for international use: recommendations from a world Health organization expert committee on child growth standards [Internet]. Am J Clin Nutr 1996;64:650–8.
6. Conde-Agudelo A, D’Souza S, Martines J, et al. Maternal nutrition and low birth weight: the use and interpretation of anthropometry in infants. Working group on infant growth. Bull World Health Organ 1995;73:165–74.
7. de Onis M, Blossner M, Villar J. Levels and patterns of intrauterine growth retardation in developing countries. Eur J Clin Nutr 1998;52 Suppl 1:S5–15.
8. Prada JA, Tsang RC. Biological mechanisms of environmentally induced causes of IUGR. Eur J Clin Nutr 1998;52 Suppl 1:S21–7, discussion S27.
9. Lawn JE, Blencowe H, Oza S, et al. Every newborn: progress, priorities, and potential beyond survival. Lancet 2014;384:188–205.
10. Monset-Couchard M, de Bethmann O, Relier J-P. Long term outcome of small versus appropriate size for gestational age co-twins/triplets. Arch Dis Child Fetal Neonatal Ed 2004;89:F310–4.
11. Lawn JE, Cousens S, Zupan J, et al. 4 million neonatal deaths: when? where? why? Lancet 2005;365:891–900.
12. Merchu O, Martin-Aguayo A, Uauy R, et al. Long-term metabolic risk among children born premature or small for gestational age. Nat Rev Endocrinol 2017;13:50–62.
13. Conde-Agudelo A, Diaz-Rossello JL. Kangaroo mother care to reduce morbidity and mortality in low birthweight infants. Cochrane Database Syst Rev 2016;3:CD003967.
14. Merson-Monfort C, de Bethmann O, Relier J-P. Long-term outcome of small versus appropriate size for gestational age co-twins/triplets. Arch Dis Child Fetal Neonatal Ed 2004;89:F310–4.
15. Lawn JE, Cousens S, Zupan J, et al. 4 million neonatal deaths: when? where? why? Lancet 2005;365:891–900.
16. Merchu O, Martin-Aguayo A, Uauy R, et al. Long-term metabolic risk among children born premature or small for gestational age. Nat Rev Endocrinol 2017;13:50–62.
17. Paul VK, Sachdev HS, Mavalankar D, et al. Reproductive health, and child health and nutrition in India: meeting the challenge. Lancet 2011;377:332–49.
18. Conde-Agudelo A, D’Souza S, Martines J, et al. Maternal nutrition and low birth weight: the use and interpretation of anthropometry in infants. Working group on infant growth. Bull World Health Organ 1995;73:165–74.
19. Lawn JE, Cousens S, Zupan J, et al. 4 million neonatal deaths: when? where? why? Lancet 2005;365:891–900.
20. Merchu O, Martin-Aguayo A, Uauy R, et al. Long-term metabolic risk among children born premature or small for gestational age. Nat Rev Endocrinol 2017;13:50–62.
21. Conde-Agudelo A, Diaz-Rossello JL. Kangaroo mother care to reduce morbidity and mortality in low birthweight infants. Cochrane Database Syst Rev 2016;3:CD003967.
22. WHO. Every newborn: an action plan to end preventable deaths. Geneva: World Health Organisation, UNICEF, 2014.
23. Mony PK, Tadele H, Gobezayehu AG, et al. Scaling up kangaroo mother care in Ethiopia and India: a multi-site implementation research study. BMJ Glob Health 2021;6:e005905.
24. Estifanos AS, Haile Mariam D, Fikre A, et al. Implementation science to design, test and scale up effective kangaroo mother care in Oromia region, Ethiopia. Acta Paediatr 2022. doi:10.1111/apa.16413. [Epub ahead of print: 12 Jun 2022].
25. Katz J, Wu LA, Mullany LC, et al. Prevalence of small-for-gestational-age and its mortality risk varies by choice of birthweight-for-gestation reference population. PLoS One 2014;9:e92074.
26 Cheng Y, Leung TY, Lao T, et al. Impact of replacing Chinese ethnicity-specific fetal biometry charts with the INTERGROWTH-21st standard. BMJ Open 2016;123 Suppl 3:48–55.

27 Villar J, Cheikh Ismail L, Victoria CG, et al. International standards for newborn weight, length, and head circumference by gestational age and sex: the newborn cross-sectional study of the INTERGROWTH-21st project. Lancet 2014;384:857–68.

28 McCowan L, Horgan RP. Risk factors for small for gestational age infants. Best Pract Res Clin Obstet Gynaecol 2009;23:779–93.

29 Chen S, Zhu R, Zhu H, et al. The prevalence and risk factors of preterm small-for-gestational-age infants: a population-based retrospective cohort study in rural Chinese population. BMC Pregnancy Childbirth 2017;17:237.

30 Muhhi A, Sudfeld CR, Smith ER, et al. Risk factors for small-for-gestational-age and preterm births among 19,269 Tanzanian newborns. BMC Pregnancy Childbirth 2016;16:110.

31 Davey DA, Macgillivray I. The classification and definition of the hypertensive disorders of pregnancy: proposals submitted to the International Society for the study of hypertension in pregnancy. Clin Exp Hypertens B 1986;5:97–133.

32 Kintiraki E, Papakatsika S, Kotrotsou G, et al. Pregnancy-Induced hypertension. Hormones 2015;14:211–23.

33 Lango MO, Horn AR, Harrison MC. Growth velocity of extremely low birth weight preterms at a tertiary neonatal unit in South Africa. J Trop Pediatr 2013;59:79–83.

34 Gautam Paudel P, Sunny AK, Gurung R, et al. Prevalence, risk factors and consequences of newborns born small for gestational age: a multisite study in Nepal. BMJ Paediatr Open 2020;4:e000607.

35 Kozuki N, Katz J, Lee ACC, et al. Short maternal stature increases risk of small-for-gestational-age and preterm births in low- and middle-income countries: individual participant data meta-analysis and population attributable fraction. J Nutr 2015;145:2542–50.

36 Ota E, Ganchimeg T, Morisaki N, et al. Risk factors and adverse perinatal outcomes among term and preterm infants born small-for-gestational-age: secondary analyses of the WHO Multi-Country survey on maternal and newborn health. PLoS One 2014;9:e105155.

37 Kaufmann P, Blaske S, Huppertz B. Endovascular trophoblast invasion: implications for the pathogenesis of intrauterine growth retardation and preeclampsia. Biol Reprod 2003;69:1–7.

38 Odéglârd RA, Vatten LJ, Nilsen ST, et al. Preeclampsia and fetal growth. Obstet Gynecol 2000;96:950–5.

39 Srivivas SK, Edlow AG, Neff PM, et al. Rethinking IUGR in preeclampsia: dependent or independent of maternal hypertension? J Perinatol 2009;29:680–4.

40 Zeitlin J, Saulel-Cubizolles M-J, De Mouzon J, et al. Fetal sex and preterm birth: are males at greater risk? Hum Reprod 2002;17:2762–8.

41 Hall MH, Carr-Hill R. Impact of sex ratio on onset and management of labour. Br Med J 1982:285:401–3.

42 McGregor JA, Leff M, Orleans M, et al. Fetal gender differences in preterm birth: findings in a North American cohort. Am J Perinatol 1992:9:43–8.

43 Rai RK, Sudfeld CR, Barik A, et al. Sociodemographic determinants of preterm birth and small for gestational age in rural West Bengal, India. J Trop Pediatr 2019;65:537–46.

44 Malacova E, Regan A, Nassar N, et al. Risk of stillbirth, preterm delivery, and fetal growth restriction following exposure in a previous birth: systematic review and meta-analysis. BJOG: Int J Obstet Gynaecol 2018;125:183–92.

45 Ferrazzi S, Caruso A, De Carolis S, et al. Proteinuria and outcome of 444 pregnancies complicated by hypertension. Am J Obstet Gynecol 1992;166:366–71.

46 Bhatia RK, Bottoms SF, Saleh AA, et al. Mechanisms for reduced colloid osmotic pressure in preeclampsia. Am J Obstet Gynecol 1987;157:106–8.

47 MacGillivray I. Pre-Eclampsia: the hypertensive disease of pregnancy. WB Saunders Company, 1983.

48 Gruenwald P. Growth of the human fetus, II. abnormal growth in twins and infants of mothers with diabetes, hypertension, or isomunization. Am J Obstet Gynecol 1966;94:1120–22.

49 Fraser IS, Weisberg E. Fertility following discontinuation of different methods of fertility control. Contraception 1982;26:389–415.