Maternal and Child Health Journal (2021) 25:1296–1304
https://doi.org/10.1007/s10995-021-03147-x

Association Between Household and Maternal Socioeconomic Factors with Birth Outcomes in the Democratic Republic of Congo and South Africa: A Comparative Study

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Accepted: 19 April 2021 / Published online: 4 May 2021

Abstract

Objective To assess and compare the associations between household socioeconomic (SES) factors with birth outcomes (low birth weight (LBW), small-for-gestational age (SGA) and preterm birth (PTB)) in the Democratic Republic of Congo (DRC) and South Africa (SA).

Methods Cross-sectional data of mother-newborn pairs collected in 2017 in the DRC were compared with mother-newborn pairs data from the SA Soweto first 1000-days pregnancy cohort study (2013–2016). Country-specific and pooled multivariable logistic regressions analyses assessed the associations between maternal education, marital status, and housing with LBW, SGA, and PTB adjusted for maternal anthropometry and obstetric factors.

Results 1084 mother-newborn pairs were recruited (DRC: 256; SA: 828). The rates of LBW, PTB and SGA were, 11.5%, 17.1% and 32.8% in the DRC and 15.9%, 10.5% and 20.1% in SA. SES factors differed between countries and sex. In the DRC, being married decreased the odds of having LBW and PTB children by 86% and 80%, respectively. In SA, being a mother with secondary level of education and above was associated with 86% reduced odds of SGA. In the pooled analyses, women with secondary level of education and above had a 2.2-fold increase in odds of giving birth to a PTB newborn. Country of residence and maternal nutritional status were stronger predictors of birth outcomes than SES factors.

Conclusion for Practice In sub-Saharan Africa, policies aiming to alleviate women's education combined with improved social support and household SES prior to and during pregnancy are critical to optimal neonatal outcomes and strategic to achieve the Sustainable Development Goals.

Keywords Socioeconomic factors · Birth outcomes · Democratic Republic of Congo · South Africa

Significance

What is known? In sub-Saharan Africa, lower household and maternal socioeconomic status (SES) (lower level of maternal education level and household poverty) is associated with adverse birth outcomes such as low birth weight, small-for-gestational-age and preterm birth, key predictors of poor population health and human capital. However, disparities in socioeconomic development between countries of the sub-Saharan Africa region may mitigate these associations, and the respective contributions of maternal socioeconomic factors versus biological factors are yet to be disentangled.

What findings does this study add? By comparing data from a low-income country (the Democratic Republic of Congo) with a middle-income country (South Africa) in

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sub-Saharan Africa, this study brings evidence that maternal marital status and housing may affect differently birth outcomes depending of the country's socioeconomic context, while maternal education remains a strong predictor of birth outcomes. In addition to the country of residence, this study shows that maternal nutritional status prior to and during pregnancy may have a stronger effect than SES factors on birth outcomes and mitigate these relationships.

Introduction

Poverty is associated with maternal undernutrition, adverse birth outcomes and poor human capital (Victora et al., 2008). Low birth weight (LBW), small for gestational age (SGA) and preterm birth (PTB) have been shown to be strong predictors of high morbidity and mortality during infancy, and have increased risk for chronic diseases in adulthood (Blencowe et al., 2019). Birth outcomes reflect disparities in sociological and economic categories of individuals or groups (Chawanpaiboon et al., 2018). The United International Children's Emergency Fund's (UNICEF) conceptual framework of maternal and child undernutrition identified poor maternal and household socioeconomic factors (SES) as critical determinants of birth outcomes (Black et al., 2013).

Birthweight (BW) is the first postnatal measurement indicating newborn growth and nutritional status, whilst LBW has been used as an indicator of impaired intra-uterine growth (UNICEF & WHO, 2019). Maternal undernutrition contributes to LBW (Fraser & Abu-Saad, 2010), whilst other maternal factors such as age (Campbell et al., 2012), diet (Chia et al., 2019), anthropometric indicators (Black et al., 2013), infection (Victora et al., 2008) and chronic conditions (e.g. hypertension, diabetes) (Victora et al., 2008), obstetrical conditions and parity(Muula et al., 2011), lifestyle (smoking and alcohol use) (Campbell et al., 2012; Chen, 2012) and access to prenatal health care (WHO, 2016) predict BW. Birth weight is closely related to gestational age at birth, which also has been associated with maternal mental and physical health during pregnancy, and foetal distress (Victora et al., 2008).

The association between SES factors and birth outcomes has been widely documented in high-income countries (Campbell et al., 2012; Wilding et al., 2019)) contrasting with sub-Saharan Africa (SSA) where the prevalence of newborns with LBW, PTB and SGA is amongst the highest worldwide at 14.6% (20.5 million) (UNICEF et al., 2019), 10.6% (14.84 million), (Chawanpaiboon et al., 2018) and 19.3% (23.3 million) (Lee Anne et al., 2017), respectively. Studies in SSA are scarce and poor birth outcomes have been associated with poor maternal education, unemployment, and household economic deprivation, as highlighted in a recent systematic review (Ngandu et al., 2019). Women with a high level of education are more likely to have better job opportunities and an income than their counterparts with a lower educational level, thus enabling easier and informed access to health information and health care for themselves and their children (Silvestrin et al., 2013). The role of marital status in birth outcomes has not yet been investigated in SSA (Ngandu et al., 2019).

However, it is important to consider that the SSA region comprises low-income (e.g. the Demographic Republic of the Congo, DRC) and middle-income (e.g. South Africa) countries with different social, cultural and political contexts. In 2018, the DRC had a lower human development index (HDI) (0.37) and a weaker gross domestic product (GDP) per capita ($US 808) than SA which had a medium HDI (0.41) and $US 12,215 per capita GDP (World Bank, 2019). The poverty level in the DRC was higher than that of SA with the percentage of the population living on less than US$ 1.90 per day being 73% and 18.8%, respectively (World Bank, 2019). However, social inequality, measured by the Gini coefficient was higher in SA (63%) than in the DRC (42.1%) (World Bank, 2019). The aim of this study was, therefore, to assess and compare the associations between household and maternal demographic and SES factors, and adverse birth outcomes (LBW, PTB and SGA) in two socioeconomically contrasting countries in SSA namely, SA and the DRC.

Methods

Study Design and Setting

This study included mother and newborn pairs living in rural and urban areas of the DRC and an urban area of SA. In the DRC, the cross-sectional study was conducted in Kasai central province, in which six out of the 26 health districts are urban. Data were collected from one urban hospital (Kananga Provincial hospital) and three rural hospitals (Mikalayi, Bunkonde, Tshikula).

For secondary analyses, South African data were collected as part of the Soweto First 1000 Days cohort (S1000) study undertaken at the Chris Hani Baragwanath Academic Hospital (CHBAH) in Soweto, Johannesburg. The S1000 study investigated the associations between maternal factors with foetal and newborn nutritional status and explored the levers of maternal and child health within the first 1000 days of life in Soweto, which is an urban-poor area in South Africa (Wrottesley et al., 2017).

Ethics Approval

The DRC study was approved by the Centre National d'Ethique of the DRC (clearance number 046/CNES/BN/PNMF/2016). The S1000 study in South Africa was approved by the Human Research Ethics Committee of the University of Witwatersrand, South Africa (clearance numbers M120524 and M130905). Written informed consent was obtained from mothers in both studies.

Participants

In the DRC, a two-stage cluster sampling was used. We first selected 4 districts out of 26 in the province in proportion to the number of rural and urban health districts within the province. Mother-newborn pairs were recruited in 4 selected hospitals between August 2016 and January 2017. In each hospital, we included post-partum mothers (72 h after delivery) with their healthy, singleton child, born after 28 weeks of pregnancy.

In SA, mother-newborn pairs were recruited at the CHBAH between 2013 and 2016. Eligibility criteria included healthy pregnant women older than 18 years, less than 18 weeks of pregnancy, with a singleton newborn, residing in Soweto (Macaulay et al., 2018). Follow up data were collected at participant homes at 6 time points: before 14 weeks, 15–19 weeks, 20–23 weeks, 24–28 weeks, 29–33 weeks and 34–38 weeks (Wrottesley et al., 2017).

Variables

Exposure: Household and Maternal Demographic and Socioeconomic Factors

Data on maternal education, maternal marital status and the type of house walls within which mothers lived were collected using interviewer-administered questionnaires adapted from the Demographic Health Survey questionnaires (Ayad et al., 1994). Maternal education was the level of education completed by the time of delivery. Maternal education was aggregated into two categories for analyses: none plus primary education vs. secondary education and above. Maternal marital status was defined as the legal marital status (single, married, widowed, divorced) and then aggregated into two categories: married vs. unmarried. The type of house walls was categorised as: walls constructed using durable materials (bare bricks, cement block, plaster finished) vs. walls constructed using non-durable materials (plastic, cardboard, mud, corrugated iron/zinc).

Birth Outcomes

Birth weight was measured using digital scales (Salter in the DRC; Seca 376 in SA) to the nearest 100 g with babies wearing no clothes (Macaulay et al., 2018). The scales were calibrated daily to ensure the reliability and accuracy of the measurements. Gestational age at birth was measured in weeks of pregnancy between the last menstrual period (LMP) and the date of delivery in the DRC and by dating ultrasound (Philip HD-9, USA) in SA (Macaulay et al., 2018). Classification of newborns was as follows: LBW (BW < 2500 g), SGA (BW < 10th percentile of the INTERGROWTH 21st standard curve), and PTB (birth before 37 gestational weeks) (Chawanpaiboon et al., 2018; Lee Anne et al., 2017; UNICEF & WHO, 2019).

Covariates

Newborn factors were the child sex (male or female) and birth weight. Maternal factors included age, height and weight according to the WHO guidelines (WHO, 2008). Maternal weight (kilogram) and height (centimetre) were measured using a digital scale to the nearest 100 g and an adult stadiometer, respectively (Macaulay et al., 2018). Interviewer-administered questionnaires were used in the DRC and in SA to obtain data on gestational age at the first prenatal visit (in weeks of pregnancy), gestational weight gain per week (GWG) (in kilograms per week of pregnancy) and parity (number of previous deliveries), maternal morbidity during pregnancy (including high blood pressure, malaria, anaemia, tuberculosis), smoking status (yes or no) and prenatal alcohol consumption (yes or no). Maternal morbidity was categorised as a binary score (disease vs no disease).

Study Sample Size

In the DRC, 256 mother-newborn pairs were included in the study after calculating to detect a 10% difference from the baseline LBW prevalence found in the literature (WHO, 2014) with 80% of power ($\alpha < 0.05$ significance). Low birth weight was used for sample size calculation because it includes PTB and SGA (WHO, 2014). In SA, data of 828 mother-newborn pairs were included in the secondary analyses.

Statistical Analyses

For each variable, a descriptive analysis was done grouped by sex. Summary statistics included proportions, means and standard deviation, or median and range. Shapiro, Skewness and Kurtosis tests were performed to identify the type of distribution for each variable. Differences by sex and by country were assessed using a Pearson's chi squared test, or an independent t-test. Multivariable logistic regression analyses and modelling were done to identify factors associated with birth outcomes. Maternal weight at first prenatal visit was excluded from multivariable regression models due to collinearity with maternal weight at delivery (variation inflation factors, $r = 0.96$). Maternal smoking was excluded from the analyses due to its small rate (< 10%) in the DRC.

For each model setting, associations between household and maternal sociodemographic and SES factors with birth outcomes were assessed. Model 1 (M1) investigated the association between SES factors (maternal education, maternal marital status and type of house walls) and birth outcomes adjusted for newborn sex. In the Model 2 (M2), M1 was adjusted for maternal characteristics (maternal height, maternal age, type of delivery, gestational age at first prenatal visit, GWG, maternal weight at delivery, maternal morbidity score and maternal lifestyle). In Model 3 (M3), M2 was adjusted for the country. Finally, multivariable logistic regression models were performed by pooling the DRC and SA data. This last model consisted of two models adjusted for the country. The significance level was set as $p \leq 0.05$ with 95% confidence intervals. Stata version 13 (StataCorp LP, College station, TX, the USA) was used for data management and analyses.

Results

A total of 1084 women-newborn pairs were included in the study (the DRC: 256; SA: 828) (Table 1). In comparison to SA women, a greater number of the DRC women had a lower level of education (SA: 2.1%; the DRC: 54.6%), were married (SA: 37.7%; the DRC: 94.8%) and were living in houses constructed of non-durable materials (SA: 13.2%; the DRC: 76.9%). The rates of LBW and SGA were lower in the the DRC (LBW: 11.3%; SGA: 10.1%) than in SA (LBW: 17.1%; SGA: 20.2%). The rate of PTB in the DRC (32.8%) was almost double that of SA (15.9%). Child sex-differences were found for maternal education, type of house in the DRC, and marital status in SA. With the exception of maternal age at delivery, household, maternal, newborn and lifestyle characteristics differed significantly between the DRC and SA. The DRC women were taller, had higher parity and later first prenatal visit, weighed less at delivery, smoked less and consumed more alcohol during pregnancy, compared to SA women. However, in both countries, the majority of women presented with morbidity conditions during pregnancy (the DRC: 78%; SA: 66.3%) and most women had a vaginal delivery (the DRC: 89.7%; SA: 58.1%).

Bivariate analyses (Supplementary Table 1) showed that maternal education and type of house were not associated with birth outcomes in the DRC. The odds of LBW decreased by 9% for every kilogram increase in maternal weight at first prenatal visit and by 63% for morbidity during pregnancy. The odds of PTB decreased by 72% for married women and by 7% for every week of delay in the first prenatal visit but increased 2.3-fold with smoking during pregnancy. The odds of SGA decreased 7% with every centimetre increase in maternal height but increased by 12% with every week of delay in the first prenatal visit.

Regression analyses adjusted for newborn and maternal characteristics were performed per country (Supplementary Table 3). After adjusting for newborn and maternal characteristics, being married was associated with 83% and 79% decreased odds of LBW and PTB, respectively. Having a secondary level of education or higher decreased the odds of SGA by 86%. In SA, no significant association between household and maternal demographic and SES factors with birth outcomes were found in the bivariate analyses nor in the regression analyses adjusted for newborn and maternal characteristics (Supplementary Tables 1 and 3). In bivariate analyses (Supplementary Table 1), a kilogram increase in maternal weight at first prenatal visit and a kilogram increase in GWG were associated with a 2% and 87% decrease in the odds of LBW, respectively. The odds of LBW increased by 3%, 27% and 57% with a one-year increase in maternal age, a unit increase in parity and having a vaginal delivery, respectively. For every centimetre increase in maternal height, for every kilogram increase in maternal weight at delivery, the odds of SGA decreased by 4% and 3%, respectively. For every kilogram increase in GWG, the odds of having PTB decreased by 63%. For every unit increase in parity and vaginal delivery there was a 20% and 74% increase in the odds of PTB, respectively. Maternal education was associated with PTB, marital status with LBW and SGA and, type of house walls with PTB and SGA (supplementary Tables 2).

In the pooled analyses adjusted for newborn and maternal characteristics, and country (Table 2), maternal education, marital status and type of house walls were associated with birth outcomes. Having higher than secondary level of education increased the odds of PTB 2.2-fold. Being legally married decreased the odds of LBW and PTB by 45% and 38%, respectively. Living in a house with durable walls decreased the odds of PTB by 39% but increased that of SGA by 92%. After adjusting for country, the odds for women with secondary level of education and above with PTB increased 2.21-fold. Maternal height, gestational age at the first prenatal visit, maternal weight at delivery and GWG confounded the association between SES with LBW. Parity, vaginal delivery, maternal weight at delivery confounded the association between SES and PTB. Child sex, parity, maternal weight at the first prenatal visit and at delivery confounded the association between SES with SGA. Gestational age at the first prenatal visit confounded the association between SES and LBW, PTB and SGA.

Table 1 Comparative characteristics of the participants in the Democratic Republic of Congo and in South Africa

		Democratic Republic of Congo (N = 256)					South Africa (N = 828)					DRC vs SA (p)
		Male (n = 187)	Female (n = 69)	P	Total		Male (n = 429)	Female (n = 397)	p	Total		
		%	%		n	%	%	%		n	%	
SES factors												
Maternal education	None + Primary	50.5	65.7	**0.03**	136	54.6	1.9	2.3	0.68	17	2.1	**< 0.01**
	Secondary + tertiary	49.5	34.3		113	45.4	98.1	97.7		809	97.9	
Maternal marital status	Unmarried (Single/widowed/divorced)	4.9	6	0.75	13	5.2	58.7	66.3	**0.03**	515	62.3	**< 0.01**
	Married	95.1	94		236	94.8	41.3	33.7		311	37.7	
Type of house	Non-durable materials	72.2	89.5	**< 0.01**	190	76.9	13.8	12.6	0.63	94	13.2	**< 0.01**
	Durable materials	27.8	10.5		57	23.1	86.2	87.4		616	96.8	
Birth outcomes												
Birthweight (mean, SD)	Kilogram	3.2 (0.5)	3.1 (0.4)	0.9	222	3.2 (0.3)	3.0 (0.6)	2.9 (0.6)	**0.05**	789	2.97 (0.6)	**< 0.01**
GA at delivery (mean, SD)	Weeks of pregnancy	37.0 (3.5)	36.2 (3.5)	0.12	235	36.6 (0.3)	38.0 (2.5)	38.2 (2.3)	**0.05**	826	38.1 (2.5)	**< 0.01**
LBW (%)	Yes	12.4	8.8	0.40	222	11.3	15.6	18.7	0.25	789	17.1	**0.03**
PTB (%)	Yes	29.2	41.8	0.06	235	32.8	16.6	15.1	0.56	812	15.9	**< 0.01**
SGA (%)	Yes	13.3	10.1	0.08	211	10.1	17.1	23.4	**0.03**	789	20.2	**< 0.01**
Maternal and newborn characteristics												
Parity (median, range)	Number of deliveries	3.9 (2–7)	3.7 (2–5)	0.95	236	3.0 (0–10)	2 (0–7)	2 (0–9)	0.99	826	2.0 (0–5)	**< 0.01**
Delivery (%)	C-section	10.8	9.1	0.70	25	10.3	41	42.8	0.59	340	41.9	**< 0.01**
	Vaginal	89.2	90.9		217	89.7	59	57.2		472	58.1	**< 0.01**
Maternal age at delivery (mean, SD)	Years	27.8 (7.9)	26.5 (6.5)	0.57	256	27.5 (0.5)	29.5 (5.8)	30.2 (6.0)	0.76	826	29.8 (5.9)	**0.57**
Maternal height (Mean, SD)	Centimetre	161.1 (7.5)	160.6 (7.6)	0.57	253	160.9 (7.3)	158.8 (6.7)	158.7 (6.8)	0.62	826	158.8 (6.7)	**< 0.01**
GA at the first prenatal visit (mean, SD)	Weeks of pregnancy	18.3 (5.9)	16.4 (5.2)	0.12	236	17.8 (0.4)	12.4 (2.4)	12.4 (2.6)	0.95	826	99.8	**< 0.01**
Duration between first prenatal visit and delivery (mean, SD)	Weeks of pregnancy	18.6 (6.1)	19.8 (5.9)	0.4	232	18.9 (6.1)	25.6 (3.4)	25.8 (3.5)	0.36	812	25.0 (6.1)	**< 0.01**
Maternal weight at the first prenatal visit (mean, SD)	Kilogram	58.2 (7.2)	56.1 (6.2)	0.45	235	57.6 (7.0)	70.8 (15.0)	71.9 (17.3)	0.99	826	71.3 (16.2)	**< 0.01**
Maternal weight at delivery (mean, SD)	Kilogram	62.5 (7.7)	60.8 (6.2)	0.45	242	61.8 (0.5)	78.8 (14.9)	79.7 (16.8)	0.99	825	79.2 (15.8)	**< 0.01**
Gestational weight gain per week (mean, SD)	Kilogram per week	0.3 (0.7)	0.4 (0.8)	0.2	226	241 (24)	0.3 (0.3)	0.3 (0.2)	0.98	826	290 (27)	**0.01**
Smoking (%)	Yes	6.1	7.8	0.64	16	6.6	8.6	8.6	0.96	71	8.6	**< 0.01**
Alcohol use (%)	Yes	30.1	37.9	0.27	71	32.1	12.4	10.2	0.37	78	11.3	**< 0.01**
Morbidity score (Score)	No morbidity	13.9	21.7	0.1	41	16	32.4	35	0.43	278	33.7	**< 0.01**
	Morbidity or co-morbidity	86.1	78.3		215	84	67.6	65		548	66.3	

Discussion

Main Findings

It is clear from the findings of this study that local/regional context matters when assessing the association between maternal and household socioeconomic and household factors and birth outcomes in sub-Saharan Africa. Living in SA as compared to the DRC was associated with reduced odds of a newborn with LBW, PTB or SGA, which reflects country-specific maternal and household resources and social position differences (education access, housing, marriage). In the DRC, being married decreased the likelihood of having LBW and PTB children while in SA being a mother with secondary level of education and above was associated with lower risks of having a SGA newborn. Furthermore, findings from the pooled analyses support that maternal education is a critical determinant of birth outcomes across SSA countries.

Maternal Education, Maternal Marital Status and Type of House Walls, and Birth Outcomes

To our knowledge, this study is among few that explore the association between marital status and birth outcomes in SSA. Whilst support from biological fathers may contribute to greater household income allowing access to health care and food security which benefit maternal and child health (Lekea-Karanika et al., 1999); these positive influences may be mitigated by factors such as domestic violence (Shah & Shah, 2010) or changing partners between two births increased the risk of having LBW and PTB newborn in Norwegian women with more than 14 years of education (Vatten & Skjaerven, 2003). Collectively, these above studies emphasize that cross-country comparisons of associations between marital status and birth outcomes must be interpreted with caution, considering the social structure, performance and quality of pre- and post-natal health care as well as the cultural contexts specific to each country. We used the type of house wall material within which participants resided as a proxy for social position and household wealth, better social position (i.e. living in a house with durable walls) decreased the risk for PTB but increased that of SGA in the pooled dataset.

Our findings also corroborate those of others which found that a lower level of maternal education was associated with LBW in SSA countries (Ngandu et al., 2019) and in Latin America (Silvestrin et al., 2013), and with SGA, PTB and LBW in high-income countries (Campbell., 2018). In the United Kingdom, a poor level of maternal education and unemployment was associated with a higher risk of SGA, which was greater in single compared to married women (Wilding et al., 2019). We found that maternal education had the strongest association with birth outcomes compared to other SES factors. This is consistent with a previous review which found that maternal education rather than maternal income was associated with birth outcomes in high income countries (Cantarutti et al., 2017), where health systems (with/without universal health care coverage), locality and income (Luo et al., 2006) contrast with the LMICs context.

Other Maternal and Child Factors with Birth Outcomes

In our study, maternal and newborn biological factors (child sex, parity, maternal age at delivery, maternal height, gestational age at first prenatal visit, GWG and maternal morbidity during pregnancy) were associated with the birth outcomes of interest independently of demographic and SES factors. Maternal height, parity, weight pre-pregnancy, and GWG was negatively associated with the risk of having a LBW, PTB or SGA newborn, reflecting the importance of maternal nutritional status during preconception and pregnancy periods. Gestational weight gain has been associated with dietary intake and physical activity in SA women (Wrottesley et al., 2017). In the S1000, previous analyses have shown that mothers consuming an energy dense diet (sugar and fat foods) during pregnancy was associated with greater GWG while maternal traditional diet (beans, legumes, traditional meats and porridge) was associated with adequate GWG (Wrottesley et al., 2017). A review conducted in London showed that maternal nutritional status and quality of maternal dietary intake in the life course affected the strong association between SES factors with LBW and PTB; maternal nutrition was rather correlated to the quality of diet in the poorest populations in comparison to their richest counterparts (Fraser & Abu-Saad, 2010). A meta-analysis in high-income countries showed that a higher GWG was associated with increased risks of PTB (McDonald et al., 2011) however, two recent reviews (in Peru, Korea, China, Japan, Italy, Denmark and USA) found that women with a higher total GWG (above Institute of Medicine's guidelines) had a lower risk of having a LBW, SGA or PTB newborn (Faucher et al., 2016; Goldstein et al., 2017).

Surprisingly, we found that maternal morbidity during pregnancy was protective against LBW. This may be attributed to women who are aware of their health conditions being more likely to have their health monitored more closely throughout pregnancy (Momplaisir et al., 2015). Earlier first prenatal visit played a confounder role in the association between maternal marital status and PTB in our findings. Prenatal alcohol use played a confounding role in

Table 2 Multivariable logistic regression analyses of SES factors and birth outcomes (LBW, PTB and SGA) in the pooled dataset from the Democratic Republic of Congo and South Africa

		LBW M3, n = 817, AOR (95% CI)	PTB M3, n = 850, AOR (95% CI)	SGA M3, n = 817, AOR (95% CI)
SES factors				
Maternal education	None + Primary	Ref	Ref	Ref
	Secondary + tertiary	0.74 (0.27–1.99)	2.21 (1.07–4.59)**	0.77 (0.36–1.65)
Maternal marital status	Unmarried (Single/widowed/divorced)	Ref	Ref	Ref
	Married	0.75 (0.45–1.24)	0.81 (0.50–1.32)	0.99 (0.66–1.50)
Type of house walls	Non- durable materials	Ref	Ref	Ref
	Durable materials	1.07 (0.55–2.06)	0.61 (0.36–1.04)*	1.48 (0.83–2.62)
Newborns characteristics				
Sex	Male	Ref	Ref	Ref
	Female	1.11 (0.71–1.74)	1.32 (0.87–1.99)	1.33 (0.92–1.93)
Maternal characteristics				
Parity	Number of deliveries	1.19 (1.03–1.37)**	1.12 (0.99–1.26)*	0.92 (0.80–1.07)
Type of delivery	C-section	Ref	Ref	Ref
	vaginal	1.26 (0.76–2.07)	1.97 (1.22–3.15)***	0.98 (0.66–1.47)
Age at delivery	Years	1.02 (0.99–1.06)	1.01 (0.98–1.05)	1.02 (0.99–1.05)
Height	Centimetre	1.01 (0.97–1.05)	1.02 (0.99–1.06)	0.97 (0.94–0.99)**
GA at the first prenatal visit	Weeks of pregnancy	0.65 (0.59–0.73)***	0.93 (0.89–0.98)**	1.14 (1.03–1.26)**
Duration between first prenatal visit and delivery	Weeks of pregnancy	0.61 (0.56–0.67)***	0.72 (0.68–0.77)***	1.11 (1.01–1.21)**
Weight at delivery	Kilogram	0.97 (0.95–0.99)***	0.99 (0.97–1.00)*	0.97 (0.95–0.98)***
Gestational weight gain per week	Kilogram per week	0.48 (0.15–1.52)	0.21 (0.07–0.61)***	0.94 (0.54–1.65)
Alcohol use during pregnancy	Yes	0.89 (0.49–1.62)	0.59 (0.32–1.11)	1.35 (0.78–2.32)
Morbidity score	No morbidity	Ref	Ref	Ref
	Morbidity or co-morbidity	0.55 (0.34–0.89)**	0.94 (0.60–1.49)	0.87 (0.58–1.29)
Country				
	DRC	Ref	Ref	Ref
	SA	16.1 (4.81–53.88)***	3.72 (1.51–9.15)***	2.44 (1.00–5.94)**

AOR adjusted odds ratio, *DRC* Democratic Republic of Congo, *GA* gestational age, *SA* South Africa

*: $0.05 < p \leq 0.1$, **: $0.01 < p \leq 0.05$, ***: $p \leq 0.01$; M1 (not shown in the table) = SES factors + child sex, M2 (not shown in the table) = M1 + Newborn and maternal characteristics, M3 = M2 + country

our study. Prenatal alcohol exposure was associated with early behavioural birth outcomes (mental disorders) rather than LBW outcomes in China (Chen, 2012). In contrast, fewer prenatal visits (no visit or < 5 visits) was associated with 5.4-fold and 9.1-fold increased odds of LBW and PTB, respectively, after adjusting for maternal level of education, younger maternal age, smoking and alcohol use in a study in Finland (Raatikainen et al., 2007).

Our findings show that the effect sizes of maternal biological factors on birth outcomes were larger than those of socioeconomic factors, which is in keeping with other studies that have suggested using maternal undernutrition as a marker of poor birth outcomes (Fraser & Abu-Saad, 2010; Victora et al., 2008) regardless of the type of delivery (Han et al., 2011).

Limitations

The estimate of gestational age using LMP may be less accurate (sensitivity and predictive value) than the ultrasound method in the first trimester compared to the last trimester (Hoffman et al., 2008). Inadequate housing may contribute to poorer child health and nutritional status (WHO, 2018). Other related SES and environmental factors such as water, sanitation and hygiene, should also be investigated in future studies to disentangle their role on birth outcomes.

Implications

Social policies should protect single women socially and economically before, during and after pregnancy to improve birth outcomes and to optimize their intergenerational influences. More context-specific mixed-methods studies in SSA that focus on effectiveness of policies and intervention programs in the field to disentangle the role of proximal factors (maternal and paternal biological factors, maternal and household sociodemographic and socioeconomic factors) from the role of distal country factors (governance, health policy and system) is needed.

Conclusion

There are disparities between SA and the DRC with respect to the associations between household and maternal SES and birth outcomes. Maternal education and marital status were associated with birth outcomes in SSA while maternal biological and country factors (socioeconomic development, governance and health systems) underpin individual and household capabilities. These are all potential levers to affect positive pregnancy outcomes and address the Sustainable Development Goals.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10995-021-03147-x.

Acknowledgements We wish to thank participants and staff that helped us during the data collection period.

Author Contributions Conceptualization of the study: NBC, SAN, RSM; Data management, analyses and interpretation: NBC, DM, SAN; RSM. Integrity of data: CBN; RSM. Editing manuscript: AM. Writing and updating manuscript: CBN, DM, AM, SAN, RSM.

Funding This study was made possible through the support of the South African Medical Research Council by the Department of Science and Technology and the National Research Foundation (DST-NRF) for the Centre of Excellence in Human Development (SAN and RSM., Grant Number: ACC2017007) and by the DST-NRF for the Centre of Excellence in Food Security (DM and RSM, Grant Number: 160502).

Declarations

Conflict of interest Authors declare no conflict of interest.

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