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The association between household socio-economic status, maternal socio-demographic characteristics and adverse birth and infant growth outcomes in sub-Saharan Africa: a systematic review

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Abstract

Adverse birth outcomes and infant undernutrition remain the leading causes of morbidity and mortality in sub-Saharan Africa (SSA). Impaired infant growth and development, which often begins during foetal development, may persist during the first 2 years of life and has been associated with higher risks of cardiometabolic diseases. This systematic review assessed the associations between maternal demographic characteristics and household socio-economic status (SES), and preterm birth (PTB), small for gestational age, low birth weight (LBW), stunting, wasting and underweight in children under 2 years of age in SSA countries. Following the Preferred Reporting Items for Systematic reviews and Meta-Analyses guidelines, we searched for publications in three electronic databases (PubMed, Scopus and ScienceDirect). Eleven studies on children under 2 years of age, in four SSA regions, published in English between 1990 and 2018, were included. All the studies were observational in design (cross-sectional or cohort studies). Maternal education was the most commonly explored exposure. Most studies (63.3%) focused on undernutrition during the first 2 years of life: LBW, PTB and stunting. Lower maternal education, maternal unemployment and lower household wealth index were the SES factors most commonly associated with adverse birth outcomes and infant undernutrition. Maternal marital status was not associated with any infant outcomes. The definitions of the SES varied, which may explain discrepancies between studies. Nutrition intervention programs in SSA need to promote education and poverty alleviation in women at reproductive age, starting from pre-pregnancy, to optimise infant growth and development and prevent the increase in the prevalence of cardiometabolic diseases.

Introduction

Undernutrition in infants under 2 years of age remains a major public health issue, particularly in low- and middle-income countries (LMICs).[1,2] The 2011 United Nation Children's Fund (UNICEF) Global Nutrition report indicated that more than 311 million children (32% of all children) under 5 years of age were undernourished. Globally, more than four million children died within a year of their birth due to inadequate nutrition.[3] In addition, poor infant nutrition has been shown to be responsible for more than 40% of deaths in children younger than 5 years, particularly during their first month of life.[1] The adverse effects of infant undernutrition include physical disabilities,[4] poor school attendance,[1] diabetes,[1] hypertension and cardiovascular disease,[5] which may affect the subsequent generation.[1,6] Therefore, undernutrition may have negative long-term consequences for a country's economic growth and development.[3]

Sixty percent of all undernutrition occurs in sub-Saharan Africa (SSA) and South Asia.[3] The impact of undernutrition on child growth and development starts *in utero*. Maternal undernutrition has been associated with poor foetal growth,[1,7,8] which may result in low birth weight (LBW, weight at birth less than 2500 g),[1] small for gestational age (SGA, newborns weighing less than the 10th percentile of a sex-specific reference population) and preterm birth (PTB, children born before 37 gestational weeks).[3,9] In 2016, UNICEF reported that 15% (20 million) of newborns worldwide had LBW and 10% (15 million) PTB.[3] In 2010, 32.4 million newborns worldwide were SGA.[9] The prevalence of SGA was 27% in LMICs, with SSA having one of the highest prevalence.[9–11] Studies in LMICs have shown that LBW, SGA and PTB are the predictors

of infant undernutrition in children below the age of 2 years.[12–15] Undernourished infants may present with underweight (weight-for-age (WAZ) less than −2 standard deviation (−2SD) of the median of the World Health Organization (WHO) growth standard) or wasting (weight-for-height (WHZ) less than −2SD of the median of the WHO growth standard) which are sometimes combined with a third form of undernutrition, stunting (height-for-age (HAZ) less than −2SD of the median of the WHO growth standard).[1,3] Globally, among children under 5 years of age in 2011, 25.9% were stunted, 15.7% were underweight and 8% were wasted.[5,15] In 2016, Africa had the second largest prevalence (31.6%) of undernutrition in children under 5 years of age in the world, and the absolute number of affected children is continuing to increase.[3]

To formulate strategies to prevent and reduce maternal and infant undernutrition in SSA, a major public health concern in the region, it is critical to understand the contextual factors associated with LBW, PTB, SGA, stunting, wasting and underweight. The period between conception and 2 years of age, the first thousand days, has been shown to be an opportune time for interventions such as immunisation, deworming, nutrient supplementation (vitamin A, iodine) that optimise child growth and development.[16] However, the prevalence of undernutrition varies between SSA countries, probably due to different factors including socio-economic status (SES), cultural and political landscapes.[3] The UNICEF causal framework for maternal and child undernutrition, the first version of which was described in 1990, outlined that infant undernutrition is associated with basic, underlying and immediate factors.[3,17] Maternal demographic characteristics and socio-economic factors have been identified as basic causes of undernutrition.[3] Empirical studies in LMICs have reported associations between household and maternal demographic characteristics and SES factors with stunting in preschool children (between 2 and 5 years of age).[18] Maternal education,[19,20] maternal occupation,[21] household poverty[7,22,23] and marital status[18] have been shown to be associated with adverse birth outcomes and child undernutrition.[1] However, most studies in SSA report those associations in children under 5 years of age as a group, overshadowing evidence during the first thousand days period. In addition, the directions of the associations between the various SES factors and infant undernutrition are not consistent throughout the studies in SSA. Therefore, we undertook a systematic review of the literature to summarise the findings on the associations between maternal demographics and household SES factors and LBW, PTB, SGA, stunting, wasting and underweight in children under 2 years of age in SSA.

Methods

Protocol and registration

This systematic review followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines.[24,25] The protocol was registered under the International prospective register of systematic reviews (PROSPERO, https://www.crd.york.ac.uk/prospero/#myprospero, number CRD42018076828).

Eligibility criteria

We considered studies published between 1990 and June 2018, which investigated the associations between maternal socio-demographic characteristics and household SES factors with birth outcomes and nutritional status of children under 2 years of age, in 52 SSA countries (Supplementary sheet S1).

Data sources

Studies included in this review were obtained from three databases: PubMed, ScienceDirect and Scopus. For studies that were not sourced through these databases, we contacted the corresponding authors to request a copy of the original publication.

Search strategy and study selection

The following combination of category of keywords was used to search for eligible studies: maternal demographic characteristics and household SES factors (maternal education, maternal occupation, maternal marital status, maternal income and household wealth) and birth outcomes and child undernutrition (LBW or SGA or PTB or stunting or wasting or underweight or undernutrition) and 52 SSA countries. We sequentially screened titles, abstracts and the full text to identify studies that matched our inclusion and exclusion criteria. The study search and selection were performed separately by two co-authors (CBN and DM) and conflicts were resolved by a third co-author (RS-M).

Data

Maternal socio-demographic characteristics and household socio-economic factors

In accordance with the UNICEF conceptual framework,[3] we considered the following maternal socio-demographic characteristics and household SES factors: maternal education, maternal occupation, maternal income, maternal marital status and household wealth. Maternal education was measured as educational milestones, qualifications attained or literacy level.[26] In LMICs, repeating school years is considered the most appropriate measure for education level of individuals.[26] Maternal marital status referred to the civil status of each mother in relation to the marriage laws in the country under consideration.[27] Maternal income and maternal occupation in LMICs are more difficult to measure because of the presence of an informal economy, self-employment and seasonal activity. Similarly, occupation was measured by informal employment and domestic work.[26] Household wealth index (HWI) was based on ownership of a range of durable assets, household measures of SES characteristics or access to basic services such as health or education.[26]

Birth outcomes

The following birth outcomes were considered: LBW, SGA and PTB. PTB or prematurity was defined as a baby born before 37 completed gestational weeks or 259 days of pregnancy.[9,28] LBW was defined as birth weight less than 2500 g regardless of gestational age.[3] Newborns classified as SGA were defined as those whose birth weight was below the 10th percentile when compared to the 1991 US national reference population[29] or the WHO standard curve.[9,30]

Undernutrition in children between birth and 2 years of age

The following categories of undernutrition were considered: stunting, wasting and underweight. Stunting was defined as children with length-for-age/HAZ adjusted for sex, less than

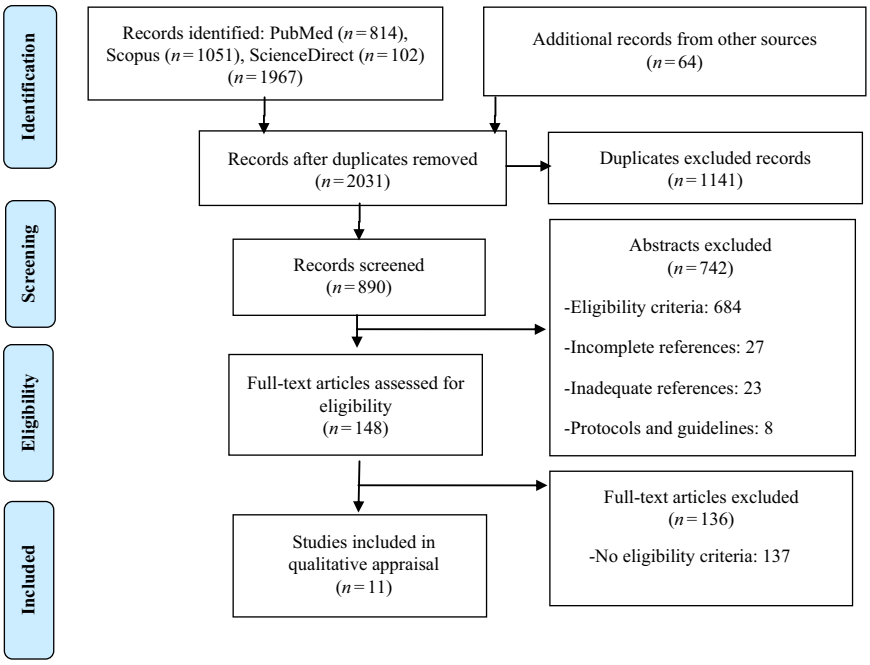

Fig. 1. Flow diagram on the association between demographic, socio-economic factors with birth and infant growth outcomes.

−2SD of the median of the WHO growth standard curve.[31] Wasting and underweight were defined as WHZ and WAZ less than −2SD of the median of the WHO growth standard curve, respectively.[31]

Synthesis of results

We extracted the following data from each study included in this systematic review: author names, year of publication, study aims, country, study design, study setting, participant's age, study sample size, SES factors, growth outcomes and quality of evidence.

Data collection process and summary measures

Data were extracted separately by two co-authors (BN and DM) and conflicts were resolved by a third co-author (RS-M). Data extraction was done independently by the first and second authors. Odds ratios (ORs) and/or adjusted odds ratios (aORs), relative risk and/or adjusted relative risk and related confidence intervals (CIs) were extracted for each association of interest.

Quality appraisal and risk of bias for primary studies

The quality of the studies included in this systematic review was assessed using the GRADE approach by two independent co-authors (BN and DM) with involvement of a third co-author (RS-M) when there was no consensus. Consensus was reached by two co-authors for five (45.4%) studies.[32–36] (Supplementary Table S2). Eight parameters were used to score the quality of each study: study design, risk of bias, inconsistency, indirectness, imprecision, publication bias, magnitude of effect, confounding and dose–response.[37] The quality of the studies was graded as follows: high (four points), moderate (three points), low (one point), and very low (zero points).

Risk of bias

The risk of bias was identified using the GRADE approach.[37,38] Studies were evaluated on three domains: recruitment of the participants (two criteria on randomisation), conduction of the study (one criterion on blinding) and the reporting of the study outcomes (two criteria). For each study, each criterion was rated as high, low or unclear. Studies were then categorised as being high risk (low rate in three or more characteristics), moderate risk (low rate in two characteristics), low risk or very low risk (low rate in less than two characteristics).

Quantitative analysis

A meta-analysis was not conducted in this systematic review as the definitions of SES factors varied across studies. In addition, for studies for which we could harmonise definitions of SES factors (maternal education and marital status), critical data necessary for the meta-analyses were not available in the published manuscript and could not be retrieved by contacting the authors.

Results

Description of studies

The processes of search, selection, inclusion and exclusion of relevant studies for this systematic review are presented in Fig. 1. We identified 2031 studies from the databases. After removing duplicate studies (1141 articles), titles and abstracts of 890 studies were screened and 148 studies were retained for full-text screening. The reasons for exclusion were as follows: duplicated study, publications before 1990, studies conducted in countries outside of SSA, no SES factors included in the study, no outcomes of interest included in the study, conference papers, editorials, newsletters, comments and notes. We included 11 studies in this systematic review.

Table 1 presents the characteristics of each study. All included studies were observational and comprised five cohort studies[32,34,36,39] and six cross-sectional surveys.[33,40–44] There were five (45.4%) high-quality studies,[40–44] five of moderate-quality[32–36] and one low-quality study.[39]

Table 1. Characteristics and summary of studies included in the systematic review

First author, year (reference)	Aim	Study design	Country	Setting	Participants age	Sample size	Demographic and socio-economic factors	Outcomes	Quality of evidences
Assefa[32]	To measure the incidence and determinants of LBW in a rural population in Ethiopia	Cohort study	Ethiopia	Urban and Rural	0–28 days	956	Maternal education, household wealth index, maternal income	LBW	Moderate
Engebretsen *et al.*[40]	To describe current infant growth patterns and their association with feeding practices in Uganda	Cross-sectional study	Uganda	Rural and Urban	0–11 months	723	Household wealth index, maternal marital status, maternal occupation, maternal education	Stunting Wasting	High
Ickes *et al.*[33]	To assess maternal socio-demographic factors that may constrain women's caring capabilities and child nutrition in Uganda	Cross-sectional study	Uganda	National	0–23 months	1897	Maternal occupation, maternal marital status, maternal education, household wealth index	Stunting Wasting Underweight	Moderate
Mamabolo *et al.*[39]	To evaluate feeding practices and growth patterns in the central region of Limpopo in SA	Cohort study	South Africa	Semi-rural	0–12 months	276	Maternal marital status, maternal occupation, maternal education	Stunting Wasting Underweight	Low
Medhin *et al.*[34]	To assess the predictors of short- and intermediate-term infant health and nutritional outcomes in Ethiopia	Cohort	Ethiopia	Rural	0–12 months	1065	Maternal marital status, maternal occupation, maternal education	Underweight Stunting Wasting	Moderate
Muhihi *et al.*[41]	To determine the risk factors of PTB and SGA in 19629 newborns in Tanzania	Cross-sectional	Tanzania	Urban and rural	0–28 days	19269	Maternal education, household wealth index	Term-AGA, SGA, PTB, SGA-PTB	High
Ndirangu *et al.*[35]	To determine the associations between SGA, PTB, maternal HIV status and infant mortality in South Africa	Cohort	South Africa	Rural	0–24 months	2368	Maternal education	SGA PTB	Moderate
Ukwuani and Suchindran[42]	To examine the relationship between women's work and infant and child nutritional status in Nigeria	Cross-sectional	Nigeria	National	0–12 months (sub group of 0–59 months)	1338	Marital status maternal occupation, maternal education, household wealth index	Stunting, wasting	High

Wamani *et al.*[43]	To examine the association between four socio-economic indicators (maternal and paternal education, household asset index and land ownership) and stunting in Uganda	Cross-sectional	Uganda	Rural	0–24 months	720	Maternal education, household wealth index	Stunting	High
Wamani *et al.*[44]	To assess the determinants of poor anthropometric status in infants and young children in Uganda	Cross-sectional	Uganda	Rural	0–23 months	698	Maternal education	Stunting Wasting Underweight	High
Watson-Jones *et al.*[36]	To determine the risk factors for poor birth outcomes and their relative contribution on the outcomes in Tanzania	Cohort	Tanzania	Rural	0–28 days	1536	Maternal occupation	PTB, LBW	Moderate

AGA, appropriate gestational age; HIV, human immunodeficiency virus; LBW, low birth weight; PTB, preterm birth; SA, South Africa; SGA, small for gestational age.

Although the studies covered the four regions of SSA, they were conducted in only five countries: four in Uganda,[33,40,43,44] two each in South Africa,[35,39] Ethiopia[32,34] and Tanzania,[36,41] and one study in Nigeria.[42] Most of the studies were conducted exclusively in rural areas,[34–36,39,43,44] five were conducted in both rural and urban areas,[32,33,40–42] and two were national surveys.[33,42]

Only four studies focused on the birth outcomes of interest,[32,36,41,45] while seven studies focused on undernutrition from birth to 2 years of age.[33,34,39,40,42–44] The distribution of studies per outcome of interest was as follows: three for LBW,[32,36,41] four for PTB,[35,36,41,45] two for SGA,[35,41] seven for stunting,[33,34,39,40,42–44] seven for wasting[33,34,39,40,42,44] and four for underweight.[33,34,39,44]

Maternal socio-demographic characteristics and household SES factors investigated in the studies were: maternal education in 11 studies,[32–34,36,39–45] maternal occupation in 5 studies,[33,36,39,40,44] maternal marital status in 5 studies[33,34,39,40,42] and maternal or HWI in 5 studies.[33,34,40,42,43] Maternal education was defined as illiterate or not,[32,33] educated or not,[33,43] student or not,[39] formal or not formal[41] and the level of education (i.e., none, primary and secondary education level).[35,39,41,42] Maternal occupation was measured as follows: staying at home vs. not staying home,[32] working in a skilled job vs. unskilled work such as farming,[36] working vs. not working,[33,42] being a housewife vs. not being a housewife.[39] Ukwuani and Suchindran[42] defined occupation in combination with other variables such as mother earning a cash payment, and taking her child with her to work. Maternal marital status was defined as follows: polygamous vs. non-polygamous marriage,[34,42] or married/living with a partner vs. divorced/widowed/not living together[33] or married vs non married.[40] Lastly, HWI was categorised into three classes (better off, middle or poor)[32] or five quintiles.[33,40,41,44] In some studies, the HWI compared mothers using a 60% cut-off for the HWI[33] or a poverty index from 1 to 12.[34]

Associations between maternal socio-demographic characteristic, household socio-economic factors and birth outcomes (Table 2)

In three studies, maternal level of education was not associated with LBW and PTB.[32,35,41] However, when cut-offs for PTB and SGA were 37th week and 3rd percentile, respectively, Muhihi *et al.*[41] found that having a mother with no formal schooling was associated with simultaneous PTB and SGA compared to having a mother who completed formal schooling. In another study, a maternal education higher than secondary level reduced the odds of SGA by 13% after adjusting for maternal age, residence, parity, maternal height and infant male sex.[41]

There was no significant association between maternal occupation and either SGA or PTB.[36] Stay-at-home mothers had 80% greater odds of having an LBW child compared to those who were working.[32] Another study[36] found that, the odds of having LBW were lower by 72% for those mothers who had skilled work compared to only 55% for those mothers who had unskilled work after adjusting for maternal characteristics (age, anthropometry, fertility desire and parity), paternal support, geographical location (residence), behavioural characteristics (physical violence) and health (access to the antenatal care services).

HWI was not significantly associated with SGA in one study.[41] However, the poorest households had 21% and 49% greater risk of PTB than affluent households in urban and rural settings, respectively.[41] Another study showed that the poorest households had

Table 2. Associations between demographic and socio-economic factors with LBW, PTB and SGA

Outcomes	Demographic and socio-economic factors	Studies	Demographic and socio-economic variables	Effect size	Effect size estimates (coefficient and CI)	Factors that variables were adjusted for
Low birth weight	Maternal education	Assefa *et al.*[32]	Illiterate (Ref: literate)	OR	1.2 (0.8–1.82)	Maternal age, residence, parity, MUAC, fertility desire, ANC, violence in pregnancy, access to health facility, involvement of the husband.
			Illiterate (Ref: literate)	aOR	0.9 (0.58–1.46)	
			Illiterate (Ref: literate)	aOR	0.9 (0.6–1.47)	
	Household WI	Assefa *et al.*[32]	Poor (Ref: better off)	OR	2.1 (1.46–2.98)	Maternal age, residence, parity, MUAC, fertility desire, ANC, violence in pregnancy, access to health facility, involvement of the husband
			Middle (Ref: better off)		1.3 (0.93–1.92)	
			Poor (Ref: better off)	aOR	1.9 (1.29–2.68)	
			Middle (Ref: better off)		1.2 (1.29–2.68)	
			Poor (Ref: better off)	aOR	2.1 (1.42–3.05)	
			Middle (Ref: better off)		1.0 (0.96–2.10)	
	Maternal occupation	Assefa *et al.*[32]	Staying at home (Ref: having employment)	OR	1.8	Maternal age, residence, parity, MUAC, fertility desire, ANC, violence in pregnancy, access to health facility, involvement of the husband
		Watson-Jones *et al.*[36]	Skilled work (Ref: staying at home)	aOR	0.28 (0.1–0.9)	Benzathine penicillin G treatment, maternal age, ethnicity, maternal sexual debut, smoker mother, maternal anthropometry, gravidity, past stillbirth, child sex, maternal illness, placental malaria
			Manual/Farmer work (Ref: staying at home)	aOR	0.45 (0.2–0.9)	

Small for gestational age	Maternal education	Muhihi *et al.*[41]	No formal schooling (Ref: completed primary)	aRR	0.88 (0.76–1.02)	Paternal education, maternal anthropometry, maternal age, parity, starting ANC in the third trimester, birth order, child sex
			Some primary (Ref: completed primary)	aRR	1.01 (0.88–1.15)	
			Secondary plus (Ref: completed primary)	aRR	0.87 (0.77–0.98)	
		Ndirangu *et al.*[35]	Some primary (Ref: no education)	RR	1.05 (0.58–1.93)	Child sex, residence, WASH, delivery place, parity, maternal age, maternal anthropometry, HIV status, infant mortality
			Secondary and tertiary (Ref: no education)	RR	1.08 (0.60–1.94)	
	Maternal occupation	Watson-Jones *et al.*[36]	Skilled work (Ref: staying at home)	OR	0.19 (0.1–1.5)	Benzathine penicillin G treatment, maternal age, ethnicity, maternal sexual debut, smoker, maternal anthropometry, gravidity, past stillbirth, child sex, maternal illness, placental malaria
			Manual/Farmer work (Ref: staying at home)	OR	0.5 (0.2–1.4)	
			Maternal occupation (Ref: no occupation)	OR	1.94	
	Household WI	Muhihi *et al.*[41]	Q1 or poorest (Ref: Q5 or richest)	aRR (urban)	1.26 (1.00–1.60)	Paternal education, maternal anthropometry, maternal age, parity, starting ANC in the third trimester, birth order, child sex
			Q2 (Ref: Q5)	aRR (urban)	1.34 (1.08–1.67)	
			Q3 (Ref: Q5)	aRR (urban)	1.18 (0.94–1.49)	
			Q4 (Ref: Q5)	aRR (urban)	1.15 (0.93–1.42)	
			Q1 or poorest (Ref: Q5 or richest)	aRR (rural)	1 (0.90–1.12)	Paternal education, maternal anthropometry, maternal age, parity, starting ANC in the third trimester, birth order, child sex
			Q2 (Ref: Q5)	aRR (rural)	0.95 (0.86–1.06)	
			Q3 (Ref: Q5)	aRR (rural)	1 (0.90–1.11)	
			Q4 (Ref: Q5)	aRR (rural)	0.95 (0.86–1.05)	

(*Continued*)

Table 2. (*Continued*)

Outcomes	Demographic and socio-economic factors	Studies	Demographic and socio-economic variables	Effect size	Effect size estimates (coefficient and CI)	Factors that variables were adjusted for
Preterm birth	Maternal education	Muhihi *et al.*[41]	No formal schooling (Ref: completed primary)	aRR	1.03 (0.91–1.17)	Paternal education, maternal anthropometry, maternal age, parity, starting ANC in the third trimester, birth order, child sex
			Some primary (Ref: completed primary)	aRR	1.11 (0.98–1.26)	
			Secondary plus (Ref: completed primary)	aRR	0.95 (0.84–1.07)	
		Ndirangu *et al.*[35]	Some primary (Ref: no education)	aRR	1.74 (0.76–3.97)	Child sex, residence, WASH, delivery place, parity, maternal age, maternal anthropometry, HIV status, infant mortality
			Secondary and tertiary (Ref: no education)	aRR	1.72 (0.77–3.85)	
	Maternal occupation	Watson-Jones *et al.*[36]	Skilled work (Ref: staying at home)	OR	0.43 (0.2–1.0)	Benzathine Penicillin G treatment, maternal age, ethnicity, maternal sexual debut, smoker, maternal anthropometry, gravidity, past stillbirth, child sex, maternal illness, placental malaria
			Manual/Farmer work (Ref: staying at home)	OR	0.84 (0.5–1.4)	
			Maternal occupation (Ref: no occupation)	OR	2.95	
	Household WI	Muhihi *et al.*[41]	Q1 or poorest (Ref: Q5 or richest)	aRR (urban)	1.21 (1.001.46)	Paternal education, maternal anthropometry, maternal age, parity, starting ANC in the third trimester, birth order, child sex
			Q2 (Ref: Q5)	aRR	1.10 (0.92–1.32)	
			Q3 (Ref: Q5)	(urban)	1.08 (0.89–1.31)	
			Q4 (Ref: Q5)	aRR	1.08 (0.90–1.29)	
			Q1 or poorest (Ref: Q5 or richest)	aRR (rural)	1.49 (1.32–1.68)	Paternal education, maternal anthropometry, maternal age, parity, starting ANC in the third trimester, birth order, child sex
			Q2 (Ref: Q5)	aRR	1.39 (1.24–1.56)	
			Q3 (Ref: Q5)	(rural)	1.13 (1.00–1.28)	
			Q4 (Ref: Q5)	aRR	1.23 (1.09–1.37)	

A, activity; ANC, antenatal care; aOR, adjusted odds ratio; aRR, adjusted relative risk; C, Cash; CI, confidence interval; HIV, human immunodeficiency virus; LBW, low birth weight; MUAC, mid-upper arm circumference; OR, odds ratio; PTB, preterm birth; Q (1,2,3,4,5), quintile (1,2,3,4,5); RR, relative risk; SGA, small for gestational age; WASH, water sanitation hygiene; WI, wealth index.

110% greater odds of having an LBW child than the richest households after adjusting for maternal mid-upper arm circumference, antenatal care (ANC) attendance, violence during pregnancy and access to a health facility.[32]

Associations between maternal demographic characteristics, household socio-economic factors and stunting (Table 3)

Several studies found that maternal marital status was not significantly associated with stunting.[33,34,39,42] The relationship between maternal level of education and stunting was not consistent across the studies reviewed. Having a mother with either no education or schooling up to primary school level was associated with 110% greater odds of stunting compared to having a mother who had been educated beyond primary school level.[43] Ickes *et al.*[33] found that educated mothers had 57% lower odds of having stunted infants, but there was no significant association between maternal literacy and infant stunting. Two studies did not find an association between maternal education and stunting.[40,42]

Ickes *et al.*[33] found that having a mother with an occupation was positively associated with 54% greater odds of stunting. The association between occupation and stunting was adjusted for child age, breastfeeding, maternal religion, maternal age, maternal education, marital status, decision maker in the family, domestic violence, maternal exposure to media, mothers travelling during pregnancy, delivering in a health facility, water sanitation and hygiene and HWI.[33,42] However, Engebretsen *et al.*[40] did not find any association between maternal occupation and risk of stunting. Studies have defined household wealth using wealth index (terciles[42]), (quintiles[33,40,43,44]), or cut-offs which varied between studies), land ownership[40,43,44] and poverty index.[13] Wamani *et al.*[43] and Engebretsen *et al.*[40] found that the lowest HWIs were associated with higher odds of stunting,[40,44] while other studies reported no significant association between HWI and infant stunting.[33,34,42]

Association between maternal socio-demographic characteristic, household socio-economic factors and wasting (Table 3)

Maternal occupation was associated with 43% lower odds of wasting in the study by Ickes *et al.*[33]; however, in the study by Ukwuani and Suchindran,[42] mothers who were not remunerated in cash and did not take their child to work had 87% greater odds of having a wasted child. Two other studies found no association between maternal occupation and wasting.[39,40] In two of the studies reviewed, there was no significant association between the HWI and wasting.[33,40] Engebertsen *et al.*,[40] Ickes *et al.*[33] and Ukwuani and Suchindran [42] did not find any significant association between wasting and maternal level of education or marital status.[33,40,42]

Associations between maternal socio-demographic characteristic, household socio-economic factors and underweight (Table 3)

The odds of having an underweight child were 40% lower for literate mothers vs illiterate mothers[33]: 35% lower for educated mothers vs non-educated mothers[33]; 76% lower for mothers who had completed primary school compared with those who had completed secondary school.

Discussion

This review has identified a lack of research in SSA (only 11 studies for 52 countries), a region with one of the highest prevalence of child undernutrition, and the role of maternal and household socio-economic determinants of impaired growth and development during the first thousand days. Furthermore, we highlighted interesting methodological challenges when assessing maternal or household socio-economic characteristics as well as important empirical findings pertaining to SSA context. Methodologically, although the definitions of LBW, SGA, PTB, stunting, wasting and underweight were standard, studies used varying definitions of SES factors that made comparison and generalisability of their results challenging. However, overall, lower HWI, maternal unemployment and low maternal education were shown to be important SES predictors of adverse birth outcomes (LBW and SGA) and infant undernutrition (stunting, wasting and underweight) in SSA.

Socio-economic factors and adverse birth outcomes

Evidence gathered in this systematic review has shown that PTB is associated with lower maternal occupation and lower HWI.[36,41] While the risk for a newborn to be SGA was associated with a lower level of maternal education in one out of two studies reviewed,[41] LBW was predicted by living in a household with a lower HWI.[32,41] In addition, having a mother with an occupation, and therefore a source of income, was associated with lower risk of LBW. In a review of studies in 22 LMICs, Watson-Jones *et al.*[36] and Vogel *et al.*[46] found that less-educated mothers had and increased risk of having a newborn that was PTB. However, in a recent study in Kenya, Wagura *et al.*[47] found that maternal level of education had no significant association with PTB but was significantly associated with previous PTB. Furthermore, in Brazil, Zambonato *et al.*[48] found an association between SGA in Brazilian newborns and a lower family income, similar to the study conducted in Tanzania in this review.[41] Similarly, in Japan, mothers living in prefectures with higher socio-economic inequality (measured by the Gini coefficient) had 24% greater risk of having a SGA newborn.[49] In addition, lower parental education and household income was associated with SGA.[49] The protective effect of maternal education, occupation and aggregated SES indices against LBW has been shown in previous studies in other LMICs (South Africa,[12] Pakistan,[50] Vietnam[51] and Bangladesh[52]), as well as in a meta-analysis of studies conducted in middle- and high-income countries.[53] In this systematic review, we did not find any study that investigated the association between maternal marital status and birth outcomes.

Socio-economic factors and infant undernutrition between birth and 2 years of age

Most studies included in this review reported that higher level of maternal education was protective against stunting and underweight, while maternal occupation and low HWI increased the risks for a child to be stunted.[33,40,43,44] The evidence was not consistent for underweight; studies found positive and negative associations with maternal education.[13,33,39] While some studies found that maternal occupation reduced the risks of wasting, others have shown the contrary.[33,42] No study found an association between marital status and stunting[33,34,39,40,42] or wasting,[33,39,40,42] and the association between marital status and underweight had not been explored.

Table 3. Associations between demographic and socio-economic factors with infant growth outcomes (stunting, wasting and underweight)

Outcomes	Demographic and SES determinant	Studies	SES factors	Effect size	Estimate effect size (value, confidence interval or *p*-value)	Adjusted variables for
Stunting	Maternal education	Ukwuani and Suchindran[42]	Primary (Ref: None)	aOR	0.94 ($p > 0.1$)	Father education, father occupation, religion, child feeding duration, maternal age, sex, birth order, ANC, place delivery, residence, immunisation, child illness, WASH
			Secondary and above (Ref: None)	aOR	1.06 ($p > 0.10$)	
		Wamani *et al.*[43]	None (Ref: above primary)	aOR	2.1 (1.1–3.9)	Child age and sex
			Stopped in primary (Ref: above primary)	aOR	2.1 (1.2–3.8)	
			Completed primary (Ref: above primary)	aOR	1.0 (0.5–2.0)	
			No educated mother (Ref: educated above primary)	aOR	2,5	Child age, child sex, father education
			Literate in 2011 (Ref: illiterate)	OR	0.84 (0.62–1.14)	
			Literate in 2006 (Ref: illiterate)	OR	0.77 (0.58–1.00)	
			Educated mother (Ref: no educated) in 2006	OR	0.72 (0.53–0.99)	
			Maternal educated in 2006 (Ref: illiterate)	OR	0.43 (0.28–0.66)	
		Mamabolo *et al.* (2004)[21]	Primary (Ref: secondary)	aOR	0.438 (0.139–1.382)	Feeding practices, child sex, maternal age at birth, parity
			Student (Ref: no student)	aOR	1.044 (0.523–2.084)	
		Engebretsen *et al.*[40]	Completed lower secondary and more (Ref: full primary and less)	OR	0.78 (052–1.18)	Child sex, child age, country wealth, residence, owning land, maternal age, father education, demography, birth weight

	Maternal occupation	Ukwuani and Suchindran[42]	A/NC/WC (Ref: NA)	aOR	0.97 ($p > 0.10$)	Father education, father occupation, religion, child feeding duration, maternal age, sex, birth order, ANC, place delivery, residence, immunisation, child illness, WASH
			A/C/WC (Ref: NA)	aOR	0.98 ($p > 0.10$)	
			A/NC/NWC (Ref: NA)	aOR	0.66 ($p > 0.10$)	
			A/C/NWC (Ref: NA)	aOR	0.88 ($p > 0.10$)	
		Ickes *et al.*[33]	Employed in 2006 (Ref: Not employed)	aOR	1.01 (0.61–1.68)	Child age, child sex, decision-making in family, maternal age at birth, violence, having travelled away from home or not, feeding practices, access to health facility
			Employed in 2011 (Ref: Not employed)	aOR	1.54 (1.05–2.25)	Child age, child sex, decision-making in family, maternal age at birth, violence, having Travelled away from home or not, feeding practices, access to health facility
		Mamabolo *et al.*[39]	Not being a housewife (Ref: being a housewife)	OR	1.254 (0.518–3.033)	
			Not working (Ref: working)	OR	0.519 (0.178–1.508)	
		Engebretsen *et al.*[40]	Has a job (Ref: Does not have a job)	aOR	0.63 (0.37–1.)	Child sex, child age, country wealth, residence, owning land, maternal age, father education, demography, birth weight
	Maternal marital status	Mamabolo *et al.*[39]	Single (Ref: married)	OR	0.749 (0.354–1.583)	Feeding practices, child sex, mother age at birth, parity
		Medhin *et al.*[34]	Polygamous marriage at 6 months of the study (Ref: not polygamous marriage)	aOR	1.06 (0.64–1.74)	Maternal characteristics (religion, ethnicity, age, MUAC), age of husband, father education, WASH, poverty, traditional surgical practices
		Medhin *et al.*[34]	Polygamous marriage at 12 months of the study (Ref: not polygamous marriage)	aOR	1.19 (0.76–1.87)	
		Ukwuani and Suchindran[42]	Two wives polygynous (Ref: one wife)	aOR	1. 2 ($p > 0.10$)	Father education, father occupation, religion, child feeding duration, maternal age, sex, birth order, ANC, place delivery, residence, immunisation, child illness, WASH
			Three wives polygynous (Ref: one wife)	aOR	1.37 ($p < 0.10$)	
		Engebretsen *et al.*[40]	Formal marriage (Ref: traditional)	aOR	1.09 (0.58–2.08)	Child sex, child age, country wealth, residence, owning land, maternal age, father education, demography, birth weight
			Single, separated, divorced, widowed (Ref: traditional)	aOR	1.91 (0.99–3.66)	
		Ickes *et al.*[33]	Married or living with partner in 2006 (Ref: single/separated/ divorced/divorced)	aOR	1.10 (0.73–1.67)	Child age, child sex, decision-making in family, maternal age at birth, violence, having travelled away from home or not, feeding practices, access to health facility
		Ickes *et al.*[33]	Married or living with partner in 2011 (Ref: single/separated/ divorced/divorced)	aOR	0.82 (0.54–1.25)	Child age, child sex, decision-making in family, maternal age at birth, violence, having travelled away from home or not, feeding practices, access to health facility

(*Continued*)

Table 3. (*Continued*)

Outcomes	Demographic and SES determinant	Studies	SES factors	Effect size	Estimate effect size (value, confidence interval or *p*-value)	Adjusted variables for
	household wealth	Ukwuani and Suchindran[42]	Medium (Ref: low)	aOR	0.78 ($p > 0.10$)	Father education, father occupation, religion, child feeding duration, maternal age, sex, birth order, ANC, place delivery, residence, immunisation, child illness, WASH
			High (Ref: low)	aOR	0.61 ($p < 0.10$)	
		Wamani *et al.*[43]	Q1 or poorest (Ref: 5 acres or more)	OR	2.1 (1.2–3.7)	Mother education, father education, child sex male, child age between 18 and 23 months
			Q2 (Ref: 5 acres or more)	OR	1.7 (0.9–2.9)	
			Q3 (Ref: 5 acres or more)	OR	1.3 (0.8–2.5)	
			Q4 (Ref: 5 acres or more)	OR	1.1 (0.6–2.0)	
		Wamani *et al.*[43]	None (Ref: 5 acres or more)	aOR	0.9 (0.5–1.8)	Child age, child sex, father education, father education
			1 acre or less (Ref: 5 acres or more)	aOR	0.9 (0.6–1.6)	
			2 acres or less (Ref: 5 acres or more)	aOR	1.2 (0.7–2.1)	
			3 or 4 acres or less (Ref: 5 acres or more)	aOR	1.0 (0.6–1.8)	
			Poorest (Ref: least poor)	OR	2.1	
		Medhin *et al.*[34]	Poverty index at 6 months (range from 0 to11)	aOR	0.94 (0.83–1.06)	Maternal characteristics (religion, ethnicity, age, MUAC), age of husband, father education, WASH, poverty, traditional surgical practices
			Poverty index at 12 months (range from 0 to11)	aOR	0.98 (088–1.09)	
		Engebretsen *et al.*[40]	Mid 40% (Ref: top 20%)	aOR	1.65 (0.74–3.68)	Child sex, child age, country wealth, residence, owning land, maternal age, father education, demography, birth weight
			Lowest 40% (Ref: top 20%)	aOR	3.50 (1.57–7.78)	
		Engebretsen *et al.*[40]	Mid 40% (Ref: top 20%)	aOR	1.71 (0.87–3.36)	Child sex, child age, country wealth, residence, owning land, maternal age, father education, demography, birth weight
			Lowest 40% (Ref: top 20%)	aOR	3.10 (0.56–6.15)	
		Engebretsen *et al.*[40]	Mid 40% (Ref: top 20%)	aOR	1.30 (0.62–2.73)	Child sex, child age, country wealth, residence, owning land, maternal age, father education, demography, birth weight
			Lowest 40% (Ref: top 20%)	aOR	2.7 (1.39–5.28)	
		Ickes *et al.*[33]	Maternal WI upper 60% in 2006 (Ref: less 60%)	aOR	0.82 (0.62–1.06)	Child sex, child age, country wealth, residence, owning land, maternal age, father education, demography, birth weight
			Maternal WI upper 60% in 2011 (Ref: less 60%)	aOR	1.17 (0.87–1.58)	
		Engebretsen *et al.*[40]	Owning land (Ref: no owing land)	aOR	1.45 (0.86–2.45)	Child sex, child age, country wealth, residence, owning land, maternal age, father education, demography, birth weight

Wasting	Maternal education	Ukwuani and Suchindran[42]	Primary (Ref: none)	aOR	1.08 ($p > 0.10$)	Father education, father occupation, religion, child feeding duration, maternal age, sex, birth order, ANC, place delivery, residence, immunisation, child illness, WASH
			Secondary and above (Ref: none)	aOR	0.86 ($p > 0.10$)	
		Engebretsen *et al.*[40]	Completed lower secondary and more (Ref: full primary and less)	OR	0.90 (0.42–1.95)	Child sex, child age, country wealth, residence, owning land, maternal age, father education, demography, birth weight
		Ickes *et al.*[33]	Literate in 2011(Ref: illiterate)	aOR	0.87 (0.54–1.41)	Child age, child sex, decision-making in family, maternal age at birth, violence, having travelled away from home or not, feeding practices, access to health facility
			Literate in 2011 (Ref: illiterate)	aOR	0.87 (0.59–1.29)	
			Educated in 2006 (Ref: not educated)	aOR	0.74 (0.47–1.15)	
			Educated in 2011 (Ref: illiterate)	aOR	0.58 (0.31–1.11)	
		Mamabolo *et al.*[39]	Primary (Ref: secondary)	OR	0.699 (0.141–3.461)	
			Student (Ref: no student)	OR	1.404 (0.508–3.880)	
	Maternal occupation	Ukwuani and Suchindran[42]	No cash/No cash/Work with child (Ref: No activity)	aOR	0.96 ($p > 0.10$)	Father education, father occupation, religion, child feeding duration, maternal age, sex, birth order, ANC, place delivery, residence, immunisation, child illness, WASH
			Activity/Cash/Work with child (Ref: no activity)		1.17 ($p > 0.10$)	
			Activity/No cash/No working with child (Ref: NA)	aOR	1.87 ($p < 0.05$)	
			Activity/Child/No working with child (Ref: no activity)	aOR	1.48 ($p > 0.10$)	
		Engebretsen *et al.*[40]	Has a job (Ref: Does not have a job)	OR	0.50 (0.14–1.76)	Child sex, child age, country wealth, residence, owning land, maternal age, father education, demography, birth weight
		Ickes *et al.*[33]	Employed in 2006 (Ref: not employed)	aOR	1.86 (0.76–4.55)	Child age, child sex, decision-making in family, maternal age at birth, violence, having travelled away from home or not, feeding practices, access to health facility
			Employed in 2011 (Ref: not employed)	aOR	0.57 (0.34–0.95)	
		Mamabolo *et al.*[39]	Not working (Ref: working)	aOR	2.943 (0.916–9.455)	
	Maternal marital status	Engebretsen *et al.*[40]	Formal marriage (Ref: traditional)	OR	0.87 (0.25–2.94)	
			Single, separated, divorced, widowed (Ref: traditional)	OR	0.33 (0.04–2.60)	
		Ukwuani and Suchindran[42]	Two wives (Ref: one wife)	OR	1.26 ($p < 0.10$)	
			Three wives (Ref: one wife)	OR	1.01 ($p < 0.10$)	
		Ickes *et al.*[33]	Married or living with partner in 2006 (Ref: single/separated/divorced/divorced)	aOR	0.97 (0.55–1.71)	Child age, child sex, decision-making in family, maternal age at birth, violence, having travelled away from home or not, feeding practices, access to health facility
			Married or living with partner in 2011 (Ref: single/separated/divorced/divorced)	aOR	1.64 (0.72–3.72)	
		Mamabolo *et al.*[39]	Single (Ref: married)	OR	0.444 (0.121–1.629)	

(*Continued*)

Table 3. (*Continued*)

Outcomes	Demographic and SES determinant	Studies	SES factors	Effect size	Estimate effect size (value, confidence interval or *p*-value)	Adjusted variables for
		Engebretsen *et al.*[40]	Mid 40% (Ref: top 20%)	aOR	1.76 (0.54–5.70)	Child sex, child age, country wealth, residence, owning land, maternal age, father education, demography, birth weight
			Lowest 40% (Ref: top 20%)		1.51 (0.48–4.71)	
			Owning land (Ref: do not own land)	aOR	1.06 (0.40–2.81)	
		Ickes *et al.*[33]	Maternal WI upper 60% in 2006 (Ref: less 60%)	aOR	1.00 (0.68–1.49)	Child age, child sex, decision-making in family, maternal age at birth, violence, having travelled away from home or not, feeding practices, access to health facility
			Maternal WI upper 60% in 2011 (Ref: less 60%)	aOR	0.80 (0.50–1.29)	
		Ukwuani and Suchindran[42]	Medium	aOR	0.82 ($p > 0.10$)	
			High	aOR	1.02 ($p > 0.10$)	
Underweight	Maternal education	Mamabolo *et al.*[39]	Primary (Ref: secondary)	OR	0.244 (0.066–0.903)	Feeding practices, child sex, mother age at birth, parity
			No student (Ref: student)		3.199 (1.111–9.208)	
		Ickes *et al.*[33]	Literate in 2011 (Ref: illiterate)	aOR	0.76 (0.53–1.10)	Child age, child sex, decision-making in family, maternal age at birth, violence, having travelled away from home or not, feeding practices, access to health facility
			Literate in 2006 (Ref: illiterate)	aOR	0.60 (0.43–0.82)	
			Educated in 2006 (Ref: no educated)	aOR	0.65 (0.45–0.94)	
			Educated in 2011 (Ref: illiterate)	aOR	0.49 (0.30–0.81)	
	Maternal marital status	Mamabolo *et al.*[39]	Single (Ref: married)	OR	0.660 (0.203–2.150)	Feeding practices, child sex, mother age at birth, parity
		Medhin *et al.*[34]	Polygamous marriage at 6 months (Ref: not polygamous)	aOR	0.89 (0.52–1.54)	Maternal characteristics (religion, ethnicity, age, MUAC), other characteristics in the household (age of husband, father education, WASH), poverty, traditional surgical practices
			Polygamous marriage at 12 months (Ref: not polygamous marriage)	aOR	0.77 (0.45–1.33)	
		Ickes *et al.*[33]	Married or living with partner in 2006 (Ref: single/separated/ divorced/)	aOR	1.6 (0.93–2.73)	Child age, child sex, decision-making in family, maternal age at birth, violence, having travelled away from home or not, feeding practices, access to health facility
			Married or living with partner in 2011 (Ref: single/separated/ divorced/)	aOR	1.20 (0.68–2.12)	

	Maternal occupation	Ickes *et al.*[33]	Maternal employment in 2006 (Ref: no employment)	aOR	1.85 (0.91–3.77)	Child age, child sex, decision-making in family, maternal age at birth, violence, having travelled away from home or not, feeding practices, access to health facility
			Maternal employment in 2011 (Ref: no employment)	aOR	1.14 (0.72–1.79)	
		Mamabolo *et al.*[39]	Not being a housewife (Ref: being a housewife)	OR	0.614 (0.131–2.874)	
			Not working (Ref: working)	OR	0.341 (0.043–2.715)	
	Household WI	Ickes *et al.*[33]	Maternal WI upper 60% in 2006 (Ref: less 60%)	aOR	0.76 (0.55–1.04)	Child age, child sex, decision-making in family, maternal age at birth, violence, having travelled away from home or not, feeding practices, access to health facility
			Maternal WI upper 60% in 2011(Ref: less 60%)	aOR	0.79 (0.54–1.14)	
		Medhin *et al.*[34]	Poverty index at 12 months (range from 0 to 11)	aOR	0.85 (0.74–0.97)	Maternal age, maternal anthropometry, maternal marital status, autonomy scale, maternal obstetric complication, substance use (Khat or alcohol), residence, number of children, father age, WASH, social support
			Poverty index at 6 months (range from 0 to 11)	aOR	0.97 (0.85–1.11)	

A, activity; AC, activity with cash; ANC, antenatal care; aOR, adjusted odds ratio; C, cash; HIV, human immunodeficiency virus; MUAC, mid-upper arm circumference; NA, not active; NC, no cash; NWC, no work with child; OR, odds ratio; Q (1,2,3,4,5), quintile; SES, socio-economic status; WASH, wash, sanitation and hygiene; WC, work with child; WI, wealth index.

A review on malnutrition over 15 years in LMICs showed that higher maternal/caregivers' level of education and greater HWI reduced the odds of stunting during infancy.[54] In a pooled analysis of five cohort studies including South Africa,[7] the results showed that low maternal education, low maternal income, low social class (measured by paternal occupation) and low paternal education were predictors of stunting at 2 years of age. However, SES factors (maternal education, maternal income, paternal occupation and paternal education) had less influence on stunting than biological factors (birth weight and maternal height), particularly in South Africa.[7] Similarly, a study in Ivory Coast found that having an educated mother was protective against stunting in 3-year-old children.[55]

In Bangladesh, Raihan *et al.*[56] found that low SES (assets, maternal and household income and maternal education) increased the risk of wasting in children younger than 5 years of age. They also found that water sanitation and hygiene characteristics (e.g., use of soap, use of hygienic latrine and safe drinking water), often used as a composite of HWI and/or as a risk factor of infectious disease, mediated the association between SES factors and wasting.[56]

The outcomes of this review align with the existing findings in children aged between 6 and 23 months in Myanmar[57] and in children under 3 years of age in Vietnam,[21] which reported that children of working mothers had a higher risk of being stunted. Also in Vietnam,[21] maternal occupation was a predictor of all forms of undernutrition (stunting, wasting and underweight), whereas maternal education and income were not. In contrast, *Ukwuani and Suchindran*[42] found that in Nigeria maternal occupation was protective against wasting suggesting that working women have an income that allows for provision of food and better care, and that mothers breastfeed for longer than their non-working peers.

Maternal and household SES factors during the first 1000 days

At the country level, a review of 121 surveys in 36 LMICs[58] found that a 5% increase in per capita gross domestic product decreased the risk of undernutrition in children aged between 0 and 35 months, but this association did not occur in the poorest households, suggesting that poverty and socio-economic inequalities are both vehicles of infant undernutrition. The first thousand days, the period between conception and 2 years after birth,[1] have been acknowledged as a critical period for child growth and development and for adult health outcomes.[58] Evidence from this review highlights that low maternal and household SES are more likely to have a negative effect on growth and development during that period.[59]

The socio-economic environment is both a contributory factor to and a consequence of infant undernutrition.[1] Maternal and household lower SES is an underlying factor of household food insecurity, and therefore of maternal and child health and undernutrition.[60] Children living in households with low SES were found to consume more carbohydrates and less protein and less fat with subsequent undernutrition.[61] Educated mothers have greater knowledge, better job opportunities, higher income, a healthy lifestyle and access to health care, all of which impact infant growth and nutritional status.[53,62] Although the level of education of the general population is improving in SSA countries, education of females is still lower than that of males.[63] McGovern *et al.*,[64] in their systematic review on stunting and economic growth, concluded that education of women is a cost-effective investment that reduces

poor infant growth and translates into greater future opportunities for children.

One study included in this review found that maternal occupation had a detrimental effect on child growth.[62] Having a job may generate an income for mothers and their households, but it can limit the time spent with their newborn. While having an occupation provides an income that enables greater access to health care, working mothers are not always available to breastfeed their children or to access health care when necessary.[62] Lack of support systems (social support, maternity leave, etc.) may jeopardise mothers' possibilities to provide optimal care for their children (including exclusive breastfeeding), thereby exposing children to the risks associated with early weaning, introduction of solid food and infectious diseases.[4] In this review, we did not find any studies conducted in SSA on the association between maternal marital status and infant undernutrition. Having a partner (married or concubine) may have a positive effect on maternal and child health through the widest network of social support, and additional income that this situation may provide; however, domestic violence may offset those benefits.[65,66]

Based on the studies included in this review, socio-economic factors were generally assessed as contextual variables (HWI) and/or as compositional measurements (education, income, occupation).[62] In addition, we highlighted that across studies, contextual and compositional SES factors were defined using different characteristics.[62] The lack of standardisation and harmonisation of SES measures may explain discrepancies observed between the studies included in this review. For example, whereas a study showed that higher maternal education level was associated with lower risk of stunting,[43] one study found no association between maternal literacy and stunting.[43] It may be that either the influence of education is different depending on the social and economic contexts, or that having a higher level of education, which is indicative of the knowledge acquired, is more important than maternal literacy, which reflects a skill. Wamani *et al.*[44] found that in rural Uganda having a secondary education level was the critical threshold at which maternal level of education was protective against stunting. The use of a variety of SES indicators may also limit comparisons within and between countries, and therefore, the identification of critical maternal and household factors to target in national or regional intervention programs that aim to promote foetal and infant optimal growth.

The majority of studies reviewed did not specifically focus on the assessment of the association between SES factors and birth outcomes or infant undernutrition. Possibly, the choice of SES indices might have been dictated by the main objective of the study. Therefore, another source of discrepancies between studies could be the covariates in the multivariate analyses. The UNICEF causal framework[3] has established that several immediate, underlying and basic causes play a role in infant undernutrition. Various combinations of causal factors were taken into account across the articles reviewed here, including infant gender,[55,60] infant feeding practices,[54,57] maternal age,[55] maternal anthropometry,[53] maternal morbidity (urinary tract infection, hypertensive disorders, malaria, human immunodeficiency virus, infection, gestational diabetes, pre-eclampsia, pregnancy induced hypertension, antepartum haemorrhage, pre-labour rupture of membranes, placental bleeding),[46] maternal obstetrical history (parity, previous PTB, gestation number),[46,48,67] access and usage of antenatal care services, household food insecurity,[55,60] household size and level of urbanisation.[54,60]

Limitations

This review has some limitations. Firstly, studies were selected using English keywords, which given the linguistic diversity in the SSA region, studies written in only other languages may have been missed. Secondly, the various definitions and measurement of SES and the inability to retrieve some key data from publications did not allow us to undertake a meta-analysis. Thirdly, one (9%) study[39] was rated low because of lack of randomisation in recruitment, no blinding in the conduction of the study, lack of adjustment for any variable and no CIs in the results.[37,38] Finally, the accuracy of gestational age may vary across studies depending on the method of assessment. These limitations could lead to a low power of the data included (quality and quantity) in the review.

Conclusion

In conclusion, despite the paucity of studies that have explored the relationship between maternal and household SES and LBW, PTB, SGA, stunting, wasting and underweight in SSA, results from this review emphasise the negative long-term effects of poor maternal and household SES on child growth during the first thousand days. More research, including using a qualitative approach, has to be undertaken to improve our understanding of contextual SES factors that are associated with undernutrition during the first thousand days in the different SSA countries. Furthermore, early intervention from pre-pregnancy through infancy may prevent undernutrition during the first 2 years of life and any irreversible damages caused by undernutrition during infancy. Finally, promoting maternal education and female employment as well as alleviating female poverty and inequality are key interventions to favour optimal maternal and child health.

Supplementary materials. To view supplementary material for this article, please visit https://doi.org/10.1017/S2040174419000680

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Search, inclusion of studies and data extraction: CBN, DM, RS-M.
Data interpretation: BN, LC, SN, RS-M.
Integrity of data: BN.
Editing manuscript: AM.
Drafting and revising manuscript: BN, DM, LC, AM, SN, RS-M.

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