Social Science & Medicine 185 (2017) 91–101

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Girl child marriage as a risk factor for early childhood development and stunting

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ARTICLE INFO

Article history:
Received 17 August 2016
Received in revised form
4 May 2017
Accepted 10 May 2017
Available online 11 May 2017

Keywords:
Africa
Sub-Saharan Africa
Child marriage
Marriage
Early childhood development
Stunting
Multiple Indicator Clusters Survey
Early childhood development index

ABSTRACT

This paper quantitatively examines the intergenerational effects of girl child marriage, or the developmental and health outcomes of children born to women who marry before age 18. The overall objective is to understand the mechanisms through which girl child marriage affects the health and well-being of children in sub-Saharan Africa, as well as the relative magnitude and impact of these mechanisms. We used data from 37,558 mother-child pairs identified through 16 national and sub-national cross-sectional surveys across sub-Saharan Africa conducted between 2010 and 2014 by the UNICEF Multiple Indicator Clusters Survey program. The Early Childhood Development Index was used to measure child development, and stunting was used to measure health. Using logistic regression, we found that the odds of being off-track for development and being stunted were 25% and 29% higher, respectively, for children born to women who married before age 18 compared to those whose mothers married later ($p < 0.001$). Geographic location and primary education, which were conceptualized as contextual factors, explained most of this relationship, controlling for country fixed-effects. In adjusted models, we found that early childbearing was not the sole pathway through which girl child marriage affected child development and health. Our final models revealed that disparities in advanced maternal education and wealth explained child development and stunting. We conclude that there are intergenerational consequences of girl child marriage on her child's well-being, and that through association with other contextual, socioeconomic, and biological factors, marrying early does matter for child development and health. Our findings resonate with existing literature and point toward important policy considerations for improving early childhood outcomes.

1. Introduction

In 2007, more than 200 million children under age 5 in low- and middle-income countries (LMICs) were estimated to fall short of internationally-accepted minimum outcomes for physical, educational, and cognitive development due to poverty, poor nutrition, and other social risks (Grantham-McGregor et al., 2007). A recent study estimated that nearly one-third of children aged 3 and 4 in LMICs were not on-track for socioemotional or cognitive development, with over 40% of those children in sub-Saharan African countries (McCoy et al., 2016). In the early years of life, competencies are built which may have long-term consequences for child well-being (Efevbera et al., 2017). Early development is shaped by biological and social factors innate within the child and the child's greater environment (Sameroff and Sameroff, 2009). Understanding early childhood outcomes such as poor health, nutrition, and developmental delays is important because they can be intervened upon, when necessary, setting children on a positive trajectory for adulthood (Anderson et al., 2003; Engle et al., 2011).

Caregivers, especially mothers, play an important role in their children's development (Efevbera et al., 2017; Calkins and Hill, 2007). One maternal risk factor that may affect early childhood development (ECD) and health is a mother's age at marriage. Girl child marriage, or early marriage, is defined as a formal union of a female before the age of 18 (UNICEF, 2014). It is often considered a violation of the rights of a girl according to international and

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http://dx.doi.org/10.1016/j.socscimed.2017.05.027
0277-9536/

regional human rights agreements and has been associated with lower educational attainment, economic opportunities, and some measures of health among young women (Erulkar, 2013a; Machel et al., 2013; Nour, 2009; Svanemyr et al., 2012).

Limited evidence describes the relationship between girl child marriage and child health and development. Mothers' early marriage was significantly associated with child stunting, underweight (Raj et al., 2010a), and increased odds of diarrhea in the last two weeks (Mashal et al., 2008), although results were inconsistent across studies. A country-level analysis found that girl child marriage was significantly associated with infant mortality rates across 96 countries (Raj and Boehmer, 2013).

Empirically, literature on girl child marriage has been closely linked to literature on adolescent motherhood (Santhya, 2011). Some studies found that earlier maternal ages were significantly associated with infant and child mortality even when controlling for sociodemographic variables (Chen et al., 2007; Legrand and Mbacke, 1993), while other studies found no significant relationship once including potential confounders (Sharma et al., 2008; Lee et al., 2008); few studies were in sub-Saharan Africa. Pre-term births, resulting in lower gestational age, and low birth weight were also more common among adolescent mothers (Chen et al., 2007; Kurth et al., 2010; Fall et al., 2015). Stunting, a measure of chronic undernutrition as a result of risk factors including breastfeeding, maternal education, wealth, and child characteristics, was more likely among infants of adolescent mothers (Fall et al., 2015). Stunting is associated with reduced child development (Teller and Alva, 2008), particularly along cognitive (Grantham-McGregor et al., 2007), socioemotional (McCoy et al., 2016), learning, and physical domains (Miller et al., 2015).

Very limited research examines the developmental and health consequences of girl child marriage in sub-Saharan Africa, where one in three girls marry before age 18 (UNICEF, 2015) and some of the largest percentages of young children fall short of developmental and nutritional milestones (Grantham-McGregor et al., 2007; McCoy et al., 2016). Among the 20 countries with the highest prevalence of girl child marriage, 85% are on the African continent (Girls Not Brides, 2017). If current trends persist, sub-Saharan Africa will have the largest number of girl child brides by 2050 (UNICEF, 2015), illuminating an important region to further investigate.

This paper quantitatively examines the intergenerational effects of girl child marriage, or the developmental and health outcomes of children born to women who marry before age 18. The overall objective of this study is to understand the mechanisms through which girl child marriage affects the health and well-being of children born to women who marry early in sub-Saharan Africa, as well as the relative magnitude and impact of these mechanisms. We used data from 16 national and sub-national cross-sectional surveys across sub-Saharan Africa conducted between 2010 and 2014 by the UNICEF Multiple Indicator Clusters Survey (MICS) program. The Early Childhood Development Index was used to measure child development, and stunting was used to measure health. Two hypotheses were tested:

> Hypothesis 1: Children born to women who married before age 18 have higher odds of being developmentally off-track and of being stunted.
>
> Hypothesis 2: Mother's age at childbirth, completion of advanced education, and household wealth are the primary mechanisms through which early marriage affects child development and nutritional status.

To our knowledge, this is the first study to elucidate the relationship between girl child marriage and the development of children early in life across cognitive, language, physical, and socioemotional domains.

2. Framework

A framework for hypothesizing the relationship between girl child marriage and child development and health was developed, informed by existing literature and preliminary qualitative fieldwork. Acknowledging the socioecological context in which children develop, including biological disposition, mother, family, community, and societal influences (Bronfenbrenner, 1977), this study focused on only one risk factor for child development and health: mother's marital age.

Prior to marriage, several complex and interacting factors create environments in which women marry at earlier ages. A literature review conducted by the first author revealed that risk factors for girl child marriage include poverty (Chandra-Mouli et al., 2013; Human Rights Watch, 2011; Wolfe, 2013), low education levels and maternal education (Erulkar, 2013a; Erulkar and Muthengi, 2009; Loaiza and Wong, 2012), lack of laws or enforcement of laws (Chandra-Mouli et al., 2013; Myers and Doornbos, 2013), cultural and social norms (Nour, 2009; Hampton, 2010; Walker, 2012), and conflict and fragility (Myers and Doornbos, 2013; Schlecht et al., 2013). Some of these same pre-marital risk factors may directly impact a child or a woman's own health and nutritional status (Gaur et al., 2013; Letamo and Navaneetham, 2014), which may directly impact her child's risk for fetal growth restriction, malnutrition, and poor health at birth with potential long-term health and developmental consequences (Sawant and Venkat, 2013).

Once a woman is married, there are different ways in which she may be vulnerable to biological and social risks, which may subsequently affect her children's development and health. Using a biosocial analysis, which posits that both biological and social processes interact and influence health and disease (Hanna et al., 2013), we theorize that through girl child marriage, both biological and social pathways determine her children's well-being. Girl child marriage often leads to early childbearing, which may have biological consequences leading to poorer health and developmental outcomes for her young children (Williamson et al., 2013). Beyond biological influence, girl child marriage can also lead to social mechanisms that directly impact her children's well-being. We conceptualize these direct social mechanisms as maternal caregiving behavior and decision-making, ultimately influencing child development and health (The Urban Child Institute, 2014).

Maternal behavior may be impacted by early motherhood. Observational data has shown teenage mothers have worse healthcare behavior for themselves and their children as compared to adult mothers (Legrand and Mbacke, 1993). Maternal behavior may also be impacted by education and wealth. While earlier primary educational attainment may influence when, why, and how a woman marries, pursuing and completing secondary schooling is often, in part, disrupted by early marriage, particularly in the context of sub-Saharan Africa (Wodon et al., 2016; Lloyd and Mensch, 2008). Early marriage was cited as a reason for up to 28% of secondary school dropouts in some African contexts (Lloyd and Mensch, 2008) and was reported as a key reason for not completing secondary school among women in a recent qualitative study (Efevbera, 2017). Lower educational attainment lowers labor market opportunities and average incomes (Filmer and Fox, 2014), impacting wealth in the marital household. Mother's advanced education, household income, and early childbearing, in turn, affect a mother's knowledge and behavior, as well as the resources she has to act on her beliefs. This can lead to poorer nutritional status and medical care as well increased poverty (Dopkins Broecker and

Hillard, 2009), initiating a cycle of continued poor health. For example, decisions to breastfeed, ensure children are immunized, and access healthcare and early education when such resources are available will affect child development and health and may be impacted by mother's maturity, knowledge, and ability to invest in related services.

Such maternal decision-making may also be impacted by a woman's autonomy in her relationship as well as norms in her local sociocultural environment. These may further be complicated by experiences in marriage such as intimate partner violence (IPV), which is more likely to occur among girls who marry early (Raj et al., 2010b) and which may further lead to poor child development and health. A woman's exposure to IPV may negatively affect her own nutritional, physical, and mental health as well as her children's responses to stress during pregnancy and infancy (Yount et al., 2011). IPV has also been negatively associated with child stunting and underweight (Sobkoviak et al., 2012) and sub-optimal breastfeeding practices in African contexts (Misch and Yount, 2014), leading to negative child health and developmental consequences in the early years.

The causes of girl child marriage are complex, and the potential mechanisms of consequences are rarely discussed in literature. In this study, we empirically adopted a simplified model. First, we tested if girl child marriage was associated with child development and health. We then examined biological and social pathways that are directly linked to the mother's age at marriage, and thus mediate the relationship between girl child marriage and child development and health. The three pathways examined were: early childbearing (a proxy for biological mechanisms), mother's completion of secondary education (a measure of advanced educational attainment), and wealth in the marital home (a proxy for resource availability in the marital home).

3. Methods

3.1. Study sample

This study used data from the MICS Program for all sub-Saharan African countries where exposure and outcome data were available. MICS were first conducted in 1995. To date, 283 surveys have been conducted in 109 countries, collecting cross-sectional, nationally- and sub-nationally representative data from women and men aged 15 to 49 (UNICEF). MICS data are the most comprehensive compilation of ECD data in LMICs due to the addition of an ECD module in Waves 4 and 5 (UNICEF, 2013a; Bornstein et al., 2012). For this study, all surveys from the fourth and the fifth rounds of MICS, conducted between 2010 and 2014 and available as of February 20, 2016, with exposure and outcome data were cleaned and aggregated into a single dataset. There were 11 national and 5 sub-national samples in the final dataset including: Central African Republic, Chad, Democratic Republic of Congo, Ghana, Kenya (Mombasa), Kenya (Nyanza Province), Madagascar (South), Malawi, Mauritania, Nigeria, Sierra Leone, Somalia (Northeast), Somalia (Somaliland), Swaziland, Togo, and Zimbabwe. Data included nationally-representative household and women information, as well as information on children under age 5 of mothers/caretakers in the sample who were randomly selected by survey administrators. The sample was restricted to children (aged 3 and 4) born to ever-married women (aged 15 to 49) across sub-Saharan Africa. Response rates for women were 93% on average, ranging from 88.2% in Somalia (Northeast) to 97.1% in the Democratic Republic of Congo, shown in Supplementary Table 1 (UNICEF, 2016). This study was determined as exempt by the Harvard Longwood Institutional Review Board (Protocol #: IRB16-0723).

3.2. Measures

Girl child marriage, the exposure variable, was defined as a self-reported formal union before age 18. Following on previous studies (Raj et al., 2010a; Raj and Boehmer, 2013), we conceptualized girl child marriage as a binary variable in our main model. We drew the age limit from the normative framework regarding the legally-permissible age of marriage set out in Article 21(2) of the African Charter on the Rights and Welfare of the Child (The African Charter, 1990). This Charter has been signed by all members of the African Union, signifying these states' intent to not undermine the terms of the agreement. This Charter has also been ratified by all but 7 members and thus creates a binding legal obligation for these ratifying states. In the MICS, women were asked: "In what month and year did you first marry or start living with a man as if married?" (MICSP, 2014, p. 115). From this data, age at marriage was calculated by subtracting the year at first marriage from the year of woman's birth. Women who did not provide a date at marriage were asked: "How old were you when you started living with your first husband/partner?" (MICSP, 2014, p. 115). This variable was used when the date of marriage was not available, per MICS survey guidelines. We also conducted robustness checks using a categorical specification of girl child marriage (married at <15 years, 15 to 17 years, or 18 + years).

The Early Childhood Development Index (ECDI), a measure of child development across the domains of physical, learning, literacy-numeracy, and socioemotional development, was used to assess if a child was off-track for development (UNICEF, 2013a). The child development questions included were developed by UNICEF, in consultation with child development experts (UNICEF, 2013b). Existing measures were first reviewed, and proposed items were tested and validated in multiple countries and in multiple stages (UNICEF, 2013b). These questions have been validated through confirmatory factor analysis across several LMICs (McCoy et al., 2016; Jeong et al., 2016). Many of the questions in the ECDI are similar to items in validated tools including the Strengths and Difficulties Questionnaire, Ages and Stages Questionnaire, and the Early Development Instrument (McCoy et al., 2016; UNICEF, 2013b). The ECDI has also been used in recent peer-review studies (McCoy et al., 2016; Miller et al., 2015; Jeong et al., 2016). We also conducted robustness checks using the child development score, a continuous ECD measure calculated as a score of 0 to 10, based on the number of on-track responses for each of the questions. (See Supplementary Fig. 2 for additional information on the construction of the ECDI in this study.)

Stunting was defined as height-for-age z-score (HAZ) less than −2, based on World Health Organization Growth Reference Standards (De Onis and Blössner, 2003). HAZ was selected over other measures to look at chronic, rather than short-term, fluctuations in malnutrition and was analyzed as a binary variable in our main model. We also conducted robustness checks using HAZ as a continuous measure.

Other covariates. To reduce confounding and to strengthen causal inference, adjusted analyses controlled for several factors identified in our framework. For additional covariates, we followed variables controlled for in related literature (Raj et al., 2010a; Mashal et al., 2008). Geographic location, as urban or rural, was determined by mother's self-reported household location. Mother's age at childbirth was calculated by subtracting the child's reported age from the mother's reported age. Binary variables were then created to assess early childbirth if a mother gave birth to the child before age 16, between ages 16 and 17, or between ages 18 and 19. The number of children ever-born to the mother was calculated by mother's self-reported number of total births. A child was identified as being born in a single or multiple birth by sorting children in the sample by mother ID. Gender, as male or female, and child's age in months, as calculated by the birth year and month reported by the mother, were also included. Binary variables were generated to measure if a mother completed at least primary school and at least a secondary school. Wealth quintile was also compiled as a relative measure of poverty, using the MICS wealth score generated by comparing enumerator-identified household assets to the number of household members (Rutstein and Johnson, 2004). Country fixed-effects were controlled for in all adjusted analyses to account for observable and unobservable differences at the national and sub-national levels.

3.3. Data analysis

To assess the relationship between girl child marriage and child development and health, logistic regression models were run. Two binary outcomes were tested: ECDI, to determine if children were off-track for development, and stunting. Robustness checks were conducted by running linear regression analyses on the child development score and HAZ.

Drawing from the framework presented in Fig. 1, a series of models were run to test pathways explaining associations between girl child marriage and each child development and health outcome. An unadjusted model (Model 1) was first run to compare the exposure of girl child marriage to each outcome. Model 2 (M2) controlled for geographic location and mother's completion of primary education to assess how much of the relationship was explained by these pre-marital contextual risk factors. Model 3 (M3) added biological factors into M2 including mother's age at childbirth, singleton/multiple birth, child's gender, child's age, and mother's number of births to assess the relationship when controlling for early childbearing and possible biological pathways. The remaining models assessed causal pathways for the relationship between girl child marriage and child outcomes. Model 4 (M4) built on M3 by adding mother's completion of secondary school to assess how much of the relationship was explained by advanced educational attainment. Model 5 (M5) built on M4 by adding household wealth quintile to assess how much of the relationship was explained by relative poverty, which is impacted by women's secondary schooling. M2 to M5 also controlled for country fixed-effects to account for observable and unobservable country-level differences including, but not limited to, differences in fragility or effects of conflict, enforcement of laws, and cultural and social norms. Individual measures of national contextual factors were not included due to the limited availability of strong measures comparable across countries and because this was not the focus of the study.

Results are presented as odds ratios, and 95% confidence intervals are reported. Hypotheses were rejected if the p-value < 0.05. We also conducted robustness checks and the Sobel-Goodman test for mediation. We found no concerns of high correlations between our exposure and remaining covariates (see Supplementary Table 3), and thus included all variables in the fully-adjusted models.

4. Results

4.1. Sociodemographic data

This sample included 37,558 mother-child pairs. The median age at marriage for mothers included in this sample was 17 years old. Fifty-one percent of mothers were married before age 18, ranging from 17% in Swaziland, where the median age at marriage was 21 years old, to 75% in Chad, where the median age at marriage was 15 years old in the sample. Trends in marital age by country were consistent with national legislation on the minimum legal age at marriage for girls in these country contexts, as shown in Table 1 (World Policy Center, 2016). The prevalence of girl child marriage in the sample is also consistent with current national estimates based on retrospective reporting by women aged 20–24 years old (Appendix A).

Table 2 shows demographic characteristics by mother's age at marriage. Fifty-three percent of children in the sample were 36 to 47 months old while 47% of children were 48 to 56 months old. Half of the children surveyed were female. Most mothers in the sample were married at the time of the survey (91%). Mothers had a median age at birth for the child included in the sample of 27 years, ranging from 11 to 46 years. Nearly one out of every three children in the sample lived in a rural setting.

Table 3 shows the percentage of children that were on-track for development or who were stunted. Overall, 56% of children were on-track based on the aggregate ECDI. More than 50% of children were on-track for the developmental domains of learning, physical, and socioemotional. However, only 15% of children in the sample were on-track for literacy-numeracy. Variations by country can also be seen in Table 3. Nearly four out of every ten children in this sample were stunted. Seventeen percent of children were severely stunted (HAZ less than −3).

4.2. Bivariate models on associations between girl child marriage and child development and health

Bivariate analyses showed a significant association between girl child marriage and child development and health (see Tables 4 and 5 for unadjusted and adjusted models by outcome and Appendix B for unadjusted bivariate models). Unadjusted M1 showed a significant association between a mother marrying before age 18 and her child being off-track for overall development, as determined by the ECDI (Table 4). The odds of being off-track for development were 25% higher among children born to women who married before age 18 as compared to children born to women who married later (OR = 1.25, 95% CI [1.20, 1.31], p < 0.001). Unadjusted M1 for stunting similarly showed a significant association between a mother marrying before age 18 and her child's nutritional status,

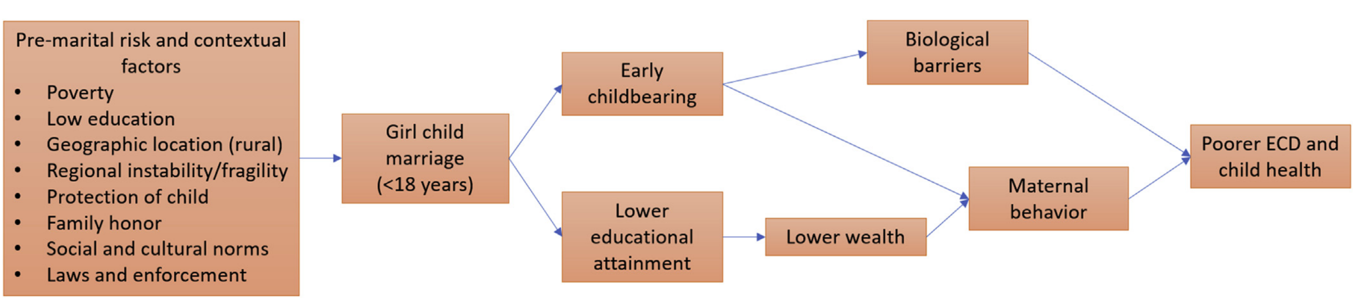

Fig. 1. Original conceptual model of framework for understanding the effects of girl child marriage on children's early development and health.

Table 1
Median age at marriage, prevalence of child marriage, and legal minimum age of marriage, by country (N = 37,558).

Country	Year of survey	Sample size	Median age at marriage (years)	Married before age 15 (%)	Married before age 18 (%)	Minimum legal age of marriage for girls (years)[a,b]	Minimum age of marriage for girls with parental consent (years)[b]	Minimum age of marriage for girls under customary or religious law (years)[b]
Central African Republic	2010	3,170	16	25	64	18	18	18
Chad	2010	4,917	15	34	75	15	15	13
Democratic Republic of Congo	2010	3,269	18	10	45	18	18	18
Ghana	2011	2,525	19	5	33	18	18	18
Kenya (Mombasa)	2009	144	18	15	48	18	16	Unknown
Kenya (Nyanza)	2011	1,770	17	15	53	18	16	Unknown
Madagascar (South)	2012	977	15	30	75	18	18	18
Malawi	2013–14	6,552	17	10	51	18	15	Unknown
Mauritania	2011	2,596	17	22	52	18	18	18
Nigeria	2011	1,077	19	14	40	21	18	Puberty (Jigwa state); 16 (Akwa-Ibom)
Sierra Leone	2010	2,457	16	18	59	18	18	No min. age
Somalia (Northeast)	2011	1,543	18	12	44	18	16	18
Somalia (Somaliland)	2011	1,555	19	11	36	18	16	18
Swaziland	2010	579	21	3	17	21	16	Unknown
Togo	2010	1,418	19	8	34	18	18	18
Zimbabwe	2014	3,009	18	5	34	18	16	No min. age
Total	2010–14	37,558	17	16	51			

[a] Exceptions can be made to lower the age of marriage in all countries except Chad, Democratic Republic of Congo, Ghana, Mauritania, Nigeria, and Swaziland.
[b] Data from World Policy Center, 2016.

Table 2
Demographic characteristics for children and their mothers in the sample by mother's age at marriage.

Covariate	Total (N = 37,558)	%	Among child marriage mothers (N = 19,206)	%	Among adult marriage mothers (N = 18,352)	%	p for difference by mother's marital age status
Child characteristics							
Age							p = 0.028
3 years old (36–47 months)	19,990	53	10,108	53	9,882	54	
4 years old (48–56 months)	17,568	47	9,098	47	8,470	46	
Gender (female %)	18,795	50	9,658	50	9,137	50	p = 0.440
Multiple birth	1,365	4	677	4	688	4	p = 0.464
Mother characteristics							
Currently married	34,347	91	17,616	92	16,731	91	p = 0.517
Mother's age at birth (median)	27		25		28		p < 0.0001
Mother's highest education level completed							p = 0.001
None/Preschool	15,776	42	9,193	48	6,573	36	
Primary	14,018	37	7,806	41	6,212	34	
Secondary or higher	7,773	21	2,206	11	5,567	30	
Number of children born (median)	4		5		4		p < 0.0001
Household characteristics							
Geographic location (urban)	10,796	29	4,821	25	5,975	33	p = 0.003
Wealth quintile							p = 0.015
Poorest	8,753	23	4,703	24	4,050	22	
Poorer	7,958	21	4,352	23	3,606	20	
Middle	7,511	20	3,990	21	3,521	19	
Richer	7,340	20	3,765	20	3,575	19	
Richest	5,996	16	2,396	12	3,600	20	

Note. Analyses clustered the standard errors at the country-cluster level.

as measured by being stunted. The odds of being stunted were 29% higher among children born to women who married before age 18 as compared to children born to women who married later (OR = 1.29, 95% CI [1.23, 1.35], p < 0.001). Similar relationships were observed for the continuous measures of child development score and HAZ, and for an alternative specification of girl child marriage, where younger marital ages were associated with increased odds of poorer child outcomes (see M1 in Supplementary Tables 4, 5, and 6.).

4.3. Adjusted models on associations between girl child marriage and child development and health

ECDI. Once we controlled for contextual factors, the magnitude of the effect of girl child marriage on child development decreased from OR = 1.25 to OR = 1.05, suggesting that the increased risk seen in M1 was explained by these three factors. A mother's completion of primary education and living in an urban setting explained much of the effect of girl child marriage and both were significantly associated with lower odds of a child being developmentally off-track. Fig. 2 shows interesting variations of M2 by country, though estimates are less precise with smaller country sample sizes. Once we additionally controlled for biological factors, girl child marriage was no longer significantly associated with being off-track developmentally (see M3 in Table 4). Both secondary schooling and wealth quintile were also significantly associated with the ECDI. Children born to women who completed secondary schooling or higher had 17.5% reduced odds of being off-track for development as compared to those born to women who did not complete at least secondary schooling (OR = 0.825, 95% CI [(0.772,

Table 3
Number and percentage of children developmentally on-track and stunted by country (N = 37,558).

Country	Sample size	On-track for development		On-track for development by domain								Nutritional status			
		Overall		Learning		Literacy-numeracy		Physical		Socio-emotional		Stunted		Severely stunted	
		N	%	N	%	N	%	N	%	N	%	N	%	N	%
Central African Republic	3,170	1,537	48	2,414	71	184	6	3,066	97	1,908	60	1,484	47	703	22
Chad	4,917	1,743	35	2,420	49	313	6	4,766	97	3,385	69	2,009	41	1,092	22
Democratic Republic of Congo	3,269	1,710	52	2,394	73	370	11	2,990	91	2,284	70	1,668	51	884	27
Ghana	2,525	1,858	74	2,256	89	572	23	2,471	98	1,914	76	686	27	228	9
Kenya (Mombasa)	144	101	70	137	95	76	53	122	85	83	58	38	26	11	8
Kenya (Nyanza)	1,770	1,171	66	1,678	95	593	34	1,580	89	1,113	63	593	34	257	15
Madagascar (South)	977	694	71	846	87	68	7	942	96	802	82	N/A	N/A	N/A	N/A
Mauritania	2,596	1,641	63	2,396	92	550	21	2,498	96	1,562	60	860	33	380	15
Nigeria	1,077	671	62	994	92	203	19	1,035	96	641	60	370	34	166	15
Sierra Leone	2,457	1,182	48	1,890	77	247	10	2,245	91	1,523	62	1,280	52	681	28
Somalia (Northeast)	1,543	554	36	1,111	72	270	18	1,215	79	698	45	N/A	N/A	N/A	N/A
Somalia (Somaliland)	1,555	934	60	1,363	88	397	26	1,378	89	974	63	N/A	N/A	N/A	N/A
Swaziland	579	365	63	546	94	98	17	572	99	351	61	149	26	39	7
Togo	1,418	778	55	1,134	80	133	9	1,346	95	968	68	520	37	169	12
Malawi	6,552	4,118	63	5,345	82	1,138	17	6,009	92	4,898	75	2,775	42	1,040	16
Zimbabwe	3,009	1,858	62	2,699	90	309	10	2,898	96	1,975	66	739	25	177	6
TOTAL	37,558	20,915	56	29,623	79	5,521	15	35,133	94	25,079	67	13,171	39	5,827	17

Table 4
Summary of logistic regression to assess the relationship between girl child marriage and if child is off-track for development based on ECDI binary score.

	Model 1		Model 2		Model 3		Model 4		Model 5	
	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI
Exposure variable										
Child marriage (<18 years)	**1.25**	**(1.20, 1.31)**	**1.05**	**(1.01, 1.10)**	1.04	(0.993, 1.09)	1.01	(0.968, 1.06)	1.01	(0.964, 1.06)
Contextual covariates										
Geographic location (urban)			**0.752**	**(0.715, 0.791)**	**0.755**	**(0.718, 0.795)**	**0.790**	**(0.749, 0.831)**	**0.934**	**(0.879, 0.993)**
Mother completed primary school			**0.820**	**(0.778, 0.865)**	**0.830**	**(0.786, 0.875)**	**0.893**	**(0.844, 0.945)**	**0.928**	**(0.877, 0.982)**
Biological covariates										
Multiple birth					1.12	(0.998, 1.25)	**1.13**	**(1.008, 1.26)**	**1.14**	**(1.02, 1.27)**
Gender (female)					**0.843**	**(0.808, 0.880)**	**0.844**	**(0.809, 0.880)**	**0.843**	**(0.808, 0.879)**
Age (months)					**0.971**	**(0.968, 0.974)**	**0.971**	**(0.968, 0.974)**	**0.971**	**(0.968,0.974)**
Number of children ever-born to mother					**1.01**	**(1.004, 1.02)**	1.01	(0.999, 1.02)	1.01	(0.997, 1.02)
Hypothesized pathways										
Mother's age at childbirth										
<16 years					1.01	(0.846, 1.22)	0.992	(0.827, 1.19)	0.965	(0.805, 1.16)
16–17 years					1.09	(0.981, 1.21)	1.08	(0.969, 1.20)	1.06	(0.951, 1.18)
18–19 years					1.04	(0.949, 1.13)	1.03	(0.942, 1.12)	1.01	(0.928, 1.11)
Mother completed secondary school							**0.760**	**(0.712, 0.812)**	**0.825**	**(0.772, 0.883)**
Wealth quintile (reference: Poorest)										
Poorer									**0.895**	**(0.839, 0.953)**
Middle									**0.825**	**(0.772, 0.881)**
Richer									**0.777**	**(0.724, 0.834)**
Richest									**0.614**	**(0.563, 0.670)**
N	37,558		37,557		37,430		37,430		37,430	
Chi-sq	118.78		2252.28		2600.12		2668.40		2795.51	

Note. Coefficients presented are odds ratios from logistic regression models with 95% CIs in parentheses. Off-track for ECDI is defined by not being on-track for at least 50% of questions in at least three of four developmental domains. M1 is unadjusted model. M2 adjusts for urban/rural, mother's primary education, and country fixed-effects. M3 adjusts for all covariates in M2 + child characteristics (gender, age, multiple birth), number of children ever born to mother, and mother's age at childbirth. M4 adjusts for all covariates in M3 + mother's secondary education. M5 adjusts for all covariates in M4 + wealth quintile. Bolded values are significant at the $p < 0.05$ level.

0.883)], $p < 0.001$). Children belonging to the richest quintile had 39% reduced odds of being off-track for development as compared to those in the poorest quintile (OR = 0.614, 95% CI [0.563, 0.670], $p < 0.001$).

Stunting. Similarly, once we controlled for contextual factors, the magnitude of the effect of girl child marriage on child development decreased from OR = 1.29 to OR = 1.12. Again, mother's completion of primary education and living in an urban setting were significantly associated with lower odds of a child being developmentally off-track (see M2 in Table 5). Fig. 3 shows interesting variations of M2 by country. Girl child marriage remained significant when controlling for biological factors, although the magnitude of its effect further decreased to OR = 1.08 (95% CI [1.03, 1.14], $p < 0.01$). Early childbearing was significantly associated with stunting, and earlier years of childbirth were associated with increased odds of being stunted (OR = 1.36 in M1, $p < 0.001$, OR = 1.25 in M2, $p < 0.001$, OR = 1.14 in M3, $p < 0.01$). As shown in the final model, both secondary schooling and wealth quintile were significantly associated with child stunting. Children born to women who completed secondary schooling or higher had 23% reduced odds of stunting as compared to women who did not complete at least secondary schooling. Children belonging to the

Table 5
Summary of logistic regression to assess the relationship between girl child marriage and if their children are stunted based on HAZ.

	Model 1		Model 2		Model 3		Model 4		Model 5	
	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI
Exposure variable										
Child marriage (<18 years)	**1.29**	**(1.23, 1.35)**	**1.12**	**(1.07, 1.17)**	**1.08**	**(1.03, 1.14)**	1.04	(0.992, 1.09)	1.04	(0.986, 1.09)
Contextual covariates										
Geographic location (urban)			**0.683**	**(0.646, 0.721)**	**0.684**	**(0.647, 0.723)**	**0.728**	**(0.688, 0.771)**	**0.925**	**(0.866, 0.987)**
Mother completed primary school			**0.732**	**(0.692, 0.775)**	**0.731**	**(0.690, 0.774)**	**0.807**	**(0.760, 0.857)**	**0.838**	**(0.789, 0.891)**
Biological covariates										
Multiple birth					**1.16**	**(1.03, 1.30)**	**1.17**	**(1.04, 1.32)**	**1.19**	**(1.06, 1.34)**
Gender (female)					**0.891**	**(0.852, 0.933)**	**0.892**	**(0.853, 0.933)**	**0.891**	**(0.852, 0.933)**
Age (months)					**0.990**	**(0.987, 0.993)**	**0.990**	**(0.987, 0.993)**	**0.990**	**(0.987, 0.993)**
Number of children ever-born to mother					1.01	(0.999, 1.02)	1.00	(0.992, 1.01)	1.00	(0.991, 1.01)
Hypothesized pathways										
Mother's age at childbirth										
<16 years					**1.36**	**(1.13, 1.64)**	**1.32**	**(1.09, 1.59)**	**1.28**	**(1.06, 1.54)**
16–17 years					**1.25**	**(1.12, 1.40)**	**1.23**	**(1.10, 1.37)**	**1.20**	**(1.08, 1.34)**
18–19 years					**1.14**	**(1.04, 1.25)**	**1.13**	**(1.03, 1.23)**	**1.11**	**(1.01, 1.22)**
Mother completed secondary school							**0.685**	**(0.640, 0.734)**	**0.770**	**(0.718, 0.827)**
Wealth quintile (reference: Poorest)										
Poorer									0.961	(0.899, 1.03)
Middle									**0.895**	**(0.835, 0.959)**
Richer									**0.780**	**(0.724, 0.841)**
Richest									**0.524**	**(0.477, 0.576)**
N	33,483		33,482		33,359		33,359		33,359	
Chi-sq	128.89		1477.16		1570.57		1687.29		1833.53	

Note. Coefficients presented are odds ratios from logistic regression models with 95% CIs in parentheses. Stunted is defined as height-for-age z-score less than −2. M1 is unadjusted model. M2 adjusts for urban/rural, mother's primary education, and country fixed-effects. M3 adjusts for all covariates in M2 + child characteristics (gender, age, multiple birth), number of children ever born to mother, and mother's age at childbirth. M4 adjusts for all covariates in M3 + mother's secondary education. M5 adjusts for all covariates in M4 + wealth quintile. Bolded values are significant at the $p < 0.05$ level. Results exclude Madagascar (South), Somalia (Northeast), and Somalia (Somaliland).

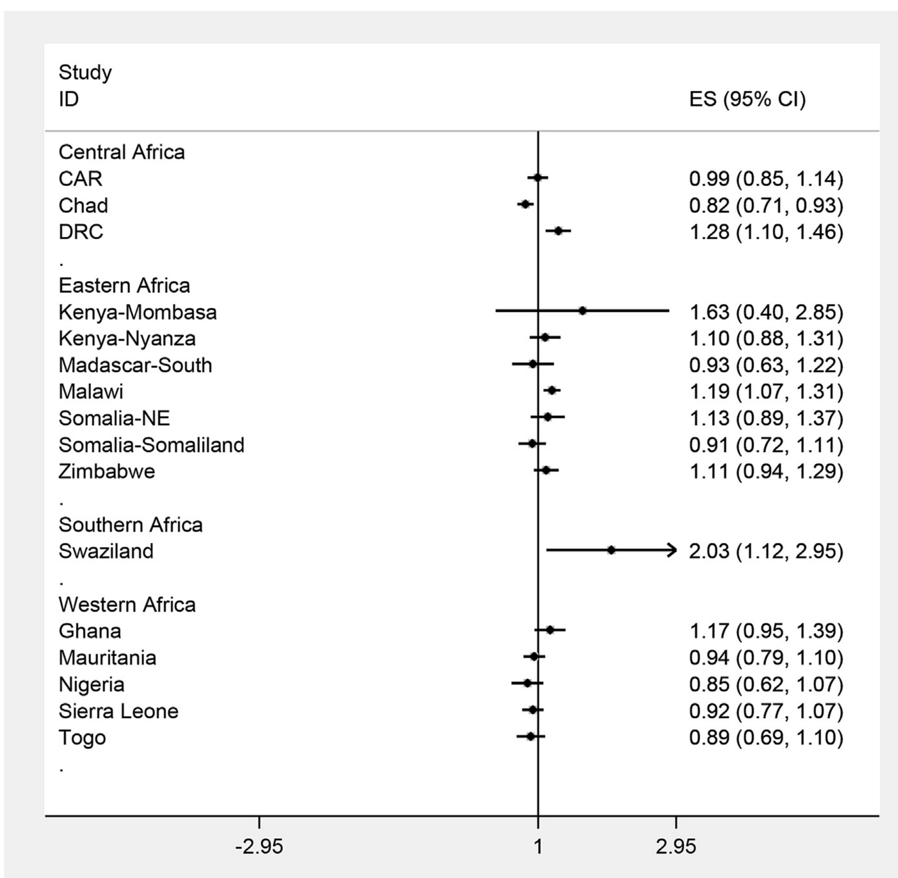

Fig. 2. Logistic regression results of girl child marriage and ECDI binary score, controlling for contextual factors, by country.

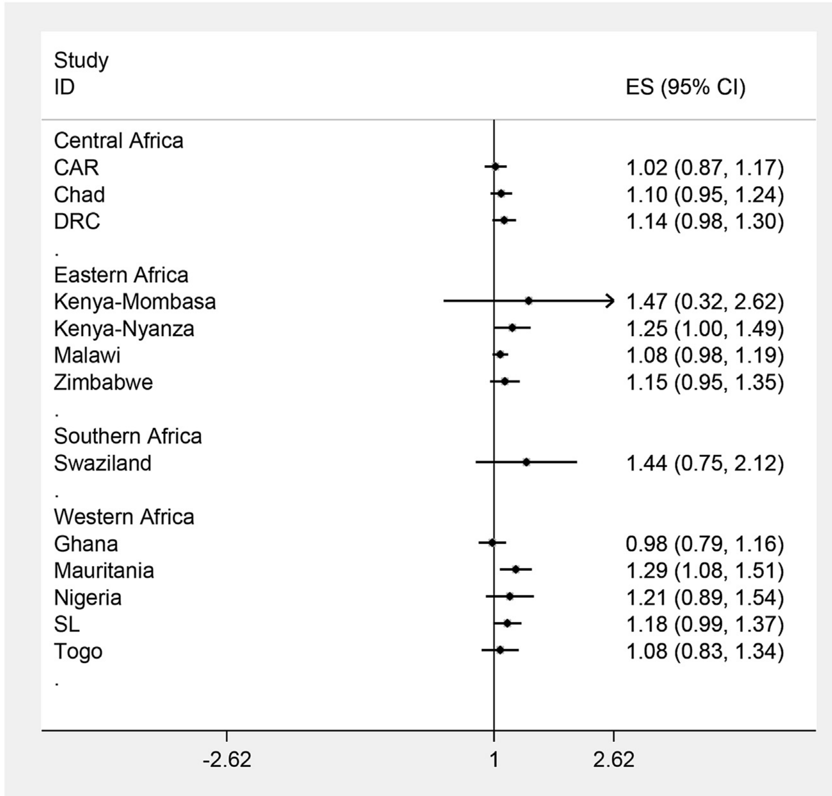

Fig. 3. Logistic regression results of girl child marriage and stunting, controlling for contextual factors, by country.

richest quintile had 48% reduced odds of stunting as compared to children in the poorest quintile.

Hypothesized mechanisms explaining the association between girl child marriage and child development and health. Early childbearing, mother's advanced education, and wealth quintile were hypothesized as mechanisms accounting for associations between girl child marriage and child development and health. Table 6 shows the relationship between girl child marriage and these intermediate variables. Even when controlling for contextual factors, women who gave birth earlier were more likely to be married before age 18. Women who completed secondary school were less likely to be married before age 18. We also see a relationship between wealth quintile and girl child marriage; women who were in the third, fourth, and fifth wealthiest quintiles were less likely to be married before age 18, with the wealthiest women being the least likely to marry early. These associations were significant at the $p < 0.01$ level.

Additionally, we conducted the Sobel-Goodman test to determine if these hypothesized mechanisms were mediators explaining the relationship between girl child marriage and child development and health (Supplementary Table 7). For being off-track for child development, age at childbirth explained 4%, completion of secondary school explained 39%, and wealth explained 13% of the effect of girl child marriage (all significant at the $p < 0.05$ level). For stunting, age at childbirth explained 9%, completion of secondary school explained 49%, and wealth explained 17% of the effect of girl child marriage (all significant at the $p < 0.05$ level). The results were consistent with the change in effect in adjusted models and reveal that the three hypothesized mechanisms differentially explain the effect of girl child marriage on child development and health.

5. Discussion

The results of our analyses suggest that children born to women who marry before age 18 had significantly higher odds of being developmentally off-track and higher odds of being stunted than those whose mothers married later. Importantly, contextual factors including mother's completion of primary education and geographic location, which may create enabling environments for early marriage, explained most of this relationship and may also explain differences observed by country. Lower levels of maternal education and living in a rural setting have been associated with higher likelihood of early marriage, particularly across the African continent (Erulkar, 2013b). Living in an urban setting may result in increased availability of health facilities, antenatal and postnatal care, and early education opportunities (Clifton, 2006), all of which can positively influence child development and health.

We also found evidence that a small part of the relationship between girl child marriage and child stunting was explained by early childbearing. Importantly, our results suggest that early childbearing was not the sole pathway through which girl child marriage affected child development and health, and the results of the Sobel-Goodman test suggest that it explained very little. Other studies have similarly found that early childbearing affects children's physical growth, which may be the result of a young mother's physiological immaturity and her body's competition for nutrients with the fetus (Fall et al., 2015; Abdullah et al., 2007). We found that early childbearing had minimal association with the child being off-track for development based on the four domains assessed. This is somewhat surprising as early childbearing has been linked to child's poor school performance (Fall et al., 2015), likely influenced by the cognitive development. Though we are

Table 6
Summary of unadjusted and adjusted analyses on the relationship between girl child marriage and intermediate variables.

	M1		M2	
	β	CI	β	CI
Mother's age at childbirth				
<16 years	**0.444**	**(0.402, 0.486)**	**0.363**	**(0.323, 0.403)**
16–17 years	**0.422**	**(0.399, 0.445)**	**0.364**	**(0.341, 0.386)**
18–19 years	**0.222**	**(0.203, 0.242)**	**0.209**	**(0.191, 0.228)**
Mother completed secondary school	**−0.287**	**(−0.299, −0.275)**	**−0.226**	**(−0.240, −0.211)**
Wealth quintile (reference: Poorest)				
Poorer	0.00957	(−0.00553, 0.0247)	−0.00325	(−0.0178, 0.0113)
Middle	−0.00608	(−0.0214, 0.00925)	**−0.0239**	**(−0.0389, −0.00892)**
Richer	**−0.024**	**(−0.0398, −0.00893)**	**−0.0382**	**(−0.0542, −0.0222)**
Richest	**−0.138**	**(−0.154, −0.121)**	**−0.131**	**(−0.150, −0.112)**

Note. Coefficients presented are OLS estimates from linear regression models with 95% CIs in parentheses. M1 is unadjusted. M2 controls for rural/urban, mother's completion of primary schooling, and country fixed effects. Bolded values are significant at the $p < 0.01$ level.

cautious to draw strong conclusions from this finding, much evidence in support of our hypothesis came from the South Asian context, which has differences in the practice of early marriage and early childbearing. Contrarily, in sub-Saharan Africa, early marriage and early childbearing are not always synonymous (Doyle et al., 2012). Our findings may point toward other factors that are more important for mother-child relationships such as mother's education, which has been found to be disrupted in some African countries through early marriage rather than early motherhood (Lloyd and Mensch, 2008).

Once we controlled for socioeconomic factors, girl child marriage was no longer significantly associated with the child outcomes measured. Instead, our final models revealed that disparities in mother's completion of secondary education and wealth explained child development and stunting. The Sobel-Goodman test revealed that advanced education explained more than one-third of the association between girl child marriage and the child outcomes assessed. The odds of a child being developmentally off-track were nearly 40% lower among children in the richest wealth quintile as compared to those in the poorest. Similarly, the odds of a child being stunted were nearly 50% lower among the wealthiest as compared to the poorest quintile. We see further evidence of what might explain the importance of wealth in our model, as its inclusion reduced the magnitudes of the effect of urban, primary education, and secondary education while we see almost no change in the magnitude of the effect of other covariates. In other words, wealth explains much of the reason why geographic location and education affect child development and stunting in our sample.

These findings resonate with the limited evidence on associations between mother's age at marriage and child outcomes, and may point towards the detrimental effects of poverty and the importance of maternal behavior in a woman's child's health and development. In India, girl child marriage was significantly associated with children's stunting in both unadjusted and adjusted models, although the magnitude of the effect was higher than this study revealed (OR = 1.85 compared to OR = 1.29). Though literature on this relationship is limited, especially in the sub-Saharan African context, researchers have suggested that the relationship between mother's marriage and child nutrition may be explained through maternal decision-making, including decisions on food for the woman herself as well as her child (Santhya, 2011). A study in Afghanistan did not find a significant relationship between girl child marriage and child stunting; however, in this study, girl child marriage was measured by mother's age at childbirth (Mashal et al., 2008), further supporting our findings that child marriage can impact a woman's child's health and development through pathways aside from early childbearing. Moreover, in the Afghanistan study, lack of maternal autonomy was significantly associated with child health including stunting, suggesting that women's ability to make decisions may further impact the decisions she makes for herself and her child (Mashal et al., 2008).

5.1. Limitations

This study used cross-sectional, observational data, posing a challenge to establishing causality and controlling for changes over time. We used a simplified framework to test mechanisms through which girl child marriage may affect child outcomes, which may not empirically measure all biosocial interactions. Despite controlling for several factors, it is possible that residual confounding exists and that environmental factors not measured in this dataset impact results. Of note, we were unable to include indicators of IPV and child health care in our dataset. Our study also does not control for female genital mutilation/cutting, which may be present in settings with child marriage and has been correlated with maternal health (Yount and Abraham, 2007). However, we are less concerned about residual confounding based on these variables because we control for observed and unobserved differences by geographic location and year using country fixed-effects.

There are also study limitations related to data collection. The exposure and child developmental outcomes were reported by mothers, rather than measured by an enumerator. Data on age at marriage were also collected in two different ways and could introduce measurement error. Even though we cannot directly assess the nature of this measurement error, it seems likely that measurement error would be random, and thus lead to an underestimation of the true causal effects of interest. There is also potential variability in how data were collected in each national and sub-national context, and in accounting for sample designs in the pooling of data across countries. However, UNICEF oversees the design and collection of MICS, providing training, oversight, and consistency across settings that allow the data to be internationally-comparable (Bornstein et al., 2012). Additionally, our careful review of each individual dataset prior to pooling, as well as our inclusion of country fixed-effects in our model, reduce concerns over data pooling.

5.2. Strengths

Despite these limitations, this study has several strengths. We used a large dataset including representative household data across several sub-Saharan African countries, limiting the threat of selection bias. The statistical methods employed allow us to assess not only associations but also the relative magnitude of the mechanisms measured. HAZ was externally-assessed by trained measurers, reducing potential for bias from self-reporting. Additionally, the use of individual outcomes, rather than aggregate cross-country comparisons, is less prone to confounding biases. We also conducted robustness checks through looking at continuous measures of each outcome to assess if there were differences in the results. Though the findings may not be generalizable to all women aged 15 to 49 in sub-Saharan Africa, the large sample size across settings increases confidence on the application of these findings to understanding the relationship between girl child marriage and child developmental and health outcomes.

6. Conclusions

Our findings reveal that there are intergenerational consequences of girl child marriage on child development and health, and that these associations were largely driven by several pathways which could potentially be addressed through targeted policies. Women across the sub-Saharan African countries in our sample who married before age 18 were more likely to give birth early, less likely to have completed secondary schooling, and were more likely to belong to poorer quintiles, all of which were associated with worse child outcomes. Our findings of the importance of maternal education and wealth on child development and health point toward important policy considerations for improving early childhood outcomes within different contexts. If the mechanisms examined could all be controlled for, a theoretical event we acknowledge is unlikely, the negative effects of early ages of marriage on children may be avoided.

As theorized in our framework, the social pathways examined may ultimately affect children through influencing maternal behavior, that is, the decisions that a mother makes for herself and her child given the context in which she is situated within, affected by limited resources, knowledge, skills, or agency and ultimately affecting her child's outcomes. Increasing the age of marriage above 18, or enforcing the legal marital age in most of the African countries included, may have a cascade effect on female opportunities which may, in turn, affect maternal biological and behavioral factors influencing child well-being. National policies and programs could further expand maternal and child health and education to enable access for women and children in rural, poorer, and lower educated environments. Such system changes can also be complimented by ensuring women and other stakeholders in local communities are aware and actively seek out these services. Girl child marriage may, in fact, be a modifiable risk factor for child development and health in the sub-Saharan African contexts explored.

Acknowledgements

Yvette Efevbera received training-grant support from the Initiative to Maximize Student Diversity GM055353-14 through the National Institutes of Health. The authors would like to acknowledge Simo Goshev at the Institute for Quantitative Social Science, Harvard University, for his support with statistical questions. The authors are also grateful to Kemi Fadayomi and Femi Fadayomi for reviewing earlier drafts of this manuscript.

Appendix C. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.socscimed.2017.05.027.

Appendix A

Child marriage among mothers in sample compared to population rates.

Country	Married before age 18 in sample (%)	Married before age 18 in population (%)[a,b]
Central African Republic	64	68
Chad	75	68
Democratic Republic of Congo	45	39
Ghana	33	21
Kenya (Mombasa)	48	26
Kenya (Nyanza)	53	26
Madagascar (South)	75	41
Mauritania	52	43
Nigeria	40	43
Sierra Leone	59	44
Somalia (Northeast)	44	45
Somalia (Somaliland)	36	45
Swaziland	17	7
Togo	34	25
Malawi	51	50
Zimbabwe	34	31

[a] As reported by Girls Not Brides, 2017.
[b] Data calculated among 20–24 year old women.

Appendix B

Summary of unadjusted bivariate analyses to assess associations between girl child marriage and child development and health outcomes.

Outcome	OR/Coefficient	p-value
Main outcomes		
ECDI (off-track)	0.797	$p < 0.001$
Stunting	1.29	$p < 0.001$
Secondary outcomes		
Child development score (out of 10)	−0.271	$p < 0.001$
HAZ	−0.166	$p < 0.001$
Developmental domain		
Learning	0.732	$p < 0.001$
Literacy-numeracy	0.692	$p < 0.001$
Physical	0.972	$p = 0.503$
Socio-emotional	1.00	$p = 0.941$

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