Annals of Global Health
VOL. 83, NO. 3–4, 2017

ISSN 2214-9996/$36.00
https://doi.org/10.1016/j.aogh.2017.10.005

ORIGINAL RESEARCH

The Effect of Early Marriage Timing on Women's and Children's Health in Sub-Saharan Africa and Southwest Asia

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Abstract

BACKGROUND Age of marriage is a barrier to mother's health care around pregnancy and children health outcomes.

OBJECTIVE We provide evidence on the health benefits of postponing early marriage among young wives (from age 10-14 to age 15-17) on women's health care and children's health for sub-Saharan Africa (SSA) and Southwest Asia (SWA).

METHODS We use data for 39 countries from the Demographic and Health Surveys to estimate the effects of postponing early marriage for women's health care and children's health outcomes and immunization using matching techniques. We also assess whether women's health empowerment and health constraints are additional barriers.

FINDINGS We found that in SSA, delaying the age of marriage from age 10-14 to age 15-17 and from age 15-17 to age 18 or older leads to an increase in maternal neotetanus vaccinations of 2.4% and 3.2%, respectively; gains in the likelihood of postnatal checks are larger for delayed marriage among the youngest wives (aged 10-14). In SWA, the number of antenatal visits increases by 34% and the likelihood of having a skilled birth attendant goes up to 4.1% if young wives postpone marriage. In SSA, the probability of children receiving basic vaccinations is twice as large and their neonatal mortality reduction is nearly double if their mothers married between ages 15-17 instead of at ages 10-14. The extent of these benefits is also shaped by supply constraints and cultural factors. For instance, we found that weak bargaining power on health decisions for young wives leads to 11% fewer antenatal visits (SWA) and 13% less chance of attending postnatal checks (SSA).

CONCLUSIONS Delaying age of marriage among young wives can lead to considerable gains in health care utilization and children health in SSA and SWA if supported by policies that lessen supply constraints and raise women's health empowerment.

KEY WORDS child mortality, health empowerment, prenatal care, southwest Asia, sub-Saharan Africa, timing of early marriage.

INTRODUCTION

Early marriage is not only a serious human rights violation driven by sociocultural factors and poverty but it is also a significant barrier to women and children's health because girls have not yet attained full maturity and the capacity to act autonomously.[1,2] The associated risks to well-being and health as a result of early marriage are widely acknowledged. Young girls who are married early begin childbearing soon after marriage, leading to increased health risks from complications in pregnancy, low infant birth weight, and

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often death during delivery. Other risks for young married girls are due to their short birth spacing[3] and greater chances of contracting HIV.[4] Inadequate access and underuse of health care services are additional reasons for poor health outcomes of young married girls as their decisions to seek care are set back because of their low household wealth and low education.[5,6] Hence, policies that advocate and support later marriage for young girls have significant health benefits both for young married girls and their children.

Specific country studies indicate the lack of access to basic health coverage among early-married mothers (EMMs). For instance, Nasrullah et al[7] find that 73% of EMMs in Pakistan have a decreased likelihood of having any prenatal care and increased chances of delivery by unskilled birth attendants—twice the amount compared with non-EMMs. Similarly, child marriage in Niger is negatively associated with the frequency of antenatal visits and having a skilled birth attendant at delivery.[8] Moreover, the risk of malnutrition is greater in young children born to girls who married young.[9]

Although many countries have established laws prohibiting early marriage, often these laws are not based on revisions of minimum age of marriage, making them difficult to enforce.[10] For the group of girls who ended up marrying very young beyond their will, however, a forward shift of their age of marriage by a few years can be an intermediate step to lessen the negative effects on health through their increasing intrahousehold bargaining power and autonomy. Improved agency for young girls could lead to a larger access and control over resources, more mobility outside the community, and increased ability to negotiate health systems more efficiently.[11] In addition, a few more years outside of marriage can increase the likelihood of these young girls to stay in school[12,13] and, relatedly, increase their degree of health literacy.[14]

The aim of the paper is 2-fold. The first objective is to offer new evidence on the impact of the timing of early marriage among the youngest wives on a wide range of women's and children's health ex-post outcomes for 39 countries in sub-Saharan Africa (SSA) and Southwest Asia (SWA). In particular, we investigate the benefits of delaying early marriage among the youngest EMMs (ie, those marrying at ages 15-17 instead of at ages 10-14) on health service use (antenatal care, skilled birth attendance, vaccinations, and postnatal checks) as well as in terms of their children's immunization uptake, mortality (neonatal and infant), and nutrition (stunting).

The second objective is to assess whether young wives' health empowerment, access to health services, and supply constraints are additional barriers for both their health and the health of their children (after isolating contextual factors driving both marriage decision and health outcomes). To evaluate this, we generated matched subsamples for the EMM and non-EMM groups with similar characteristics (eg, family composition, education, family wealth, and other socioeconomic community variables) by propensity score matching.

We focused on SSA and SWA because they account for 55% of the world's child marriage prevalence and the 10 countries with the highest prevalence are from these 2 regions. Also, SSA and SWA are the furthest away from health equality. For instance, Organization for Economic Cooperation and Development countries have antenatal health coverage of nearly 90%, whereas in SSA and SWA this is less than 50%.[15] In 2013, SSA contributed roughly half (3.1 million) of the under-5 deaths worldwide and Southern Asia almost a third (2.02 million).[16]

METHODS

Data. The analysis is based on 39 Demographic and Health Surveys (DHS) from the SSA and SWA regions.[17] We use the more recent DHS for each country (for details of the countries and survey years, see Online Supplementary Appendix, Supplementary Table 1 in the online version at doi:10.1016/10.1016/j.aogh.2017.10.005). DHS surveys are nationally representative household samples for lower- and middle-income countries, and they are an important source for population health studies[18,19] because of their comparability, quality, and coverage. The primary working sample populations were women aged 20-29 years who had their last baby born alive in the 5 years preceding the survey. For this group, we compared women (and their children) who first married or entered into union between ages 11 and 17 with those who married at age 18 or older. The lower bound of age 20 was used to avoid both measurement error in age of marriage and girls younger than age 18 where there is uncertainty on whether they will eventually marry, and the upper bound of 29 years of age was chosen to account for decreasing fertility patterns. We created separate samples for maternal and child health variables. As shown in Table 1, sample sizes varied from 209,617 (SSA) and 104,713 (SWA) for the outcome "skilled birth attendant present at birth," to 37,983 (SSA) and 21,544 (SWA) for the outcome "stunting."

Outcomes. The first set of indicators includes outcomes for women's health-seeking behavior around

Table 1. Samples' Summary Statistics and for Women's Health Care and Children Health Outcomes

Sub-Saharan Africa (SSA) and South West Asia (SWA): 39 LMICs DHS Surveys 2004-2014

Women's Health Care	No. of Antenatal Visits		Vaccination Neotetanus		Skilled Birth Attendant		Postnatal Check	
	SSA	SWA	SSA	SWA	SSA	SWA	SSA	SWA
N	207,614	105,582	209,463	105,896	209,617	104,713	169,870	62,188
Whole sample	3.70	3.55	0.76	0.81	0.07	0.31	0.45	0.24
Early marriage (aged 10-14)	3.02	2.23	0.65	0.75	0.03	0.17	0.36	0.21
Early marriage (aged 15-17)	3.47	2.90	0.74	0.79	0.05	0.26	0.44	0.22
Married (18 or older)	4.22	4.94	0.81	0.86	0.09	0.44	0.49	0.31
Early marriage (aged 10-17)	3.32	2.68	0.71	0.78	0.04	0.23	0.42	0.22
Children's Health Outcomes	**Child Basic Vaccinations**		**Neonatal Mortality**		**Infant Mortality**		**Stunting**	
	SSA	SWA	SSA	SWA	SSA	SWA	SSA	SWA
N	171,753	105,070	49,100	27,830	49,100	27,830	37,983	21,544
Whole sample	0.21	0.17	0.014	0.017	0.030	0.025	0.31	0.36
Early marriage (aged 10-14)	0.14	0.13	0.020	0.020	0.040	0.030	0.35	0.43
Early marriage (aged 15-17)	0.21	0.15	0.013	0.020	0.030	0.028	0.34	0.40
Married (18 or older)	0.25	0.23	0.013	0.013	0.025	0.019	0.27	0.29
Early marriage (aged 10-17)	0.18	0.14	0.015	0.020	0.033	0.029	0.34	0.41

Includes 34 SSA countries and 5 SWA countries. See Supplementary Table 1 (Online Appendix 1 in the online version at doi:10.1016/10.1016/j.aogh.2017.10.005) for a list of countries and surveys' years. Working samples include ever-married women aged 20-29.
DHS, Demographic and health surveys; LMICs, lower- and middle-income countries.

pregnancy—that is, the number of antenatal visits (measured the intensity of prenatal care), neotetanus vaccinations (whether mothers had been given toxoid injections during pregnancy), skilled birth attendant (whether a doctor, nurse, or midwife was present at birth), and postnatal checks (whether the baby had been checked 2 months after delivery). The second group of indicators contains outcomes for children's health care after birth, mortality, and malnutrition. Children's basic vaccinations include bacille Calmette-Guerin, diphtheria-pertussis-tetanus, polio, and measles during the first year of life. Birth histories covering a 5-year period provided by women were used to calculate child mortality binary indicators: neonatal mortality (if the child died within the first month of life) and infant mortality (if the child died before first birthday). Stunting indicates chronic malnutrition for children younger than age 5 years.

Covariates. As well as the key covariates early marriage and timing of early marriage, the analysis included a wide range of household and community covariates. Household covariates are: number of children at home, male-headed household, mother's working status and religion, mother's body mass index, father's occupation type, parental education, and household wealth. Community covariates include health variables (average number of children younger than age 4, proportion of underweight mothers), community location (urban/rural), and socioeconomic background (a development index based on household assets and proportion of fathers with an upper/nonfarm occupation). We also included country variables such as gross domestic product per capita, number of health workers per 1000 people, and proportion of the population with access to improved water and sanitation.[20]

Statistical Analyses. Because marrying young is not a random event and is influenced by an array of socioeconomic and cultural factors, a comparison of EMMs and their children with the group of women marrying later would be biased. To attenuate the selection bias generated by confounding factors we used matching techniques.[21] We attempted to isolate the effect of early marriage, controlling for observables (from Table 2), pursuing a 2-fold approach. First, to estimate the relative benefits of delaying early marriage on mother's health care surrounding pregnancy and children's health outcomes—the first objective of the paper—we adopted a multitreatment approach.[22] This procedure minimized the impact of observables in the selection of marriage at different ages. We define 3 treatments effects: married between ages 10 and 14 (treatment 0, t = 0), married between ages 15 and 17 (treatment 1, t = 1), and married after age 18 (treatment 2, t = 2)—that is, we

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Table 2. Summary Statistics (Means) of Covariates by Treatment Status (Time of Marriage)

	SSA			SWA		
Variables	Married (Aged 10- 14)	Married (Aged 15-17)	Married (Aged 18 or Older)	Married (Aged 10-14)	Married (Aged 15-17)	Married (Aged 18 or Older)
Individual						
No. of sisters	1.353	1.124	0.753	1.238	1.050	0.642
No. of brothers	1.429	1.152	0.754	1.323	1.124	0.692
Household head—male	0.934	0.915	0.893	0.961	0.952	0.900
Mother work	0.569	0.580	0.577	0.334	0.307	0.271
Mother—Muslim	0.496	0.369	0.263	0.412	0.290	0.202
Mother's BMI	23.525	23.781	24.441	22.909	23.910	26.809
Household wealth—Q1	0.298	0.241	0.177	0.266	0.198	0.099
Household wealth—Q2	0.245	0.220	0.178	0.233	0.205	0.141
Household wealth—Q3	0.187	0.199	0.185	0.218	0.219	0.187
Household wealth—Q4	0.151	0.188	0.201	0.180	0.217	0.248
Household wealth—Q5	0.118	0.151	0.258	0.104	0.162	0.326
Father occupation—farm	0.555	0.529	0.396	0.338	0.295	0.201
Father occupation—lower nonfarm	0.255	0.279	0.343	0.468	0.473	0.423
Father occupation—upper nonfarm	0.190	0.192	0.261	0.194	0.232	0.376
Mother education—none	0.627	0.562	0.470	0.476	0.468	0.393
Mother education—at least some primary	0.271	0.304	0.307	0.320	0.268	0.204
Mother education—at least some secondary	0.102	0.134	0.223	0.205	0.264	0.403
Father education—none	0.620	0.556	0.472	0.464	0.461	0.390
Father education—at least some primary	0.287	0.309	0.303	0.334	0.271	0.199
Father education—at least some secondary	0.094	0.135	0.224	0.202	0.268	0.411
Community						
No. of children younger than 4	0.430	0.400	0.350	0.283	0.280	0.254
Underweight mothers (%)	0.109	0.094	0.077	0.282	0.271	0.208
Rural community	0.763	0.726	0.618	0.697	0.656	0.558
Development index	-0.309	-0.163	0.137	-0.378	-0.287	0.125
Parents with secondary education (%)	0.142	0.171	0.232	0.295	0.323	0.394
Upper nonfarm occupation—father (%)	0.437	0.573	0.713	0.263	0.317	0.557

Additional country controls included log of GDP per capita, proportion of urban population, number of wealth workers per 1000 people, and proportion of population with access to improved water source and sanitation facilities (World Bank, 2015).[20]
BMI, body mass index; GDP, gross domestic product; SSA, sub-Saharan Africa; SWA, Southwest Asia.

divided the early married treatment group into 2 additional treatment groups (ie, girls married at a very young age and girls married at an intermediate age). Multivalued treatment effects are constructed by contrasting the parameters of the distributions that the outcome variable would have had under each level of treatment—that is, the population-averaged treatment effects of getting treatment 1 instead of 0, treatment 2 instead of 0, and treatment 2 instead of 1. The treatment equation included household, community health, and socioeconomic controls as well as country variables, and, for the health equation, additional controls used were education and household wealth because they are observed after marriage.

For the second objective of the paper (ie, the analysis of women's empowerment on health decisions, access to family planning, and supply constraints as mediating pathways from early marriage to health), we conducted regressions on matched subsamples obtained by propensity score matching on the early marriage treatment. Within these regressions, we interacted these mediating factors with the categorical variable early marriage. Here, we matched additional covariates for both women and husband education as well as occupation and family wealth. We employed nearest neighbor matching without replacement with a small caliper to generate balancing of covariates among the treated and untreated groups (see Online Supplementary Appendix in the online version at doi:10.1016/10.1016/j.aogh.2017.10.005 for details on the matching procedure and the construction of matched subsamples). Importantly,

matched subsamples generated in this manner identified comparable mothers married before and after age 18. We carried out multilevel estimations on matched subsamples to account for clustering of observations, where level 1 is given by mothers (or children) and level 2 by communities. Estimates for multitreatment effects were obtained using the poparms command of Stata (StataCorp, College Station, TX), propensity score matching estimations using psmatch2, and multilevel analysis with the meglm and melogit commands.

RESULTS

Descriptive. Table 1 shows the distribution of outcomes by age of marriage for SSA and SWA. In both regions, there are significant gaps in health outcomes not only by early marriage groups but also by the timing of marriage. For example, compared with EMMs who had married between ages 10 and 14, EMMs married between ages 15 and 17 were 0.45-0.67 times more likely to attend prenatal services, had 4%-9% greater chances of being vaccinated for neotetanus, and had an additional 2%-10% chance that a qualified health worker was present when they gave birth. Equally, infant mortality and stunting rates were between 1% and 3% lower for the EMMs married between ages 15 and 17. Furthermore, Table 2 shows information on covariates by timing of marriage. There are major differences, with women who married earlier being noticeably disadvantaged. For instance, in SSA, households of the women married very young had nearly double the number of children than those from the non–early married group, and they were 30% more likely to be poorest (fall into the bottom quintile of wealth distribution), whereas for the non-EMMs group there was only a 17% chance.

Effects of Timing of Marriage on Health Outcomes. Figure 1 contains the estimated densities for the predicted probabilities for each treatment condition on the other 2 treatments. Because none of the densities indicated any mass with values too close to 0 or 1, estimates did not encounter any common support problems.

As shown by Table 3 (Panel A), if girls had the agency to postpone early marriage, this could have far-reaching effects on their health care outcomes. Delaying marriage among the youngest married group of EMMs from ages 10-14 to ages 15-17 (t1 vs t0) has effects of similar magnitude to delaying early marriage from ages 15-17 to age 18 or older (t2 vs t1) for the outcomes "neotetanus vaccinations" and "postnatal checks." In SSA, for example, the impact of postponing marriage among EMMs is 2.4% versus 3.2% increases for ages 15-17 versus age 18 or older for the outcome "neotetanus vaccinations," though it is even larger for postnatal checks because the contrasting effects of t1 against t0 (=0.039) are higher than for t2 against t1 (=0.021). Equally, for SWA, further benefits are obtained by marriage among the youngest married group of EMMs: for number of antenatal visits (t1 vs t0 = 0.34, t2 vs t1 = 0.52) and skilled birth attendant (t1 vs t0 = 0.041, t2 vs t1 = 0.069). Obviously, the largest estimates are when contrasting effects of t2 versus t0.

Moreover, if early-married girls in the youngest age group (ages 10-14) hypothetically either had the agency and empowerment to postpone their marriage or had not been pressured into marriage by their families, their communities, or the influence of social norms, this would have led to considerable benefits for their children's health (Panel B of Table 3). This is particularly the case for SSA, where the probability of children receiving basic vaccinations was twice as large (0.054 vs 0.028) and the reduction of neonatal mortality was nearly double (–0.009 vs –0.006) if their mothers married between ages 15 and 17 instead of marrying earlier at ages 10-14. For the 2 regions, there were also positive effects for infant mortality by postponing marriage among the youngest EMMs. It should be noted that for the SSA region, estimates are driven by the larger effects in Western Africa and Eastern Africa (see Supplementary Table 2 of Online Appendix 2 in the online version at doi:10.1016/10.1016/j.aogh.2017.10.005, including SSA's subregions estimates).

Mediating Factors on the Effects of Early Marriage on Health. Here we examine supplementary pathways mediating the effect of early marriage on health outcomes using matched subsamples. We looked at whether women's empowerment in health decisions, access to family planning services, and supply constraints (ie, distance to health facilities) account for some of the negative effects of child marriage on health using subsamples of treated and untreated women with similar distributions of observables characteristics (household and community covariates of Table 2). After matching on the propensity score for the treatment variable early marriage, sample sizes of matched subsamples were reduced between 64% (SWA) to 74% (SSA) from the original sample sizes (see Supplementary Table 3 of Online Appendix 3 in the online version at doi:10.1016/10.1016/j.aogh.2017.10.005).

Estimates for the interaction term between these mediating effects and the binary variable early

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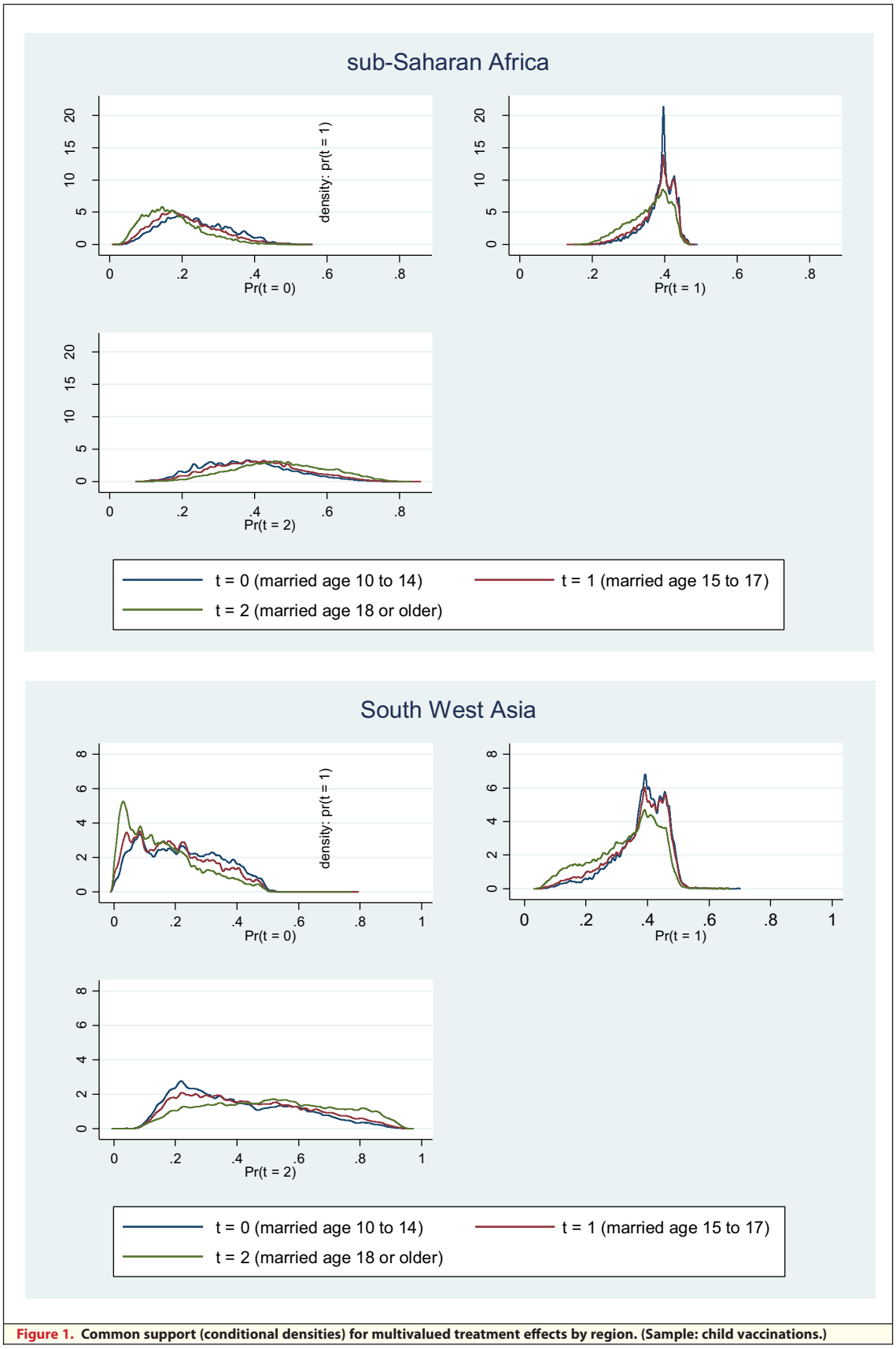

Figure 1. **Common support (conditional densities) for multivalued treatment effects by region. (Sample: child vaccinations.)**

Table 3. Effect of Age of Marriage (Multitreatment Effects) on Mother's Health Care and Children's Health Outcomes

	SSA			SWA		
	Estimate	CI		Estimate	CI	
Panel A—Mother's health care outcomes						
Antenatal visits numbers						
Married aged 15-17 vs aged 10-14 (t1 vs t0)	0.085‡	0.051	0.120	0.340‡	0.229	0.451
Married aged 18 or older vs aged 10-14 (t2 vs t0)	0.457‡	0.422	0.492	0.859‡	0.751	0.968
Married aged 18 or older vs aged 15-17 (t2 vs t1)	0.372‡	0.346	0.397	0.519‡	0.475	0.563
Vaccination neotetanus						
Married aged 15-17 vs aged 10-14 (t1 vs t0)	0.024‡	0.019	0.030	0.016‡	0.006	0.027
Married aged 18 or older vs aged 10-14 (t2 vs t0)	0.056‡	0.051	0.062	0.029‡	0.018	0.039
Married aged 18 or older vs aged 15-17 (t2 vs t1)	0.032‡	0.028	0.036	0.012‡	0.007	0.018
Skilled birth attendant						
Married aged 15-17 vs aged 10-14 (t1 vs t0)	0.004‡	0.001	0.007	0.041‡	0.032	0.051
Married aged 18 or older vs aged 10-14 (t2 vs t0)	0.027‡	0.024	0.030	0.110‡	0.101	0.119
Married aged 18 or older vs aged 15-17 (t2 vs t1)	0.023‡	0.021	0.025	0.069‡	0.063	0.075
Postnatal Check						
Married aged 15-17 vs aged 10-14 (t1 vs t0)	0.039‡	0.032	0.046	0.016‡	0.006	0.025
Married aged 18 or older vs aged 10-14 (t2 vs t0)	0.061‡	0.054	0.067	0.041‡	0.031	0.050
Married aged 18 or older vs aged 15-17 (t2 vs t1)	0.021‡	0.016	0.027	0.025‡	0.018	0.032
Panel B—Children's Health Outcomes						
Child Basic Vaccinations						
Married aged 15-17 vs aged 10-14 (t1 vs t0)	0.054‡	0.048	0.059	0.039‡	0.027	0.051
Married aged 18 or older vs aged 10-14 (t2 vs t0)	0.082‡	0.076	0.088	0.099‡	0.087	0.111
Married aged 18 or older vs aged 15-17 (t2 vs t1)	0.028‡	0.024	0.033	0.060‡	0.054	0.066
Neonatal mortality						
Married aged 15-17 vs aged 10-14 (t1 vs t0)	−0.009‡	−0.014	−0.005	−0.005*	−0.011	0.001
Married aged 18 or older vs aged 10-14 (t2 vs t0)	−0.015‡	−0.020	−0.011	−0.016‡	−0.022	−0.010
Married aged 18 or older vs aged 15-17 (t2 vs t1)	−0.006‡	−0.009	−0.004	−0.011‡	−0.014	−0.007
Infant Mortality						
Married aged 15-17 vs aged 10-14 (t1 vs t0)	−0.015‡	−0.021	−0.009	−0.008†	−0.015	0.000
Married aged 18 or older vs aged 10-14 (t2 vs t0)	−0.031‡	−0.037	−0.026	−0.023‡	−0.030	−0.015
Married aged 18 or older vs aged 15-17 (t2 vs t1)	−0.016‡	−0.020	−0.013	−0.015‡	−0.019	−0.011
Stunting						
Married aged 15-17 vs aged 10-14 (t1 vs t0)	−0.006	−0.022	0.009	−0.025†	−0.054	0.003
Married aged 18 or older vs aged 10-14 (t2 vs t0)	−0.048‡	−0.063	−0.032	−0.072‡	−0.100	−0.044
Married aged 18 or older vs aged 15-17 (t2 vs t1)	−0.042‡	−0.052	−0.031	−0.047‡	−0.061	−0.032

Controls are from Table 2. The contrasting parameters for women's health care and their children's health outcome distributions are as follows: (i) t1 vs t0 is the outcome that girls married aged 10-14 (t0) would have had if they had married at age 15-17 (t1); (ii) t2 vs t0 is the outcome that girls married aged 10-14 (t0) would have had if they had married after age 17 (t2); (iii) t2 vs t1 is the outcome that girls married aged 15-17 (t1) would have had if they had married after age 17 (t2). Delta-method standard errors.

CI, confidence interval; SSA, sub-Saharan Africa; SWA, Southwest Asia.

* $P < .10$.

† $P < 0.05$.

‡ $P < .01$.

marriage are presented in Table 4. We found intrahousehold bargaining power regarding health decisions matters relatively greater for EMMs than for non-EMMs (again, with the 2 groups having similar background characteristics). The indicator "husbands having control over women's health expenditure" lead to 0.11 (SWA) fewer antenatal visits and 13% fewer chances (SSA) of going to postnatal checks for EMMs compared with non-EMMs (model M1). Among EMMs, access to information on fertility decisions was also affected by less access to family planning services. In SSA and SWA, "having not heard of or not being offered family planning services" (models M2 and M4) was related to 0.10 and 0.20 fewer prenatal visits and approximately 0.30 less chance of having a skilled professional at birth in either region, as well as to 0.80 or 0.65 fewer chances to attend postnatal checks or of children having basic

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Table 4. Early Marriage Interactions Effects of Health Empowerment, Family Planning, and Distance to Health Facilities: Linear and Logit (Odds Ratio) 2-Level Multilevel Estimates on Matched Subsamples

	SSA					SWA				
	M1	M2	M3	M4	M5	M1	M2	M3	M4	M5
Outcome: Antenatal visits number										
Early marriage (EM)	−0.299‡	−0.202‡	−0.274‡	−0.168‡	−0.270‡	−0.490‡	−0.378‡	−0.844‡	−0.579‡	−0.514‡
Women's health care decision husband	−0.298‡					−0.151‡				
Women's health care decision husband × EM	0.100‡					−0.113†				
Heard of family planning		0.544‡					1.056‡			
Heard of family planning × EM		−0.066‡					−0.198‡			
Visited health facility			0.285‡					1.505‡		
Visited health facility × EM			0.072‡					0.245		
Health facility told family planning				0.284‡					0.232*	
Health facility told family planning × EM				−0.105‡					0.082	
Distance to health facility problem					−0.336‡					−0.434‡
Distance to health facility problem × EM					0.107‡					−0.093*
N (matched sample)	142,926	147,878	146,716	96,880	131,568	64,536	68,400	10,506	8905	58,349
Outcome: Skilled Birth Attendant										
Early marriage	0.664‡	0.616‡	0.807‡	0.563‡	0.656‡	0.562‡	0.668‡	0.884	1.133	0.586‡
Women's health care decision husband	0.809‡					0.826‡				
Women's health care decision husband × EM	0.923					0.819‡				
Heard of family planning		1.432‡					2.912‡			
Heard of family planning × EM		1.090					0.703‡			
Visited health facility			1.354‡					1.451‡		
Visited health facility × EM			0.664‡					1.203		
Health facility told family planning				1.094*					1.336*	
Health facility told family planning × EM				0.770‡					0.459‡	
Distance to health facility problem					0.772‡					0.583‡
Distance to health facility problem × EM					0.936					0.852†
N (matched sample)	147,057	152,256	151,078	98,925	136,000	63,427	67,289	10,888	9283	57,212
Outcome: Postnatal Checks										
Early marriage	0.926‡	0.877‡	0.853‡	0.848‡	0.884‡	0.813‡	0.910*	0.800	0.794†	1.196†
Women's health care decision husband	1.006					0.773‡				
Women's health care decision husband × EM	0.870‡					0.982				
Heard of family planning		1.623‡					2.168‡			
Heard of family planning × EM		1.002					0.791‡			
Visited health facility			1.993‡					1.655‡		
Visited health facility × EM			1.059					1.146		
Health facility told family planning				1.399‡					1.777‡	
Health facility told family planning × EM				0.928					1.017	
Distance to health facility problem					0.712‡					0.781‡
Distance to health facility problem × EM					1.045					0.550‡
N (matched sample)	120,063	121,484	120,299	75,598	112,925	34,550	36,909	7297	5846	27,778
Outcome: Children's Vaccinations										
Early marriage	0.881‡	0.872‡	0.881‡	0.847‡	0.822‡	0.550‡	0.765‡	0.923	0.673‡	0.448‡
Women's health care decision husband	0.906‡					0.980				
Women's health care decision husband × EM	0.969					1.194‡				
Heard of family planning		1.283‡					1.465‡			
Heard of family planning × EM		−0.001					0.658‡			
Visited health facility			2.010†					3.387‡		
Visited health facility × EM			0.949					0.615†		
Health facility told family planning				1.492‡					1.363‡	
Health facility told family planning × EM				0.976					0.743	
Distance to health facility problem					0.980					0.736‡
Distance to health facility problem × EM					1.079*					1.101
N (matched sample)	119,334	124,101	122,651	77,584	110,130	63,660	67,304	9882	8404	57,170

For details on the construction of matched samples, see Online Supplementary Appendix 3 in the online version at doi:10.1016/10.1016/j.aogh.2017.10.005.
SSA, sub-Saharan Africa; SWA, Southwest Asia.

* $P < .10$.
† $P < .05$.
‡ $P < .01$.

vaccinations (in SWA). Distance to health facilities and related security concerns (model M5) were also extra barriers to health-seeking behavior for EMMs. In SWA, for example, EMMs had 15% and 24% less chances to have access to skilled birth attendants and for children to have received basic vaccinations, respectively.

DISCUSSION

We found that delaying age of marriage among young wives in SSA and SWA—which could be accomplished by empowerment and community policies, for instance—could lead to considerable gains in maternal health care use and children's health. In SSA, delaying the age of marriage from ages 10-14 to ages 15-17 and from ages 15-17 to age 18 or older was related to an increase in maternal neotetanus vaccinations of 2.4% and 3.2%, respectively; it led to larger gains in the likelihood of postnatal checks among the youngest married wives, whereas the probability of children receiving basic vaccinations was twice as large and their neonatal mortality reduction was nearly double if their mothers married between ages 15 and 17 instead of at ages 10-14. In SWA, the number of antenatal visits increased by 34%, and the likelihood of having a skilled birth attendant went up to 4.1% with delayed early marriage.

Differences in estimates by region and by indicator types could reflect differential regional bottlenecks on effective coverage as well as differential benefits of increasing young wives' health literacy. In SSA, by delaying their age of marriage until ages 15-17, the gains for girls married at ages 10-14 were greater for postnatal checks, child vaccinations, and neonatal mortality, whereas in SWA they were relatively greater for neotetanus vaccinations (though there were still improvements in the case of antenatal care, child mortality, and stunting). These distinct findings for the 2 regions may suggest 2 distinct policy actions.

First, the SSA's finding of the effect that shifting forward the age of marriage has on the youngest married girls in terms of postnatal checks, children vaccinations, and neonatal mortality suggests that in this region further education could have a leading role in better care around birth through a greater ability to access and process new health information. Maternal education enhances health-seeking behaviors for children.[23] Importantly, our estimates validate the fact that health literacy on essential newborn care in poor settings is powerfully shaped by slight changes in the mother's behavior, with education being a strong enabler. For example, postnatal care in SSA is associated with a reduction in neonatal mortality of 0.51-0.34.[24] Our findings are supported by earlier studies[25] reporting the pronounced effect schooling has on neonatal mortality for Eastern Africa (the subregion driving SSA's estimates) and by the fact that most child marriage programs in Eastern Africa have strong education components alongside reproductive health measures.[26,27] Hence, an effective policy could be to target schools as reentry points into health care, with readmissions of young wives after the birth of a child involving teachers, community leaders, and health service providers. Conversely, as in other studies,[28] we found that the frequency of antenatal visits and skilled birth attendance coverage in SSA have relatively lower leverage effects.

Second, for the SWA region, the large effect on the uptake of neotetanus vaccinations for the group of girls married at the youngest age could be the reason behind the estimated effect on decreased neonatal preventable deaths (of 5 per 1000 live births). Indeed, studies have found that neonatal tetanus is an important preventable cause of neonatal mortality. For example, the northern states of India (where child marriage is widespread and health services are scanty) account for 56% of deaths in India as a result of neonatal tetanus.[29] Empowering policies for the youngest wives that contribute to a delay of marriage could raise their chances of tetanus vaccination during pregnancy. This is likely to have maximal impact because child brides live in communities where neonatal tetanus is common because most births take place in unhygienic conditions and are attended to by untrained professionals.[30] Our estimates also indicate that reductions in children's stunting rates can be significant through delayed marriage, which is critical given the poor levels of nutrition in the region and its relationship with infant mortality. Thus, SWA's programs educating young mothers on the importance of neotetanus vaccinations and appropriate feeding practices are vital because of the powerful effects on neonatal and infant mortality.

Nevertheless, in the matched sample analysis we found that shifting the time of marriage is not enough in silo and needs to be implemented in parallel with other measures lifting economic and cultural barriers withholding EMMs' health-seeking behavior. That is, we found that even by isolating household, community, and country factors, infrastructure constraints still need to be addressed (such as low access to family planning services and lack of empowerment on health decisions). For example, we found that the weak bargaining power of young wives regarding health

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decisions leads to 11% fewer antenatal visits (SWA) and 13% less chance of going to postnatal checks (SSA).

These results have clear policy implications. Direct and indirect costs of accessing health care hit young wives the hardest because of travel times and time spent away from productive work, all of which represent a higher economic burden,[28] and, accordingly, a great deal can be attained by reducing distance to health centers in child marriage hotspots. Also, efforts to deliver family planning programs should be strengthened for young wives because their scarcity leads to short birth spacing, which strains family resources, and to higher infant mortality. We also found that increasing women's intrahousehold bargaining power on health decisions is key. Changing sociocultural perceptions on women's role in a society are essential for interventions to function. Most child marriage programs include empowerment initiatives as a primary objective.[27] Our results suggest that more efforts should be put toward empowering girls with health information and skills.

CONCLUSIONS

Using data for 39 countries from SSA and SWA, this paper empirically assessed the relationship between timing of early marriage and an array of women's health care and children's health outcomes. We also considered whether health empowerment and supply factors are additional constraints on observed poor health behavior of early married mothers. We found significant positive effects by increasing age at time of marriage (from ages 10-14 to ages 15-17) on women's health care use and on children's health. The scope of these benefits, however, varies across regions and outcomes. In addition, we found that the likelihood of these benefits being realized can be noticeably increased by removing constraints in the health supply side as well as cultural barriers related to health empowerment.

The paper conveys 2 vital messages for the post-2015 development agenda and the new Sustainable Development Goals (SDGs). First, success on achievement of SDGs would be hindered if across-goals synergies (SDG 3, health, and SGD 5, gender equality) are not considered. Second, synergies can be implemented through intermediate steps. Policies geared toward giving incentives to move forward the timing of marriage among the youngest wives could yield improvement in women's health care and children's health in the medium term toward the 2030 deadline.

For the next 15 years, the issue of delaying early marriage should be at the forefront of development policy for disadvantaged women and society as a whole. Our analysis indicates that the health care benefits of delayed marriage are enormous and so introducing policies that make this a priority should be pursued by countries in the 2 regions we have studied. Policies are in themselves not enough. Early marriage in many poor countries is locked in with cultural practices and values that undermine the empowerment of women. Policies that address and improve women's voices in decision making at the local level can enhance their rights in terms of delaying marriage.

SUPPLEMENTARY DATA

Supplementary data to this article can be found online at doi:10.1016/10.1016/j.aogh.2017.10.005.

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