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RESEARCH ARTICLE

The role of education in child and adolescent marriage in rural lowland Nepal

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Abstract

Marriage during childhood and adolescence adversely affects maternal and child health and well-being, making it a critical global health issue. Analysis of factors associated with women marrying ≥18 years has limited utility in societies where the norm is to marry substantially earlier. This paper investigated how much education Nepali women needed to delay marriage across the range of ages from 15 to ≥18 years. Data on 6,406 women aged 23-30 years were analysed from the Low Birth Weight South Asia Trial on the early-marrying and low-educated Maithili-speaking Madhesi population in Terai, Nepal. Multivariable logistic regression models assessed the associations of women's education with marrying aged ≥15, ≥16, ≥17 and ≥18 years. Cox proportional hazards regression models quantified the hazard of marrying. Models adjusted for caste affiliation. Women married at median age of 15 years and three-quarters were uneducated. Women's primary and lower-secondary education were weakly associated with delaying marriage, whether the cut-off to define early marriage was 15, 16, 17 or 18 years, with stronger associations for secondary education. Caste associations were weak. Overall, models explained relatively little of the variance in the likelihood of marriage at different ages. The joint effects of lower-secondary and higher caste affiliation and of secondary/higher education and mid and higher caste affiliation reduced the hazard of marrying. In early-marrying and low-educated societies, changing caste-based norms are unlikely to delay women's marriage. Research on broader risk factors and norms that are more relevant for delaying marriage in these contexts is needed. Gradual increases in women's median marriage age and increased secondary education may, over time, reduce child and adolescent marriage.

Keywords: child and adolescent marriage; education; Nepal

Introduction

Public health efforts focus on delaying women's age at first childbearing. However, in South Asia, where women typically marry before having children, efforts need first to delay the age at which they marry (Marphatia et al., 2017). The broader health and human capital consequences of early marriage for adolescents, mothers and their children also make it a key public health concern in its own right (L. M. Bates et al., 2007; Chari et al., 2017; Finlay et al., 2011; Godha et al., 2016; Goli et al., 2015; Marphatia, Saville, Manandhar, Cortina-Borja, et al., 2021; Wells et al., 2021; Wodon et al., 2017). Early marriage may also be a mechanism for transmitting gendered

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socio-cultural norms across families and generations (Asadullah & Wahhaj, 2019; Bicchieri et al., 2014).

The universal minimum age at marriage is set as 18 years by the United Nations (UN) and the Sustainable Development Goals (SDGs) aim to eliminate the practice of 'child, early, and forced' marriage by 2030 (UN General Assembly, 2015, 2018). Globally, 19% of women aged 20-24 years married <18 years; South Asia is the region with the second highest prevalence (28%) (UNICEF, 2021). In Nepal, where this study is based, 33% of women aged 20-24 years married <18 years and 8% <15 years in 2019 despite a legal minimum marriage age of 20 years (previously permitted <18 years with parental permission) (The National Civil (Code) Act, 2017 (2074), 2017; His Majesty's Government of Nepal, 1963; UNICEF, 2021). Paradoxically, because so much attention has been directed to delaying marriage to ≥18 years, there is relatively little understanding of factors associated with delaying marriage beyond individual earlier ages such as 15, 16 and 17 years. This is despite the fact that delaying marriage beyond these ages is critical for reducing child and adolescent marriage.

Worldwide, efforts supporting girls' schooling have had the highest rate of success in delaying marriage (Kalamar et al., 2016; Malhotra & Elnakib, 2021b). Generally the longer girls stay in school, the later they are likely to marry (Delprato et al., 2015; Sekine & Hodgkin, 2017; Wodon et al., 2017). Women with secondary education typically marry at an older age than those with primary or no education (Bongaarts et al., 2017; Malhotra & Elnakib, 2021a). In Nepal, for example, uneducated women aged 25-49 years married 4.6 years earlier than secondary/higher educated women (16.8 vs 21.4 years) in 2016 (MOHP et al., 2017). Education and marriage are thus presented as mutually exclusive life pathways, but their association may be nonlinear. Studies identify a threshold effect, with secondary education of 9-11 years needed to delay marriage to ≥18 years (Bongaarts et al., 2017; Marphatia et al., 2020; Mathur et al., 2003; Pandey, 2017; Raj et al., 2014; Scott et al., 2021; Wodon et al., 2017).

Other studies have been more critical of the role that education alone can play in delaying marriage (Marphatia, Wells, et al., 2022). For example, the substantial increase in girls' education has not corresponded with similar delays in their age at marriage (Field & Ambrus, 2008; Raj et al., 2014). Even conditional cash transfers (CCTs) in Bangladesh and India which have supported girls to stay in school for longer have amounted to girls marrying just after 18 years of age, when parents received the cash transfer (Amin, 2007; Nanda et al., 2015). CCTs have also had limited impact in delaying marriage and first pregnancy in Malawi and Zambia (Dake et al., 2018). Reviewing evidence on CCTs aiming to delay marriage and increase girls' educational attainment across South Asia and sub-Saharan Africa, Amin et al. conclude that although girls' educational attainment has increased, it has not successfully challenged the early marriage norm, which remains widely practiced (Amin et al., 2017). This suggests that we need to better understand the socio-cultural norms which shape both the level of education and age at marriage of girls in different societies (Bicchieri et al., 2014; Caldwell et al., 1983; Maertens, 2011, 2013).

Defining 'early' marriage

Whilst delaying marriage to ≥18 years is the ultimate goal, in some societies it is the norm for women to marry well below this age. For example, the Maithili-speaking Madhesi women in this study who reside in the Terai (Province 2) have the lowest median age at marriage (15 years) and educational attainment (77% have never been to school) countrywide (MOHP et al., 2017; Pandey, 2017; Sah, 2018). Moreover, the prevalence of women aged 20-24 years marrying <18 years in Province 2 has only marginally decreased, from 78% in 2005 to 71% in 2016 (Scott et al., 2021).

A previous study assessed the odds of Maithili-speaking Madhesi women delaying marriage ≥18 years (Marphatia et al., 2020). Results showed that women needed to complete secondary education, of 9 and ideally 11 years, to both marry after ≥18 years and to have their first pregnancy two years thereafter. Marriage was the gateway to reproduction. The most effective public

health measure for delaying first pregnancy in this population would therefore be to delay the age at which women marry in the first place.

Whilst this analysis was informative, the 15% of women who actually married ≥18 years represent a rare group in this population. From both research and policy perspectives, understanding what predicts marriage at ≥18 years, although crucial in the UN/human rights literature and efforts, is of limited value for understanding why the majority of women are married at much earlier ages. Instead, the factors that predict delaying marriage to earlier ages than 18 years need to be better understood. In earlier marrying societies, nudging towards a slowly increasing marriage age and education level may represent a more realistic pathway to progress in ultimately achieving these SDGs.

Study goal and conceptual diagram

This present analysis follows previous work by Raj et al. (Raj et al., 2014), but introduces two important differences. Raj et al. used Demographic Health Survey (DHS) data (1996-2011) from Nepal on 6,774 women aged 20-24 years to examine country-level associations of women's education with marrying <14, at 14-15 and 16-17 years (Raj et al., 2014).

Analysing data on 6,406 women aged 23-30 years, this study contributes new knowledge on how much education Maithili-speaking Madhesi women need to delay their marriage age to ≥15, ≥16, ≥17 and ≥18 years. Our study focuses on individual marriage age groups, or milestones. It considers changes in individual risk factors in relation to their associations with marrying at successive later ages, during childhood and adolescence.

In the context of our study, and generally throughout South Asia, marriage is a negotiation between women's natal and prospective marital households based on a range of characteristics and preferences. These include caste, the educational attainment of spouses and parents, socio-economic status and needs of each household, age at menarche, and dowry rates, which increase for the natal household in association with a girl's age and education level (Asadullah & Wahhaj, 2019; Human Rights Watch, 2016; Jeffrey & Jeffery, 1994; Marphatia, Wells, et al., 2022; Mathur et al., 2001; Raj et al., 2015; Samuels et al., 2017). Our analysis adjusts for caste.

This article is structured as follows. Section 2 describes the context of our study, data, and statistical methods. Section 3 reports our results. Section 4 discusses our results and potential policy and research implications within the context of the broader literature.

Methods

Study population

Data come from the cluster randomized controlled (non-blinded) Low Birth Weight South Asia Trial (LBWSAT), which assessed the impact of interventions during pregnancy on the birth weight and growth of children aged 0-16 months (Saville et al., 2016, 2018). Briefly, between December 2013 and February 2015, 25,090 married and pregnant women were recruited into the trial. The Maithili-speaking Madhesi population in this study reside in southern Dhanusha and Mahottari districts of the Terai region, but their socio-cultural practices are similar to the bordering Indian state of Bihar. Our population are subsistence farmers, with 24% engaging in sharecropping, a third exchanging food for labour and 63% producing their own staple foods (e.g. pulses, rice and wheat) (Saville et al., 2020).

Compared to other populations in Nepal, Madhesi women have the lowest rate of educational attainment and a high prevalence of early marriage (MOHP et al., 2017; Pandey, 2017; Sah, 2018). Compared to women in Province 2 of the Terai where our study is based, Maithili-speaking Madhesi have a lower median age at marriage (16 years vs 15 years) and a greater proportion are uneducated (56% vs 77%) (Marphatia et al., 2020). Husbands are generally more educated

Table 1. Bias in missing and available data on women's age at marriage and their education

	Missing data ($n = 3,883$)		Available data on women's age at marriage and their education ($n = 20,799$)		
	Median	IQR	Median	IQR	
Women's age (y)[1]	21	6	21	6	
	Frequency	%	Frequency	%	*p*-value[3]
Husband's education level (y)[2]					0.009
None	1,368	46.2	10,071	48.4	
Primary (1-5 years)	349	11.8	2,388	11.5	
Lower-secondary (6-8 years)	520	17.6	3,182	15.3	
Secondary or higher (≥9y)	723	24.4	5,158	24.8	
Caste affiliation[1]					0.105
Disadvantaged: Muslim, Dalit	1,428	37.1	7,386	35.5	
Middle: Janjati, Terai castes	1,557	40.5	8,765	42.1	
Advantaged: Yadav, Brahmin	862	22.4	4,648	22.3	

IQR interquartile range. %, Percentage.
[1]For missing data, women's age and caste $n = 3,847$.
[2]For missing data, husband's education $n = 2,960$.
[3]Chi squared test.

and older than their wives (Niraula & Morgan, 1996). Generally, women have little autonomy or choice over when and who they will marry (Clarke, 2013; Maharjan & Sah, 2012). After marriage, seclusion norms restrict them primarily to the household (Gram et al., 2017).

Sample selection

We used the same sample of 6,406 women aged 23-30 years as used in a previous paper investigating associations of education and marrying ≥18 years (Marphatia et al., 2020). Briefly, of the 25,090 women recruited into the trial, 18,684 women were excluded due to: multiple pregnancies ($n = 408$) during trial; no data on key variables ($n = 3,883$); aged <23 years ($n = 13,271$) and >30 years ($n = 944$); very young married women (<10 years, $n = 76$); and those having their first pregnancy either before, or >12 years after marriage ($n = 102$). The younger women were excluded because they would not have had the chance to complete greater levels of schooling and the older, mostly uneducated women, who were from a different cohort than the main sample in relation to their schooling (Marphatia et al., 2020). There were minimal biases in husband's education between women with data vs those with missing data on their age at marriage and educational attainment (Table 1).

Variables

In multivariable logistic regression models, outcome variables related to four early marriage age groups spanning childhood and adolescence: ≥15 years, ≥16 years, ≥17 years and ≥18 years. The same reference group (marrying 10-14 years) was maintained across these marriage age groups (Figure 1). In cox proportional hazards models, the outcome variable was age at marriage (y).

The key predictor variable was women's educational attainment (number of schooling years completed), coded according to the education system in Nepal: none, primary (1-5 years),

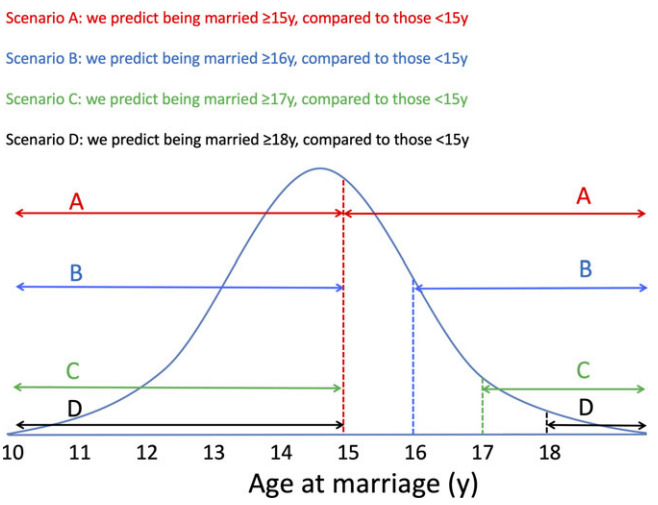

Figure 1. Summary of marriage age groups used in multivariable logistic regression analysis.
The outcome variable, 'early marriage' used four different marriage age groups, as shown in Scenarios A, B, C and D. To ensure comparability across these groups, the same reference group, of marrying <15 years, was used. Scenario A, marrying ≥15 years, included the full sample of women ($n = 6,406$). Scenario B, marrying ≥16 years, excluded $n = 1,537$ women married at 15 years. Scenario C, marrying ≥17 years, excludes $n = 2,290$ women married at 15-16 years. Scenario D, marrying ≥18 years, excluded $n = 3,064$ women married at 15-17 years.

lower-secondary (6-8 years) and secondary/higher (≥9 years) (Ministry of Education Nepal, 2016). Models adjusted for caste affiliation to ensure the associations between women's education and their marriage age were not an artefact of this factor. Caste was linked to socio-economic status, and was coded as: disadvantaged (Dalit, Muslim), middle (Janjati, other Terai), or advantaged (Yadav, Brahmin). Household wealth was not included because it was measured in women's marital household, after marriage, and is thus an inappropriate predictor of the timing of marriage (which occurred before wealth was measured).

Data analysis

Given the skewed distribution of age, women's age and marriage age were summarised with median and interquartile range (IQR). Kaplan-Meier Survival plots estimated the probability of women delaying marriage stratified by four levels of women's education. The log-rank test assessed these differences. Heat tables presented women's education as a percentage within their marriage age groups.

As shown in Figure 1, other than the marrying ≥15 years group, the other marriage age groups excluded some women. Sensitivity analysis explored whether using the full sample of women across different marriage age groups changed the results.

Mixed-effects logistic regression models with a random effect on the intercept accounting for within-cluster variability were fitted to estimate adjusted Odds Ratios (aORs) at 95% Confidence Interval (CI) of (a) women's educational attainment with marrying after different ages, and (b), accounting for caste. The Nakagawa-Schielzeth marginal R^2 value evaluated goodness-of-fit by measuring the percentage of variance explained by the model's fixed effects (Nakagawa & Schielzeth, 2013).

Mixed-effects cox proportional hazards regression models with a random effect on the intercept accounting for within-cluster variability quantified the effects of women's education level and caste on the probability, transformed into Hazards Ratios (HR), with 95% CI, of marrying. An interaction term examined joint effects of women's education level and caste.

To interpret the interaction terms, we multiplied the relevant coefficient for education, caste and the interaction term. Goodness-of-fit was assessed by the Bayesian Information Criteria (BIC) value. A lower BIC value denoted a better fit.

As the goal in this study was to understand how much education was required to delay marriage to different ages, 'no education' and 'disadvantaged caste' were set as the reference groups for predictor variables. Models did not control for women's age because there was no consistent pattern with the outcome variables, and there was no difference in the results when age was included. Models adjusted for trial arms, however as the trial recruited pregnant married women, interventions could not have influenced marriage age or education (which typically ends before/at marriage).

Analyses were performed in SPSS 27 (IBM Corp., Armonk, NY). Mixed-effects logistic and Cox proportional hazards regression models were fitted using the R library lme4 (D. Bates et al., 2014) and coxme (Therneau, 2015) respectively.

Results

Descriptive findings

The study sample and the four early marriage age groups used as outcome variables are described in Table 2. Women had married at median age of 15 years (IQR 3). Women were mostly uneducated, meaning they had never been to school. Only a small proportion of women had completed lower-secondary or higher education. Husbands were more educated than wives. Thirty-seven percent of households were from disadvantaged castes, 41% from mid and 22% from advantaged caste.

The Kaplan-Meier Survival plot in Figure 2 showed differences by women's education level in the probability of delaying marriage ($p < 0.001$). Among women with zero, primary (1-5 years), and lower-secondary (6-8 years) education, the median age at marriage was 15 years, and for those with ≥9 years of education, the median age at marriage was 17 years.

Heat tables showed the proportion of women marrying at a given age by their level of education. Red shaded boxes showed the highest percentages and green the lowest. Table 3 showed that for women with zero to eight years of education, the most common age at marriage was 14-15 years. The secondary/higher educated women married variously at 15 years, 17 years, then 19 years.

Association of education with marriage at different age groups

Table 4. Panel A showed adjusted ORs of women's education with different marriage age groups. Across the different marriage age groups, relative to the reference group of uneducated women, the odds of marrying at a later age increased with each higher level of education, with the biggest pay-off for the secondary/higher educated women (Models 1-4). With each yearly increase of age at marriage, the magnitude of the effect of primary education slightly decreased, that of lower-secondary slightly increased from marrying ≥15 and ≥16 years and decreased thereafter. The aOR for secondary/higher increased substantially with each later age at marriage. For example, higher educated women were five and 15 times more likely for marrying ≥15 years and ≥18 years respectively.

Table 4. Panel B adjusted for caste. Mid caste groups had higher odds of marrying at ≥15 years. Advantaged caste groups had higher odds of marrying across the different age groups, with the biggest pay-off for marrying ≥18 years (Models 1-4). Across the marriage age models, women's greater educational attainment increased the odds of later marriage, with stronger associations for secondary/higher education. In comparison to Panel A, adjusting for caste marginally decreased the magnitude of the effect of women's education.

Table 2. Characteristics of women ($n = 6,406$)

	Median	IQR
Women's age (y)	25	3
Women's age at marriage (y)	15	3
Explanatory variables	Frequency	%
Women's education level (y)		
None	4,942	77.1
Primary (1-5 years)	575	9.0
Lower-secondary (6-8 years)	345	5.4
Secondary or higher (≥9y)	544	8.5
Husband's education level (y)		
None	3,608	56.3
Primary (1-5 years)	749	11.7
Lower-secondary (6-8 years)	809	12.6
Secondary or higher (≥9y)	1,204	19.4
Caste affiliation		
Disadvantaged: Muslim, Dalit	2,375	37.1
Middle: Janjati, Terai castes	2,650	41.4
Advantaged: Yadav, Brahmin	1,381	21.6
Outcome variables		
Reference group: Married 10-14 years ($n = 6,406$)	2,403	37.5
Outcome: Married ≥15 years (includes all women)	4,003	62.5
Reference group: Married 10-14 years ($n = 4,869$)	2,403	49.4
Outcome: Married ≥16 years (hence excluding $n = 1,537$ women married at 15 years)	2,466	50.6
Reference group: Married 10-14 years ($n = 4,116$)	2,403	58.4
Outcome: Married ≥17 years (hence excluding $n = 2,290$ women married at 15-16 years)	1,713	41.6
Reference group: Married 10-14 years ($n = 3,342$)	2,403	71.9
Outcome group: Married ≥18 years (hence excluding $n = 3,064$ women married at 15-17 years)	939	28.1

IQR, interquartile range. %, Percentage.

Inclusion of caste marginally increased the proportion of the variance explained by models in Panels A and B. Overall, however, the proportion of the variance explained by these factors was low (range 0.058 to 0.137). Models explained a greater proportion of the variance as marriage age increased, suggesting that other factors (unmeasured by this study) explained the odds of marrying at younger ages, < 16 years.

Sensitivity analysis

Table 5 showed similar results when using the full sample of women across the different marriage age groups.

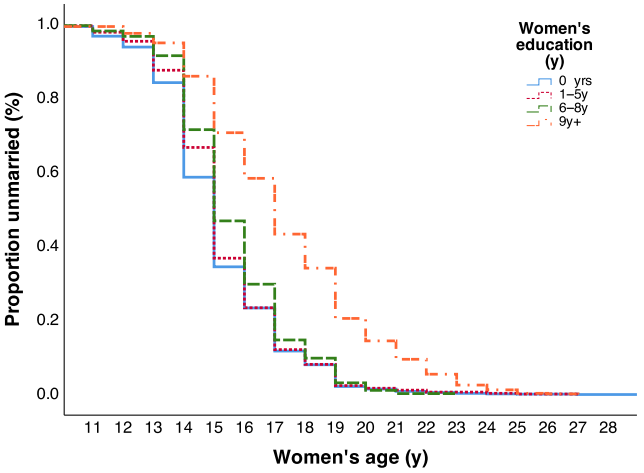

Figure 2. Kaplan-Meier Survival Curves, women's age at marriage by their educational attainment.
The Kaplan-Meier Survival plot shows differences in the probability of delaying marriage by women's education level ($p < 0.001$).

Cox proportional hazards models

Mixed-effects cox proportional hazards regression (Table 6 Model 1) showed that relative to uneducated women, the hazard of marrying was 9% lower for primary, 20% for lower-secondary and 59% for higher-secondary/above education. Relative to the disadvantaged caste, being from an advantaged caste also reduced the hazard of marrying by 9%.

The coefficients for education and advantaged caste decreased with the inclusion of interaction terms (Model 2). The joint effect of lower-secondary education and advantaged caste reduced the hazard of marrying by 9%. The joint effects of higher secondary education and mid and advantaged caste reduced the hazard of marrying by 63% and 64% respectively. However, compared to a model with no interaction terms, the goodness-of-fit (BIC value) was lower when the interaction terms were added.

Discussion

Whilst the legal minimum age at marriage is now 20 years, it is still common for Nepali women, especially those residing in Province 2 of the Terai region, and from the Maithili-speaking Madhesi group, to marry well below this age, at a median age of 15 years. Use of the ≥18 years cut-off for studying early marriage, in a population where only a small minority marries after this age, misses most of the variability in marriages taking place during childhood and adolescence. This study asks a more relevant question in this population, 'how much education is required to achieve small increments in the age at which women marry,' across the range of age groups from 15 years to ≥18 years. Whilst human rights legislation and efforts aim to delay all marriages to ≥18 years, in societies where the majority or women marry much earlier, understanding of what delays marriage at an earlier age is needed to develop a viable plan for long-term progress (Schaffnit et al., 2019).

The key finding was that associations of women's education level with the likelihood of early marriage showed little variation, regardless of which age group was used to define early marriage. The one exception to this pattern was that the odds of marrying after a given age steadily increased with later marriage age among the most highly educated group. However, this was due to a change in the composition of this group. With each additional year used to define early marriage (e.g. from 16 to 17 years), the highly educated group disproportionately lost those with modest levels

Table 3. Heat table for women's education as a percentage within their age at marriage ($n = 6,406$)

	Women's age at marriage (y)														
	10 years	11 years	12 years	13 years	14 years	15 years	16 years	17 years	18 years	19 years	20 years	21 years	≥22 years	Row %	Total *n*
Women's education (y)															
None	0.5	2.6	2.9	9.6	25.6	24.2	11.1	11.6	3.7	5.9	0.7	0.6	0.9	100%	4,942
1-5 years	0.3	1.7	2.4	7.8	20.9	29.9	13.4	11.3	4.0	5.7	0.7	0.5	1.2	100%	575
6-8 years	0.3	1.4	1.4	5.2	20.0	24.6	17.1	15.1	4.9	6.7	2.0	0.9	0.3	100%	345
≥9 years	0.6	0.0	1.8	2.6	9.0	15.3	12.3	15.1	9.2	13.6	6.1	5.0	9.6	100%	544

%, Percentage. *n*, number.

Table 4. Results from mixed-effects multivariable logistic regression models reporting the association of education with marrying at different age groupings

	Model 1: Married ≥15 years $n = 6{,}406^1$ $R^2 = 0.056$		Model 2: Married ≥16 years $n = 4{,}869^2$ $R^2 = 0.089$		Model 3: Married ≥17 years $n = 4{,}116^3$ $R^2 = 0.103$		Model 4: Married ≥18 years $n = 3{,}342^4$ $R^2 = 0.132$	
Panel A: Associations with women's education only	aOR (95% CI)	*p*-value	aOR (95% CI)	*p*-value	aOR (95% CI)	*p*-value	aOR (95% CI)	p-value
Women's education (none = ref)	1.00		1.00		1.00		1.00	
Primary (1-5y)	1.60 (1.31, 1.95)	0.001	1.51 (1.20, 1.89)	0.001	1.46 (1.13, 1.90)	0.004	1.48 (1.07, 2.03)	0.017
Lower-secondary (6-8y)	2.04 (1.58, 2.64)	0.001	2.35 (1.77, 3.12)	0.001	2.14 (1.56, 2.93)	0.001	2.17 (1.47, 3.18)	0.001
Secondary or higher (≥9y)	5.29 (4.06, 6.87)	0.001	8.30 (6.31, 10.93)	0.001	10.37 (7.78, 13.82)	0.001	15.76 (11.54, 21.53)	0.001
Intercept	1.58 (1.07, 2.31)	0.020	0.84 (0.53, 1.27)	0.381	0.76 (0.33, 0.83)	0.006	0.21 (0.12, 0.34)	0.001
Panel B: Women's education and caste	Model 1: Married ≥15 years $n = 6{,}406^1$ $R^2 = 0.060$		Model 2: Married ≥16 years $n = 4{,}869^1$ $R^2 = 0.091$		Model 3: Married ≥17 years $n = 4{,}116^3$ $R^2 = 0.105$		Model 4: Married ≥18 years $n = 3{,}342^4$ $R^2 = 0.135$	
	aOR (95% CI)	*p*-value	aOR (95% CI)	*p*-value	aOR (95% CI)	*p*-value	aOR (95% CI)	p-value
Women's education (none = ref)	1.00		1.00		1.00		1.00	
Primary (1-5y)	1.55 (1.27, 1.89)	<0.001	1.46 (1.16, 1.84)	0.001	1.42 (1.10, 1.85)	0.008	1.43 (1.04, 1.97)	0.029
Lower-secondary (6-8y)	1.93 (1.49, 2.50)	<0.001	2.24 (1.68, 2.98)	<0.001	2.04 (1.48, 2.80)	<0.001	2.06 (1.39, 3.05)	<0.001
Secondary or higher (≥9y)	4.87 (3.72, 6.37)	<0.001	7.72 (5.83, 10.22)	<0.001	9.64 (7.17, 12.94)	<0.001	14.42 (10.45, 19.91)	<0.001
Caste (Disadvantaged = ref)	1.00		1.00		1.00		1.00	
Mid	1.21 (1.07, 1.38)	0.003	1.16 (1.00, 1.34)	0.056	1.15 (0.97, 1.36)	0.108	1.09 (0.88, 1.35)	0.423
Advantaged	1.25 (1.06, 1.48)	0.007	1.23 (1.02, 1.71)	0.030	1.23 (1.00, 1.52)	0.049	1.32 (1.02, 1.70)	0.035
Intercept	1.41 (0.96, 2.09)	0.083	0.76 (0.49, 1.17)	0.214	0.48 (0.30, 0.77)	0.002	0.19 (0.12, 0.32)	<0.001

aOR, Adjusted Odds Ratio. CI, 95% Confidence Interval. Nakagawa-Schielzeth marginal R^2. Models include fixed and random effects estimates for geographic clusters and control for trial arm. As associations of trial arm with early marriage across the four age groupings were not statistically significant, they are not reported in Tables.

[1]n = 2,403 married <15y vs *n* = 4,003 married ≥15y.

[2]*n* = 2,403 married <15y vs *n* = 2,466 married ≥16y.

[3]*n* = 2,403 married <15y vs *n* = 1,713 married ≥17y.

[4]*n* = 2,403 married <15y vs *n* = 939 married ≥18y.

Table 5. Results from mixed-effects multivariable logistic regression models reporting the association of education with marrying at different age groupings using the full sample of women in each marriage age group

	Panel A: Associations with women's education only					
	Model 1: Married ≥16 years $n = 6{,}406^1$ $R^2 = 0.063$		Model 2: Married ≥17 years $n = 6{,}406^2$ $R^2 = 0.061$		Model 3: Married ≥18 years $n = 6{,}406^3$ $R^2 = 0.071$	
	aOR (95% CI)	*p*-value	aOR (95% CI)	*p*-value	aOR (95% CI)	*p*-value
Women's education (none = ref)	1.00		1.00		1.00	
Primary (1-5y)	1.21 (1.00, 1.47)	0.046	1.12 (0.91, 1.39)	0.292	1.13 (0.86, 1.49)	0.372
Lower-secondary (6-8y)	1.89 (1.49, 2.39)	0.001	1.50 (1.16, 1.93)	0.002	1.34 (0.98, 1.85)	0.070
Secondary or higher (≥9y)	5.76 (4.68, 7.09)	0.001	5.76 (4.72, 7.03)	0.001	6.83 (5.56, 8.40)	0.001
Intercept	0.47 (0.33, 0.66)	0.001	0.26 (0.18, 0.38)	0.001	0.09 (0.06, 0.14)	0.001
	Panel B: Women's education and caste					
	Model 2: Married ≥16 years $n = 6{,}406^1$ NK = 0.062		Model 3: Married ≥17 years $n = 6{,}406^2$ NK = 0.062		Model 4: Married ≥18 years $n = 6{,}406^3$ NK = 0.074	
	aOR (95% CI)	*p*-value	aOR (95% CI)	*p*-value	aOR (95% CI)	*p*-value
Women's education (none = ref)	1.00		1.00		1.00	
Primary (1-5y)	1.19 (0.98, 1.45)	0.072	1.11 (0.89, 1.37)	0.354	1.12 (0.85, 1.48)	0.410
Lower-secondary (6-8y)	1.82 (1.44, 2.31)	<0.001	1.46 (1.13, 1.88)	0.004	1.31 (0.95, 1.82)	0.100
Secondary or higher (≥9y)	5.46 (4.41, 6.77)	<0.001	5.48 (4.46, 6.74)	<0.001	6.45 (5.18, 8.03)	<0.001
Caste (Disadvantaged = ref)	1.00		1.00		1.00	
Mid	1.09 (0.96, 1.24)	0.196	1.03 (0.89, 1.19)	0.669	0.96 (0.80, 1.16)	0.701
Advantaged	1.17 (0.99, 1.38)	0.060	1.18 (0.99, 1.40)	0.071	1.24 (1.00, 1.54)	0.052
Intercept	0.44 (0.31, 0.63)	<0.001	0.25 (0.18, 0.37)	<0.001	0.09 (0.06, 0.14)	<0.001

aOR, Adjusted Odds Ratio. CI, 95% Confidence Interval. Nakagawa-Schielzeth marginal R^2. Models include fixed and random effects estimates for geographic clusters and control for trial arm. As associations of trial arm with early marriage across the three age groupings were not statistically significant, they are not reported in Tables. [1] = 3,940 married <15y vs $n = 2{,}466$ married ≥16y. [2] $n = 4{,}693$ married <16y vs $n = 1{,}713$ married ≥17y. [3] $n = 5{,}467$ married <17y vs $n = 939$ married ≥18y.

Table 6. Mixed-effects cox proportional hazards model of the probability of marrying

	Model 1: Women's education & caste $n = 6{,}406$ Model fit = 99069.66		Model 2: Interaction terms $n = 6{,}406$ Model fit = 99106.38	
	HR (95% CI)	*p*-value	HR (95% CI)	*p*-value
Women's education (none = ref)	1.00		1.00	
Primary (1-5y)	0.91 (0.83, 0.99)	0.034	0.96 (0.81, 1.13)	0.585
Lower-secondary (6-8y)	0.80 (0.71, 0.89)	<0.001	0.60 (0.45, 0.80)	0.001
Secondary or higher (≥9y)	0.41 (0.37, 0.45)	<0.001	0.71 (0.46, 1.09)	0.120
Caste (Disadvantaged = ref)	1.00		1.00	
Mid	0.95 (0.90, 1.01)	0.100	0.96 (0.90, 1.02)	0.185
Advantaged	0.91 (0.84, 0.98)	0.009	0.90 (0.82, 0.97)	0.010
Interaction terms: uneducated women & disadvantaged caste	1.00		1.00	
Women's primary education & mid caste			0.93 (0.76, 1.15)	0.505
Women's lower-secondary education & mid caste			1.28 (0.92, 1.78)	0.143
Women's secondary education & mid caste			0.57 (0.36, 0.89)	0.014
Women's primary education & advantaged caste			0.94 (0.73, 1.20)	0.620
Women's lower-secondar education & advantaged caste			1.69 (1.18, 2.41)	0.004
Women's secondary education & advantaged caste			0.56 (0.35, 0.89)	0.013

HR, Hazards Ratio; CI Confidence Interval. Model fit was assessed by the Bayesian Information Criteria (BIC) value. Models include fixed and random effects estimates for geographic clusters and control for trial arm. As associations of trial arm with early marriage were not statistically significant, they are not reported in Tables.

of higher education, as they were more likely to marry, and becomes increasingly characterised by those with very high levels of education. This counter-intuitively resulted in a more protective effect of secondary education as the age used to define early marriage was increased.

Second, there was a weak association of caste, with the mid caste groups having slightly higher odds of marrying at ≥15 years only and advantaged caste groups having higher odds of marrying across the different age groups. However, the proportion of the variance explained with the inclusion of caste was only marginally higher compared to models with women's education only. This suggests that caste-based norms play a small role in driving early marriage in this population. Broader societal norms and practices may underlie women's early marriage and lack of education [35,36], but few studies have focused on these factors specifically in early marrying populations. The joint effects of lower-secondary education and higher caste affiliation, and secondary/higher education and mid and higher caste affiliation also reduced the hazard of marrying.

Overall, therefore, women's education of ≥9 years was most strongly associated with delaying marrying beyond the different age groupings. However, the highly educated group was a minority in this population, and overall, women's education explained little of the variance in marriage age, accounting for < 10% of the variance in the odds of marrying ≥15 years and ≥16 years and 10% and 13% of the variance for marrying ≥17 years and ≥18 years respectively. This was most likely because most women in this society were uneducated, therefore the global effort to increase girls' secondary education will have little bearing on the practiced norms in this society. Education at the primary, and not just secondary level, is still necessary, and has broader benefits for child and adolescent health and well-being. However, both are insufficient to substantially delay marriage. Therefore, the factors that really matter for delaying early marriage in this and other populations with median marriage ages well below the 18-years cut-off have yet to be identified.

The findings of this study are similar to two ecological analyses from Nepal, although they use slightly different groupings to define early marriage and women's education level. Raj et al., using DHS Nepal data (1996-2011) on women aged 20-24 years, found primary education protected against marrying < 14 years, secondary education was associated with marrying at 14-15 years, but ≥9 years of schooling were needed to marry at 16-17 years (Raj et al., 2014). However, the overall effect size of education remained modest. Pandey, using Nepal 2011 DHS data on women aged 15-49 years, found weak associations of primary and secondary education, but very strong effects of >10 years of education for marrying >15 and >19 years (Pandey, 2017).

However, Raj et al.'s study did not investigate the variance explained by education, so we cannot attribute how much of a difference education actually makes for delaying the timing of marriage (Raj et al., 2014). Pandey reported 'max-rescaled R^{2}' values of 0.17 and 0.25 for the marrying >15 years and >19 years models but does not discuss their importance (Pandey, 2017). If comparable to the Nakagawa- Schielzeth R^2 values used in this study, then associations of husband's education, caste and development region may explain their higher values, though their effect sizes were relatively weak in Pandey's study (Pandey, 2017). In contrast, Scott et al., also using DHS data (on women aged 20-24 years) attributed 67% of the reduction in marriages < 18 years in Nepal between 2005 and 2016 to the increased secondary education (of ≥10 years) of girls, and 30% to improvements in household wealth (Scott et al., 2021).

These varying results may be explained by the use of different (and wider ranges of) marriage age and education groups, predictive factors (and the difficulty in disentangling their independent effects), societal norms, time periods and geography, whereas this study focused on a particularly early-marrying and low education population. Whilst studies typically use marital household wealth as a proxy for the natal household (Delprato et al., 2015; Sekine & Hodgkin, 2017; Wodon et al., 2017), this study not include wealth because using a factor (wealth) measured in a different household, after the event (marriage age), to predict the event itself is inappropriate.

Implications

Implications of this study include the need for further research disaggregating beyond the 18 years cut-off to different earlier age thresholds, investigating both the risk of, and delay in, marriage age during childhood and adolescence. Importantly, the socio-economic profile of this and other similar populations are underrepresented in studies, and yet, is where early marriage is still prevalent despite universal legislation delaying it to 18 years, and more recently 20 years in Nepal.

Why education does, or in the case of this study, does not really appear to substantially delay marriage in some societies needs to be better understood. Longitudinal research is needed in different contexts on broader factors shaping the timing of marriage, including biological factors (maternal and infant undernutrition, age at menarche), natal household factors and decision making around which of marriage or school drop-out comes first and why (Marphatia, Wells, et al., 2022).

We also need to better understand the socio-cultural norms underpinning not only early marriage, but also the lower educational attainment of girls, both of which are likely to maintain their lower social status (Bicchieri et al., 2014; Caldwell et al., 1983; Maertens, 2011, 2013; Marphatia et al., 2017). Lower educated women are also likely to be paired with lower educated men, and this may then adversely impact household livelihood (Marphatia, Saville, Manandhar, Amable, et al., 2021). In this context, early marriage, lower educational attainment, interactions with similar early married peers and marital household members may perpetuate women's own gendered attitudes (Asadullah & Wahhaj, 2019).

From a policy perspective, increasing women's time in school over time, will still have tangible effects in delaying their marriage. Greater efforts are needed to ensure girls complete the minimum 9 years of schooling required to delay marriage to 18 years. However, these school-based interventions will miss the girls who have never been to school, or already dropped out. Equal efforts are therefore needed to ensure girls go to school in the first place, and complete at the least primary education, which will build human capital and delay younger marriages when the consequences are arguably the severest.

To achieve sustained progress in delaying girls' marriage, a holistic and longer-term approach focusing on increasing girls' access to education and health care, supporting their empowerment, and understanding gendered social norms is likely to be more successful than a single-focus intervention, such as education or conditional cash transfers (Amin et al., 2017; Malhotra, 2019; Malhotra & Elnakib, 2021b).

Limitations of this study include the lack of data on broader factors which may contribute to delaying marriage, including natal household wealth, parental educational attainment and attitudes, the timing of menarche, and the quality of education received by women. This study focused on a particularly low-educated and earlier marrying population, but the association between education and marrying at different ages is likely to be widely applicable and valid in other parts of South Asia.

Data accessibility statement. Requests to access the dataset, through a data sharing agreement, should be directed to Dr Naomi Saville, n.saville@ucl.ac.uk.

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