**Parent-offspring conflict unlikely to explain ‘child marriage’ in northwestern Tanzania**

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**Approximately 40% of women in sub-Saharan Africa marry before their 18th birthday1. Within the international development sector this phenomenon is referred to as ‘child marriage’, widely equated to forced marriage, and recognized as damaging to multiple dimensions of female wellbeing1,2. An escalating global campaign to end early marriage typically assumes that its high prevalence is driven by a conflict of interests between parents and daughters, with parents coercing daughters to marry early for the parents’ economic benefit3. However, a parent-offspring conflict model of early marriage has not been explicitly tested. Here we present a study of marriage transitions in rural Tanzania, where marriage before or just after 18 years is normative. Consistent with parental coercion, we find that bridewealth transfers are highest for younger brides. However, autonomy in partner choice is very common at all ages, relationships between age at marriage and female wellbeing are largely equivocal, and women who marry early achieve relatively higher reproductive success. We conclude that in contexts where adolescents have autonomy in marriage choices, and where marriage promotes economic and social security, early marriage may be better understood as serving the strategic interests of both parents and daughters.**

Female marriage under 18 years is cross-culturally common, was historically ubiquitous, and remains legal with parental consent and/or judicial approval in the majority of countries worldwide. Yet, as part of a growing focus on the vulnerability of female adolescence in low-income nations, a global target to eliminate ‘child marriage’ by 2030 has been set by the 2015 Sustainable Development Goals4. Humanitarian concern focuses on lack of informed consent to marry and purported hardships for those marrying early including a lack of empowerment, poor mental health, diminished sexual and reproductive health, and low educational attainment5–7. Here, we investigate why early marriage is so common, despite its purported negative consequences. We refer to early marriage, rather than ‘child marriage’, throughout to avoid the use of subjective boundaries of childhood that are not universally applicable8,9, and in recognition that in many contexts individuals married under 18 years do so not as children per se, but as adolescents (i.e. at 16 or 17 years), a time of emerging responsibility and autonomy10.

The evolutionary biologist Robert Trivers11 recognized that while close genetic relatedness dictates that parental and offspring interests often align, individual offspring may benefit from increased parental investment even when it disadvantages their siblings, leading to parent-offspring conflict. By extension parents and offspring may also have divergent preferences over offspring mating, with parents prioritizing unions advantageous to the family unit and offspring prioritizing their own self-interest11. When conflicts arise, parents may try to manipulate or coerce their children in order to win the conflict. While parent-offspring conflict theory has been applied to ideal partner characteristics12,13, it has rarely been applied to the timing of marriage14. This is surprising because timing of marriage is closely associated with reproductive success7 and thus subject to selection. Moreover, policy discourse on early marriage routinely emphasizes the role of parents in perpetuating early marriage despite apparent harm to their daughters; parents are portrayed as seeing their daughters as financial burdens15,16 or commodities3 to be strategically married for the economic gain of parents and their wider family unit. Such narratives imply that parents benefit from earlier marriage of their daughters because it reduces the burden of care, freeing investment for other offspring, especially if it is associated with favorable economic transfers at marriage3 i.e. relatively large bridewealth (transferred from a man to his bride’s family) or small dowry transfers (transferred from a bride’s parents to her in-laws). In contrast, daughters are understood to benefit from delaying marriage longer than is ideal for their parents through the extraction of parental investments in human capital, ultimately boosting wellbeing across multiple dimensions.

Supporting a parent-offspring conflict model of early marriage in which parents manipulate their daughters to ‘win’ the conflict, girls from relatively poor families are typically more likely to marry early5,17, and in sub-Saharan Africa short-term income shocks are linked to earlier marriages, an effect exaggerated in areas practicing bridewealth18. This implies that parents may use daughters’ marriages to ease economic hardship, an implication supported by some qualitative research19, at cost to daughters’ wellbeing5,6,17. However, ethnographic studies also highlight that both parents and daughters sometimes evaluate early marriage as a strategy for minimizing economic and social risk in the face of local constraints9,19–21, and that daughters may see marriage as their primary means of gaining status in their community22, suggesting early marriage is sometimes locally understood as beneficial rather than costly to girls and women. These considerations undermine a universal application of a parent-offspring conflict model to early marriage.

With the objective of testing hypotheses derived from parent-offspring conflict theory, we conducted a survey of girls and women (n=993) aged 15-35 years living within a rural but urbanizing ward of Mwanza Region, Tanzania currently undergoing fertility decline23. Specifically, we address whether parental coercion of daughters accounts for high rates of early marriage, with parents benefitting economically at cost to their daughters’ wellbeing (measured by current mental health, empowerment, nutritional status, and schooling) and/or reproductive success (approximated by age-specific fertility). Notably, from an evolutionary perspective reproductive success and wellbeing are conceptually distinct; natural selection generally favor behaviors which maximize reproductive success, even at detriment to individual wellbeing. However, from an international development perspective, reproductive success could also be considered a dimension of wellbeing, since high fertility can compromise both maternal and child health.

Rates of marriage before 18 years are high in Tanzania generally (37% in 201424) and in the study area specifically: among ever-married women, age at first marriage ranged between 13-29 years, with a median of 20 years (mean=18.58; s.d.=2.72, n=497); 35% married before 18 years; and 2% married ‘very early’ (i.e. before 15 years; Table 1; Supplementary Table 1). Thus, this is a context, not atypical for East Africa, where rates of early marriage are very high, but primarily concern adolescents rather than children per se. Of participants who had formally married (i.e. with a ceremony), 69% received bridewealth in cows, money, and/or other gifts at an average value of 571 USD (min=0; max=2680; s.d.=407, n=247). High rates of poverty and the tradition of bridewealth present incentives for parents to marry their daughters early, both to gain capital and extract higher bridewealth for younger brides, reinforcing scope for parent-offspring conflict over the timing of marriage. On the other hand, both pre-marital births and divorce are common in this region25, suggesting that marriage choices may be less consequential to a woman’s life course compared to contexts where pre-marital birth and divorce are not normative.

If early marriage is driven by parental coercion, then we expect that parents and their family unit will benefit from their daughters marrying earlier rather than later. We find that timing of marriage is not correlated with probability of receiving bridewealth (χ2(4)=3.79, p=0.44; Figure 1a). However, given that bridewealth was received, women married at younger ages received higher bridewealth (χ2(4)=9.59, p=0.05) consistent with a parental incentive for their daughters to marry early. Women who married over 22 years were expected to receive the equivalent of 152 USD less than those married from 15 through 17 years once accounting for current age and village of residence, while participants married under 15 years receive an expected 456 USD more than those married from 15 through 17 years (Figure 1b; Supplementary Tables 2-3). We also tested how family configuration influenced risk of early marriage, predicting that women with more older brothers would be most likely to marry earlier given the increased pressure on parents to accrue capital to pay their sons’ bridewealth transfers. We find a relationship between number of older brothers and timing of marriage, although it is not dose-response; only those with four or more older brothers (9.5%) marry earlier than those with fewer brothers, particularly from ages 16 to 19 years (Figure 1c; χ2(8)=17.46, p=0.03). A similar relationship is not found with other siblings (Supplementary Tables 4-7).

When parents and their children’s interests diverge, parents are expected to manipulate their children to ‘win’ the conflict at cost to the child, especially in gerontocratic and collectivist societies26. Thus, a parent-offspring conflict model suggests that daughters will be coerced to enter early marriages against their best interests and as such we could expect that girls and women who married at earlier ages would be less likely to have chosen their own husband. We do not find this (χ2(4)=7.65, p=0.11): regardless of age at marriage, participants were very likely to have chosen their own partner (Figure 1d; Supplementary Table 8).

Finally, if early marriage is driven by parents winning a parent-offspring conflict, then we expect daughters to experience costs to their wellbeing and/or reproductive success with earlier ages at marriage. We considered four aspects of women’s current wellbeing: mental health, empowerment in household decision-making, nutritional wellbeing (BMI), and schooling. For each measure, we assessed the association between marital timing and wellbeing in two ways: first, we compared ever-married women by age at first marriage controlling for current age and village of residence (Supplementary Tables 9-12); and second, we contrasted ever and never-married women within current age groups controlling for village of residence (Supplementary Tables 13-16). Among ever-married women, age at first marriage was unrelated to mental health (χ2(4)=4.20, p=0.38), empowerment in household decision-making (χ2(4)=1.91, p=0.75), or nutritional status (BMI) (χ2(4)=2.19, p=0.70) (Figure 2). Mental health and, to some extent empowerment, appear to be poorer for women who married ‘very early’ (<15 years) compared to women married at older ages, although such marriages are extremely rare in this population and confidence intervals for these estimates are very wide. When compared to never-married girls/women of the same age, ever-married 15-17-year-olds had higher empowerment (χ2(4)=17.07, p=0.002) but poorer mental health (χ2(4)=13.22, p=0.02). Both analysis methods indicate that early marriage is correlated with lower educational attainment. Among ever-married women for example, those married at or over 18 years had 1.76 (married at 18-19 years 95% CI 0.64, 2.89) to 3.95 (married at 22-29 years 95% CI 2.69, 5.21) times higher odds of having attended secondary school than those married from ages 15 through 17 years (χ2(3)=57.63, p<0.001). No women who had married under 15 years attended secondary school. However, as we discuss further below, strong local norms prohibiting marriage to (or sexual relationships with) schoolgirls27,28 suggest that leaving school is more likely to precede marriage than vice versa in the study area.

Women’s age-specific fertility (based on currently living offspring) was negatively correlated with age at first marriage, controlling for village of residence (χ2(4)=57.15, p<0.001). Women who married over 18 years were expected to have .2 (married 18-19 years 95% CI -0.48, 0.09) to 1.68 (married 23-29 years 95% CI -2.15, -1.21) fewer living children than those who married from 15 through 17 years (Figure 3a; Supplementary Table 17a); put another way, a woman married from 15 through 17 years is expected to have 3.12 children by age 30 compared to 1.45 children for women who delayed marriage until over 22 years (Supplementary Table 17b). It is possible that ‘very early marriage’ is detrimental to fertility (an expected .25 fewer children given current age compared to those married aged 15 though 17 years; Figure 3a), but few women were married this early and confidence intervals are wide. When comparing number of living children by marital status within current age groups, we find that ever-married women have higher predicted number of living children than never-married women within all age groups (χ2(4)=27.35, p<0.001; Figure 3b; Supplementary Table 18). As such, while our findings are largely equivocal with respect to relationships between early marriage and wellbeing, early marriage is clearly associated with higher reproductive success.

Together, our findings strongly suggest that while the potential for parent-offspring conflict over the timing of marriage is present in this population, locally high rates of early marriage are more likely to be driven by the interests of both parents and daughters than parental coercion. Parents benefit from daughters’ early marriages through the receipt of higher bridewealth transfers; and this is particularly exaggerated for daughters married at very young ages. This effect is likely highly generalizable, with research in other settings also showing that bridewealth transfers are larger29 and dowry transfers are lower30 when brides are relatively young, and a wider literature demonstrating the high currency of female youth on the mating market31. Parents may use this wealth to gain capital to marry off their sons, again a plausible scenario consistent with ethnographic work in the nearby Tarime District32. The reception of high bridewealth also comes with non-economic benefits for parents; one woman in this study noted that bridewealth “is a respect to the parents and the woman who is married and respect even for the manbecause he will be blessed by God and the parents.”

With parents standing to benefit from their daughters’ early marriages, we could expect that parents would attempt to control the marital process. It is not uncommon for parents and daughters to disagree over ideal son-in-law/husband characteristics12,13, with parents favoring marriages which strengthen alliances and ensure long-term socioeconomic stability of the lineage20. But even if parents and offspring agree over who to marry, we could expect parental control over the marital process to manifest in the exertion of control over the daughters’ partner choices. We do not find evidence of this. Rather, in direct contradiction to the popular notion that early marriages are parent-driven (with the terms ‘child’, ‘arranged’ and ‘forced’ marriage often used interchangeably by the ‘end child marriage’ movement)33, the overwhelming majority of women report autonomy in partner choice. It is possible that young women misreported who chose their partners during interviews. However, ethnographic data from this area27,34 support our conclusion that young women are active agents in marriage decisions. Autonomy in marriage choices, along with our findings that women marrying early do not suffer obvious penalties to wellbeing and have higher reproductive success than women marrying later, cast doubt on the notion that early marriage, at least in late adolescence, is inherently costly to girls and young women.

That wellbeing was not universally lower for those girls/women who marry under 18 years requires special consideration given widespread consensus that such marriages are definitively harmful24,35. We emphasize that our study concerns marriage primarily in late adolescence, and so is less informative about very early marriage (<15 years), which is more common in other regions2. There is some suggestion that very early marriage is associated with poor mental health (though the paucity of such marriages within this population makes these effects difficult to quantify). Early marriage is also correlated with lower education. However, the causal relationships between early marriage and these “harms” are unclear. Counter to the dominant development sector narrative of early marriage causing low education attainment, causality seems more likely to run in the opposite direction in this setting. Strong local norms against marrying or having sex with schoolgirls27,28 and the lack of viable alternatives to marriage for women following schooling suggest that school drop-out commonly prompts marriage rather than vice versa. Furthermore, while early pregnancy may lead some girls to leave school, high rates of pre-marital childbearing27 mean that marriage itself is not clearly implicated as disruptive to educational attainment. Indeed, we might anticipate marriage in such cases to be advantageous relative to young mothers raising children without a husband.

In some regards, early marriage may also benefit some young women: for minors, having ever-married is correlated with higher empowerment in household decision-making compared to never-married peers. Qualitative work from this27 and other Tanzanian populations19,22 also highlights perceived benefits to early marriage among girls and young women such as accelerated entry to adulthood (and associated privileges) when childhood roles expire, self-efficacy, and increased status within the community. Furthermore, very early marriages may be pursued strategically by young girls as a means of removing themselves from harmful situations at home and gaining control over their lives22,27. Negligible costs and potential benefits can make early marriage attractive to some women when considered in conjunction with other features of the local environment. In this context, marriage is an important social institution27,34, women face reputational costs of delaying marriage, and notions of readiness to marry are not fixed to specific age categories27. With a lack of viable alternatives to marriage, and with local norms permitting divorce and remarriage, the long-term opportunity costs of marrying at a young age are likely minimal for most girls and women. Indeed, marriage may be the best available option to many young women once educational opportunities have run dry, even if she has not reached the internationally preferred age of consent. Thus, we suggest both parents and daughters in this area of Tanzania often stand to benefit from the daughters’ early marriage.

As in other studies7,17, we find that women who marry early have relatively high reproductive success. This is consistent with a propensity for early marriage to be favored by natural selection, even in the presence of costs to wellbeing. Indeed, more generally, life history theory emphasizes that early reproduction in harsh environments is likely fitness-enhancing because it ensures childrearing takes place before parental death and while grandparents are available as alloparents36,37. Yet, very early marriage was associated with relatively low age-specific fertility, though again the rarity of this event means confidence intervals are wide. A cost to fertility for very young ages of marriage could be caused by higher infant and maternal health risks that come with early reproduction37and our study may underestimate these costs by excluding mothers who die in childbirth. Alternatively, an association between very early marriage and lower fertility may be due to higher rates of marital dissolution among those married before 15 years and resulting gaps in reproductive schedules. Given that all women we interviewed had an expected 10 to 30 reproductive years left, there is some possibility that women who married at later ages will “catch up” by continuing to reproduce longer than women who married earlier. However, even if this does happen, shorter generation times due to early reproduction could lead to selection for this behavior if timing of first reproduction is transmitted over generations38.

Like the majority of past studies on age at marriage and wellbeing39–41 our analyses are open to unmeasured confounding thus limiting causal inference. However, unmeasured socioeconomic confounds are unlikely to lead us to underestimate costs of early marriage. Poverty in childhood is a well-established predictor of both poor wellbeing and early marriage5,17. Consequently, cross-sectional studies of early transitions to marriage and childbearing are more likely to overestimate costs to wellbeing, as has been concluded in recent reviews of a parallel literature on teenage pregnancy in high-income populations42. Unlike most past studies, we use a sizable sample from a single population. Studies linking early marriage to harm often use nationally-representative datasets (e.g. Demographic and Health Survey data39–41) highly vulnerable to confounding between ecological and individual-level predictors of wellbeing43. The very localized nature of our study ensures relative socioeconomic and cultural homogeneity, reducing the scope for such confounding. This approach could raise the critique that our data are not representative of early marriages more widely. Yet such a critique only underscores our take home message: although parental coercion is widely applied as the dominant explanation for early marriage across cultural contexts, such an explanation is unlikely to be universally applicable.

Our study by no means suggests that parent coercion never drives early marriage, but rather that such an explanation for high rates of early marriage is only appropriate in some contexts. The scope for parent-offspring conflict in marital timing will be higher in areas where women’s autonomy over marriage is low and divorce not sanctioned. For example, arranged and forced marriages are more common and divorce less acceptable in South Asia than in sub-Saharan Africa44 making it more likely that early marriages are costly to women because they cannot remove themselves from marriages, and beneficial to parents because they control the process. Regions where ‘very early’ marriage (<15 years) is more common may also be prone to greater parent-offspring conflict over the timing of marriage because very early marriages are more likely to cause harm45 and less likely to take place with meaningful consent from daughters10. Within East Africa, parental coercion may also drive early marriage in some communities where arranged marriages are common18,21,32 and/or where rapid changes in livelihood are creating instability20. Even within our study site, the potential for conflict over timing of marriage is present and could increase as the population continues transitioning to low fertility and urban living, and parents and children’s interests diverge34. We anticipate, however, that our findings are generalizable to other settings where ‘child marriage’ primarily occurs in later adolescence, and hope our research here leads to a more critical perspective on the assumptions of the ‘end child marriage’ movement.

To universally apply a parent-offspring conflict model of early marriage is politically expedient, galvanizing and unifying the agenda of international campaigns to abolish ‘child marriage’. However, through the promotion of this narrative, there is a risk of creating stigma and shame where there previously was none surrounding a commonplace behavior with both costs and benefits for young women. A parallel can be drawn with teenage pregnancy in high-income populations42. Campaigns to reduce teenage pregnancy in the 1990’s and 2000’s first framed teenage pregnancy as the result of “bad choices” by the poor and later, more compassionately, as an undesirable consequence of socioeconomic inequality. The public promotion of both narratives left teenage mothers dealing with judgement and pity from their communities, reinforcing their vulnerable position42. Discussions of teenage pregnancy have since gained nuance – shifting focus to view early childbearing as a rational response to constrained socioeconomic opportunities with potential for both harmful and beneficial wellbeing consequences37,42. We conclude by suggesting that a similar level of nuance, and cultural sensitivity, should now be applied to marital timing in low-income nations. Early marriages may be harmful in some contexts, while in others present the best locally-available option serving strategic interests of both parents and daughters.

**Methods**

All data were collected from Kisesa, a rural, but urbanizing Ward located 20km west of Mwanza city in the Mwanza Region of northwest Tanzania. The majority of the 35,000 residents are Sukuma, the largest ethnic group in Tanzania. Traditionally agro-pastoralists, the Sukuma now occupy a variety of occupations; within Kisesa, most Sukuma are Christian, with 20% practicing indigenous religions and <1% practicing Islam. Since 1994, a Health and Demographic Surveillance System (HDSS) has operated within Kisesa23. We conducted surveys with 993 girls/women aged 15-35 years in 743 households in two villages – Kisesa Town and Welamasonga - within the HDSS from July through October of 2017. Households containing at least one eligible participant were selected randomly using the 2016 HDSS as the sampling frame. The sample size was chosen to balance statistical power against budgetary and time constraints. Household heads completed a household roster and a survey on household characteristics. Within each household, all girls/women aged 15-35 years completed a survey which included information on their birth and relationship histories, experience of marriage, and wellbeing; women aged 18-20 years were under-represented in the sample as they were the most likely to have moved since the 2016 HDSS (for school, marriage, or work). Surveys were conducted in Swahili or Sukuma by enumerators from the Tanzanian National Institute of Medical Research (NIMR) using tablets. Ethical approval for this research was granted by the University of California Santa Barbara Human Subjects Committee (1-17-0405), the London School of Hygiene and Tropical Medicine Research Ethics Committee (13809), and the NIMR Mwanza Lake Zone IRB (MR/53/100/463). Informed consent was obtained verbally from all participants over age 18 years; consent from the parents of unmarried minors was obtained verbally prior to obtaining verbal assent from the unmarried minor.

All models with age at first marriage as the primary predictor were restricted to ever-married women who had valid ages at first marriage (n=497 after dropping 5 women with unrecorded or improbable ages at first marriage). Models for which current age and marital status were the key predictors include the full sample of women (n=993). All models controlled for village of residence and, when appropriate, current age in years to account for variation in marriage behaviors between cohorts of women. Potential socioeconomic confounders were not included as the cross-sectional nature of our study did not allow credible measure of these factors. We used an alpha level of 0.05 for all statistical tests. Descriptive statistics for variables included in models are provided in Table 1; the same statistics by age at first marriage are available in Supplementary Table 1. Predicted values in Figures 1-3 were calculated while holding women’s current age at 24 and village of residence as Kisesa Town.

Age at first marriage was calculated using data from a relationship history questionnaire. We include both formal and informal arrangements in our definition of marriage. Formal marriage includes those married legally, or through a traditional or religious ceremony. Informal marriage includes cases where a couple lived together as husband and wife, but had no ceremony or documentation formalizing their union. Age at first marriage was split into five categories (13-14, 15-17, 18-19, 20-22, and 23-29 years) based on both relevant cut-offs within the development literature (i.e. ‘very early marriage’ [marriage before age 15 years], and ‘early marriage’ [marriage before 18 years]) and with consideration for the actual distribution of ages at first marriage.

Bridewealth data were collected for women who indicated they had ever been formally married (n=359). Women were asked if they received bridewealth, and if so, in what currency (cows, goats, Tanzanian Shillings [TSH], or other livestock) and the quantity of each currency. Given the importance of bridewealth in this area as a sign of respect, most women readily knew the value of their bridewealth if they received it. To estimate the value of bridewealth in US dollars, payments were first converted to TSH and summed; cows were given a value of 350,000 TSH, goats a value of 50,000 TSH, and other livestock 20,000 TSH. The total value in TSH was then divided by 2,200 as an estimate of value in USD. A logistic regression was used to test for a relationship between age at marriage and probability of receiving bridewealth. This model was restricted to women who had ever been formally married. While bridewealth was most commonly exchanged in formal marriages, those in informal marriages may have exchanged a delayed bridewealth or “compensation” payment. We did not collect data on bridewealth for informal marriaes and do not want to assume that bridewealth was not exchanged in these circumstances, so informal unions were excluded from this analysis. A linear regression assessed correlations between marital age and value of bridewealth among women who reported receiving any bridewealth (n=247); four participants who specified that they received bridewealth but indicated a value of 0 were included in this analysis, though their exclusion did not change the results.

Women who were married were asked how many older/younger brothers/sisters they had immediately before getting married. Due to high rates of mortality and fertility23, we did not ask about current number of siblings as this may have changed since they got married. Unmarried women were asked for their current number of siblings. Relationships between number of older brothers and timing of marriage was assessed using a discrete-time event history analysis with age in years as the time variable. To determine whether any effects of number of older brothers were unique, we ran similar models with (a) number of older sisters, (b) number of younger sisters, and (c) number of younger brothers. For each model, we tested the proportional hazards assumption by including an interaction between number of siblings and age and age-squared. Number of older brothers was found to have a time-varying relationship with marriage and thus this interaction was retained in the model.

Women who had ever been married were asked who chose their first husband: themselves, their mother, their father, or someone else. Women could select more than one person. A binary variable was created to indicate whether a woman chose her own first partner independently (i.e. without parental or other involvement) or not. It is likely that in the case of formal marriages, even if a woman chose their husband independently she (and her husband-to-be) would seek her parents’ blessing before the marriage through the initiation of bridewealth negotiations. A logistic regression was used to assess correlations between age at first marriage and probability of choosing one’s own partner.

Four components of women’s wellbeing were measured, chosen based on previous literature linking these outcomes to early marriage6,46,47. A mental health score was estimated using a modified version of the Hopkins Symptoms Checklist previously used in Tanzania48. Respondents were read symptoms regarding their mental health and indicated whether, and how strongly they had experienced each symptom within the last month. They could respond “not at all”, “a little”, “some” or “a lot”; scores were reverse coded such that low values represent poorer mental health. Two women chose not to answer the questions about mental health and were excluded from analysis. Empowerment was measured by asking who made various decisions within the household about things like making purchases for daily needs, when to sell assets, and when to visit family or friends49. Married women could respond that decisions were made by themselves, their husband, their parents, their parents-in-law, or together with their husband. Unmarried women could respond that decisions were made by themselves, their parents/guardians, or together with their parents/guardians. Women with higher scores made more decisions on their own or with their husband and were considered to have greater empowerment. Women’s BMI was calculated from their height and weight as a measure of nutritional wellbeing; though not generally presented as a consequence of early marriage, poor nutritional status may link early marriage, early reproduction, and resultant poor maternal and child health outcomes6. BMI was only calculated for women with reasonable weights and heights and who were not pregnant at the time of interview (n=871). Highest level of school attendance was quantified as a binary variable indicating whether a woman had ever attended secondary school or higher. One woman chose to withhold information about her education and was excluded from education analyses.

Relationships between wellbeing measures and marital age were assessed in two ways. Firstly, we considered variation in wellbeing outcomes by age at first marriage among ever-married women. We used linear (empowerment, mental health, and BMI) and logistic (education) regressions to assess this link; a categorical predictor of age at first marriage was used in these models. Continuous wellbeing outcomes (empowerment, mental health, and BMI) were scaled so that their mean was 0 and standard deviation was 1. Secondly, we contrasted measures of wellbeing for never and ever-married women within their current age groups. Again, both linear and logistic regressions were run with the same outcomes, but the primary predictor was an interaction between current age group (15-17, 18-19, 20-24, 25-29, and 30-35 years) and marital history (ever or never-married).

Given that participants were all still of reproductive age, age-specific fertility was calculated as a proxy for reproductive success. Age-specific fertility was measured as the residuals from a linear regression predicting number of living children with current age. A linear regression was then used to assess the link between age-specific fertility and age at first marriage; current age was excluded as a predictor as age is taken into account in the outcome. Similarly to wellbeing, we additionally contrasted fertility for never and ever-married women by age, by running a model with an interaction between current age group and marital history. In this case because age was a main predictor in the model, our outcome was number of living children rather than age-specific fertility and thus a Poisson regression was run.

**Data Availability**

The data that support he findings in this study are available from the corresponding author and the National Institute of Medical Research, Tanzania upon request.

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**Competing Interests:**

The authors declare no competing interests.

**Author Contributions:**

DWL conceptualized the study. SBS designed the study. SBS, AH, DWL and MU collected data. SBS conducted the data analysis. SBS and DWL wrote the manuscript, and AH and MU contributed to editing the manuscript.

**Figure 1:** Marital timing and parental benefits. Predicted probability of receiving bridewealth (a, n=359), predicted value of bridewealth in USD (b, n=247), predicted survival curve by number of older brothers (c, n=990), and predicted probability of choosing own first partner by age at first marriage (d, n=497) with 95% confidence intervals. Values predicted from models holding village in Kisesa town (a-d) and age at 24 years (a, b, and d). Models in Supplementary Tables 2-8

**Figure 2:** Marital timing and women’s wellbeing. Predicted value of women’s empowerment score (a, n=497; b, n=993), mental health score (c, n=496; d, n=991), and BMI (e, n=407; f, n=871), and predicted probability of attending secondary education or higher (g, n=497; h, n=993) by age at first marriage for ever-married women (column 1), and by marital status and current age for all women (column 2) with 95% confidence intervals. Values predicted from models holding village in Kisesa town (a-h) and age at 24 years (a, c, e, g). Models in Supplementary Tables 9-16.

**Figure 3:** Marital timing and women’s fertility. Predicted age-specific fertility by age at first marriage for ever-married women (a, n=497), and predicted number of living children by marital status and current age for all women (b, n=993) with 95% confidence intervals. Values predicted from models holding village in Kisesa town (a and b) and age at 24 years (a). Models in Supplementary Tables 17-18.

*Table 1: Descriptive statistics*

|  |  |
| --- | --- |
| Number of women  | 993 |
| Number of ever-married women | 497 |
| Current age (years) – n (%) |  |
| 15-17 | 252 (25.38) |
| 18-19 | 121 (12.19) |
| 20-24 | 223 (22.46) |
| 25-29 | 184 (18.53) |
| 30-35 | 213 (21.45) |
| Age at first marriage (years) – n (%) |  |
| 13-14  | 10 (2.01) |
| 15-17 | 164 (33.00) |
| 18-19 | 174 (35.01) |
| 20-22 | 107 (21.53) |
| 23-29 | 42 (8.45) |
| Bridewealth |  |
| Received bridewealth^ - n (%) | 247 (68.80) |
| Value of bridewealth in USD# - mean (s.d.; min, max) | 571.46 (406.90; 0, 2680) |
| Number of siblings – mean (s.d.; min, max) |  |
| Older brothers  | 1.45 (1.45; 0, 9) |
| Younger brothers  | 1.52 (1.42; 0, 13) |
| Older sisters  | 1.35 (1.53; 0, 8) |
| Younger sisters  | 1.64 (1.58; 0, 12) |
| Who chose first partner - n (%) |  |
| Mother and/or father only | 21 (4.23) |
| Woman only | 447 (89.94) |
| Woman with help` | 13 (2.62) |
| Someone else only | 16 (3.22) |
| Wellbeing  |  |
| Women's Empowerment Score - mean (s.d.; min, max) | 1.42 (0.27; 1, 2) |
| Mental health score - mean (s.d.; min, max) | 1.56 (0.49; 1, 4) |
| Body mass index\* - mean (s.d.; min, max) | 22.00 (4.41; 9, 60) |
| Attended secondary school or higher - n (%) | 370 (37.49) |
| Fertility (RS proxy) - mean (s.d.; min, max) |  |
| Number of living children | 1.59 (1.90; 0, 9) |
| Age-specific fertility  | 0.00 (1.21; -4, 5) |
| ^of ever formally married women (n=364) |  |
| #of women who received any bridewealth (n=247) |  |
| `general this ‘help’ comes from the woman’s parents |  |
| \*non-pregnant women only |  |