Improving estimates of the links between child marriage and poor fertility outcomes

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Abstract

Over 44.5% of Indian women aged 20 and 24 years are estimated to have had child marriages. These women are at high risk for maternal morbidity and mortality. Most recently, Raj (2009) reported estimates of the effects of child marriage on poor fertility outcomes in India. However, this study had several methodological problems. Since large resources are currently being devoted to these issues, it is important to have accurate information. Hence, we improve the methods of Raj (2009). We find there is less consistency in the differences between adult and child marriages for fertility related outcomes than is reported in Raj (2009). We also find that the differences may be largely functions of marriage duration and not of only having had a child marriage. We identify two policy initiatives for improving outcomes for young adult women in child marriages, and these are reducing sterilization and increasing contraception usage.

Introduction

Marriage of children under the age of 18 has been outlawed in India since 1978. However, 44.5% of Indian women between the ages of 20 and 24 years are estimated to have been married as children (UNICEF 2007 and Raj 2009). Most fundamentally, child marriage is a violation of the basic human rights of a child, such as the rights to education and protection from sexual abuse (UNCRC 1990). However, marriage at a young age also has serious health consequences for girls, including increased risk of maternal morbidity and mortality, and HIV transmission (UNICEF 2001, 2006 and UNFPA 2005). At the same time, the United Nations Millennium Development Goals have highlighted the urgent need to reduce maternal deaths in

the world, and the majority of these occur in India (WHO 2010). Thus, studying links between child marriage and fertility related outcomes may help address two major public health issues: it may help identify (1) specific populations for improving maternal health in India, and (2) specific policy areas for alleviating some of the health outcomes of child marriage. Since prevention efforts have either failed or been weak, policy measures to address the consequences of child marriage are crucial.

Most recently, Raj (2009) has studied the link between child marriage and fertility and fertility control outcomes, and found child marriages have far worse fertility outcomes than adult marriages. Thus, Raj (2009) recommends specifically targeting family planning programs towards women that have had child marriages. However, since family planning and maternal health are currently high priority issues for India, and large resources are being devoted to various related policy measures, it is crucial to have the most accurate information on these links so that policies are effective and not wasteful. In addition, given the prevalence of child marriage in India, it is also important to have the best available information on the specific consequences of child marriage so that resources in this area are also used well.

Our initial reading of Raj (2009) suggested there were methodological problems with the study; in particular we were concerned about post-treatment bias in some estimates, the handling of missing data, and with the systematic differences between women who had child marriages and the comparison group who had adult marriages. Furthermore, we found the results surprising given that poor fertility outcomes are pervasive across many populations in India (UN

2011). In the current article, we replicate the results of Raj (2009), and then improve the statistical analysis to obtain new estimates.

Original paper on child marriage and poor fertility outcomes

The original paper, Raj (2009), has two aims: to estimate the prevalence of child marriage, defined as marriage before the age of 18 years, and to estimate the effect of child marriage on fertility and fertility-control outcomes, using the Indian National Family and Health Survey-3. The article estimates that 44.5% of women aged 20-24 years had child marriages in India. We find this estimate to be reasonable based on the quality of the survey data that was used, and similar findings by UNICEF. To address the second aim, Raj (2009) conducts logistic regression analyses to determine the effect of child marriage on fertility related outcomes. The study identifies significant associations between child marriage and a range of poor fertility outcomes, such as three or more childbirths, multiple unwanted pregnancies, and female sterilization. On the basis of these findings, Raj (2009) recommends increased enforcement of child marriage prevention laws, and increased family-planning support for women who were married as children.

Dataset

The data used in the original and current analyses are from the National Family and Health Survey-3, which is a household survey conducted during 2005 and 2006 in India by the International Institute for Population Sciences in Mumbai. We were able to download the dataset directly from the Demographic and Health Surveys website. The survey is representative at the national and state levels, and uses stratification and a multi-stage

sampling design based on first selecting villages and then households. The full sample contains data from more than 230,000 interviews of men and women between 15 and 54 years of age on population, health, and nutrition topics; the original analysis and most of our analysis restricts the sample to 14,813 ever-married women between the ages of 20 and 24 years. In this group, those women that were married before the age of 18 were determined to have had child marriages. Table 1 shows summaries of selected demographic variables for women in the 20-24 age group in each marriage category.

	Never married	Adult marriage	Child marriage
Wealth index			
1 (poorest)	8%	22%	70%
2	12	25	63
3	21	30	50
4	29	37	34
5 (wealthiest)	48	37	16
Highest level of education			
No formal education	6%	23%	72%
Primary	13	28	59
Secondary	29	39	32
Higher	72	26	3
Area of residence			
Mega city	49%	30%	21%
Large city	41	34	24
Small city	39	33	28
Large town	36	34	30
Small town	34	33	33
Rural	18	30	53

Table 1. Comparison by selected demographics of women between the ages of 20 and 24 years, the age group of interest in our study. The women are grouped by marriage category - never married, married as adults, and married as children. Analysis in our study was performed only on women who have been married. We have included never married women in this table for comparison purposes. Percentages are estimated using survey sampling weights and are nationally representative.

Results of replication of original paper

To replicate the original analysis, we began by tabulating key demographic variables by marriage category, and comparing our results to the corresponding tables in Raj (2009). We found identical results when comparing with both the number of observations in each category of the demographic variables and the nationally representative percentages produced using sampling weights.

Next, we attempted to replicate the logistic regression analyses to produce estimates of the odds ratios of all the fertility related outcomes for child versus adult marriages that are presented in Raj (2009). There were two key issues to note with the replication effort. First, in Raj (2009), 185 observations were dropped during the regression analyses that existed in the earlier descriptive statistics tables, and we were not able to determine which observations were removed. Second, we discovered four of the outcome variables had large fractions of missing data (see Table 2), but Raj (2009) did not describe handling of missing data. Thus, we experimented with a range of assumptions on the missing data (see Table 4) and concluded that the missing data were likely set to the mode of the observed data in each outcome variable. We contacted the authors of Raj (2009), but the authors did not provide further information.

Our final replication results are similar to the estimates in Raj (2009), with the exception of a few cases, as shown in Table 3. Throughout much of this paper, we continue to present results in the same format as Raj (2009) to make comparisons easy.

Fertility related outcome	Percent missing data	Mode and Median
No contraceptive use before first childbirth	53%	1
Childbirth in first year of marriage	21	0
Any unwanted pregnancies	24	0
Multiple unwanted pregnancies	24	0

Table 2. Percentage of missing data in fertility related outcome measures. The mode and median equaled the same value in all cases, and were likely used to impute missing data in Raj (2009).

	Raj (2009) Adjusted OR	Replicated Adjusted OR
No contraceptive use before first childbirth	1.37 (1.22-1.54)	1.44 (1.23 - 1.69)
Childbirth in first year of marriage	1.03 (0.95-1.12)	1.02 (0.91 - 1.14)
Any childbirths	5.71 (5.2-6.26)	6.55 (5.76 - 7.46)
Three or more childbirths	7.4 (6.45-8.5)	9.12 (7.55 - 11.02)
Repeat childbirth in less than 24 months	3 (2.74-3.29)	2.88 (2.55 - 3.26)
Any unwanted pregnancies	1.67 (1.51-1.83)	1.63 (1.43 - 1.86)
Multiple unwanted pregnancies	2.36 (1.9-2.94)	2.25 (1.69 - 2.98)
Any pregnancy termination	1.48 (1.34-1.63)	1.43 (1.26 - 1.62)
Sterilized	6.68 (5.78-7.6)	6.5 (5.37 - 7.88)

Table 3. Replication results. We were able to replicate the adjusted odds ratios for child marriage in Raj (2009) for most of the fertility outcomes. The odds ratios for any child births and multiple child births were two outcomes we were not able to replicate closely. Any differences likely result from 185 observations dropped in Raj (2009) without notation and uncertainty in how the study handled missing responses (3000-7000 out of 14,813 observations) for the following outcomes: no contraception before first birth, childbirth in first year of marriage, any unwanted pregnancies, and multiple unwanted pregnancies.

Improved statistical analysis

In each of the following sections, we demonstrate one at a time, each of our methodological changes: addressing post-treatment bias, multiple imputations, and matching. We then present our new estimates following these changes and compare to those obtained in Raj (2009).

Methodological Flaw 1: Post-treatment bias

As a first step in evaluating the original analysis, we evaluate the choice of the final reported quantities in the original article from a policy perspective. The final quantities that are presented in Raj (2009) are odds ratios of fertility and fertility-control outcomes between child and adult marriages, after controlling for demographics and post-treatment variables such as marriage duration. We find there are two serious problems with this choice. First, odds-ratios are difficult to interpret and not useful to most readers or policy-makers, and we demonstrate the usefulness of presenting probabilities in our results. Second, Raj (2009) controls for post-treatment variables in an attempt to measure only the direct effect of child marriage on fertility related outcomes. However, since the *policy relevant* quantity of interest is the *total* effect of

child marriage, some of the reported estimates in Raj (2009) are biased. We discuss this problem next.

Raj (2009) generates biased estimates of the total effect of child marriage on fertility related outcomes by controlling for what are consequences of child marriage itself. As shown in Figure 1, the original article mistakenly excludes pathways between child marriage and fertility related outcomes that pass through other variables, even though the policy relevant quantity of interest is the total effect (indirect and direct effects) of child marriage. We identify three such mediating variables, namely wealth, education, and marriage duration that were used as control variables in the original analyses. While wealth and education were included to reduce omitted variable bias, marriage duration was included to improve measurement of the direct effect of child marriage on fertility related outcomes.

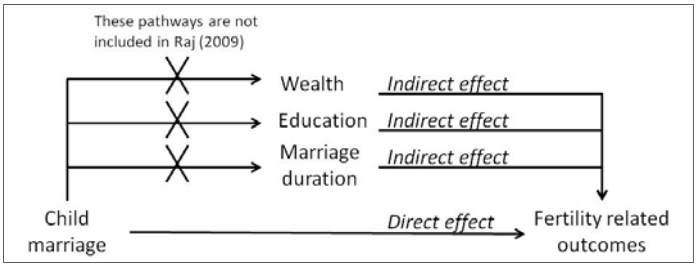

Figure 1. Direct and indirect effects of child marriage on fertility related outcomes. In Raj (2009), indirect effects of child marriage on fertility related outcomes through wealth, education, and marriage duration were excluded in an attempt to identify the direct effect of child marriage. We find the direct effect as modeled in Raj (2009) is not a policy-relevant quantity of interest.

To understand why marriage duration generates post-treatment bias, it is important to recall that the sample used in the analysis only includes women that are 20-24 years of age who have been married. Thus, within this age group, marriage duration is clearly a consequence of having had a child marriage or adult marriage in most cases. We find a Pearson correlation statistic between child marriage and marriage duration to be 0.61 (95% confidence interval is

0.606-0.626), indicating a strong positive correlation between the two. Thus, it is not surprising that once marriage duration is controlled for in the statistical models in Raj (2009), most effects of child marriage on fertility related outcomes disappear. For these reasons, we do not include marriage duration in our statistical models.

On the other hand, wealth and education are covariates that present problems both when they are included and excluded from the statistical models. When they are excluded, they may cause omitted variable bias in the estimates because they may have an effect on both child marriage and fertility related outcomes. On the other hand, if they are included, they may generate post-treatment bias and may incorrectly estimate the total effect of child marriage on fertility related outcomes. However, one reasonable way to deal with this is to present a range of estimates, both with and without wealth and education in the statistical models, as we do in our results.

Methodological Flaw 2: Modal imputation of missing data

We found four of the fertility related outcome measures were missing large amounts of data (see Table 2) for ever-married women between the ages of 20 and 24 years. As mentioned earlier, we also found that our replication results were most similar to the original results if we assumed the missing data were set to the mode of the observed data for each particular outcome. In Table 4, we demonstrate this by showing the range of possible estimates based on assumptions about the values of missing data.

	Raj (2009) Adjusted OR	Adjusted OR missing data = modal value	Adjusted OR with 5 multiply imputed datasets	Adjusted OR missing data is list-wise deleted
No contraceptive use before first childbirth	1.37 (1.22-1.54)	1.44 (1.23-1.69)	2.85 (2.58-3.14)	2.96 (2.46-3.56)
Childbirth in first year of marriage	1.03 (0.95-1.12)	1.02 (0.91-1.14)	0.61 (0.55-0.67)	0.67 (0.6-0.76)
Any unwanted pregnancies	1.67 (1.51-1.83)	1.63 (1.42-1.86)	1.15 (1.02-1.29)	1.25 (1.09-1.44)
Multiple unwanted pregnancies	2.36 (1.9-2.94)	2.25 (1.69-2.98)	1.40 (1.12-1.75)	1.85 (1.38-2.46)

Table 4. Range of estimates based on assumptions about missing data. This table shows that our replication results are most similar to the estimates reported in Raj (2009) for outcomes with missing data if we assume that missing data are set to the mode of the observed values of each outcome variable. Here, we use the modeling assumptions and presentation of quantities as in Raj (2009) for ease of comparison. Hence, the statistical models control for age, education, area of residence, region of residence, wealth, and religion.

By replacing missing data with modal values, Raj (2009) assumes that the missing responses to these items in the survey would have been the same as the most frequent response in the survey. However, since missing responses likely systematically differ from completed responses with the most frequent answers, this is a strong assumption. Further, making statistical inference about missing data is a reasonable approach given the large amount of information available in the survey. Hence, we make use of all the covariates and outcome variables in the analysis, along with others in the full survey dataset, to impute the missing data. We do this by using multiple imputation methods to create five multiply imputed datasets (we repeated the analysis with ten multiply imputed datasets and found five was sufficient) (Honaker and King 2011). We then repeat the logistic regressions in Raj (2009) on these five datasets and combine the separate estimates to obtain the results in Table 3, Column 3. To make comparisons easier, we use the original models and quantities of interest in this demonstration. As can be seen, there are large differences between the reported estimates in Raj (2009) and our estimates based on multiple imputation.

To test the validity of our multiple imputations, we conducted a couple of diagnostics. In the first of these, we used different starting values for our optimization algorithm to make sure our imputed values were not dependent on any particular starting values. We found that

regardless of our starting position, our results always converged to the same values. In the second diagnostic, we tested our imputation model by dropping *observed* values one at a time and then estimating imputed values for each of these. We then compared our imputed values with the actual values for these observations, and found we were able impute correctly for many observations, though not all. However, all of the variables we were imputing were binary, and this made interpreting the results difficult. This is an area where more research would be helpful. Overall, multiple imputation has been shown to be an efficient alternative to listwise deletion (King and Honaker 2001). On the other hand, replacing missing data with the most frequent values likely induces bias.

Methodological Flaw 3: Poor multivariate balance between child and adult marriages

In comparing the child and adult marriage groups, we see significant differences in the categories of wealth, education, wealth, and area of residence. Women in the child marriage group are more likely to be in the poorest quintile of wealth (70.4% vs. 22.2%), have no formal education (71.6% vs. 22.6%), and reside in a rural area (52.5% vs. 29.7%). Poor overlap between the two groups means that some observations in the child marriage group will not have close counterfactuals in the adult marriage group. Thus, controlling for these covariates solely through regression as done in Raj (2009) may be expected to result in a higher degree of model dependence than otherwise desired. Estimated differences for observations without close counterfactuals would thus be pure extrapolations. A formal test for multivariate imbalance in age, education, area of residence, region, wealth, and religion between the two groups shows moderate multivariate imbalance (L1=0.501) and a low level of common support in the data

(LCS=40.9%). Moreover, univariate imbalance in education, area of residence, wealth, and marriage duration is significantly high as expected.

We employed matching in order to increase the area of overlap between the child and adult marriage groups. By matching, we prune observations which do not have close counterfactuals, and reduce any model dependence that may exist. We chose the Coarsened Exact Matching (CEM) algorithm due to its applicability to multiply imputed data (Iacus, King, and Porro 2009). The CEM algorithm first creates strata of observations by coarsening each covariate. It then applies exact matching on the coarsened covariates and discards observations falling into strata which do not contain members of both the control and treatment group. We performed CEM matching on all the covariates in our logistic regression, utilizing default coarsening criteria. Following matching, multivariate balance improves significantly (L1=0.379) as does the area of overlap between the child and adult marriage groups (LCS =100%). Although we find that the results of Raj (2009) would not have changed significantly with matching, our final results are on matched data following imputation.

Results

After using multiple imputation to impute missing data and using Coarsened Exact Matching to improve multi-covariate balance between child and adult marriages, we obtain estimates of odds ratios of fertility related outcomes for child versus adult marriages as shown in Table 5. Once again, for ease of comparison with Raj (2009), we present odds ratios. We show results both with and without education and wealth to provide a range of estimates that contain either post-treatment bias due to including these variables in the models or omitted variable bias due

to excluding these variables from the regressions. However, as can be seen by comparing the second and third columns of results in Table 5, including or excluding wealth and education does not change most estimates.

Our odds ratios change in different directions and magnitudes relative to Raj (2009) for each of the fertility related outcomes. In some cases, such as whether a woman has a repeated childbirth in less than 24 months, there is little difference in results; in other cases, such as whether a woman used contraception before her first childbirth, our estimates are much larger; and in some other cases, such as whether a woman has childbirth in the first year of marriage, our results reverse the conclusions of Raj (2009). In most cases, our estimates are smaller than those reported in Raj (2009). Most importantly, our results suggest there is far less consistency in the responses to fertility related questions among women between the ages of 20 and 24 years than indicated by Raj (2009). For example, our estimate of the odds ratio of having multiple unwanted childbirths for child versus adult marriages is not significantly different from one, yet the odds ratio of sterilization for child versus adult marriages is over six. This appears to be an inconsistent result since sterilization is often a response to having multiple unwanted pregnancies.

Fertility related outcome	Original analysis: Raj (2009) Adjusted OR	Current analysis: Adjusted OR, including education and wealth in model	Current analysis: Adjusted OR, excluding education and wealth in model
No contraceptive use before first childbirth	1.37 (1.22-1.54)	3.05 (2.66-3.48)	2.90 (2.61-3.24)
Childbirth in first year of marriage	1.03 (0.95-1.12)	0.64 (0.57-0.73)	0.64 (0.57-0.64)
Any childbirths	5.71 (5.2-6.26)	6.62 (5.74-7.65)	6.75 (5.95-7.62)
Three or more childbirths	7.40 (6.45-8.5)	9.15 (7.45-11.23)	12.33 (10.26-14.86)
Repeated childbirth in less than 24 months	3.00 (2.74-3.29)	2.88 (2.52-3.29)	3.46 (3.07-3.9)
Any unwanted pregnancies	1.67 (1.51-1.83)	1.19 (1.03-1.39)	1.11 (0.98-1.27)
Multiple unwanted pregnancies	2.36 (1.9-2.94)	1.35 (0.96-1.79)	1.39 (1.01-1.82)
Any pregnancy termination	1.48 (1.34-1.63)	1.43 (1.24-1.64)	1.42 (1.25-1.6)
Sterilised	6.68 (5.78-7.6)	6.40 (5.22-7.91)	7.79 (6.44-9.4)

Table 5. Comparison of original adjusted odds ratios from Raj (2009) for fertility related outcomes with the current analyses. The second and third columns present estimated odds ratios from the current analysis both with and without education and wealth in the statistical model. When education and wealth are included, there may be post-treatment bias present in the estimates, and when education and wealth are not included, there may be omitted variable bias in the estimates. All analyses use survey sampling weights to produce national level estimates, and adjust for age, area of residence, region of residence, and religion.

Since odds ratios are difficult to interpret, we also present estimated differences in probabilities between child and adult marriages of having some of the fertility related outcomes in Table 5. These are presented in Table 6 for prototypical individuals that have wealth, live in areas of residence, or have highest education levels as indicated in the table, and other covariates set to their mean values in the sample. The results suggest that, with the exception of three or more child births, differences in probabilities of these fertility related outcomes between child and adult marriages are similar between the poorest and middle income people, between people with no formal education and those having secondary school education, and between people in rural and small cities. Furthermore, compared with the odds ratios presented above and in Raj (2009), it is now much easier to see that probability differences of "Any unwanted pregnancies" and "Multiple unwanted pregnancies" between child and adult marriages within these groups is not significantly different from zero.

	Wealth		Education		Area	
Fertility related outcomes	Poorest	Middle	No Formal	Secondary	Rural	Small City
No contraceptive use before first childbirth	0.26 (0.23-0.28)	0.26 (0.23-0.28)	0.26 (0.23-0.28)	0.25 (0.23-0.28)	0.25 (0.23-0.28)	0.25 (0.22-0.27)
Three or more childbirths	0.18 (0.14-0.21)	0.15 (0.13-0.18)	0.31 (0.27-0.36)	0.16 (0.13-0.2)	0.16 (0.13-0.2)	0.14 (0.1-0.19)
Any unwanted pregnancies	0.02 (0-0.04)	0.03 (0-0.05)	0.02 (0-0.04)	0.03 (0-0.05)	0.03 (0-0.05)	0.02 (0-0.05)
Multiple unwanted pregnancies	0.01 (0-0.02)	0.02 (0.01-0.03)	0.02 (0-0.03)	0.01 (0-0.03)	0.01 (0-0.03)	0.01 (0-0.03)
Sterilised	0.09 (0.07-0.11)	0.08 (0.06-0.11)	0.09 (0.06-0.11)	0.09 (0.07-0.11)	0.09 (0.07-0.11)	0.07 (0.04-0.12)

Table 6. Differences in probabilities of fertility related outcomes between child and adult marriages for prototypical individuals. Individuals have wealth, education, or area of residence as indicated, and other covariates set to their mean values in the sample. The models used to generate these estimates used five multiply imputed datasets, Coarsened Exact Matching, and logistic regressions that controlled for age, level of education, area of residence, region of residence, wealth, and religion. The estimates are weighted using survey sampling weights and are representative at the national level.

Sensitivity analysis with shifted age group

As previously addressed, teasing apart the effect on fertility outcomes from child marriage and marriage duration is difficult. Raj (2009) attempts to tease apart this effect by including marriage duration in the logistic regression, but this approach introduces post-treatment bias. We instead have chosen to accomplish this task by repeating our analysis for the 20-24 age group on an older cohort of women, the 25-29 age group. When comparing women married as children or adults in the 25-29 age group, the effect of duration of marriage on fertility related outcomes will have attenuated, thus reducing its effect on our outcomes of interest. Table 7 shows the results of this analysis. We find that the odds ratios for women married as children show a downward trend with age. This likely indicates that although women married as children do have worse fertility control outcomes, the dramatic effect seen in the 20-24 age group are biased by duration of marriage, and that the women married as adults will see some of these unfavorable outcomes as well, but at a much later age. Although time effects may be contributing to these differences between the two age groups, it is unlikely a span of four years would cause these.

	Adjusted OR's After Imputation and Matching Ages 20-24	Adjusted OR's After Imputation and Matching Ages 25-29
No contraceptive use before first childbirth	3.05 (2.66-3.48)	2.21 (1.75-3.48)
Childbirth in first year of marriage	0.64 (0.57-0.73)	0.55 (0.48-0.68)
Any childbirths	6.62 (5.74-7.65)	3.95 (2.85-7.23)
Three or more childbirths	9.15 (7.45-11.23)	4.79 (3.7-10.31)
Repeat childbirth in less than 24 months	2.88 (2.52-3.29)	1.85 (1.51-3.1)
Any unwanted pregnancies	1.19 (1.03-1.39)	1.17 (1.02-1.36)
Multiple unwanted pregnancies	1.35 (0.96-1.79)	1.14 (0.89-1.45)
Any pregnancy termination	1.43 (1.24-1.64)	1.11 (0.93-1.55)
Sterilized	6.40 (5.22-7.91)	3.13 (2.33-7.28)

Table 7. Comparison of effect of child marriage in women aged 20-24 and 25-29. When repeating our analysis on women in an older age group (25-29), we find that the estimated effect of child marriage decreases for most fertility control outcomes.

Discussion

We improve the methodology used in Raj (2009) through the use of multiple imputation to address missing data and matching to improve multi-covariate imbalance. Our imputation and matching validity checks suggest our model is an improvement on the methods of Raj (2009). However, we still face the vulnerabilities of using survey responses in cross-sectional form. We find two key areas where policy initiatives would be useful to direct towards young adult women who had child marriages, and these are the promotion of contraceptive use and decreasing the practice of sterilization. These findings are consistent with Raj (2009).

However, our results convey a less consistent picture of the differences between child and adult marriages than is described in Raj (2009). For instance, even though a woman with a child marriage is much more likely to be sterilized, women with child marriages do not have significantly higher probabilities of having had any or multiple unwanted pregnancies. We also find that women between the ages of 20 and 24 years who had adult marriages have a higher probability of having a child in the first year of marriage than those who had child marriages, and this is the opposite of the finding in Raj (2009). Interestingly, we find the differences in probabilities of most fertility related outcomes between child and adult marriages do not differ when comparing the poorest and middle class women, those with no formal education and those who have completed secondary education, and those who live in rural areas with small city dwellers.

While it is clear that sterilization and lack of contraceptive use is high among women with child marriages, and that this should be addressed, we find that the differences between child and adult marriages in poor fertility outcomes are much smaller among women in the 25-29 years

age group. There are two possible explanations for this. The first is that there is some time effect causing systematic differences related with child marriage between women who are 20-24 years of age in the sample and those who are 25-29 years of age. The other possibility is that much of the effect that is due to child marriages among women who are 20-24 years of age is related with marriage duration, as Raj (2009) attempts to demonstrate by controlling for marriage duration in the statistical analyses. We find this explanation more convincing since the problems related with child marriage are unlikely to have changed over such a short period. However, inducing post-treatment bias in this manner is not the right way to address this question because of the extremely high correlation between child marriage and marriage duration in this group. Thus, we instead repeat the analysis among women who were ever-married between the ages of 25-29 to demonstrate this more appropriately. Our results suggests that poor fertility outcomes exist broadly among young adult women and thus sterilization and contraception related public health initiatives should not focus on women in child marriages to the neglect of women with adult marriages. At the same time, girls and women that have child marriages may benefit from focused efforts at younger ages, when poor fertility outcomes are much more pronounced when compared with their counterparts in adult marriages.

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