Happily Ever After? Mental Health Effects of Early Marriage in Indonesia *

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Abstract

Early marriage is a manifestation of gender discrimination against girls, leading to adverse consequences on their wellbeing. This article contributes to the literature by examining the effects of early marriage on the mental wellbeing of women - an area often overlooked in research. Using nationally representative longitudinal data from Indonesia and applying difference-in-differences regression model with fixed-effects, this study finds that marrying early, particularly by the age of 18 years, has a strong negative impact on women's mental health. Specifically, women who marry early are 9.6 percentage points more likely to be depressed. It further finds that a one-year delay in marriage decreases the likelihood of having depression by approximately four percent of the mean. These findings add to the evidence of health effects of early marriage and provide a rationale for policy interventions implemented towards eradicating it.

JEL classification: J12; J16; O12
Keywords: Marriage, women, Indonesia, mental health, difference-in-differences

Accepted at *Feminist Economics*

1 Introduction

Early marriage is a widespread phenomenon where 1 in 5 women (21 percent) are married before their 18th birthday.[1] More than 12 million girls are married in childhood each year, and an estimate of 650 million girls and women have been married as children globally (UNICEF 2020). Early marriage is an indication of gender inequality and discrimination against girls (Leeson & Suarez 2017). Girls who marry early are not only deprived of their childhood but also the opportunity to lead a better life. They are more likely to experience poor maternal health

*I thank Nadezhda V. Baryshnikova, Terence Cheng, Mandar Oak, Giulio Zanella, and participants at the Australian Gender Economics Workshop 2020 for useful comments and discussions. I also appreciate the feedback and suggestions received from the editor, the associate editor, and the three anonymous reviewers. This paper was written during Danusha Jayawardana's PhD research at the University of Adelaide and postdoctoral research at the University of Queensland, Australia. The Indonesia Family Life Survey (IFLS) data are proprietary of RAND Corporation and are publicly available at https://www.rand.org/well-being/social-and-behavioral-policy/data/FLS/IFLS.html

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[1]An early marriage where the participant is under 18 years is referred to as child marriage.

(Clark et al. 2006, Field & Ambrus 2008) as well as lower educational attainment limiting their employment opportunities and potential earnings (Bajracharya et al. 2019, Delprato et al. 2015, Field & Ambrus 2008, Nguyen & Wodon 2014, Wodon et al. 2017, Yount et al. 2018). Moreover, such underage unions can further result in intergenerational effects affecting the wellbeing of their children (Adhikari 2003, Chari et al. 2017, Finlay et al. 2011, Sekhri & Debnath 2014, Sunder 2019, United Nations Children's Fund 2014). These impacts are often larger when the girl marries very early (Male & Wodon 2016).

Early marriage may also have a profound effect on the psychological and emotional wellbeing of women. This may be due to the abrupt end of education, limiting the girl's mobility in terms of pursuing a career or developing companionships. Furthermore, marrying at a very young age can be a stressful and traumatic experience. Girls are often separated from their families and friends to cohabitate with their husband and his family, putting them at greater risk of social isolation (UNICEF 2014). Marital responsibilities, such as childbearing and child-rearing, can place significant physical and mental demands on young girls, who are still developing themselves (Steinhaus & John 2018). Girls are also more likely to be victims of intimate partner violence and forced sexual relations. It is shown that girls who marry before they are 15 years old are 50 percent more likely to be affected by physical or sexual violence from a partner (Kidman 2017). According to studies in psychology, being constantly exposed to such adverse and stressful experiences can impact mental health, causing disorders such as depression, anxiety and panic attacks, which may persist into adulthood (Hammen 2005, McMahon et al. 2003).

This article examines the impact of early marriage on the mental health of women in Indonesia. Indonesia is a prime case study because in absolute terms, Indonesia has the eighth highest number of child brides in the world, where 1 in 10 women are married before the age of 18 years. Moreover, in a developing country setting, Indonesia has the most comprehensive household panel data – the Indonesia Family Life Survey (IFLS). Critically and uncommonly, the recent two waves include a validated measure of mental health: the 10-item Centre for Epidemiological Studies Depression Scale (CES-D-10). Employing several identification strategies such as fixed effects and Coarsened Exact Matching (CEM) combined with difference-in-differences, I seek to assess the causal effect between an early marriage of a woman and her mental health status. The results reveal that early marriages have a significant negative impact on women's mental health. More specifically, women who marry early, that is by the age of 18 years, are 9.6 percentage points more likely to be depressed. Additionally, I find that delaying the marriage

by one-year decreases the likelihood of having depression by approximately four percent of the mean. These findings are robust to a variety of sensitivity checks. I further provide suggestive evidence that restricted labour market mobility and poor physical health are potential mechanisms through which early marriage adversely affects the mental health of women.

This study makes several contributions to the literature. First, it adds to the sparse literature on the causal effects of women's marital age on their socioeconomic wellbeing. Compared to studies on educational, physical health and intergenerational outcomes of early marriage, studies on mental health effects are limited (Parsons et al. 2015). Therefore, to the best of my knowledge, I provide first evidence on the causal effect of early marriage on mental health. This is important as emotional wellbeing is crucial for women's empowerment. According to Kabeer (2005), a woman's ability to make choices and decisions depends on three interrelated dimensions: resources, agency and achievements. Poor mental health affects all these dimensions and thereby women's overall wellbeing.

Second, this study contributes to the extensive literature on 'missing women' in developing countries (Anderson & Ray 2010, Sen 1990). Developed by Sen (1990), the concept of 'missing women' refers to the low ratio of women to men in developing countries. This occurs as a result of excess mortality of women due to gender discrimination and negligence (Anderson & Ray 2010). Early marriage is a practice that signifies entrenched gender inequality which affects women disproportionately. This paper highlights that early marriage results in an increase in depression for women. This, in turn, can lead to detrimental consequences, as individuals with mental disorders are more vulnerable to risk-taking behaviours such as self-harm (WHO 2020). According to Anderson & Ray (2010), self-inflicted injuries are a primary cause of death for over 100,000 women in East Asia. Therefore, the findings may provide a possible explanation in understanding the excess mortality of women in developing countries.

Methodologically, this paper differs from the existing econometric studies on early marriage. Following the seminal paper by Field & Ambrus (2008), many studies apply an Instrumental Variable (IV) strategy where age at menarche is used as an instrument for early marriage (or child marriage) (see Chari et al. (2017), Roychowdhury & Dhamija (2021), Sekhri & Debnath (2014)). However, considering the context of this study, using age at menarche could be problematic due to potential violation of exclusion restriction. This is because, the timing of puberty (both earlier and delayed) is said to be associated with depressive symptoms among girls (Mendle et al. 2016, 2018, Rudolph et al. 2014). As an alternative, I employ two estimation approaches

by exploiting the panel structure of the IFLS data. Initially, I use a fixed-effects model to address an important source of endogeneity arising from unobserved individual heterogeneity. For instance, personal norms and attitudes may be associated with both mental health status and timing of marriage, which differ across individuals but is unobserved. Since the fixed-effects model cannot address all sources of endogeneity, I additionally use a matched difference in difference (matched DD) approach to further strengthen the identification. By considering early marriage as the treatment variable, I apply Coarsened Exact Matching (CEM) with difference-in-differences including individual fixed effects. The advantage of combining methods is that it offsets the limitations of a single method leading to a robust estimator (Gertler et al. 2011). In particular, CEM accounts for selection bias through observed characteristics, while the difference-in-differences takes care of any unobserved characteristics that are constant across time between the treatment and control groups, thus resulting in an unbiased estimator.

From a policy perspective, the results provide valuable insights for laws and policies targeted at ending child marriages. Explicitly, the findings justify the need to accelerate the progress towards eradicating early marriage as the consequences of it affect not only the physical wellbeing but also the emotional wellbeing of girls. Moreover, this paper also emphasises the importance of providing the required psychological support and access to mental healthcare to those women who are married as children - an area that has been often overlooked.

2 Background

2.1 Child marriage and mental health in Indonesia

Indonesia has a high incidence of child marriage in the Asia Pacific region, where one in 10 women (11.2 percent) was married or in union before the age of 18 years in 2018 (BAPPENAS 2019). In absolute terms, Indonesia has the eighth highest number of child brides in the world. One of the main reasons for early marriage in Indonesia is the Marriage Law 1974 that does not require to meet the 18 years threshold for marriage, which is generally accepted by the International Human Rights Treaty Bodies. According to the Marriage Law 1974, with parental consent, girls are allowed to marry at 16 and boys at 19 years (BAPPENAS & UNICEF, 2019). It is also possible to marry off girls even earlier by obtaining the approval from religious courts or local officials, in which case there would be no minimum age of marriage.

The prevalence of early marriage in Indonesia depends on poverty and rural residence. Girls from poor and rural households have a 15 to 20 percent higher likelihood of marrying before 18

years compared to girls from affluent and urban households (BAPPENAS & UNICEF, 2017). Early marriage inevitably hinders education. Only nine percent of married girls under 18 years complete their senior secondary education as opposed to 54 percent of their unmarried peers (BAPPENAS & UNICEF, 2017). This means girls who marry in childhood are six times less probable to complete their secondary education.

As a developing country, there exists a considerable stigma around mental health issues in Indonesia, where people with mental health problems are often stereotyped and discriminated. According to the World Health Organisation (2017*b*), 6.4 percent of individuals aged 15 years and above experience mental disorders in Indonesia. However, there are significant inequalities in mental and emotional disorders across dimensions such as gender, age, place of residence, economic status, education and employment status. The statistics reveal that women are more prone to mental disorders where the proportion is 7.8 percent compared to that of 4.9 percent of men. In terms of age profile, the percentage of individuals with poor mental health remains around 5 to 8 percent among the age groups of 15 to 64 years. This percentage increases strikingly up to 18 percent among the elderly (WHO 2017*b*).

Considering education, there is a clear difference between the least educated and most educated. Individuals with no education are four times more likely to experience poor mental health compared to individuals with higher education (WHO 2017*b*). Economic status and place of residence also affect mental health. Individuals from poorest quintile are two times more likely to suffer from mental disorders compared to individuals in the wealthiest quintile of households. These figures depict that poor mental health is, in fact, an issue in Indonesia, and thus identifying the possible causes are essential for control and prevention efforts.

2.2 Review of literature

This study closely relates to the literature on the impacts of early marriage on the wellbeing of women. Parsons et al. (2015) provide a systematic review of this literature. Though there are a plethora of studies examining the effects of early marriage (or child marriage) on both women and their children, most estimate associations rather than causal effects. This could be problematic since the effect of early marriage on outcomes such as education or health could be endogenous due to factors such as unobserved heterogeneity, reverse causality or selection bias. The seminal paper by Field & Ambrus (2008) addresses this concern by utilising age at menarche as an instrumental variable. Drawing from biological research, they argue that genetic factors play an important role in determining the timing of puberty and the fact that these genetic

variations are random makes it a good instrument. Based on this strategy, Field & Ambrus (2008) find that early marriage leads to lower educational attainment for women in terms of schooling years and literacy as well as the use of antenatal health care practices in Bangladesh.

Following Field & Ambrus (2008), few studies have used age at menarche as an instrument to isolate the causal effect of early marriage on various outcomes. For instance, Sunder (2019) shows the intergenerational impacts of women's age at marriage in Uganda, while Chari et al. (2017) and Sekhri & Debnath (2014) provide evidence from India. In another study in India, it is shown that delayed marriage leads to a reduction in domestic violence, especially that of physical violence (Roychowdhury & Dhamija 2021). Using longitudinal data from Bangladesh, Asadullah & Wahhaj (2018) provide causal evidence on how early marriage can lead to increased transmission of traditional gender norms.

In contrast to the above, a limited number of studies have used different instruments. For example, using child marriage measures at the primary sampling unit (PSU) as instrumental variables, Nguyen & Wodon (2014) and Wodon et al. (2016) examine the effect of early marriage on schooling attainment and literacy in Africa. On the other hand, Ramnarine (2017) uses drought and flood shocks as an instrumental variable for age at marriage. Based on data from Bangladesh, this study also finds that early marriages have long term implications where children from early marriages are more likely to be stunted.

The above studies highlight that the instrumental variable approach is the key identification strategy employed to isolate the causal effects of early marriage. However, Hombrados (2017) argues that this approach could be problematic due to potential violation of the exclusion restriction. Therefore, as an alternative identification strategy, Hombrados (2017) applies a Regression Discontinuity Design (RDD), which exploits the change of legal marital age of women from 15 to 18 years in Ethiopia to identify the causal effect of child marriage on infant mortality. The findings suggest that the increase in legal marital age had significant effects on reducing both child marriage and infant mortality.

Another gap in early marriage literature is the non-existence of empirical evidence on the causal effect of early marriage on women's mental health (Parsons et al. 2015). It is a well-known fact that girls who marry early tend to experience a higher risk of isolation, depression and panic attacks than those married later, due to adverse consequences such as lower education, increased domestic violence and poor health (Parsons et al. 2015). This is further established by studies such as Gage (2013); Le Strat et al. (2011) and Steinhaus & John (2018), which provide strong

evidence that marrying particularly at a very young age leads to poorer mental health among women in both developed and developing countries. None of these studies establish a causal effect.

To the best of my knowledge, this article is among the first to examine the causal effect of early marriage on women's mental health in a developing country context. Contrary to previous studies, I combine several identification strategies to address the potential endogeneity of women's age at marriage. Therefore, this paper seeks to address both the evidence and methodological gaps in early marriage literature.

3 Data and measures

I use data from the Indonesia Family Life Survey (IFLS). The IFLS is a nationally representative and comprehensive longitudinal survey of households in Indonesia. In terms of representation, IFLS is a sample drawn from 13 of the country's 26 provinces which consist of 83 percent of the Indonesian population. There is relatively low attrition, with the re-contact rate of over 85 percent in each wave (Strauss et al. 2016). In this study, I use data from the 2007 and 2014 waves of the IFLS since information on mental health was collected for the first time in 2007.

I restrict the sample to women between ages 15 and 35 years in 2007 and are also surveyed in the 2014 wave. The minimum cut-off point of 15 years is chosen as the questions on mental health and marital history are available only for individuals who are 15 years and above. Following Field & Ambrus (2008), I select the maximum age of 35 years to minimise censoring of women who either marry late in life or those who have changes in marital status such as remarriage due to separation or divorce. The sample of women is also restricted to those who are either unmarried or married once. This means, married women who are either separated, divorced or widowed are excluded from the sample (which accounts for about one percent of the total sample) to avoid biased estimates. However, as a robustness check, I relax this restriction on marital status. Accordingly, the sample consists of 11,358 observations from 5,679 women. Thirty percent of the women are married by the age of 18 years. Figure 1 in the supplementary materials presents the distribution of the age at marriage.

3.1 *Measure of early marriage*

I use the marital history module of IFLS to obtain data on marital status. As the main variable of interest, I construct a binary variable which takes on a value of 1 if the woman was married by the age of 18 years to denote early marriage, and 0 otherwise. The use of a binary variable instead of age at marriage allows variation in marital status between the two waves facilitating fixed-effects estimation. As shown in Table 1, four percent of women in the sample who are not married in the first wave are married by the age of 18 years during the next wave.

Table 1: Transition probabilities for early marriage

Early marriage status in wave 1 (2007)	Early marriage status in wave 2 (2014)		Total number of women
	0	1	
0	3,892	160	4,052
	(96.0)	(4.0)	(100.0)
1	0	1,627	1627
	(0.0)	(100.0)	(100.0)
Total	3,892	1,787	5,679
	(68.5)	(31.5)	(100.0)

Notes: The percentages in parenthesis sum up to 100 across rows. '0' denotes the number of women with no early marriage status, while '1' denotes the number of women with an early marriage status (i.e. married by the age of 18 years).

3.2 *Measure of mental health status*

Mental health status is assessed using the 10-item Centre for Epidemiological Studies Depression Scale (CES-D-10), which is a self-reported measure of depression based on ten questions (Radloff 1977). As a validated scale, it has a consistent performance in both developed and developing countries (Mackinnon et al. 1998) and thus widely used in research.

The ten questions refer to how often the respondent experienced each of the depressive symptoms during the past week. The CES-D score is calculated by obtaining the sum of these ten responses, with positively phrased statements reverse-coded. This ranges from 0 to 30 with higher scores reflecting more pronounced depressive symptoms. I construct two dependent variables based on the CES-D scale. First, I use the composite score of the ten questions. Second, I use an indicator variable for depression that takes on a value of 1 if the CES-D score is 10 and above and 0 otherwise (Andresen et al. 1994).

3.3 *Other covariates*

The regression analysis controls for several individual and household level characteristics. The individual controls include age, religion (indicated as Muslim) and height measured in centimetres.[2] Since the sample includes both married and unmarried women, an indicator that takes on a value of 1 if the woman is married and 0 otherwise is used as a control variable to distinguish between women who are married and unmarried. The effect of marriage on mental wellbeing can vary, based on whether the woman is newly wed or not (Clark et al. 2008, Rudolf & Kang 2015). To account for such intertemporal effects of marriage, I control for the number of years in marriage. Subjective wellbeing during marriage also depends on the bargaining power (Bethmann & Rudolf 2018). Therefore, as a measure of bargaining power, I use parents' education as control variables.

At the household level, I include dummy variables for urban/rural residence and individual provinces to control for the regional heterogeneity. Since unobservable economic shocks at the provincial level may affect both mental health and early marriage outcomes, I control for baseline regional poverty rates (proxied by the percentage of poor people in the province in 2007) interacted with time dummy to account for it.[3] A complete list of variables is given in Table S1 in the supplementary materials.

3.4 *Descriptive statistics*

The summary statistics describing the sample are shown in Table 2.[4] The average mental health score is 3.5. A CES-D score of 10 or above (based on the 10-item scale) indicates the presence of clinical depression (Andresen et al. 1994). Seven percent of women experience depressive symptoms. The sample means of mental health score for child brides and non-child brides are also shown in Table 2. Interestingly, there is a significant difference between the mean values of mental health score or level of depression between the two groups. Figure 2 in the supplementary materials graphs the distribution of the CES-D score by early marriage status. On average, both groups depict similar distributions. However, the distribution for late marriages has a higher

[2]Since the effect of age on mental health is likely to be non-linear, I use two-year age bands in the regression analysis.

[3]Data on the percentage of people by province are extracted from the BPS - Statistics Indonesia. Retrieved July 02, 2021, `https://www.bps.go.id/indicator/23/192/8/percentage-of-poor-people-by-province.html`

[4]The main identification strategy is based on a sample of 160 women who experience early marriage during the sample time frame, which is discussed under Section 4.2. Hence, I show the differences in observable characteristics for this sample of individuals compared to the control group in wave 4 (2007), as these are the women who contribute to explaining the impact of early marriage on mental health.

density at lower CES-D scores, suggesting lower depressive symptoms on average, compared to the early marriage group.

The average age of the sample respondents is 24.8 years and nearly 60 percent of the women live in an urban area. Child brides are significantly different from non-child brides in several dimensions. The significant difference of the parents' education status between the two groups highlights the presence of unobservable differences. This implies that Ordinary Least Squares (OLS) can result in biased estimates on the effect of early marriage on mental health.

Table 2: Summary Statistics

	Full Sample		Treated Group		Control Group		Mean
	Mean	SD	Mean	SD	Mean	SD	Difference
Outcome variables							
CES-D Score	3.54	3.43	4.26	3.76	3.52	3.41	0.74***
Depression	0.07	0.25	0.11	0.31	0.06	0.24	0.04**
Covariates							
Age	24.78	5.84	16.41	1.53	25.12	5.70	-8.71***
Height (cm)	151.48	5.85	150.65	5.75	151.51	5.85	-0.86*
Muslim	0.90	0.29	0.97	0.17	0.90	0.30	0.07***
Urban	0.60	0.49	0.43	0.50	0.60	0.49	-0.17***
Married	0.58	0.49	0.00	0.00	0.61	0.49	-0.61***
Years married	3.01	3.88	0.00	0.00	3.14	3.90	-3.14***
Regional poverty	14.93	6.83	14.33	7.33	14.96	6.81	-0.63
Mother's education	6.60	3.42	5.48	3.11	6.68	3.42	-1.21***
Father's education	7.67	3.25	6.65	2.80	7.76	3.27	-1.10***
No. of individuals	4,052		160		3,892		

Notes: The descriptive statistics are based on the pre-treatment sample observed in wave 4 (2007). Mean difference is the difference of means between the treated (child brides) and control group (non-child brides) for each of the variables. ***p<0.01, ** p<0.05, * p<0.1.

4 Estimation strategy

4.1 *Panel fixed-effects model*

To identify the effect of early marriage on mental health, I first estimate the following fixed-effects model:

$$MH_{it} = \alpha + \beta EM_{it} + \eta \mathbf{X}_{it}^{'} + \varphi_i + \gamma_t + \varepsilon_{it} \tag{1}$$

where MH_{it} is the mental health status (either CES-D score or indicator variable as described above) of woman i in year t. The main independent variable is EM_{it}, which is a dummy variable that equals to 1 if the woman i is married by the age of 18 years in year t and 0 otherwise. $\mathbf{X}_{it}$ is a vector of individual and household-level characteristics of woman i in year t. φ_i and γ_t denote

unobserved time-invariant individual-specific effects and time fixed-effects respectively, and ε_{it} is the error term.

There are several sources of individual time-invariant fixed effects that could lead to biased estimates. For instance, the genetic health endowments of an individual woman can influence both her health status and timing of marriage. Healthier girls, both physically and emotionally, are more likely to marry early than those who are not (Leeson & Suarez 2017, Siow 1998, Stutzer & Frey 2006). Moreover, they also tend to be emotionally stable in the long run, and events such as an early marriage may not have a considerable impact on their mental health. This means such forms of unobserved heterogeneity can lead to a positive relationship between early marriage and mental health. On the other hand, family norms and attitudes towards children can also influence wellbeing and marriage decisions. Parents who are more concerned about the wellbeing of their children are less likely to marry off their daughters early (Leeson & Suarez 2017). They are also likely to allocate more resources to improve the child's health. Therefore, such favourable attitudes towards children could explain a lower likelihood of early marriage and a higher likelihood of having better mental health, implying a negative selection bias. The fixed-effects approach could deal with these types of selection bias, allowing us to consistently estimate β - the effect of early marriage on mental health. Using within transformation or mean differencing, it eliminates φ_i in equation (1), which denotes unobserved time-invariant individual fixed effects that could be possibly correlated with both the marriage decision and mental health of the woman.

4.2 *Coarsened exact matching (CEM) combined with difference-in-differences (DD) estimator*

One caveat of the above fixed effects model is, it could only address endogeneity due to unobserved time-invariant individual heterogeneity. Therefore, to strengthen the identification strategy, I employ a difference-in-differences (DD) estimator with panel fixed effects.

To employ the DD technique, I restrict the sample to women who are either unmarried or not had an early marriage in wave 4 (2007) and are also observed in wave 5 (2014). The purpose of such restriction is to create a set up where a subsample of women is exposed to the treatment (i.e. had an 'early marriage') in the second time period (wave 5) but not in the first period (wave 4). This would represent the treatment group. The remaining group of women who are

not exposed to the treatment (i.e. no early marriage) during either period would be the control group.

By using the double-difference estimator, I seek to rule out two potential endogeneity concerns. First, I control for both observed as well as unobserved time-invariant factors in the treatment group by comparing the before-and-after mental health outcomes (the first difference) of those who married early (Gertler et al. 2011). Second, to account for omitted time-varying factors such as changes in socioeconomic conditions which can have an impact on mental health, I compare this first difference with the same estimate for a group of women who did not have an early marriage resulting in a double difference estimator.

One of the concerns in estimating the treatment effect, is the non-random assignment of the treatment resulting in selection bias. Girls who married early, for instance, may come from poorer households, which in itself may affect their mental health. This suggests that the outcomes of girls who marry early and those who do not, would differ even in the absence of being married early, leading to biased estimates. Hence, to deal with such treatment selection bias, I use CEM to create a control and a treatment group that are similar on observable characteristics. According to Blackwell et al. (2009), the underlying mechanism of CEM is to exactly match the treatment and control groups by temporarily coarsening variables and use the original values of the matched units for regression. Compared to other matching techniques, such as propensity score and Mahalanobis distance matching, CEM can reduce model dependence, imbalance, estimation error and bias (Iacus et al. 2012).

By using the weights generated by the CEM process, I estimate the following fixed effects DD model:

$$MH_{it} = \alpha + \gamma EM_{it} + \delta Post_t + \beta EM_{it} * Post_t + \eta \mathbf{X}_{it}^{'} + \varphi_i + \varepsilon_{it} \tag{2}$$

where MH_{it} is the mental health status (either CES-score or indicator variable as described above) of woman i in year t. EM_{it}, is a dummy variable that equals to 1 if the woman i is married by the age of 18 years in year t and 0 otherwise, $Post_t$ is an indicator variable which takes on a value of 1 for wave 5 (2014) and 0 for wave 4 (2007). The variable of interest is $EM_{it} * Post_t$ which equals to 1 if the woman i had an early marriage in wave 5 (2014) and 0 otherwise. $\mathbf{X}_{it}$ is a vector of individual and household-level characteristics of woman i in year t. φ_i denotes unobserved time-invariant individual heterogeneity and ε_{it} is the error term.

The strength of the above model is that it combines three different econometric techniques

that address different sources of endogeneity, resulting in an unbiased estimator. More specifically, panel fixed-effects consider unobserved individual heterogeneity, CEM deals with selection bias, whereas DD estimator accounts for possible changes in trends. Therefore, it can be argued that the coefficient of the interaction term β - may denote the causal effect of early marriage on the mental health of women.

5 Empirical results

5.1 *Fixed-effects model estimates*

The first set of results are derived using a panel fixed-effects regression model. I estimate two separate equations considering the dependent variable as: (1) the composite score on CES-D scale (higher scores indicate higher levels of depression), and (2) an indicator for depression that takes the value of 1 if the CES-D score is greater than 10. Table 3 presents the results. As a benchmark, I also report the Ordinary Least Squares (OLS) estimates. The estimated coefficients from OLS models are small and statistically not significant from zero. As discussed in Section 4.1, these OLS estimates might be downward biased reflecting endogeneity due to the effects of any unobserved and observed time-invariant covariates that are correlated with decision to have an early marriage (Cunningham 2021). Fixed effects model eliminates such time invariant effects when estimating the impact of early marriage on the mental health of women.

Table 3: Effect of early marriage on mental health - OLS and FE results

	OLS		Fixed-Effects	
	CES-D Score	Depression	CES-D Score	Depression
	(1)	(2)	(3)	(4)
Early marriage	0.073	0.002	1.187**	0.092**
	(0.126)	(0.010)	(0.504)	(0.046)
Married	-0.973***	-0.051***	-1.122***	-0.067***
	(0.136)	(0.011)	(0.218)	(0.019)
Other covariates	Yes		Yes	
Province FE	Yes		Yes	
Year FE	Yes		Yes	
Individual FE	No		Yes	
Observations	11,358		11,358	
No. of individuals	5,679		5,679	
R-squared	0.133	0.074	0.234	0.129

Notes: All regressions are based on the sample of women who had an early marriage either during the sample period or before. Early marriage is denoted as a binary variable which takes on a value of 1 if the woman is married by the age of 18 years and 0 otherwise. Estimations in Columns 1 and 2 are via OLS, and 4 and 5 are via panel fixed effects model. Other covariates include woman's age, height, religion (Muslim), number of years married, urban/rural location, parents' years of schooling and regional poverty. Robust standard errors in parentheses, clustered at individual level. *** p<0.01, ** p<0.05, * p<0.1.

The estimation results of the fixed effects specification are reported in Columns 3 and 4 of Table 3. Women who marry early are more likely to develop depressive symptoms. On average, early marriage leads to an increase in mental health score (based on the CES-D scale) by approximately 1.2 points, which is statistically significant at 5% level. Given the sample mean score of 3.5, this translates into a 34 percent increase. When considering the depression indicator, a similar result is observed. Those who marry early, are 9.2 percentage points more likely to be depressed. The fact that these fixed-effects estimates are significantly different from those estimates derived from OLS imply that the time-invariant unobservables and regressors are possibly correlated.

5.2 *Matched difference-in-difference estimation results*

Following fixed-effects estimates, Table 4 presents the results of difference-in-difference regression models. The estimated coefficient of EarlyMarriage*Post denotes the effect of early marriage on mental health of women which is the treatment effect. The OLS coefficients are positive and statistically significant (see Columns 1 and 2). However, these may be biased due to unobserved heterogeneity, which is addressed through fixed effects. The fixed effects DD estimates (Columns 3 and 4) are quite similar to that of previous results in both the magnitude and statistical significance.[5]

As discussed in Section 4.2, to deal with sample selection bias, I combine coarsened exact matching with difference-in-differences (matched DD) to obtain the unbiased treatment effect. The variables used for exact matching are age, religion (Muslim), height and whether the individual is living in an urban or rural area.[6] Table S2 in the supplementary materials provides the matching outcomes on pre-treatment data (2007 baseline). Out of the total of 160 girls who are married early, 159 girls are matched to 1,052 girls who do not fall into the category of early marriage. Table S2 also shows that the overall multivariate imbalance reduces from 0.82 to 0.20. The univariate imbalances also show a substantial reduction. To diagnose the

[5]It is important to note that the reduction in sample size is due to the sample being restricted to women who are either unmarried or not had an early marriage in wave 4 (2007), as explained in Section 4.2.

[6]To select the matching variables, I first identify the significant covariates in wave 4 that determine an early marriage (i.e. treatment) in wave 5 based on an OLS estimation. These variables include age, quadratic of age and religion (Muslim). I exact match on these variables and check covariate balance. Since the treatment and control groups are unbalanced in terms of height and urban/rural location (both of which are potential proxies for poverty), I also consider these two variables in addition to age and religion. I further increase the matching variables based on intuition. However, due to exact matching, an increase in the number of matching variables leads to a decline in sample size significantly. Hence these results are shown as robustness checks (see Section 6).

quality of the matching outcomes, I assess the covariate balance of the two subsamples, both pre and post-matched. Table S3 in the supplementary materials reports the results. As expected, there are significant mean differences between the treated and control groups of the pre-matched sample in the year prior to the event of an early marriage, including the measures of mental health. However, after CEM matching, women in both treated and control groups do not differ in terms of either the CES-D score or mean depression probability. Compared to the pre-matched sample, the post-matched mean differences of other covariates also show a significant reduction, indicating a reasonable match by CEM.[7]

Columns 5 and 6 of Table 4 report the DD estimates with the weights generated by the CEM process. The coefficients of the treatment effect are significant and larger in magnitude when compared to DD estimates without matching. This implies that matching addresses an important source of endogeneity.[8]

Table 4: Effect of early marriage on mental health - DD estimates

	OLS		Fixed-effects		Matching and FE	
	CES-D Score	Depression	CES-D Score	Depression	CES-D Score	Depression
	(1)	(2)	(3)	(4)	(5)	(6)
Early marriage	-0.172	-0.007				
	(0.320)	(0.027)				
Post treatment	2.678***	0.160***	3.146***	0.189***	0.018	-0.058
	(0.220)	(0.018)	(0.602)	(0.052)	(1.921)	(0.164)
EarlyMarriage*Post	1.094**	0.078*	1.230**	0.096**	2.197**	0.205***
	(0.488)	(0.044)	(0.504)	(0.045)	(0.916)	(0.067)
Married	-0.948***	-0.048***	-1.095***	-0.066***	-1.009	-0.047
	(0.148)	(0.012)	(0.221)	(0.019)	(0.628)	(0.052)
Other covariates	Yes		Yes		Yes	
Province FE	Yes		Yes		Yes	
Individual FE	No		Yes		Yes	
R-squared	0.128	0.074	0.225	0.124	0.228	0.135
Observations	8,104		8,104		2,422	
No of individuals	4,052		4,052		1,211	

Notes: All regressions are based on the restricted sample of women who had an early marriage during the sample time frame. Early marriage is denoted as a binary variable which takes on a value of 1 if the woman is married by the age of 18 years and 0 otherwise. The variable of interest is EarlyMarriage*Post which equals to 1 if the woman had an early marriage in wave 5 (2014) and 0 otherwise. Difference-in-difference estimations in Columns 1 and 2 are via OLS, and 4 and 5 are via panel fixed effects model. The matching FE results in Columns 5 and 6 are estimated using both fixed effects and the corresponding weights generated by CEM. Other covariates include woman's age, height, religion (Muslim), number of years married, urban/rural location, parents' years of schooling and regional poverty. Robust standard errors in parentheses, clustered at individual level. *** p<0.01, ** p<0.05, * p<0.1.

[7]It is important to note that with coarsening, there would be some imbalance remaining in the matched data. Such imbalance can be controlled via a statistical model (Blackwell et al. 2009).

[8]One of the key identifying assumptions of DD is that the mental health *trends* would be the same in both groups in the absence of treatment (early marriage), which is referred to as the parallel trend assumption (Angrist & Pischke 2009). However, this assumption is not needed, given that the matched sample of women prior to the treatment (i.e. early marriage) is similar in terms of observable characteristics.

6 Robustness checks

The sample of interest used in the analysis consists of both married and unmarried women. However, the inclusion of women who are either married or unmarried in both periods may raise a concern of biased estimates, especially when deriving inferences from the matched DD estimation. This is because, a married or an unmarried woman would not be a perfect counterfactual to a woman who had an early marriage. To allay this concern, as the first robustness check, I estimate the DD model by confining the sample to only those women who are unmarried in wave 1 (2007), but married in wave 2 (2014). Results reported in Table S4 in the supplementary materials show that the coefficients of interest (EarlyMarriage*Post) continue to be significant and similar to those in Table 4.

Second, I examine whether the results are driven by the sample restrictions in terms of marital status.[9] I include the group of women who are married but either separated, divorced or widowed and re-estimate the effect of early marriage on mental health. Since such changes in marital status could adversely affect mental health, I control for it by including a dummy variable which is assigned a value of 1 if a woman is either separated, divorced or widowed and 0 otherwise. As presented in Table S5 in the supplementary materials, the estimates are similar in magnitude to the original fixed effects estimates reported in Table 3.

Third, in Section 5.2, I matched the treatment group (i.e. those who had an early marriage) and control group based on a limited number of covariates - age, religion (Muslim), height and urban/rural location. However, it can be argued that the decision to marry early also depends on other factors such as household income, education level and physical health status of the woman. Therefore, based on intuition, I increase the number of covariates that are used to match the treatment and control groups as a robustness check. In this regard, I estimate two alternative CEM models using different combinations of matching variables. First, in addition to the above matching variables, I match on proxies for poverty (such as whether the household uses nearby river, land or sea as the toilet and uses firewood for cooking), since poverty is a key cause of early marriage (Otoo-Oyortey & Pobi 2003). As the second alternative, I further increase the number of matching variables. Considering the combination that gives the best matching outcomes, the selected variables are age, religion (Muslim), height, urban/rural location, whether the woman is still in school, level of education, the number of acute morbidities experienced during the last

[9] These results are derived using the panel model estimates. The use of DD estimation also provides qualitatively similar results.

four weeks as a proxy for physical health, and whether the household uses the nearby river, land or sea as the toilet. The coarsened exact matching summaries of both alternatives presented in Tables S6 and S7 in the supplementary materials show that CEM has produced a reasonable match, where the overall multivariate and univariate imbalances are reduced post-match. Panel A of Table S8 reports the DD estimates with the CEM weights. Columns 3 to 6 show that the coefficients of the treatment effect in two alternative CEM models are mostly larger in magnitude compared to baseline matched DD estimates reported in Columns 1 and 2. This is because matching on more observable characteristics results in a better counterfactual leading to strong significant results. Given that we are unable to match on all observables, this implies that our estimated results may be biased downwards. I further check the robustness of the CEM estimates to other matching techniques, such as Mahalanobis Distance Matching (MDM) and Propensity Score Matching (PSM). The results reported in Panel B of Table S8 show that the estimates are similar, indicating that our results are robust to various matching techniques.

Fourth, the main empirical results discussed in Section 5 are estimated by a dummy variable which takes on the value of 1 if the woman is married by the age of 18 years and 0 otherwise. As a robustness check, I further examine the consistency of the results by taking age at marriage instead of the dummy variable. Given that age at marriage is a time-invariant variable, the use of fixed-effects is not feasible. Therefore, to estimate the coefficient of age at marriage while allowing for individual heterogeneity, I apply the Correlated Random Effects (CRE) model and Hausman-Taylor (HT) approach.[10] Table S9 reports the results from CRE and HT estimations. It is important to note that these estimates are not directly comparable to those obtained from the fixed-effects estimations reported in Table 3, due to differences in samples. Both married and unmarried women are included in the sample used in basic fixed effects regressions, whereas only married women are included in the sample used for CRE and HT regressions. This is inevitable because the age at marriage is available only for married women. Based on CRE estimates (see Columns 1 and 2 of Table S9) delaying marriage by one-year decreases the CES-D score by 0.05 points (1% of the mean), whereas it decreases the probability of being depressed by approximately 0.3 percentage points (4% of the mean). This is consistent with the estimates in Tables 3 and 4, given that early marriage is likely to increase the probability of having depression. Considering the HT estimates (Columns 3 and 4), the age at marriage does not have a significant effect on either the mental health score (CES-D) or the probability of having depression.

[10] See Mundlak (1978) and Chamberlain (1982) for CRE model, and Hausman & Taylor (1981) for HT approach.

7 Potential mechanisms

Given that early marriage has a strong adverse effect on women's mental health, it is important to investigate the underlying mechanisms through which this might operate. According to Holmes & Rahe (1967), life events that require drastic changes in behaviour and lifestyle to adopt are associated with greater levels of stress. Since marriage is a major life event (Holmes & Masuda 1973) with diverse responsibilities, adopting into it can be too demanding, especially for young girls, leading to anxiety and depression. Furthermore, an early marriage could be a traumatic experience for girls due to several other reasons as well. Separation from their family and friends at a very young age, leads them to feel socially isolated or rejected. It also causes an abrupt end to education, limiting the girl's mobility in terms of pursuing a career or developing companionships. Intimate partner violence, forced sexual relations and early pregnancies are all associated with early marriages (UNICEF 2014), exerting both physical and mental tension on girls. This suggests that education, labour market outcomes, bargaining power, intimate partner violence and fertility outcomes are potential mechanisms by which early marriage affects mental health. In the following section, based on data availability, I provide suggestive empirical evidence on three of the probable pathways: education, labour market outcomes, and physical health status.

To examine the channels, I estimate the same DD model with CEM weights, considering indicators for women's labour force participation, education attainment and physical health status as outcome variables.[11] Table 5 presents the results. Women who marry early are nine percentage points less likely to be seeking for a job, meaning they are more likely to be out of the labour force. On the other hand, early marriage increases the probability of being a housekeeper by 15 percentage points. This suggests that early marriage limits women's ability to pursue employment opportunities and hence leads to poor mental health. Furthermore, in terms of physical health, I find that women who marry early are less likely to report that they are healthy. This indicates that physical health is also a potential channel through which early marriage affects mental health, as it is a key determinant of mental health (Liew 2012). Considering educational outcomes, early marriage does not have a significant effect on any of the outcomes. Taken together, the findings in Table 5 provide suggestive evidence that early marriage adversely affects mental health through factors such as restricted labour market

[11] The definitions and summary statistics of these additional outcome variables are presented in Table S10 in the supplementary materials.

mobility and poor physical health.[12]

Table 5: Mechanisms - Effect of early marriage on labour market, education and physical health outcomes

Panel A	Employed	Seeking for a job	Schooling	House keeping
	(1)	(2)	(3)	(4)
Post treatment	0.608***	0.120	-0.705***	-0.024
	(0.155)	(0.107)	(0.129)	(0.114)
EarlyMarriage*Post	0.006	-0.087*	-0.060	0.149*
	(0.084)	(0.047)	(0.059)	(0.078)
R-squared	0.381	0.116	0.686	0.556
Observations	2,422	2,422	2,422	2,422
No. of individuals	1,211	1,211	1,211	1,211
Panel B	Elementary	Junior	Senior	Tertiary
	(5)	(6)	(7)	(8)
Post treatment	0.029	-0.544***	0.139	0.363***
	(0.036)	(0.095)	(0.153)	(0.113)
EarlyMarriage*Post	0.013	0.014	-0.084	0.049
	(0.023)	(0.044)	(0.051)	(0.037)
R-squared	0.029	0.159	0.263	0.500
Observations	2,422	2,422	2,422	2,422
No. of individuals	1,211	1,211	1,211	1,211
Panel C	Health Status	Bed ridden	Acute morbidity	Days missed due to ill-health
	(9)	(10)	(11)	(12)
Post treatment	0.162	-0.037	0.093	1.527
	(0.131)	(0.344)	(0.668)	(1.159)
EarlyMarriage*Post	-0.108*	0.223	0.337	-0.356
	(0.058)	(0.156)	(0.315)	(0.523)
R-squared	0.075	0.026	0.151	0.038
Observations	2,422	2,422	2,422	2,422
No. of individuals	1,211	1,211	1,211	1,211

Notes: All regressions are based on the restricted sample of women who had an early marriage during the sample time frame. The variable of interest is EarlyMarriage*Post which equals to 1 if the woman had an early marriage in wave 5 (2014) and 0 otherwise. All DD estimations are derived using both fixed effects and the corresponding weights generated by CEM. Other covariates include woman's age, height, religion(Muslim), indicator for marital status, number of years married, urban/rural location, parents' years of schooling and regional poverty. Robust standard errors in parentheses, clustered at individual level. *** p<0.01, ** p<0.05, * p<0.1.

8 Conclusion

Early marriage signifies entrenched gender inequality and discrimination against girls, leading to repercussions on their wellbeing. Though there is a limited number of studies on the causal effect of early marriage on education and physical health, there is no econometric analysis on the impact of early marriage on mental health. I address this evidence gap by examining the causal effect of early marriage on the woman's mental health. To this end, I use longitudinal data

[12]It is important to highlight that these results should be interpreted with caution due to low sample size for certain outcome variables (such as seeking for a job and schooling) and remaining imbalances between treatment and control groups.

from the Indonesia Family Life Survey (IFLS) and use panel fixed effects and coarsened exact matching with difference-in-differences (matched DD) to address the endogeneity bias of early marriage. I find that early marriage has a strong adverse effect on women's mental health. I also provide suggestive evidence that restricted labour market mobility and poor physical health are potential mechanisms through which this occurs.

These findings have several important implications. First, the costs of early marriage are underestimated. This is because, in addition to adverse impacts of early marriage on physical wellbeing, it can also have a significant effect on the emotional wellbeing of women, an aspect which has been generally overlooked. Therefore, the total benefit of eradicating this harmful practice globally would be much higher than the previously estimated $22 billion (The Economist 2019), if we consider the large economic costs of mental disorders in developing countries (Mathers et al. 2008).

Second, the findings shed further light on the phenomenon of 'missing women' in developing countries (Anderson & Ray 2010, Sen 1990). Early marriage is a manifestation of gender discrimination which disproportionately affects women. This study highlights that such underage unions can exacerbate poor physical health that leads to mental health problems such as depression. This, in turn, can cause detrimental consequences as individuals with mental disorders are more vulnerable to risk-taking behaviours such as self-harm. According to the World Health Organisation (2017*a*), self-harm is the second leading cause of death among girls aged 15-19 years. This emphasizes the importance of ensuring psychological wellbeing among adolescent girls by protecting them from harmful practices such as early marriage. When considering the estimates of missing women, Indonesia is identified as one of the Asian countries with a significant number of missing females accounting for more than one million in 2010 (Bongaarts & Guilmoto 2015). Moreover, according to Anderson & Ray (2010), self-inflicted injuries are a primary cause of death for over 100,000 women in East Asia. Given that early marriage is associated with poor mental health, the findings provide a possible explanation of this excess mortality of women in developing countries, and underscore the importance of eliminating early marriage to ensure both the short- and long-term wellbeing of women.

From a policy perspective, the findings highlight two key points. First, with almost 650 million girls and women around the world married as children, this study recognises a cohort of women who require adequate psychological support, mental healthcare and counseling services. Given the inter-generational transmission of poor mental health, addressing the mental health

issues of such women would ensure the mental wellbeing of both women and their children. Second, the study provides valuable insights for laws and policies targeted at ending child marriages. Specifically, it gives a rationale for Indonesia's new policy of raising the minimum age at which girls can marry from 16 to 19 years (The Economist 2019) - an important step towards ending early marriages in Indonesia. Such policy measures would conclusively promote gender equality as well as better outcomes for women.

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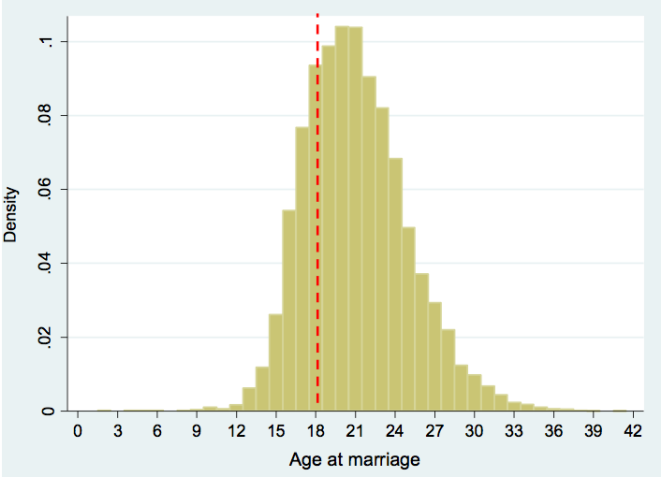
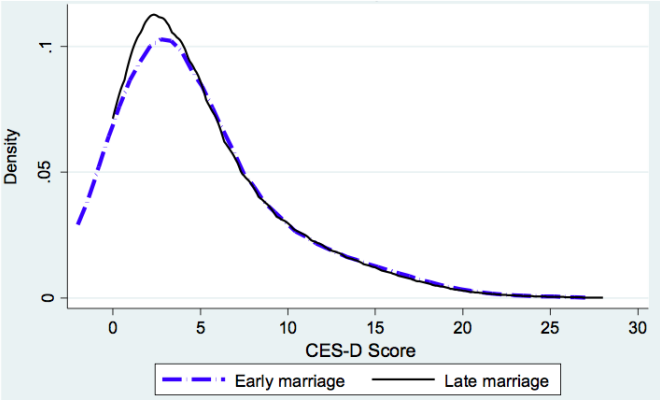
Supplementary Materials

Figure 1: The distribution of age at marriage



Notes: This figure is based on data from wave 4 (2007) and wave 5 (2015) and includes all women who had an early marriage either during the sample period or before. The dotted line at 18 years represents the generally accepted threshold for marriage.

Figure 2: The distribution of mental health score



Notes: This figure is based on data from wave 4 (2007) and wave 5 (2015) and includes all women who had an early marriage either during the sample period or before.

Table S1: Variable Description

Variable	Description
CES-D score	The mental health score based on CES-D-10 scale
Depression	=1 if the CES-D score is greater than 10
Covariates	
Age	Age of the individual
Height (cm)	The height in centimeters
Muslim	=1 if the religion is Islam
Urban	=1 if the household is in an urban area
Married	=1 if married
Years married	Number of years since marriage
Mother's education	Mother's years of schooling
Father's education	Father's years of schooling
Regional poverty	Percentage of poor people in the province
Provincial dummies	Separate indicator variables for each of the following provinces: North Sumarta, West Sumarta, South Sumarta, Lampung, Jakarta, West Java, Central Java, Yogyakarta, East Java, Bali, West Nusa Tenggara, South Sulawesi and South Kalimantan

Table S2: Coarsened Exact Matching Summary

	Control (Early marriage = 0)	Treatment (Early marriage = 1)
All	3892	160
Matched	1052	159
Unmatched	2840	1

Pre-match multivariate L1 distance: 0.821

	Pre-match univariate imbalance		Sample mean	
	L1	Mean Difference	Control (EM = 0)	Treatment (EM = 1)
Muslim	0.067	0.067	0.902	0.969
Age	0.785	-8.668	28.518	19.850
Height (cm)	0.115	-1.436	149.951	148.515
Urban	0.172	-0.184	0.637	0.453

Post-match multivariate L1 distance: 0.199

	Pre-match univariate imbalance		Sample mean	
	L1	Mean Difference	Control (EM = 0)	Treatment (EM = 1)
Muslim	0.000	0.000	0.969	0.969
Age	0.035	-0.106	16.527	16.421
Height (cm)	0.050	-0.101	146.018	145.917
Urban	0.000	0.000	0.428	0.428

Table S3: Covariate Balance

	Pre-matched sample (without CEM weights)			Post-matched sample (with CEM weights)		
	0	1	Diff	0	1	Diff
Outcome variables						
CES-D score	3.52	4.26	0.741***	4.25	4.26	0.009
	[0.05]	[0.30]	[0.276]	[0.12]	[0.30]	[0.332]
Depression	0.06	0.11	0.043**	0.10	0.11	0.008
	[0.00]	[0.02]	[0.020]	[0.01]	[0.02]	[0.026]
Covariates						
Age	25.12	16.41	-8.710***	16.53	16.42	-0.106
	[0.09]	[0.12]	[0.451]	[0.05]	[0.12]	[0.132]
Height (cm)	151.51	150.65	-0.859*	150.76	150.65	-0.104
	[0.09]	[0.46]	[0.481]	[0.17]	[0.46]	[0.481]
Muslim	0.90	0.97	0.067***	0.97	0.97	0.000
	[0.00]	[0.01]	[0.024]	[0.01]	[0.01]	[0.015]
Urban	0.60	0.43	-0.172***	0.43	0.43	0.000
	[0.01]	[0.04]	[0.039]	[0.02]	[0.04]	[0.042]
Married	0.61	0.00	-0.606***	0.01	0.00	-0.015
	[0.01]	[0.00]	[0.039]	[0.00]	[0.00]	[0.010]
No. of years married	3.14	0.00	-3.135***	0.02	0.00	-0.022
	[0.06]	[0.00]	[0.309]	[0.01]	[0.00]	[0.027]
Religional poverty	14.96	14.33	-0.628	15.78	14.39	-1.391**
	[0.11]	[0.58]	[0.551]	[0.21]	[0.58]	[0.591]
Father's education	7.76	6.65	-1.103***	8.00	6.63	-1.368***
	[0.09]	[0.27]	[0.321]	[0.12]	[0.27]	[0.341]
Mother's education	6.68	5.48	-1.209***	7.02	5.42	-1.594***
	[0.08]	[0.28]	[0.314]	[0.12]	[0.27]	[0.338]
N	3892	160	4052	1052	159	1211

Notes: Mean difference is the difference of means between the treated (child brides) and control group (non-child brides) for each of the variables. ***p<0.01, ** p<0.05, * p<0.1.

Table S4: Robustness check - Estimates based on the restricted sample of women who are unmarried in 2007 but married in 2014

	OLS		Fixed-effects		Matching and FE	
	CES-D Score	Depression	CES-D Score	Depression	CES-D Score	Depression
	(1)	(2)	(3)	(4)	(5)	(6)
Early marriage	-0.044	0.001				
	(0.326)	(0.027)				
Post treatment	2.637***	0.168***	2.278**	0.093	0.184	-0.006
	(0.390)	(0.033)	(1.005)	(0.088)	(1.660)	(0.153)
EarlyMarriage*Post	0.890*	0.077	1.155**	0.097**	2.345***	0.174**
	(0.522)	(0.047)	(0.527)	(0.047)	(0.814)	(0.074)
Married	-1.120***	-0.072**	-1.451***	-0.072**	-1.001*	-0.078
	(0.357)	(0.032)	(0.416)	(0.036)	(0.606)	(0.056)
Other covariates	Yes		Yes		Yes	
Province FE	Yes		Yes		Yes	
Individual FE	No		Yes		Yes	
R-squared	0.107	0.065	0.201	0.119	0.236	0.134
Observations	3,388	3,388	3,388	3,388	2,014	2,014
No. of individuals	1,694	1,694	1,694	1,694	1,007	1,007

Notes: All regressions are based on the restricted sample of women who are unmarried in 2007 but married in 2014. Early marriage is denoted as a binary variable which takes on a value of 1 if the woman is married by the age of 18 years and 0 otherwise. The variable of interest is EarlyMarriage*Post which equals to 1 if the woman had an early marriage in wave 5 (2014) and 0 otherwise. Difference-in-difference estimations in Columns 1 and 2 are via OLS, and 4 and 5 are via panel fixed effects model. The matching FE results in Columns 5 and 6 are estimated using both fixed effects and the corresponding weights generated by CEM. Other covariates include woman's age, height, religion (Muslim), number of years married, urban/rural location, parents' years of schooling and regional poverty. Robust standard errors in parentheses, clustered at individual level. *** p<0.01, ** p<0.05, * p<0.1.

Table S5: Robustness check - Relaxing marital status

	OLS		Fixed-effects	
	CES-D Score	Depression	CES-D Score	Depression
	(1)	(2)	(3)	(4)
Early marriage	0.050	0.000	0.994**	0.078*
	(0.125)	(0.010)	(0.493)	(0.044)
Married	-0.962***	-0.050***	-1.072***	-0.063***
	(0.135)	(0.011)	(0.217)	(0.019)
Other covariates	Yes		Yes	
Province FE	Yes		Yes	
Individual FE	No		Yes	
R-squared	0.133	0.076	0.234	0.131
Observations	11,538	11,538	11,538	11,538
No. of individuals	5,769	5,769	5,769	5,769

Notes: All regressions are based on the sample of women who had an early marriage either during the sample period or before. Early marriage is denoted as a binary variable which takes on a value of 1 if the woman is married by the age of 18 years and 0 otherwise. Estimations in Columns 1 and 2 are via OLS, and 4 and 5 are via panel fixed effects model. Other covariates include woman's age, height, religion (Muslim), number of years married, urban/rural location, parents' years of schooling, regional poverty as well as a dummy variable denoting whether the woman is either separated, divorced or widowed. Robust standard errors in parentheses, clustered at individual level. *** p<0.01, ** p<0.05, * p<0.1.

Table S6: Coarsened Exact Matching Summary - Alternative 1

	Control (Early marriage = 0)	Treatment (Early marriage = 1)
All	3892	160
Matched	907	155
Unmatched	2985	5

Pre-match multivariate L1 distance: 0.861

	Pre-match univariate imbalance		Sample mean	
	L1	Mean Difference	Control (EM = 0)	Treatment (EM = 1)
Muslim	0.067	0.067	0.902	0.969
Age	0.785	-8.710	25.123	16.413
Height (cm)	0.115	-4.406	149.411	145.005
Urban	0.172	-0.172	0.603	0.431
Cook - firewood	0.164	0.164	0.280	0.444
Toliet river/land/sea	0.100	0.100	0.112	0.212

Post-match multivariate L1 distance: 0.315

	Post-match univariate imbalance		Sample mean	
	L1	Mean Difference	Control (EM = 0)	Treatment (EM = 1)
Muslim	0.000	0.000	0.981	0.981
Age	0.028	-0.081	16.481	16.400
Height (cm)	0.056	-0.074	145.764	145.691
Urban	0.000	0.000	0.432	0.432
Cook - firewood	0.000	0.000	0.452	0.452
Toliet river/land/sea	0.000	0.000	0.200	0.200

Table S7: Coarsened Exact Matching Summary - Alternative 2

	Control (Early marriage = 0)	Treatment (Early marriage = 1)
All	3892	160
Matched	359	113
Unmatched	3533	47

Pre-match multivariate L1 distance: 0.961

	Pre-match univariate imbalance		Sample mean	
	L1	Mean Difference	Control (EM = 0)	Treatment (EM = 1)
Muslim	0.067	0.067	0.902	0.969
Age	0.785	-8.710	25.123	16.413
Height (cm)	0.115	-4.406	149.411	145.005
Urban	0.172	-0.172	0.603	0.431
Schooling	0.287	0.287	0.170	0.456
Education senior	0.022	-0.022	0.460	0.438
Toliet river/land/sea	0.100	0.100	0.112	0.212
Acute morbidity	0.115	0.181	2.357	2.538

Post-match multivariate L1 distance: 0.853

	Post-match univariate imbalance		Sample mean	
	L1	Mean Difference	Control (EM = 0)	Treatment (EM = 1)
Muslim	0.000	0.000	0.991	0.991
Age	0.140	-0.039	16.437	16.398
Height (cm)	0.149	-0.106	151.105	150.999
Urban	0.000	0.000	0.469	0.469
Schooling	0.000	0.000	0.575	0.575
Education senior	0.000	0.000	0.496	0.496
Toliet river/land/sea	0.000	0.000	0.106	0.106
Acute morbidity	0.000	0.000	2.274	2.274

Table S8: Robustness check: Alternative matching

Panel A	CEM Model (Main)		CEM Model (Alternative 1)		CEM Model (Alternative 2)	
	CES-D Score	Depression	CES-D Score	Depression	CES-D Score	Depression
	(1)	(2)	(3)	(4)	(5)	(6)
Post treatment	0.018	-0.058	1.353	0.076	-1.465	-0.057
	(1.921)	(0.164)	(2.280)	(0.191)	(2.683)	(0.247)
EarlyMarriage*Post	2.197**	0.205***	2.678***	0.174**	3.565***	0.212*
	(0.916)	(0.067)	(0.982)	(0.080)	(1.291)	(0.127)
Married	-1.009	-0.047	0.175	0.037	-0.761	-0.099
	(0.628)	(0.052)	(0.685)	(0.065)	(0.987)	(0.086)
Other covariates	Yes		Yes		Yes	
Province FE	Yes		Yes		Yes	
Individual FE	Yes		Yes		Yes	
R-squared	0.228	0.135	0.216	0.132	0.263	0.154
Observations	2,422	2,422	2,124	2,124	944	944
No. of individuals	1,211	1,211	1,062	1,062	472	472

Panel B	Mahalanobis distance matching model		PSM matching model	
	CES-D Score	Depression	CES-D Score	Depression
	(7)	(8)	(9)	(10)
Post treatment	1.640	0.032	1.777	0.051
	(1.774)	(0.156)	(1.836)	(0.160)
EarlyMarriage*Post	2.292***	0.188***	2.343***	0.192***
	(0.796)	(0.071)	(0.819)	(0.072)
Married	-0.540	-0.016	-0.501	-0.020
	(0.607)	(0.054)	(0.622)	(0.055)
Other covariates	Yes		Yes	
Province FE	Yes		Yes	
Individual FE	Yes		Yes	
R-squared	0.236	0.157	0.239	0.164
Observations	3,324	3,324	3,324	3,324
No. of individuals	1,662	1,662	1,662	1,662

Notes: All regressions are based on the restricted sample of women who had an early marriage during the sample time frame. Early marriage is denoted as a binary variable which takes on a value of 1 if the woman is married by the age of 18 years and 0 otherwise. The variable of interest is EarlyMarriage*Post which equals to 1 if the woman had an early marriage in wave 5 (2014) and 0 otherwise. Difference-in-difference estimations in Columns 1 to 6 in Panel A are via panel fixed effects model with corresponding weights generated by CEM. Difference-in-difference estimations in Columns 7 and 8 (Panel B) are via panel fixed effects model with weights generated by MDM, while Columns 9 and 10 use PSM weights. Other covariates include woman's age, height, religion (Muslim), number of years married, urban/rural location, parents' years of schooling and regional poverty. Robust standard errors in parentheses, clustered at individual level. *** p<0.01, ** p<0.05, * p<0.1.

Table S9: Robustness check - Effect of age at marriage on mental health

	CRE		HT	
	CES-D Score	Depression	CES-D Score	Depression
	(1)	(2)	(3)	(4)
Age at marriage	-0.048***	-0.003***	-0.320	-0.025
	(0.013)	(0.001)	(0.382)	(0.028)
Other covariates	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Observations	9,119	9,119	9,119	9,119

Notes: All regressions are based on the sample of married women. Estimations in Columns 1 and 2 are via Correlated Random Effects (CRE) model, and Columns 3 and 4 are via Hausman-Taylor (HT) approach. Other covariates include woman's age, height, religion (Muslim), number of years married, urban/rural location, parents' years of schooling and regional poverty. Robust standard errors in parentheses, clustered at individual level. *** p<0.01, ** p<0.05, * p<0.1.

Table S10: Outcome variables for mechanisms - Variable description and summary statistics

Variable	Description	Mean	SD
Labour market outcomes			
Employed	=1 if working/helping to get an income	0.41	0.49
Seeking for a job	=1 if looking for a job or unemployed	0.03	0.17
Schooling	=1 if a student	0.07	0.26
Housekeeping	=1 if a house keeper	0.49	0.5
Educational outcomes			
Elementary	=1 if the individual has elementary education	0.25	0.43
Junior	=1 if the individual has junior education	0.24	0.43
Senior	=1 if the individual has senior education	0.35	0.48
Tertiary	=1 if the individual has tertiary education	0.15	0.36
Physical health outcomes			
Health status	=1 if the reported health status is 'healthy'	0.84	0.36
Bed ridden	=1 if confined to bed or home for one or more months	0.26	1.23
Acute morbidity	Number of acute morbidities experienced during the last 4 weeks	2.65	2.13
Days missed	Number of days missed during the last 4 weeks in primary activity due to poor health	1.77	3.65