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The role of child marriage and marital disruptions on hypertension in women - A nationally representative study from India

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ABSTRACT

Child marriage is associated with negative health trajectories among women in low- and middle-income countries (LMICs). Marital disruptions in LMICs are also associated with adverse socioeconomic and health outcomes in women. Yet, little is known about the compounded health effects of experiencing both child marriage and marital disruptions. Using nationally representative data from India among women aged 18–49 years, we examined the effects of marital age (i.e., marriage before or after 18 years) and martial disruptions (i.e., widowed/divorced/separated) on the odds of having hypertension. Findings suggest that together, marital disruptions and child marriage increase the risk of hypertension. Specifically, women married as children and who experienced marital disruptions were 1.2 (95% CI: 1.2–1.3) times more likely to have hypertension compared to women who married as adults and currently in marriage. Additionally, among women married as children, those who experienced martial disruptions had a higher risk (AOR = 1.1, 95% CI: 1.0–1.2) of hypertension compared to their currently married peers. These results suggest public health strategies must consider contextual effects of being widowed/divorced/separated among women who were married as children. Simultaneously, prevention initiatives should be strengthened to reduce the incidence of child marriage in LMICs and associated downstream health consequences.

1. Introduction

Marital status, including being single, married, separated, widowed, or divorced, is considered to play a key role promoting positive health trajectories. In general, being married may act as a protective factor against illness or mortality by conferring social and financial stability, which in turn can support positive health outcomes (Karimi et al., 2019; Kim & McKenry, 2002; Manzoli et al., 2007; Shor et al., 2012). However, *child* marriage, defined as marriage or union under 18 years of age, may act as a threat to a woman's health and wellbeing (Abera et al., 2020; Hampton, 2010; John et al., 2019; Le Strat et al., 2011; Vasilenko et al., 2016). Indeed, child marriage is stressful transition from adolescence to adulthood (Warner & Houle, 2018) and a violation of human rights. This harmful practice is prevalent in many lower- and middle-income countries (LMICs), where 36% of girls are married before reaching their 18th birthday (United Nations Population Fund (UNFPA), 2022). These child brides face significant threats to autonomy under a patriarchal society (Gupta, 1995; Jensen & Thornton, 2003; McCleary-Sills et al., 2015), are less likely to complete higher levels of education, and are less likely to engage in the workforce (Wodon et al., 2017). Women married as children are also likely to experience several negative outcomes including psychological distress, and interpersonal violence (Fan & Koski, 2022). Further, these women experience threats to reproductive health (Irani & Roudsari, 2019), with childbearing potentially occurring prior to physiological and mental maturity.

Burgeoning literature suggests consequences also extend to risk of developing chronic health outcomes later in life. For example, recent, but limited studies, have found increased risk of hypertension among women married as children in LMICs (Datta, Tiwari, & Glenn, 2022; Datta et al., 2021, 2022; Datta & Tiwari, 2022; Vikram, 2021). As such, it is critical to consider the primary prevention of child marriage to circumvent negative health outcomes in later life. However, it is of equal importance to consider the negative physical and psychological sequalae among the 650 million *existing* adult women who were previously

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married as children (United Nations Children's Fund, 2021). One consideration affecting the trajectory of developing such adverse outcomes among this group is change in marital status such as dissolution (i.e., disruptions) resulting from widowhood, divorce, and separation, which are linked to existing risky health behaviors like alcohol and substance use, as well as poor quality of life, and psychological distress (Ding et al., 2021; Gilmour et al., 1986.)

Although limited published evidence exists in the child marriage literature, martial disruptions, in general, are associated with loss of social support and various forms of social disadvantages that can lead to potential psychological distress and lack of health behavior regulation (Williams & Umberson, 2004). Further, individuals who are widowed, divorced or separated experience a higher risk of mortality compared to married individuals (Manzoli et al., 2007). Of importance, marital disruptions among women specifically from LMICs are linked to several stressors stemming from restrictions against remarriage and societal or cultural omission. Widowhood in LMICs such as India, is also associated with various forms of socioeconomic deprivations as well as poor health status (Lloyd-Sherlock et al., 2015) and risky health behaviors, such as tobacco use (Datta, Ravula, Pollard, & Shimul, 2022; Datta, Tiwari, & Fazlul, 2022).

Taken together, the cumulative challenges in the LMICs faced by child brides, in addition to the burden of marital disruptions, may result in increased risk of health challenges later in life compared to their peers. A conceptual framework describing the relationship between child marriage, marital disruptions, and hypertension is presented in Fig. 1. This model illustrates the complex literature showing impact of child marriage on hypertension through biological, psychosocial, and lifestyle factors, with the plausible role of marital disruptions affecting these pathways. Yet, the health effects of marital disruptions among child brides have received limited empirical attention to date. To improve our understanding in this area, we sought to explore the risk of hypertension among women married as children who experienced marital disruptions using nationally representative data from India, the second-most populous country of the world and home to the largest number of widowed women (The Loomba Foundation, 2016) as well as women married as children (United Nations Children's Fund, 2020).

2. Methods

2.1. Data

We used anonymized, publicly available secondary data from the 2019-21 wave of India National Family Health Survey (NFHS-5). The NFHS-5 is a nationally representative survey that covers all 28 states and 8 union territories of India and provides data on a wide range of health topics. The NFHS-5 survey protocol was reviewed and approved by the International Institute for Population Sciences (IIPS) Institutional Review Board and the ICF Institutional Review Board (International Institute for Population Sciences (IIPS) and ICF, 2021). Our sample consisted of 524,512 ever married women of reproductive age (18–49 years), of whom 319,959 were married in adulthood, and 204,553 were married as children. At the time of the survey, 495,029 women were currently in marriage and 29,483 were widowed/separated/divorced.

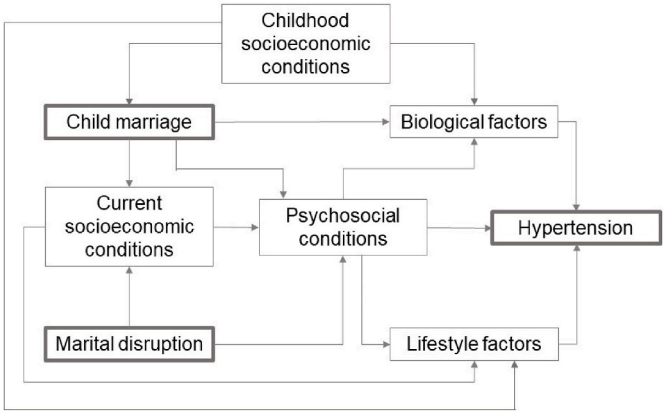

Fig. 1. Conceptual framework.

2.2. Measures

In the NFHS-5, respondents' blood pressure was measured using Omron Blood Pressure Monitor. Three readings were obtained during a single visit, with 5 min intervals between each reading. A respondent was determined to be hypertensive if the average systolic blood pressure (SBP) level was ≥140 mmHg, average diastolic blood pressure (DBP) level was ≥90 mmHg or if the respondent was taking antihypertensive medications to lower blood pressure (International Institute for Population Sciences (IIPS) and ICF, 2021).

The NFHS-5 reports on various information regarding respondents' marriage and sexual activity including age at first marriage. A respondent was classified as a child bride if they were ≤17 years at the time of marriage. Respondents' marital status was based on the responses to one question "What is your current marital status." Response options included "never in union", "married", "living with partner", "widowed, divorced, no longer living together/separated." Respondents' answers were categorized in four mutually exclusive groups based on marital age and marital status responses, excluding "never in union": i) married as adult and currently in marriage, ii) married as child and currently in marriage, iii) married as adult and currently widowed/divorced/separated, and iv) married as child and currently widowed/divorced/separated.

2.3. Statistical analyses

To assess the risk of hypertension in relation to child marriage and marital disruption, we first examined how the prevalence of hypertension varied across these mutually exclusive groups. We estimated a logistic regression as follows:

$$logit\ (HTN_i) = \alpha_0 + \alpha_1 CM^1 DM_i^0 + \alpha_2 CM^0 DM_i^1 + \alpha_3 CM^1 DM_i^1 \quad (1)$$

Where, HTN_i was a binary variable indicating whether respondent i was hypertensive or not. Variables $CM^j DM^k$ were binary variables denoting respective mutually exclusive child marriage and marital disruption categories. Superscripts j and k in $CM^j DM_i^k$ referred to age (i.e., <18 years or ≥ 18 years) at marriage and disrupted marital status (i.e., in-marriage or widowed/divorced/separated), respectively. CM^0 referred to married as adult and CM^1 referred to married as child; DM^0 referred to no marital disruption; and DM^1 referred to marital disruption. The variable $CM^0 DM_i^0$, denoting respondent i being married as adult and currently in marriage, served as the reference category.

Next to obtain adjusted odds in favor of being hypertensive, we estimated a multivariable logistic regression as follows:

$$logit\ (HTN_i) = \beta_0 + \beta_1 CM^1 DM_i^0 + \beta_2 CM^0 DM_i^1 + \beta_3 CM^1 DM_i^1 + \boldsymbol{X_i \beta_4} + State \quad (2)$$

Where **X** was the vector of sociodemographic and anthropometric correlates including age, educational attainment, marital status, number of unions, household wealth index quintiles, religion, caste, body mass index (BMI) categories, tobacco use, alcohol use, time since last birth, and parity (i.e., number of children born). These covariates are common in literature on population level prevalence of hypertension in India (Abariga et al., 2020; Anchala et al., 2014; Ghosh & Kumar, 2019). Additionally, we estimated another multivariable model, controlling for age at first birth, which is strongly associated with child marriage (Fan & Koski, 2022) and is a predictor of hypertension in women (Datta et al., 2021). We, however, did not intend to assess the relationship between

hypertension and these correlates in our analysis. Rather, these correlates were included in the model to examine whether the relationship between child marriage and hypertension persisted after controlling for these sociodemographic and anthropometric characteristics.

Of note, due to the cross-sectional nature of data, we could not measure childhood socioeconomic conditions of the respondents as presented in our conceptual framework in Fig. 1. Instead, we proxied childhood socioeconomic conditions using current socioeconomic conditions such as education, household wealth, urban/rural residence, etc. We also controlled for anthropometric attributes such as body mass index categories and lifestyle factors such as tobacco and alcohol use, which are linked to childhood socioeconomic conditions. As such, our empirical analyses imply a conservative estimate of the relationship between child marriage, marital disruption, and hypertension in women.

We also controlled for state fixed effects in the multivariable model to account for state level variations in health care policies. All models were estimated using complex survey weights entailing the two-stage stratified sampling framework of the NFHS-5. Analyses were conducted for the full sample, as well as by younger age (18–34 years), older age (35–49 years), urban, and rural sub-samples.

To check the robustness of our analyses, we separately estimated equation (2) for the household wealth index quintiles and performed Chow tests to examine whether the relationship varied across household wealth. Lastly, to offer a nuanced understanding of the relationship, we explored the independent roles of marital disruption on the risk of hypertension among child brides, and the role of child marriage on the risk of hypertension among widowed/divorced/separated women. For this analysis, we estimated the following multivariable logistic models:

$$logit\ (HTN_i) = \gamma_0 + \gamma_1 DM_i + \boldsymbol{X_i \gamma_3} + State \quad (3)$$

$$logit\ (HTN_i) = \theta_0 + \theta_1 CM_i + \boldsymbol{X_i \theta_3} + State \quad (4)$$

DM_i in equation (3) was a binary variable that took the value 1 if individual i was widowed/divorced/separated at the time of the survey, and 0 otherwise. CM_i in equation (4) was a binary variable that took the value 1 if individual i was married before age 18 years, and 0 otherwise. Equation (3) was estimated for the sub-group of women who were widowed/divorced/separated at the time of the survey. Equation (4) was estimated for the sub-group of women who were married as children. Level of significance was set at 5% level (i.e., $\alpha = 0.05$) for all analyses.

3. Results

3.1. Descriptive results

The study sample demographic characteristics are presented in Table 1. Approximately 42% of the women in our sample were married as children. A significantly higher proportion of child brides had lower educational attainment and came from poorer households ($p < 0.001$). The proportions of child brides and women married as adults who were widowed/divorced/separated women were 7% and 5%, respectively ($p < 0.001$).

The distribution of women by age and socioeconomic groups across the four mutually exclusive child marriage and marital disruption groups are presented in Fig. 2. Marital disruptions were more prevalent among older women compared to younger women (i.e., aged 18–34 years) (3% vs. 9%, $p < 0.001$). Prevalence of child marriage was also higher among the older age group (38% vs. 46%, $p < 0.001$). As such, the proportion of women married as children and widowed/divorced/separated was significantly lower among the younger age group than the older age group (1% vs 5%, $p < 0.001$). However, the proportion of women married as children was comparable (≈3%) across urban and rural areas. The distribution was relatively lower in the top wealth index quintile, which is attributable to the lower prevalence of child marriage

Table 1
Descriptive statistics.

	All	In marriage		Widowed/divorced/ Separated (WDS)	
		Married as adult	Married as child	Married as adult	Married as child
Outcome variable					
Hypertension	17.17	15.53	18.51	22.24	26.1
	(37.71)	(37.02)	(37.55)	(43.21)	(42.43)
Explanatory variables					
Married as adult – in marriage	55.51 (49.7)	100.00 –	0 –	0 –	0 –
Married as child – in marriage	38.91 (48.75)	0 –	100.00 –	0 –	0 –
Married as adult – WDS	2.76 (16.38)	0 –	0 –	100.00 –	0 –
Married as child – WDS	2.82 (16.55)	0 –	0 –	0 –	100.00 –
Categorical covariates					
Education					
No education	28.47	19.68	39.01	33.04	51.65
	(45.13)	(40.65)	(47.16)	(48.87)	(48.28)
Primary	14.22	10.88	18.45	15.86	19.87
	(34.92)	(31.83)	(37.51)	(37.96)	(38.55)
Secondary	45.13	49.65	40.32	40.51	26.93
	(49.76)	(51.12)	(47.43)	(51.01)	(42.86)
Higher	12.19	19.8	2.22	10.6	1.55
	(32.72)	(40.74)	(14.25)	(31.98)	(11.92)
Wealth Index Quintiles					
1st (Poorest)	19.05	14.68	24.96	18.77	23.7
	(39.27)	(36.18)	(41.84)	(40.57)	(41.08)
2nd (Poorer)	20.31	17.24	24.39	20.87	23.82
	(40.23)	(38.62)	(41.52)	(42.23)	(41.16)
3rd (Middle)	20.82	19.78	21.89	22.37	24.91
	(40.6)	(40.73)	(39.98)	(43.3)	(41.78)
4th (Richer)	20.8	22.88	17.93	21.33	18.86
	(40.59)	(42.95)	(37.09)	(42.56)	(37.79)
5th (Richest)	19.03	25.42	10.84	16.67	8.71
	(39.25)	(44.51)	(30.05)	(38.72)	(27.24)
Religion					
Hindu	82.26	81.71	83.03	81.5	83.39
	(38.2)	(39.53)	(36.3)	(40.35)	(35.96)
Muslim	12.82	12.33	13.8	10.79	10.93
	(33.43)	(33.61)	(33.35)	(32.23)	(30.14)
Christian	2.27	2.73	1.46	3.97	2.93
	(14.91)	(16.65)	(11.61)	(20.29)	(16.29)
Other	2.64	3.24	1.71	3.74	2.76
	(16.04)	(18.1)	(12.52)	(19.73)	(15.81)
Caste					
None	25.68	27.44	23.52	24.92	21.51
	(43.69)	(45.62)	(41.01)	(44.94)	(39.7)
Scheduled caste	21.9 (41.35)	20.05 (40.94)	24.09 (41.35)	22.82 (43.61)	26.97 (42.88)
Scheduled tribe	9.39	8.8	9.97	11.26	11.29
	(29.17)	(28.96)	(28.97)	(32.85)	(30.57)
Other backward class	43.03 (49.51)	43.7 (50.71)	42.42 (47.78)	41 (51.11)	40.23 (47.37)
BMI					
Normal (18.5–24.9)	57.84 (49.38)	57.44 (50.55)	58.51 (47.64)	57.78 (51.32)	56.43 (47.9)
Underweight (<18.5)	13.41 (34.07)	12.73 (34.08)	14.43 (33.97)	12.51 (34.37)	13.51 (33.03)
Overweight (25.0–29.9)	21.07 (40.78)	21.87 (42.26)	19.95 (38.64)	20.6 (42.02)	21.26 (39.53)
Obese (≥30.0)	7.68 (26.63)	7.96 (27.67)	7.11 (24.85)	9.11 (29.9)	8.79 (27.36)
Age at first birth					
Didn't give birth	8.85 (28.41)	12.13 (33.38)	3.85 (18.60)	15.43 (37.54)	7.01 (24.67)
≤ 15	5.47 (22.73)	0.19 (4.50)	12.41 (31.88)	0.55 (7.67)	18.23 (37.30)
16–17	12.38 (32.94)	0.43 (6.71)	29.02 (43.88)	0.83 (9.44)	29.45 (44.04)
18–19	21.29 (40.94)	10.11 (30.82)	37.35 (46.77)	10.69 (32.11)	30.04 (44.29)
20–24	39.36 (48.85)	56.58 (50.67)	15.61 (35.09)	54.16 (51.77)	13.38 (32.89)

(continued on next page)

Table 1 (*continued*)

	All	In marriage		Widowed/divorced/ Separated (WDS)	
		Married as adult	Married as child	Married as adult	Married as child
25+	12.65	20.55	1.76	18.33	1.9
	(33.24)	(41.31)	(12.70)	(40.21)	(13.17)
Time since last birth					
Didn't give birth	6.87	9.09	3.1	15.32	6.99
	(25.30)	(29.39)	(16.77)	(37.42)	(24.64)
Currently pregnant	1.98	3.04	0.74	0.12	0.02
	(13.93)	(17.55)	(8.30)	(3.52)	(1.39)
< 6 months	3.84	4.94	2.78	0.44	0.2
	(19.22)	(22.16)	(15.90)	(6.89)	(4.37)
6–12 months	4.74	5.98	3.57	0.6	0.32
	(21.24)	(24.25)	(17.94)	(7.99)	(5.42)
2–3 years	13.73	16.54	11.34	3.23	1.54
	(34.41)	(37.99)	(30.66)	(18.37)	(11.88)
4–5 years	9.69	10.95	8.77	4.5	2.57
	(29.58)	(31.92)	(27.35)	(21.53)	(15.28)
6–10 years	19.24	19.23	20.18	15.27	10.22
	(39.42)	(40.30)	(38.81)	(37.37)	(29.27)
> 10 years	39.91	30.22	49.5	60.54	78.14
	(48.97)	(46.95)	(48.34)	(50.79)	(39.93)
Binary covariates					
Multiple union	1.64	1.43	1.79	2.35	3.06
	(12.71)	(12.15)	(12.82)	(15.73)	(16.58)
Tobacco use	5.21	3.84	6.49	8.44	11.12
	(22.21)	(19.66)	(23.82)	(28.89)	(30.37)
Alcohol use	0.88	0.71	0.97	1.73	2.17
	(9.33)	(8.57)	(9.46)	(13.55)	(14.09)
Continuous covariates					
Age	33.93	33.21	34.14	39.48	39.74
	(8.47)	(8.46)	(8.28)	(7.77)	(7.12)
Parity	2.31	1.97	2.8	1.93	2.66
	(1.48)	(1.37)	(1.47)	(1.46)	(1.57)
Sample size	524,512	304,295	190,734	15,664	13,819

Note: Estimates were obtained using complex survey weights. Standard deviations are in parenthesis.

(55% in bottom quintile vs. 23% in top quintile, $p < 0.001$) and marital disruption (6% in bottom quintile vs. 4% in top quintile, $p < 0.001$) among women in wealthier households.

Prevalence of hypertension in our study sample was 17.2%. With respect to marital age, hypertension prevalence was 15.8% among women who were married as adults, and 3.2 %-points higher (95% CI: 2.84–3.50) among women who were married as children. With respect to marital status, hypertension prevalence was significantly higher among women who were widowed/divorced/separated compared to married women (16.8% vs. 24.2%, $p < 0.001$). Among the four mutually exclusive groups, prevalence of hypertension was the lowest for "women married as adults and currently in marriage" (15.5%) and was the highest for "women married as children and currently widowed/divorced/separated" (26.1%). A higher prevalence of hypertension among child brides was evident in both married and widowed/divorced/separated groups.

Figs. 3 and 4 illustrate the hypertension prevalence across the four mutually exclusive child marriage and marital disruption categories by sociodemographic and socioeconomic groups. Compared to "women married as adults and currently in marriage", "women married as children and currently widowed/divorced/separated" had a higher ($p < 0.05$) hypertension prevalence in all groups including single or multiple union, educational attainment, household wealth, religion, and caste. Except for the 18 to 34 age group, this pattern was similar among women aged 35–49 years, and in both urban and rural areas.

3.2. Regression results

Table 2 presents the crude odds ratios in favor of having hypertension. The likelihood of being hypertensive increased with age and decreased with higher educational attainment. Overweight and obese women had significantly higher likelihood of hypertension compared to women with normal BMI values. The odds of having hypertension increased with number of births and were higher among tobacco and alcohol users. These estimates are consistent with the extant literature on hypertension in India (Abariga et al., 2020; Anchala et al., 2014; Ghosh & Kumar, 2019).

Compared to "women married as adults and currently in marriage",

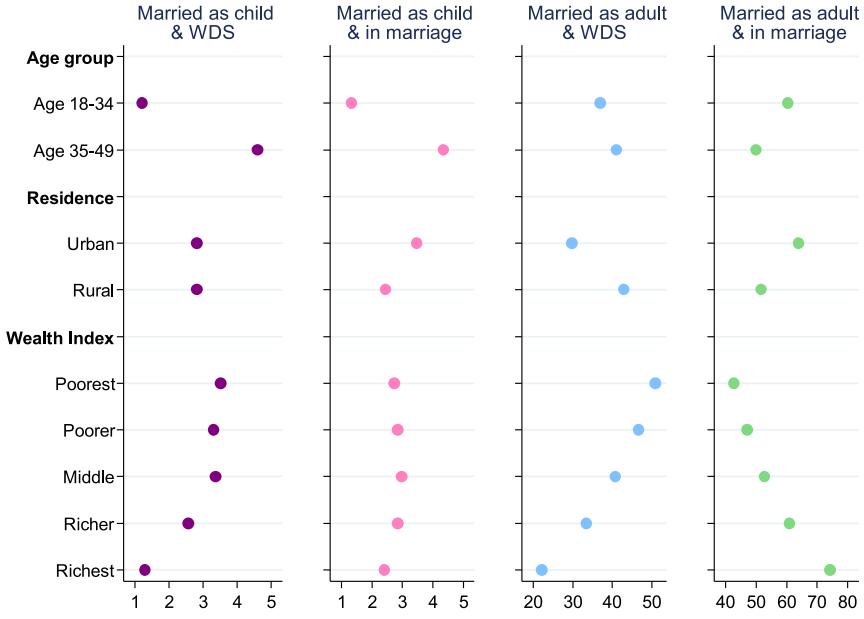

Fig. 2. Distribution of women by child marriage and widowed/divorced/separated groups across age group, residence, and wealth index quintiles
Note: Estimates were obtained using complex survey weights.

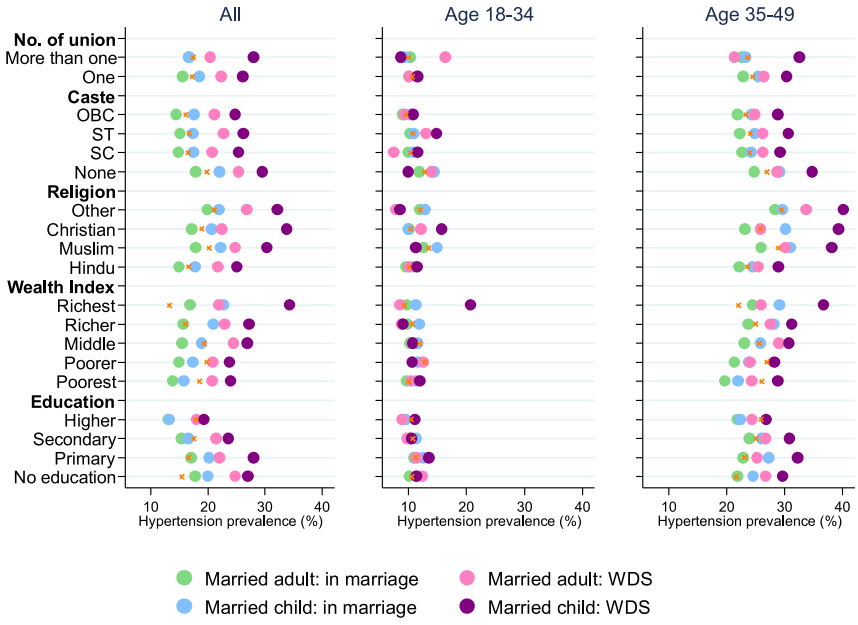

Fig. 3. Hypertension prevalence across socioeconomic groups by marital age and marital status groups – by younger (18–34) and older (35–49) age groups
Note: Estimates were obtained using complex survey weights. The orange-colored cross shows the average prevalence of the respective socioeconomic groups. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

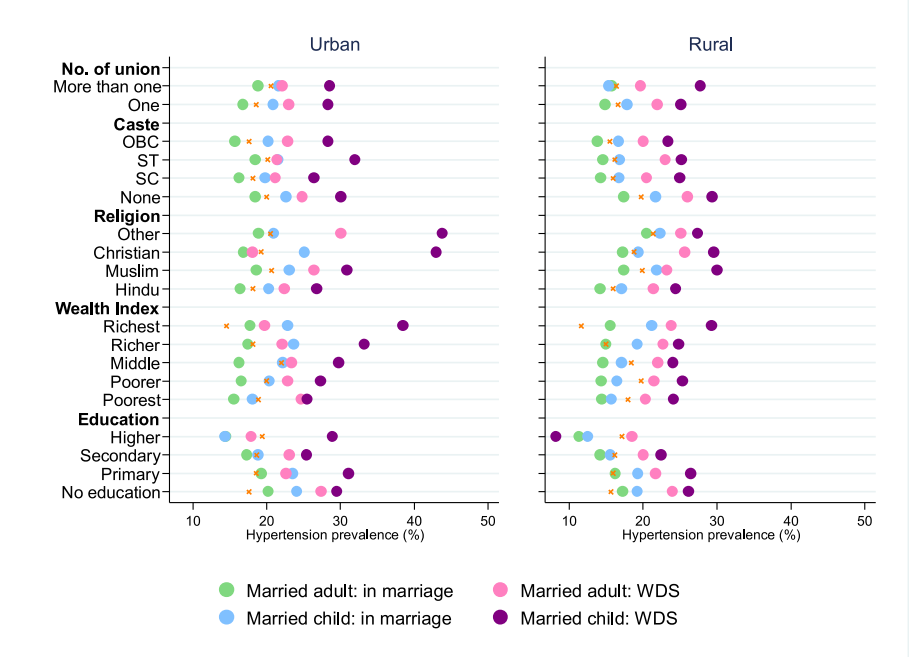

Fig. 4. Hypertension prevalence across socioeconomic groups by marital age and marital status groups – by urban and rural areas
Note: Estimates were obtained using complex survey weights. The orange-colored cross shows the average prevalence of the respective socioeconomic groups. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

women across the other three groups had significantly higher odds the odds of hypertension ($p < 0.001$). Specifically, the odds were: 1.2 (95% CI: 1.2–1.3) times higher for women "married as children and in marriage", 1.6 (95% CI: 1.5–1.7) times higher for women "married as adults and widowed/divorced/separated", and 1.9 (95% CI: 1.8–2.0) times higher for "married as children and widowed/divorced/separated". These trends persisted across urban and rural sub-groups, as well as among women aged 35–49 years. The higher odds of hypertension among women who were widowed/divorced/separated, however, were not statistically significant for women aged 18–34 years of age.

The adjusted odds in favor of having hypertension for the four mutually groups are shown in Table 3. After controlling for various sociodemographic and anthropometric correlates along with state fixed effects, women "married as children and in marriage" and "married as children and widowed/divorced/separated" were 1.1 (95% CI: 1.2–1.8) and 1.3 (95% CI: 1.2–1.3) times, respectively, more likely to have

Table 2
Crude odds ratios in favor of being hypertensive.

	All	Age 18-34	Age 35-49	Urban	Rural
Child marriage & WDS					
Married as adult – in marriage	Ref.	Ref.	Ref.	Ref.	Ref.
Married as child – in marriage	1.235*** (1.207, 1.265)	1.163*** (1.118, 1.211)	1.153*** (1.121, 1.187)	1.305*** (1.245, 1.367)	1.243*** (1.210, 1.276)
Married as adult – WDS	1.558*** (1.470, 1.650)	1.030 (0.887, 1.195)	1.204*** (1.130, 1.282)	1.475*** (1.325, 1.643)	1.604*** (1.504, 1.710)
Married as child – WDS	1.924*** (1.820, 2.035)	1.155 (0.998, 1.337)	1.473*** (1.386, 1.565)	1.959*** (1.745, 2.199)	1.930*** (1.815, 2.052)
Age	1.071*** (1.069, 1.073)	1.061*** (1.056, 1.066)	1.070*** (1.067, 1.074)	1.080*** (1.076, 1.083)	1.067*** (1.065, 1.069)
No. of union					
1	Ref.	Ref.	Ref.	Ref.	Ref.
≥2	0.937 (0.867, 1.014)	0.896 (0.785, 1.024)	0.957 (0.869, 1.054)	1.078 (0.904, 1.285)	0.896* (0.824, 0.975)
Education					
No education	Ref.	Ref.	Ref.	Ref.	Ref.
Primary	0.973 (0.942, 1.006)	1.095** (1.028, 1.167)	1.093*** (1.052, 1.135)	0.936 (0.867, 1.010)	0.963* (0.929, 0.999)
Secondary	0.780*** (0.760, 0.801)	0.967 (0.919, 1.018)	1.052** (1.020, 1.085)	0.734*** (0.693, 0.778)	0.754*** (0.732, 0.776)
Higher	0.622*** (0.594, 0.651)	0.826*** (0.771, 0.885)	0.894*** (0.839, 0.951)	0.565*** (0.525, 0.608)	0.561*** (0.527, 0.597)
Wealth index quintiles					
1st (Poorest)	Ref.	Ref.	Ref.	Ref.	Ref.
2nd (Poorer)	1.094*** (1.051, 1.138)	0.984 (0.922, 1.051)	1.040 (0.992, 1.090)	1.07 (0.996, 1.149)	1.018 (0.978, 1.059)
3rd (Middle)	1.170*** (1.122, 1.221)	0.950 (0.890, 1.014)	1.099*** (1.048, 1.153)	1.078 (0.999, 1.163)	1.036 (0.995, 1.078)
4th (Richer)	1.202*** (1.150, 1.256)	1.028 (0.962, 1.099)	1.186*** (1.127, 1.248)	1.127** (1.041, 1.221)	1.115*** (1.068, 1.164)
5th (Richest)	1.251*** (1.195, 1.310)	1.016 (0.940, 1.099)	1.302*** (1.238, 1.370)	1.092* (1.008, 1.183)	1.178*** (1.123, 1.235)
Religion					
Hindu	Ref.	Ref.	Ref.	Ref.	Ref.
Muslim	1.274*** (1.210, 1.340)	1.390*** (1.283, 1.505)	1.311*** (1.248, 1.376)	1.179*** (1.094, 1.271)	1.309*** (1.221, 1.403)
Christian	1.173*** (1.101, 1.249)	1.021 (0.911, 1.145)	1.128** (1.046, 1.217)	1.077 (0.954, 1.215)	1.215*** (1.130, 1.307)
Other	1.346*** (1.268, 1.428)	1.214*** (1.099, 1.341)	1.351*** (1.260, 1.449)	1.166* (1.020, 1.332)	1.433*** (1.346, 1.526)
Caste					
None	Ref.	Ref.	Ref.	Ref.	Ref.
Scheduled caste	0.802*** (0.770, 0.835)	0.788*** (0.736, 0.843)	0.856*** (0.820, 0.893)	0.886*** (0.825, 0.951)	0.773*** (0.735, 0.813)
Scheduled tribe	0.811*** (0.773, 0.850)	0.819*** (0.758, 0.885)	0.862*** (0.819, 0.907)	1.009 (0.895, 1.138)	0.786*** (0.743, 0.831)
Other backward class	0.778*** (0.751, 0.806)	0.722*** (0.679, 0.768)	0.826*** (0.796, 0.858)	0.853*** (0.805, 0.904)	0.746*** (0.713, 0.782)
BMI					
Normal	Ref.	Ref.	Ref.	Ref.	Ref.
Underweight (BMI <18.5)	0.702*** (0.676, 0.728)	0.812*** (0.770, 0.857)	0.723*** (0.688, 0.760)	0.637*** (0.574, 0.707)	0.712*** (0.685, 0.741)
Overweight (BMI 25.0–29.9)	1.816*** (1.765, 1.868)	1.544*** (1.470, 1.622)	1.696*** (1.641, 1.752)	1.818*** (1.722, 1.918)	1.828*** (1.770, 1.889)
Obese (BMI ≥30.0)	2.807*** (2.701, 2.918)	2.207*** (2.054, 2.371)	2.549*** (2.439, 2.664)	2.952*** (2.767, 3.150)	2.710*** (2.585, 2.842)
Age at first birth					
Didn't give birth	Ref.	Ref.	Ref.	Ref.	Ref.
≤15	2.217*** (2.093, 2.348)	1.717*** (1.563, 1.885)	1.054 (0.962, 1.154)	2.380*** (2.108, 2.687)	2.187*** (2.051, 2.332)
16–17	1.749*** (1.664, 1.838)	1.282*** (1.195, 1.376)	0.923 (0.846, 1.006)	1.840*** (1.657, 2.042)	1.738*** (1.645, 1.837)
18–19	1.500*** (1.432, 1.571)	1.121*** (1.053, 1.193)	0.843*** (0.776, 0.917)	1.583*** (1.442, 1.739)	1.482*** (1.407, 1.562)
20–24	1.393*** (1.334, 1.455)	1.070* (1.013, 1.131)	0.762*** (0.703, 0.826)	1.409*** (1.294, 1.535)	1.385*** (1.318, 1.455)
25+	1.564*** (1.487, 1.645)	1.168*** (1.084, 1.259)	0.720*** (0.661, 0.785)	1.512*** (1.378, 1.658)	1.563*** (1.475, 1.657)
Time since last birth					
Didn't give birth	Ref.	Ref.	Ref.	Ref.	Ref.
Currently pregnant	0.494*** (0.443, 0.551)	0.676*** (0.602, 0.758)	0.400* (0.192, 0.833)	0.422*** (0.334, 0.532)	0.531*** (0.469, 0.601)
<6 months	0.699*** (0.647, 0.754)	0.915* (0.841, 0.996)	0.617*** (0.490, 0.777)	0.625*** (0.523, 0.746)	0.736*** (0.677, 0.800)
6–12 months	0.618*** (0.573, 0.665)	0.825*** (0.759, 0.896)	0.413*** (0.332, 0.514)	0.524*** (0.446, 0.615)	0.662*** (0.609, 0.720)
2–3 years	0.650*** (0.615, 0.686)	0.837*** (0.784, 0.895)	0.483*** (0.424, 0.549)	0.639*** (0.571, 0.715)	0.660*** (0.621, 0.702)
4–5 years	0.796*** (0.751, 0.845)	1.005 (0.937, 1.077)	0.471*** (0.421, 0.527)	0.724*** (0.646, 0.812)	0.835*** (0.780, 0.894)
6–10 years	1.108*** (1.053, 1.167)	1.256*** (1.178, 1.339)	0.578*** (0.530, 0.631)	1.060 (0.959, 1.171)	1.135*** (1.071, 1.204)
>10 years	2.118*** (2.021, 2.220)	1.690*** (1.561, 1.830)	0.885** (0.817, 0.959)	2.094*** (1.918, 2.286)	2.130*** (2.017, 2.249)
Parity	1.116*** (1.108, 1.124)	1.053*** (1.038, 1.069)	0.972*** (0.963, 0.981)	1.163*** (1.145, 1.182)	1.110*** (1.101, 1.119)
Tobacco use	1.250*** (1.197, 1.305)	1.200*** (1.101, 1.307)	1.009 (0.961, 1.059)	1.319*** (1.185, 1.469)	1.261*** (1.203, 1.323)
Alcohol use	1.554*** (1.441, 1.676)	1.549*** (1.345, 1.783)	1.277*** (1.173, 1.391)	1.508** (1.175, 1.935)	1.610*** (1.489, 1.741)
Observations	524,512	272,518	251,994	124,009	400,503

Note: Estimates were obtained using complex survey weights. 95% confidence intervals are in parenthesis. ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

hypertension compared to women "married as adults and in marriage". Except for the age 18–34 years sub-group, these results were similar across age 35–49 years, and urban and rural sub-groups. The odds were similar but slightly smaller when age at first birth was accounted for. The odds for women "married as adults and widowed/divorced/separated", however, were not statistically different from that of women "married as adults and in marriage" in the full sample and in urban and rural sub-groups, and 17% lower in the age 18–34 years sub-group.

Table 4 presents the adjusted odds ratios by household wealth index quintile sub-groups. The higher adjusted odds in favor of having

Table 3
Adjusted odds ratios in favor of being hypertensive.

	All	Age 18-34	Age 35-49	Urban	Rural
Panel A.					
Married as adult – in marriage	Ref.	Ref.	Ref.	Ref.	Ref.
Married as child – in marriage	1.146*** (1.118, 1.176)	1.072** (1.025, 1.122)	1.165*** (1.129, 1.201)	1.151*** (1.094, 1.211)	1.136*** (1.103, 1.169)
Married as adult – WDS	1.028 (0.967, 1.092)	0.829* (0.713, 0.964)	1.072* (1.004, 1.146)	0.971 (0.866, 1.088)	1.060 (0.990, 1.134)
Married as child – WDS	1.247*** (1.176, 1.322)	0.896 (0.766, 1.049)	1.323*** (1.241, 1.410)	1.250*** (1.107, 1.411)	1.237*** (1.160, 1.319)
Observations	523,232	271,929	251,303	123,727	399,505
Panel B.					
Married as adult – in marriage	Ref.	Ref.	Ref.	Ref.	Ref.
Married as child – in marriage	1.066*** (1.032, 1.100)	1.038 (0.982, 1.097)	1.075*** (1.034, 1.118)	1.063 (0.990, 1.141)	1.062*** (1.026, 1.101)
Married as adult – WDS	1.021 (0.961, 1.085)	0.824* (0.708, 0.958)	1.066 (0.998, 1.139)	0.965 (0.861, 1.082)	1.053 (0.984, 1.127)
Married as child – WDS	1.143*** (1.075, 1.216)	0.859 (0.733, 1.008)	1.209*** (1.129, 1.294)	1.136 (0.997, 1.295)	1.142*** (1.067, 1.222)
Observations	523,232	271,929	251,303	123,727	399,505

Notes: Estimates were obtained using complex survey weights. 95% confidence intervals are in parenthesis. ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$. All models in Panel A account for the following correlates: age, educational attainment, wealth index quintiles, religion, caste, BMI group, parity (i.e., number of children born), time since last birth, indicator for more than one union, tobacco use, alcohol use, and state fixed effects. Models in Panel B account for age at first birth in addition to other covariates listed above.

Table 4
Adjusted odds ratios in favor of being hypertensive by wealth index quintiles.

	Wealth Index Quintiles				
	Poorest	Poorer	Middle	Richer	Richest
Panel A.					
Married as adult – in marriage	Ref.	Ref.	Ref.	Ref.	Ref.
Married as child – in marriage	1.123*** (1.064, 1.186)	1.089** (1.033, 1.148)	1.147*** (1.088, 1.209)	1.210*** (1.144, 1.279)	1.103** (1.034, 1.176)
Married as adult – WDS	1.037 (0.912, 1.180)	1.007 (0.888, 1.143)	1.155* (1.019, 1.309)	1.017 (0.888, 1.165)	0.884 (0.762, 1.026)
Married as child – WDS	1.268*** (1.132, 1.419)	1.162* (1.036, 1.304)	1.255*** (1.108, 1.422)	1.197* (1.042, 1.374)	1.432*** (1.174, 1.748)
Observations	111,576	116,602	109,740	100,003	85,311
Panel B.					
Married as adult – in marriage	Ref.	Ref.	Ref.	Ref.	Ref.
Married as child – in marriage	1.043 (0.976, 1.114)	1.017 (0.953, 1.085)	1.046 (0.977, 1.119)	1.163*** (1.081, 1.251)	1.047 (0.959, 1.143)
Married as adult – WDS	1.030 (0.905, 1.172)	1.004 (0.885, 1.139)	1.148* (1.012, 1.302)	1.011 (0.882, 1.158)	0.881 (0.759, 1.022)
Married as child – WDS	1.162* (1.031, 1.309)	1.072 (0.949, 1.211)	1.131 (0.990, 1.292)	1.135 (0.979, 1.316)	1.345** (1.093, 1.654)
Observations	111,576	116,602	109,740	100,003	85,311

Notes: Estimates were obtained using complex survey weights. 95% confidence intervals are in parenthesis. ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$. All models in Panel A account for the following correlates: age, educational attainment, wealth index quintiles, religion, caste, BMI group, parity (i.e., number of children born), time since last birth, indicator for more than one union, tobacco use, alcohol use, and state fixed effects. Models in Panel B account for age at first birth in addition to other covariates listed above.

hypertension for the "married as children and in marriage" were evident across all wealth index quintiles. Chow test results suggest that the estimated odds in favor of having hypertension for respective child marriage and marital disruption categories were similar across the wealth index quintiles. The relationship between hypertension and "child marriage and marital disruption" thus, was robust across various levels of household wealth. The estimates, however, were not statistically significant for the three middle wealth index categories (i.e., poorer, middle, and richer) when we accounted for age at first birth.

Lastly, the results showing role of marital disruption on hypertension among child brides, and the role of child marriage on hypertension among widowed/divorced/separated women are shown in Table 5. Child brides who were widowed/divorced/separated were 1.1 (95% CI: 1.0–1.2) times more likely to have hypertension compared to child brides who were in marriage. The odds, however, were not statistically significant in the younger age (i.e., 18–34 years) and urban sub-groups. Among widowed/divorced/separated women, the subgroup married as children were 1.2 (95% CI: 1.2–1.3) times more likely to have hypertension compared to those who were married as adults. Except for the age 18–34 years sub-group, these results were persistent across all sub-groups.

4. Discussion

There has been a dearth of evidence on the health outcomes related to marital disruptions among child brides. Studies on marital disruptions have mostly examined mortality risks in older populations (Shor et al., 2012). Studies on the health consequences of child marriage have mostly focused on maternal and reproductive health outcomes in young mothers (Fan & Koski, 2022). The current study provides novel insight on the intersection of child marriage, marital disruptions and a chronic cardiovascular health outcome, hypertension, among women of reproductive age in India. Our results showing that child marriage is a risk factor for hypertension among these women who were in marriage, are consistent with the findings in extant literature (Datta, Tiwari, & Glenn, 2022; Datta & Tiwari, 2022; Datta, Tiwari, & Glenn, 2022). However, this study further establishes the association between marital disruptions among women married as children with increased risk of hypertension in adulthood. These results underscore the need to address existing, and potentially long-term health disparities in this population.

Given the negative health, social, and behavioral outcomes associated with child marriage, it would be plausible to first consider that the marital disruptions would, in fact, decrease associated stress among this group of women. However, findings of heightened risk of chronic health outcomes following marital disruptions among these women underscores the complexity of this association and the need for further exploration. Several mechanisms may explain this increased risk as depicted by the various socioeconomic, psychosocial and lifestyle factors in our presented conceptual framework. For example the transition to widowhood in India is associated with a change in social status in society and potential residential isolation within community living (Mohindra et al., 2012). While this new shift may exacerbate mental

Table 5
Odds ratios in favor being hypertensive for marital disruption among child brides and for child marriage among widowed/divorced/separated women.

	All	Age 18-34	Age 35-49	Urban	Rural
A. Married as children					
Widowed/ divorced/ separated	1.093** (1.031, 1.159)	0.858 (0.733, 1.003)	1.134*** (1.065, 1.209)	1.076 (0.951, 1.217)	1.095** (1.027, 1.168)
Observations	204,049	97,950	106,099	38,122	165,923
B. Married as children					
Widowed/ divorced/ separated	1.081** (1.019, 1.146)	0.850* (0.726, 0.994)	1.124*** (1.055, 1.198)	1.063 (0.940, 1.203)	1.084* (1.017, 1.156)
Observations	204,049	97,950	106,099	38,122	165,923
C. Widowed/divorced/separated					
Child marriage	1.221*** (1.118, 1.334)	1.082 (0.827, 1.416)	1.239*** (1.129, 1.359)	1.295** (1.080, 1.553)	1.178*** (1.071, 1.296)
Observations	29,364	7205	22,155	7849	21,514
D. Widowed/divorced/separated					
Child marriage	1.115 (0.994, 1.250)	1.093 (0.800, 1.494)	1.120 (0.993, 1.263)	1.160 (0.912, 1.475)	1.085 (0.959, 1.227)
Observations	29,364	7205	22,155	7849	21,514

Note: Estimates were obtained using complex survey weights. 95% confidence intervals are in parenthesis. ***p < 0.001, **p < 0.01, *p < 0.05. All models in Panel A and C account for the following correlates: age, educational attainment, wealth index quintile, religion, caste, BMI group, parity (i.e., number of children born), time since last birth, indicator for more than one union, tobacco use, alcohol use, and state fixed effects. Models in Panel B and D account for age at first birth in addition to other covariates listed above.

health symptomology and stress among women in general, child brides may be particularly impacted as a product of inherent contextual factors affecting many of these females. For example, child brides are likely to have with limited to no work experience compared to their adult peers (Wodon et al., 2017). Additionally, child brides are likely to receive limited parental support as they mostly belong to the poor socio-economic strata in India (Paul, 2020). Coupled with the loss of their primary financial support established during marriage, these social disadvantages may heighten risk of physiological stress and marital satisfaction, one of the crucial determinants in measuring risk of cardiovascular disease (Dhindsa et al., 2020; Kiecolt-Glaser & Newton, 2001; Wang et al., 2005). Absence of spousal support may additionally influence development of chronic health disease via engagement in health-compromising behaviors such as smoking (Datta, Ravula, Pollard, & Shimul, 2022), increased drinking and poor diet (Lee et al., 2005). However, these mechanisms remains to be explored among women married as children.

While beyond the scope of exploration in this paper, one other potential mechanism driving hypertension risk may be related to interactions between marital disruptions and unique adolescent childbearing (i.e., biological) and parenting experiences of child brides. For example, women married as children are at increased likelihood of reproductive adversity such as stillbirth and unsafe abortions (Patra, 2016). Among those with successful term births, delivery in early motherhood is a risk factor for development of chronic heart disease. Coupled with adverse reproductive events related to child marriage, marital disruptions during such times of significant psychosocial burden may serve to exacerbate existing risk of hypertension development. However, the child marriage literature on the confluence of interwoven contextual factors and social determinants in affecting risk of chronic disease is in nascent stage, leaving significant openings to conduct longitudinal, empirical work in this area and the multifaceted pathways driving associations.

These findings must be considered in light of several limitations. First, these data were cross-sectional in nature, limiting the ability to examine causal associations, and as previously mentioned, true measures of childhood socioeconomic conditions. Second, no data were available on gestational hypertension, pre-eclampsia, or family history of hypertension, which could influence the hypertension outcome in women. Third, while the NFHS-5 provides data on marital status, data were not available on the age at which marital disruptions occurred. The age at which widowhood/divorce/separation occurs may have differential effects on the psychological adjustment of individuals experiencing these transitions. In the context of these findings, marital disruptions during the early stages of marriage may compound the nuanced challenges associated with child marriage. However, further research is needed to explore the role of age at time of disruption on health outcomes among women married as children. Fourth, we are unable to comment on the generalizability of our results as the impact of marital disruptions may differ by not only societal and cultural norms, but the time period in which it occurs; the impact of marital disruption in past decades is likely to differ from its present impact. The effects of marital disruptions may further change in the future, with the COVID-19 and its ever-changing impact on psychosocial functioning.

5. Conclusion

Findings from this study emphasize the importance of using targeted approaches for awareness building and regular screening for hypertension among women were married as children inclusive of those experiencing marital disruptions. Effective coping strategies for loss also may be needed to mitigate the potentially negative implications for health in adulthood. One important consideration will be the exploration of culturally sensitive strategies for such populations in LMICs like India, who face distinct challenges compared to their peers. However, identification and implementation of sustainable upstream educational interventions in childhood should be considered to increase female autonomy and reduce risk of child marriage among vulnerable populations.

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Author statement

Ashwini Tiwari, Biplab Datta: Conceptualization; Biplab Datta: Methodology, Formal Analysis, Data curation; Ashwini Tiwari, Biplab Datta, Mohammad Rifat Haider, Murshed Jahan: Writing- Original draft preparation. Biplab Datta: Visualization; Ashwini Tiwari: Supervision; Ashwini Tiwari, Biplab Datta:Writing- Reviewing and Editing; Revisions.

Ethical statement

The study was based on publicly available secondary survey data from the National Family Health Survey (NFHS-5). The NFHS-5 survey protocol was reviewed and approved by the International Institute for Population Sciences (IIPS) Institutional Review Board and the ICF Institutional Review Board (*National Family Health Survey (NFHS-5), 2019-21*, 2021). The interpretation and discussion from this study represent those of the authors and not the Ministry of Health and Family

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Declaration of competing interest

None.

Data availability

Data will be made available on request.

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