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Coresidence with mother-in-law and maternal anemia in rural India

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ABSTRACT

In a highly patriarchal society such as India, and many Middle Eastern, African, and East Asian countries, coresidence with the mother-in-law is ubiquitous during the early years of marriage. During the period when women have to make crucial fertility decisions, they are under the supervision of the mother-in-law. Using the National Family Health Survey 2005–2006, and estimation strategies such as propensity score (PS) weighted regressions and a difference-in-differences type approach with PS matching, we estimate the *causal effect* of coresidence during pregnancy on maternal anemia among rural women in India. Here, coresidence and non-coresidence during pregnancy define our treatment and control, respectively. Women coresiding with both in-laws had fewer children, were younger, more educated, wealthier, and less likely to be Muslim and from scheduled castes and tribes compared to non-coresident women. Results indicate that the mother-in-law is a potentially valuable resource during pregnancy. For example, living with the mother-in-law reduced the likelihood of moderate to severe anemia by 13.2 percentage points compared to no coresidence. Under joint coresidence with both in-laws, the effect dropped to 8.5 percentage points. Moreover, women living with the mother in-law were 16.8 percentage points more likely to receive any iron supplementation. From a public health perspective and for policy making, the results indicate that safe motherhood programs should be augmented with awareness generation components which target the mother-in-law. Furthermore, pregnant women in nuclear families need particular attention.

1. Introduction

Saas-bahu (Mother- and daughter-in-law) television serials constitute one of the most popular genres of Indian television soap operas. Their appeal across South Asia is a testament to the relevance of *Saas-bahu* dynamics in contemporary South Asian society. Most married women live with the mother-in-law through early pregnancies (Jejeebhoy and Sathar, 2001; Foster, 1993). The mother-in-law plays a significant and substantial role in household decision making and welfare in other patriarchal societies such as in many Asian, Arab and African countries, especially in rural areas.

Living with the mother-in-law in a patriarchal joint family provides a woman with the least autonomy (Dyson and Moore, 1983; Cain et al., 1979; and Bloom et al., 2001). Status as daughter-in-law is negatively associated with economic decision-making, access to resources, and freedom of mobility (Balk, 1997; Jejeebhoy, 2000). Gupta et al. (2012) report more than one in four rural women in Côte d'Ivoire experience lifetime in-law abuse that was significantly associated with in-law-perpetrated reproductive control. Other studies relate coresidence with women's risk of domestic violence (e.g., Olutola, 2012), intimate partner violence (e.g., Clark et al., 2010) and delaying childbirth and working (e.g., Chu et al., 2014). On the other hand, mothers-in-law in Senegal improved pregnancy related nutritional practices for daughters-in-law by reducing workload and improving diet during pregnancy when guided by a participatory communication and empowerment education approach (Aubel et al., 2004). Karmacharya et al. (2017) report Nepali grandmothers' correct knowledge about child nutrition and feeding practices translated into mothers' correct knowledge and improved infant and child feeding practices. Despite the relevance of the topic, the estimation of the *causal effect* of coresidence with the mother-in-law on the wellbeing of women has received relatively little attention in the empirical literature (Foster, 2004; Balk, 1997). Since most rural Indian women have a coresident mother-in-law during their peak childbearing years, we focused on maternal anemia, the most common preventable health risk during pregnancy, as the primary outcome of interest. Maternal anemia in India is mostly iron-deficiency anemia and amenable to prevention and control through better nutrition prior to and during pregnancy as well as ante-natal iron supplementation. The National Family Health Survey (NFHS) Report 2005–2006 (IIPS and Macro International, 2007) documents that 58.7%

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of Indian pregnant women were anemic to some degree, while an alarming 32.8% had moderate to severe anemia. (Table 10.24.1, IIPS and Macro International, 2007). While 65.1% of women received some level of iron supplementation during pregnancy, only 23.1% took it for the minimum prescribed 90 days (Table 8.6, IIPS and Macro International, 2007).

There are several potential explanations for the high prevalence of prenatal anemia and low intake of prescribed iron supplements during pregnancy. First, limited autonomy could curtail pregnant women's ability to make adequate nutritional investments or seek prenatal care (Bloom et al., 2001). Second, coresident daughters-in-law are possibly nutritionally deficient to begin with, even prior to becoming pregnant (Foster, 2004; Varghese, 2009a). However, it is also possible that the experienced mother-in-law serves as a valuable resource. The mother-in-law could contribute to housekeeping and childcare services, and escort the pregnant daughter-in-law to medical facilities.

To assess the causal effect of coresidence, we analyzed two questions: first, what factors influenced participation in coresidence? Second, did a coresident mother-in-law affect the probability of a pregnant woman being moderate to severely anemic and her intake of prenatal iron supplementation? We used methodologies such as ordinary least squares (OLS), probit, an approach similar to difference-in-differences combined with propensity score (PS) matching (DID-type matching), and PS weighted regressions and the NFHS-3 (2005–2006) data to address the research questions.

2. Background

2.1. Maternal anemia

Maternal anemia is a common health concern across the world. Anemia during pregnancy is a risk factor in as much as 20% of maternal mortality (World Health Organization, 2008). In a systematic review of 29 studies, Rahman et al. (2016) found about 43% of women experienced anemia during pregnancy in low- and middle-income countries. The Indian government considered maternal anemia a priority public health issue: the provision of ante-natal iron supplementation has been a major component of its reproductive and child health efforts such as the National Iron Plus Initiative (NIPI) (Deb, 2015). To control anemia, NIPI prescribes daily iron supplementation of 100 mg for 100 days to pregnant women, and doubles the dose to anemic women.

Clinical studies of a wide variety of maternal and fetal health outcomes in South Asia found negative associations with maternal anemia, particularly moderate to severe anemia. Stoltzfus et al. (2005) estimated the odds ratio of maternal mortality in India associated with a 1 g/dl improvement in pregnancy hemoglobin (Hb) within the range of 5–12 g/dl Hb as 0.61 and 0.82, based on studies by Konar et al. (1980) and Sarin (1995), respectively. Pre-term delivery was 3–4 times more likely for anemic women. Moderate to severely anemic women were 4–6 times more likely to have had prolonged labor and abnormal delivery. The risk of intra-uterine deaths was 2–4 times higher for the fetuses of anemic women and low birth weight was about twice as common among them (Bakhtiar et al., 2007; Lone et al., 2004; Malhotra et al., 2002). These studies related to urban women who have greater access to overall antenatal care and antenatal care from doctors compared to their rural counterparts as reported in NFHS-3 (IIPS and Macro International, 2007). Moreover, the IFA (iron and folic acid tablets) coverage was only 61% in rural areas compared to 76% in urban areas (IIPS and Macro International, 2007).

2.2. Role of mother-in-law

Under the patriarchal joint family system, the mother-in-law operates at the top of a power hierarchy among the realm of activities allotted to women. The mother-in-law's powerful position allows her to affect the welfare of daughter-in-law by influencing the latter's consumption of food and health investments and her contribution to household production.

The mother-in-law may have limited altruistic feelings towards the daughter-in-law, who is considered *parayi beti* (someone else's daughter), and her interest in the daughter-in-law's wellbeing would mostly be guided by her own self-interest. On the one hand, she could derive satisfaction from exerting power, and on the other, she would hurt herself if its exercise adversely affects the daughter-in-law's health leading to poorer outcomes for grandchildren. The net effect of the mother-in-law on maternal health would then depend on the relative strength of these conflicting interests. While the mother-in-law would be dependent on at least one of her daughters-in-law for care in her old age, she most likely discounts this threat looming in the far future in formulating her current treatment of her newly married daughter-in-law.

3. Data

We used the NFHS-3, a nationally representative survey of 124,835 women of ages 15–49, containing rich demographic and health information, including the Hb level. Of the women included in the analysis sample, 3.3% of all women and 4.8% of pregnant women did not have anemia information. Villages formed the primary sampling unit (PSU) for the rural sample with selection probability proportional to population. Households were randomly selected. All women of reproductive age from a household were selected. NFHS provides sampling weights, which adjust for selection probability and interview non-response.

We restricted the analyses to 12,910 currently married women living with their husbands in the villages of the north Indian states of Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh, Uttarakhand, Jharkhand, and Chattisgarh. These states comprise about 40% of the Indian population. These states not only lag in terms of maternal and child health indicators and ante-natal care (IIPS and Macro International, 2007), but are also more strictly patriarchal and provide women with less autonomy (Dyson and Moore, 1983; Jejeebhoy, 2000). Under the safe motherhood programs of the Indian government, these states are classified Low Performing States and receive special funding. Moreover, the NFHS-3 2005–2006 report documented that maternal health and antenatal and postnatal care for rural women lagged behind their urban counterparts (IIPS and Macro International, 2007). To design effective policies to improve maternal and child health in these states, it is more important to isolate the effects of family dynamics on maternal health in the rural regions of these states, rather than national averages since those statistics may mask the extent of the mother-in-law effect in such low performing states. For example, in a Southern state like Kerala, where 94% of women receive at least one ante-natal care visit and 96% receive iron supplementation, 'mother-in-law effect' may not be substantial.

This paper focused on two categories of women: pregnant women and women with a child below one year. There were 1,058 pregnant women and 1,704 women with a child under one year in the sample. To minimize the effect of unobservable confounding factors on the mother-in-law effect, the sample excluded widows, divorced or separated women, women with non-resident husbands, and women who currently live with their husbands in their natal household.

The analyses of ante-natal iron supplementation were further restricted to women with a child below one year since the data did not contain coresidence history, and some of the currently non-coresident women, who formed the comparison group, may have been coresident during the pregnancy under analysis. Hence, the restricted sample reduces contamination bias assuming that moving out of the parental household is less likely when children are very young. NFHS-3 collected detailed ante-natal care data for the most recent birth in the last five years.

4. Methods

Estimation of the mother-in-law effect on maternal health is not straightforward since coresidence of mother- and daughter-in-law is not a random event. It is a matter of choice – the product of a conscious decision by the participants in the relationship. An ordinary least squares (OLS) estimate of the effect may be biased due to factors such as non-random selection and reverse causality. For example, unobserved attributes such as innate health status may not only induce anemia but also influence marriage and thereby coresidence. Similarly, the incidence of anemia may also affect coresidence decisions. Although coresidence, as a natural consequence of arranged marriages, is a household level decision based on customs; we addressed the different sources of potential bias using different empirical strategies. (Amin, 1996; Caldwell et al., 1984; Foster, 1993; Mathur, 2008; Goode, 1963; and Dyson and Moore, 1983). Moreover, to estimate heterogeneous effects, we defined coresidence to comprise four mutually exclusive treatments: one, currently living with both the father- and mother-in-law; two, currently living with the mother-in-law; three, currently living with the father-in-law; and, four, currently living with neither.

4.1. Participation in coresidence

We formulated participation in coresidence as a discrete choice problem with four available choices and estimated its likelihood with a multinomial probit model.

To conceptualize things,

$$C_{ik} = \sum_{l=1}^{L} \beta_{lk} D_i + \sum_{m=1}^{M} \beta_{mk} E_i + \sum_{n=1}^{N} \beta_{nk} A_i + \varepsilon_{ik}$$

the error terms ε_{ik} were assumed to be independently distributed standard normal random variables for each coresidence type, $k = \{1,2,3,4\}$. The probability that the ith woman chose a particular type of coresidence (C_{ik}) was based on her own and her household's traits. The probabilities are written:

$$P(C_{ik} = k|D_i,\ E_i,\ A_i,\ \beta_{lk}, \beta_{mk}, \beta_{nk},\ \sum *) = \int_{-\infty}^{\sum_{l=1}^{L} \beta_{l1} D_i + \sum_{m=1}^{M} \beta_{m1} E_i + \sum_{n=1}^{N} \beta_{n1} A_i} \cdots$$

$$\int_{-\infty}^{\sum_{l=1}^{L} \beta_{lk-1} D_i + \sum_{m=1}^{M} \beta_{mk-1} E_i + \sum_{n=1}^{N} \beta_{nk-1} A_i} f(\varepsilon_{i1}^*, \ldots, \varepsilon_{ik-1}^*) \partial\varepsilon_{i1}^*, \ \ldots, \partial\varepsilon_{ik-1}^*$$

Here, *f(.)* is the probability density function of the multivariate normal distribution and Σ is the covariance matrix such that $\sum = \begin{bmatrix} \sigma_1^2 & \cdots & \sigma_{1n} \\ \vdots & \ddots & \vdots \\ \sigma_{1n} & \cdots & \sigma_n^2 \end{bmatrix}$.

We categorized the factors influencing participation into demographic (D_i), household's economic status (E_i), and woman's traditional attitude variables (A_i). The first category included the woman's age, age at marriage, education, number and gender of children, household size, religion, caste, and state. A woman's height accounted for unobserved factors such as a woman's general health status influencing marriage or coresidence decisions.

In the absence of a direct income or current consumption measure in the NFHS-3, husband's education, his occupation, household's ownership and acreage of agricultural land, and the NFHS-3 wealth index accounted for the influence of economic conditions on the choice decision. The household size accounted for the households' consumption demands. It can be argued that women with certain unobserved traditional attitudes might be more likely to coreside – either because they chose to coreside or because they were chosen – and these attitudes might in turn influence their health seeking behavior. Hence, we also included son preference and acceptability of domestic violence as indicators of traditional gender attitudes. We assumed these attitudes are pre-treatment variables.

4.2. Effects of coresidence

We used an approach similar to DID matching and PS weighted regressions to estimate the causal effect of coresidence.

In the potential outcomes framework, the average treatment effect on the treated (ATT), δ, is estimated as follows:

$$\delta = E(Y_1 - Y_0 \,|C = 1).$$

Here Y_1 and Y_0 denote the potential outcomes under treatment (coresidence) and control (non-coresidence), respectively; C denotes treatment status. Note, that

$$\delta = (Y_1 \,|C = 1) - E(Y_0 \,|C = 1).$$

However, $E(Y_0 \,|C = 1)$ cannot be observed in the data. DID-type matching and propensity score weighted regression follow different routes to ensure that

$$E(Y_0 \,|C = 1) = E(Y_0 \,|C = 0)$$

i.e., the outcome for the comparison group is an adequate proxy for the missing counterfactual.

4.2.1. Propensity scores

The propensity score is the probability of treatment assignment conditional on observed baseline characteristics. The coresidence treatment variable had four mutually exclusive values. We applied Imbens (2000) and Lechner (2001a, 2002) methodology that extended propensity score estimation to the multiple treatment case. Under the regime of K+1 mutually exclusive treatments, with each subject participating only in one of D ∈ {0, 1, …, K} treatments, only one of the outcomes of $\{Y_0,\ Y_1,\ \ldots,\ Y_k\}$ is observed for each, while the remaining outcomes constitute the missing counterfactuals. The pairwise average treatment on the treated parameter, conditional on belonging to any two of the treatment groups, $k,\ k' \in \{0,1,\ \ldots K\},\ k \neq k'$ is

$$\delta = E(Y_k - Y_{k'} \,|D = k)$$

$$= E(Y_k \,|D = k) - E(Y_{k'} \,|D = k)$$

$$= E(Y_k \,|D = k) - E(Y_{k'} \,|D = k',\ \mathrm{P}^{\mathrm{k|kk'}}).$$

When comparing any two treatments, we ignored the existence of multiple treatments as the others are not required for identification. The propensity scores

$$\mathrm{P}^{\mathrm{k|kk'}}(x) = \mathrm{P}^{\mathrm{k|kk'}}(D = k|D \in \{k, k'\},\ X = x)$$

are generated using individual binary probit models of two treatments at a time. However, comparing the effect of each treatment relative to each of the other treatments was neither relevant from a policy perspective nor had adequate sample size. Moreover, Lechner (2001a, 2002) showed propensity scores generated through multinomial probit and individual binary probits perform similarly and suggested the latter might be more robust.

We estimated binary propensity scores by individual probit regressions for three subsamples: one with women who coresided with the mother-in-law; another with women who coresided with the father-in-law; and the other sample included women who coresided with both. All samples included women who did not coreside with their in-laws as the control group. The propensity score can be written as: $\mathrm{P}^{\mathrm{k}}(x) = (C = k|\, X = x)$. Here, C denotes coresidence of type k, $k = \{1,2,3,4\}$; x denotes pre-treatment variables which were also used to estimate the probability of participation in coresidence.

4.2.2. Difference-in-differences type matching estimation

If women with certain latent attributes or attitudes selected into

coresidence, matching using the outcomes of non-coresident pregnant women alone as the counterfactual would not produce unconfounded results. Accordingly, we use non-pregnant coresident women as an additional comparison group to control for unobserved attributes that drive selection into coresidence but are similar across pregnant and non-pregnant women. For example, if common unobserved cultural traits drive selection into coresidence across pregnant and non-pregnant women, the DID type estimator (formalized below) controls for such factors. If selection effects come into play only during pregnancy, the use of non-pregnant women as an additional comparison group may be inadequate (Beard, 2000; Gandotra and Pandey, 1982). However, OLS regressions found no difference between coresident and non-coresident women in the duration of current pregnancy. Women coresiding with either only mother-in-law or with both parents-in-law were similar in terms of first time pregnancy, preceding birth interval, current contraception, and probability of being currently pregnant. These results encouraged us to use non-pregnant women as an additional comparison group. The results are available upon request. This DID-type methodology can be applied only to maternal anemia. Let P_i denote pregnancy and C_i denote coresidence. The DID-type matched estimator of the form

$$\delta = \{ E(Y_i|P_i = 1, C_i = 1) - E(Y_i|P_i = 0, C_i = 1) \} - \{ E(Y_i|P_i = 1, C_i = 0) - E(Y_i|P_i = 0, C_i = 0) \}$$

can provide an unbiased estimate of the causal effect of coresidence during pregnancy in the presence of selection on common unobservables across pregnant and non-pregnant women.

For women coresiding with the mother-in-law sample, for example, we calculated the probability of anemia for women accounting for the covariates and the PS under the following scenarios:

(i) Pregnant ($P_i = 1$) and coresided with mother-in-law ($C_i = 1$)
(ii) Pregnant ($P_i = 1$) and did not coreside ($C_i = 0$)
(iii) Not pregnant ($P_i = 0$) and coresided with mother-in-law ($C_i = 1$)
(iv) Not pregnant t ($P_i = 0$) and did not coreside ($C_i = 0$)

The δ coefficient quantified the difference in the probability of anemia for pregnant women under the specific form of coresidence compared to non-coresident pregnant women, relative to non-pregnant women.

4.2.3. Propensity score weighted regression

To estimate the average causal effect, regression and PS weighting methods were combined by a process termed "doubly robust" (Hirano and Imbens, 2001; Imbens, 2004). The observations belonging to the treatment group are given a weight equal to unity, and those of the comparison group, a weight of $p^k(x)/[1 - p^k(x)]$. We then estimated weighted least squares regressions of the form:

$$Y_i = \alpha + \beta X_i + \delta C^k + \varepsilon_i$$

5. Results

5.1. Types of coresidence

Panel I, Table 1 shows that 33.8% of the full sample of women, 48.7% of pregnant women and almost 47% of women with a child below one year currently coresided with the mother-in-law. Coresidence with both was the most common family structure and almost 22% of women lived under it. Coresidence with only the mother-in-law was the second most common family structure, with 11.9% of all women belonging to it. Only 4.8% of women had just the father-in-law in the household. Panel II, Table 1 indicates that 66.6% of pregnant women and almost 70% of women with a child below one year coresided with the mother-in-law in a father-in-law-headed household.

Table 1
Structure of current coresidence.

I. Types of current coresidence

Type	First time pregnant	Pregnant	Child below 1 year	All women
Both parents-in-law	53.38	35.29	35.71	21.95
Only Mother-in-law	12.79	13.37	11.28	11.87
Only Father-in-law	8.93	5.35	5.34	4.84
Neither parent-in-law	24.89	45.98	47.68	61.34
N	282	1,058	1,704	12,910

II. Coresidence with mother-in-law by relation to the head of household

Head of household	First time pregnant	Pregnant	Child below 1 year	All women
Father-in-law	76.76	66.64	69.96	57.33
Husband	11.86	24.30	23.34	35.92
Mother-in-law	10.06	8.40	6.55	6.49
Self	1.31	0.66	0.15	0.27
N	191	527	809	4,365

Note: Figures are in percentages. Each column of Panel II categorizes, by household headship, the first two rows of the corresponding column of Panel I. Summary statistics are weighted by NFHS sampling weights.

5.2. Demographic and socio-economic characteristics

Tables 2 and 3 illustrate the differences between each of the three treatment groups defined by coresidence type and the comparison group (no coresidence) on key demographic and socio-economic characteristics. Compared to women without coresiding in-laws, coresident women had fewer children, were younger, more educated and wealthier, less likely to be Muslim and from scheduled castes and tribes; and more likely to belong to land owning classes. These differences confirmed earlier findings by Vlassoff and Vlassoff (1980).

5.3. Outcomes

Table 4 presents the means of prevalence of anemia among pregnant women (Panel I) and iron supplementation (Panel II). Among pregnant women, 58.1% were anemic and almost 34.8% had moderate to severe anemia. Per NFHS, an Hb level less than 11 g/dl was considered anemic for pregnant women and less than 12 g/dl for non-pregnant women. 7 g/dl < Hb < 10 g/dl was moderate anemia and Hb < 7 g/dl was severe anemia.

Coresiding pregnant women were less likely to be moderately to severely anemic compared to non-coresident pregnant women. For example, only about 30.7% of pregnant women coresiding with both the parents-in-law were moderately to severely anemic compared to 40.8% of non-coresident pregnant women.

Panel II, Table 4 shows 51.3% of women with children younger than one year received iron supplementation. However, only 9.6% women took the supplements for the minimum prescribed 90 days. Almost 57.6% of women coresiding with both took iron supplements, while women coresiding with only the mother-in-law topped the list of iron supplementation for 90 days at 13.8%. The corresponding percentages for non-coresident women were only 46% and less than 7%.

5.4. Participation equation and propensity scores

The estimated marginal effects in Table 5 show that self-selection into coresidence at the individual level was limited, at least on observable traits. Once the observations were weighted with the propensity scores, much of the differences in observable characteristics between the various coresident groups and the comparison group of

Table 2
Summary statistics: Pregnant women.

Variables	Both parents coresident	Only mother-in-law coresident	Only father-in-law coresident	No coresidence
Demographics				
Age (in years)	21.78**	24.19**	22.97**	26.57
	(0.23)	(0.56)	(0.78)	(0.31)
Age at marriage (in years)	16.56**	16.11	16.59†	16.03
	(0.12)	(0.22)	(0.28)	(0.13)
Height (cm)	151.30	151.24	151.51	151.45
	(0.32)	(0.51)	(0.79)	(0.3)
Primary Education (1 = Yes)	0.14†	0.14	0.14	0.10
	(0.02)	(0.03)	(0.05)	(0.01)
Secondary Education (1 = Yes)	0.29**	0.12	0.15	0.10
	(0.03)	(0.03)	(0.05)	(0.01)
Higher Education (1 = Yes)	0.02*	$	0.04	0.01
	(0.01)		(0.03)	(0.00)
Husband primary education	0.15	0.18	0.16	0.19
	(0.02)	(0.04)	(0.05)	(0.02)
Husband secondary education	0.56**	0.38	0.46	0.34
	(0.03)	(0.05)	(0.07)	(0.02)
Husband higher education	0.11**	0.05	0.09	0.04
	(0.02)	(0.02)	(0.04)	(0.01)
Household size and composition				
Number of sons	0.49**	0.87*	0.78*	1.15
	(0.04)	(0.10)	(0.17)	(0.07)
Number of daughters	0.67**	1.08**	0.68**	1.51
	(0.06)	(0.14)	(0.16)	(0.07)
Household size	8.73**	7.01**	6.77**	4.85
	(0.21)	(0.04)	(0.48)	(0.11)
Cultural Norms				
Son preference (1 = Yes)	0.36**	0.44	0.49	0.45
	(0.03)	(0.05)	(0.07)	(0.03)
Wife-beating acceptable (1 = Yes)	0.55	0.55	0.36**	0.57
	(0.03)	(0.05)	(0.07)	(0.03)
Caste and Religion				
Muslim (1 = Yes)	0.10*	0.14	0.06*	0.16
	(0.02)	(0.03)	(0.04)	(0.02)
Scheduled Caste (1 = Yes)	0.19**	0.21*	0.24	0.32
	(0.02)	(0.04)	(0.06)	(0.02)
Scheduled Tribe (1 = Yes)	0.09	0.18*	0.12	0.12
	(0.01)	(0.03)	(0.04)	(0.01)
Other Backward Castes (1 = Yes)	0.57**	0.47	0.47	0.41
	(0.03)	(0.05)	(0.07)	(0.03)
Wealth				
Wealth Index	2.46**	2.06**	2.15*	1.70
	(0.07)	(0.10)	(0.18)	(0.05)
Agricultural Land 0–2 acres (1 = Yes)	0.38	0.41	0.42	0.34
	(0.03)	(0.05)	(0.07)	(0.02)
Agricultural Land 2–10 acres (1 = Yes)	0.34**	0.25	0.24†	0.14
	(0.03)	(0.04)	(0.06)	(0.02)
Agricultural Land ≥ 10 acres (1 = Yes)	0.05**	0.02	0.04	0.02
	(0.01)	(0.01)	(0.04)	(0.01)

Note: Summary statistics are weighted by NFHS survey weights. $: Only 3 women had higher education. Height, age at marriage, age, sons, daughters, household size and wealth index are numbers and the rest are proportions. †,*, and ** indicate statistical significance of the difference in means between the neither parent coresident group and each treatment group at the 10%, 5% and 1% levels. Linearized standard errors are in parentheses.

Table 3
Summary statistics: Women with a child under one year.

Variables	Both parents coresident	Only mother-in-law coresident	Only father-in-law coresident	No coresidence
Demographics				
Age	22.23**	24.89**	24.70**	27.43
	(0.18)	(0.42)	(0.50)	(0.24)
Age at marriage	16.47**	16.22	16.00	15.94
	(0.11)	(0.21)	(0.28)	(0.09)
Height (cm)	150.96	150.73	150.95	150.75
	(0.27)	(0.45)	(0.58)	(0.23)
Primary Education	0.16**	0.13	0.16	0.09
	(0.02)	(0.03)	(0.04)	(0.01)
Secondary Education	0.29**	0.18**	0.26**	0.09
	(0.02)	(0.03)	(0.05)	(0.01)
Higher Education	0.02*	0.03	0.03	0.01
	(0.01)	(0.01)	(0.02)	(0.00)
Husband primary education	0.13	0.14	0.17	0.16
	(0.01)	(0.03)	(0.04)	(0.01)
Husband secondary education	0.53**	0.48**	0.46*	0.33
	(0.02)	(0.04)	(0.06)	(0.02)
Husband higher education	0.12**	0.06	0.08	0.05
	(0.01)	(0.02)	(0.03)	(0.01)
Household size and composition				
Number of sons	0.96**	1.44**	1.28**	1.80
	(0.04)	(0.09)	(0.11)	(0.06)
Number of daughters	1.10**	1.60**	1.44**	1.96
	(0.05)	(0.13)	(0.12)	(0.05)
Household size	9.57**	7.37**	7.70**	5.90
	(0.15)	(0.18)	(0.31)	(0.08)
Cultural Norms				
Son preference	0.36**	0.41	0.43	0.46
	(0.02)	(0.04)	(0.06)	(0.02)
Wife-beating acceptable	0.52**	0.61	0.67	0.60
	(0.02)	(0.04)	(0.05)	(0.02)
Caste and Religion				
Muslim	0.08**	0.09*	0.09†	0.15
	(0.01)	(0.02)	(0.03)	(0.01)
Scheduled Caste	0.19**	0.27*	0.22	0.28
	(0.02)	(0.04)	(0.05)	(0.02)
Scheduled Tribe	0.11**	0.10**	0.11	0.16
	(0.01)	(0.02)	(0.03)	(0.01)
Other Backward Castes	0.54**	0.47	0.47	0.41
	(0.02)	(0.04)	(0.06)	(0.02)
Wealth				
Wealth Index	2.54**	2.11**	2.18**	1.72
	(0.05)	(0.09)	(0.12)	(0.04)
Agricultural Land 0–2 acres	0.36	0.41	0.35	0.39
	(0.02)	(0.04)	(0.05)	(0.02)
Agricultural Land 2–10 acres	0.35**	0.28**	0.36**	0.16
	(0.02)	(0.04)	(0.05)	(0.01)
Agricultural Land ≥ 10 acres	0.09**	0.06*	0.03	0.01
	(0.01)	(0.02)	(0.02)	(0.00)

Note: Summary statistics are weighted by NFHS survey weights. See Table 2 notes for other details.

non-coresident women disappeared.

5.5. Impact analyses

5.5.1. Anemia in pregnancy

DID-type matching estimates in Table 6 show coresidence with the mother-in-law reduced the likelihood of moderate to severe anemia by 13.2 percentage points (p-value < 0.01) compared to non-coresidence. OLS, probit and propensity score weighted regressions produced similar results (not shown). The protection from coresidence dropped to about

Table 4
Mean of outcomes.

I Prevalence of anemia among pregnant women[a]

Type of coresidence	Pregnant women		All women	
	Moderate to severe anemia	Anemia	Moderate to severe anemia	Anemia
Both parents coresident	30.61** (2.67)	54.19† (2.90)	17.43 (1.00)	56.68* (1.04)
Mother-in-law alone coresident	28.01** (4.20)	60.96 (4.53)	16.51 (1.06)	59.17 (1.41)
Father-in-law alone coresident	26.90* (6.08)	49.70 (7.36)	16.12 (1.59)	57.98 (2.20)
Neither parent coresident	40.75 (2.52)	61.27 (2.52)	17.74 (0.48)	59.22 (0.62)
All	34.76 (1.64)	58.11 (1.71)	17.45 (0.37)	58.59 (0.48)
N	1,005	1,005	12,444	12,444

II. Iron Supplementation for women with a child below the age of 1 year

Type of coresidence	Iron	Iron for 90 days
Both parents coresident	57.62** (2.22)	11.69** (1.37)
Mother-in-law alone coresident	54.65† (4.06)	13.78* (2.83)
Father-in-law alone coresident	47.77 (5.67)	10.94 (3.58)
Neither parent coresident	46.05 (1.92)	6.78 (0.87)
All	51.27 (1.34)	9.55 (0.75)
N	1,633	1,633

Note: Figures are in percentages and weighted by the NFHS survey weights. Linearized standard errors are in parentheses. †,*, and ** indicate statistical significance of the difference in means between the neither parent coresident group and each treatment group at the 10%, 5% and 1% levels. [a] See text for detailed definition of anemia.

8.5 percentage points under joint residence with both parents-in-law (p-value < 0.05). There was also suggestive evidence of a 12.7 percentage point beneficial effect of coresidence with the father-in-law (p-value < 0.10). However, coresidence with the mother-in-law increased the likelihood of mild anemia by 11.3 percentage points (p-value < 0.05).

5.5.2. Iron supplementation

Estimates from the PS weighted regressions in Panels I and II in Table 7 show women living with the mother in-law were 16.8 percentage points more likely to receive iron supplementation (p-value < 0.01) and 6.4 percentage points more likely to receive iron supplementation for ninety days (p-value < 0.05).

5.6. Robustness checks

5.6.1. Sensitivity to economic factors

In addition to the NFHS wealth index (Rutstein and Johnson, 2004), we included husband's education and occupation, acreage of agricultural land (primary source of rural income), and household size as proxies for economic conditions (Montgomery et al., 2000 and Filmer and Pritchett, 2001). Since proxies are noisy measures, we estimated 'errors-in-variables' regressions assuming classical measurement error. Panel III, Table 8 shows coresiding with only the mother-in-law had the largest beneficial effect on the likelihood of maternal moderate to severe anemia after accounting for measurement error in all economic variables.

Table 5
Participation model of pregnant women.

Multinomial probit marginal effects

Variables	Both parent coresident	Mother-in-law alone coresident	Father-in-law alone coresident	Neither parent coresident
Demographics				
Age (in years)	−0.023** (0.009)	0.009 (0.006)	0.000 (0.004)	0.014† (0.007)
Age at marriage (in years)	0.015 (0.013)	−0.011 (0.011)	0.003 (0.006)	−0.007 (0.010)
Height (cm)	−0.006 (0.004)	0.001 (0.003)	0.002 (0.002)	0.002 (0.003)
Lactating (1 = Yes)	0.059 (0.054)	0.017 (0.047)	−0.012 (0.031)	−0.063† (0.038)
Literate (1 = Yes)	0.027 (0.073)	0.000 (0.068)	−0.028 (0.045)	0.001 (0.055)
Husband literate (1 = Yes)	0.067 (0.071)	−0.074 (0.069)	−0.031 (0.048)	0.038 (0.065)
Education (in years)	0.016 (0.010)	−0.015† (0.009)	0.002 (0.006)	−0.002 (0.009)
Husband's education (in years)	−0.000 (0.008)	−0.000 (0.007)	0.002 (0.005)	−0.001 (0.008)
Husband's occupation	0.017 (0.017)	−0.029† (0.015)	0.003 (0.010)	0.009 (0.013)
Household size and composition				
Number of sons	−0.167** (0.032)	−0.035 (0.025)	−0.006 (0.019)	0.209** (0.021)
Number of daughters	−0.118** (0.030)	−0.052* (0.023)	−0.039** (0.016)	0.209** (0.020)
Household size	0.146** (0.014)	0.048** (0.012)	0.020** (0.005)	−0.214** (0.011)
Cultural Norms				
Son preference (1 = Yes)	−0.006 (0.048)	0.012 (0.043)	0.038 (0.031)	−0.044 (0.035)
Wife-beating acceptable (1 = Yes)	0.047 (0.044)	−0.012 (0.039)	−0.080** (0.028)	0.045 (0.036)
Caste and Religion				
Muslim (1 = Yes)	0.048 (0.080)	0.023 (0.071)	−0.077 (0.034)*	0.006 (0.065)
Scheduled Caste (1 = Yes)	0.042 (0.083)	−0.039 (0.068)	−0.051 (0.039)	0.048 (0.071)
Scheduled Tribe (1 = Yes)	0.003 (0.088)	0.087 (0.094)	−0.022 (0.046)	−0.067 (0.060)
Other Backward Caste (1 = Yes)	0.094 (0.069)	−0.013 (0.064)	−0.027 (0.039)	−0.054 (0.058)
Wealth				
Wealth Index (quintiles)	0.021 (0.027)	0.011 (0.026)	−0.006 (0.016)	−0.026 (0.025)
Agricultural Land 0–2 acres	0.132* (0.062)	−0.040 (0.051)	−0.002 (0.035)	−0.091* (0.045)
Agricultural Land 2–10 acres	0.148* (0.063)	−0.077† (0.046)	−0.019 (0.036)	−0.052 (0.042)
Agricultural Land ≥ 10 acres	−0.039 (0.129)	−0.149* (0.070)	−0.004 (0.089)	0.193 (0.130)
N	1005	1005	1005	1005

Wald Chi square (84) = 429.37.
Prob. > Chi square = 0.000.
Note: Multinomial probit estimation of the participation equation includes demographic, economic, and attitude variables, and state dummies. Marginal effects are estimated at the mean of the control variables, except for dummy variables which capture a discrete change from 0 to 1. In addition to the variables in Tables 2 and 3, state and husband's occupation dummies and quadratic terms for age and height were also included in the participation equation. Robust standard errors clustered at the PSU level and weighted by the NFHS survey weights are in parentheses. †,*, and ** indicate statistical significance at the 10%, 5% and 1% levels.

Table 6
Effect of coresidence on anemia during pregnancy.

Difference-in-differences type with Propensity Score Matching			
Variables	Moderate to severe anemia	Mild anemia	No anemia
Both parents*Pregnant	−0.085*	0.040	0.044
	(0.038)	(0.036)	(0.039)
Mother-in-law*Pregnant	−0.132**	0.113*	0.019
	(0.047)	(0.055)	(0.051)
Father-in-law*Pregnant	−0.127†	0.021	0.106
	(0.069)	(0.074)	(0.082)
Both parents-in-law	−0.001	0.003	−0.002
	(0.013)	(0.019)	(0.019)
Mother-in-law alone	−0.002	0.017	−0.015
	(0.012)	(0.017)	(0.016)
Father-in-law alone	−0.005	0.023	−0.018
	(0.017)	(0.026)	(0.024)
Pregnant	0.276**	−0.214**	−0.062*
	(0.028)	(0.025)	(0.028)
Primary educated	0.008	−0.018	0.01
	(0.012)	(0.016)	(0.016)
Secondary educated	−0.005	−0.028†	0.033*
	(0.012)	(0.016)	(0.016)
Higher educated	−0.054†	0.033	0.021
	(0.030)	(0.044)	(0.046)
Husband primary educ.	−0.018	0.022	−0.004
	(0.012)	(0.014)	(0.015)
Husband sec. educ.	−0.025*	0.007	0.017
	(0.011)	(0.013)	(0.013)
Husband higher educ.	−0.055**	0.015	0.040
	(0.020)	(0.024)	(0.026)
N	12,407	12,407	12,407
R^2	0.036	0.037	0.043

Note: Difference-in-differences type coefficients are estimated in a single regression and includes both pregnant and non-pregnant women in the sample. Controls for demographic, economic, and attitude variables, and state dummies were included. Robust standard errors clustered at the PSU level weighted by the NFHS survey weights are in parentheses. †,*, and ** indicate statistical significance at the 10%, 5% and 1% levels.

Table 7
Effect of coresidence on iron supplementation.

I. Received iron supplementation			
	Both parents coresident	Mother-in-law alone coresident	Father-in-law alone coresident
OLS	0.022	0.077†	−0.044
	(0.046)	(0.046)	(0.059)
N	1633	1633	1633
R^2	0.149	0.149	0.149
Probit	0.028	0.083	−0.057
	(0.051)	(0.050)	(0.065)
N	1633	1633	1633
Pseudo R^2	0.118	0.118	0.118
Propensity Score Weighted Regression	0.045	0.168**	−0.001
	(0.066)	(0.056)	(0.061)
N	971	934	805
R^2	0.308	0.344	0.47
II. Received iron supplementation for 90 days			
OLS	0.041†	0.067*	0.031
	(0.024)	(0.029)	(0.038)
N	1633	1633	1633
R^2	0.142	0.142	0.142
Probit	0.041*	0.074**	0.035
	(0.022)	(0.032)	(0.039)
N	1633	1633	1633
Pseudo R^2	0.186	0.186	0.186
Propensity Score Weighted Regression	0.051	0.064*	0.044
	(0.032)	(0.031)	(0.037)
N	971	934	805
R^2	0.273	0.482	0.388

Note: Propensity score weighted regressions are run separately for each treatment with neither parent coresident as the comparison group. The outcome is for the most recent pregnancy for women with a child below the age of 1 year. Controls for demographic, economic, and attitude variables, and state dummies were included. Robust standard errors clustered at the PSU level and weighted by the NFHS survey weights are in parentheses. †,*, and ** indicate statistical significance at the 10%, 5% and 1% levels.

5.6.2. North India versus south India

To explore interregional differences in the prevalence and consequences of coresidences, we compared the South Indian states of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu, with their higher levels of female autonomy (Dyson and Moore, 1983) to the principal analysis sample. Panel I, Table 9 shows overall coresidence with the in-laws was significantly lower in South India compared to the North: around 70% of south Indian women did not coreside with in-laws. Despite overall lower rate of coresidence in the South, coresidence during pregnancy and the first year after child birth were similar across both regions. The regions were similar in terms of the prevalence of moderate to severe anemia during pregnancy. But the iron supplementation rate in the South was around 80% while only 50% women in the North had iron supplementation while carrying their youngest child below the age of one. Table 10 shows the 'mother-in-law effect' was stronger in the North for iron supplementation only. In North India, living with the mother-in-law makes it 17 percentage points more likely for pregnant women to receive ante-natal iron supplementation.

6. Discussion

The results indicate almost half of the pregnant women and women with a child below one year currently coresided with the mother-in-law. Age and number of children were the strongest predictors of coresidence during pregnancy. Older women with more children were less likely to coreside. Land ownership was another significant predictor of coresidence for women with a child under one. Coresidence with younger children was more common among upper caste Hindus, illustrating land owning classes had longer coresidence who were more likely to be from the higher castes.

We find that living with the mother-in-law was beneficial for pregnant women in rural areas of some of the poorest states in North India. Coresident women were less likely to suffer from moderate to severe anemia and more likely to receive ante-natal iron supplementation. Additionally, a significant adverse effect of coresiding with the mother-in-law on mild anemia could be the corollary of the positive effect found in for moderate to severe anemia – coresidence may have helped women transition from a potential state of moderate to severe anemia to that of mild anemia.

The effect of coresiding with the mother-in-law during pregnancy, though still beneficial, waned under coresidence with both parents-in-law, a household structure under which the mother-in-law is most powerful. This finding aligns with the negative consequences of coresiding with mothers-in-law noted elsewhere in the coresidence literature on empowerment, domestic violence, and health. However, the overall beneficial effects of coresidence with the mother-in-law observed across outcomes and various forms of coresidence indicated the existence of a potential trade-off between mother-in-law's exertion of power and her utility from the birth of healthy grandchildren, with the latter, perhaps, outweighing the former in the particular context studied here. It is also possible that the father-in-law's needs for the

Table 8
Errors-in-variables regression of moderate to severe anemia.

I. Measurement error: Only wealth and land variables				
	(1)	(2)	(3)	(4)
	No measurement error	Reliability Ratio = 0.9	Reliability Ratio = 0.8	Reliability Ratio = 0.75
Both parents coresident	−0.069	−0.064	−0.053	−0.041
	(0.050)	(0.050)	(0.051)	(0.054)
Mother-in-law alone coresident	−0.139**	−0.137**	−0.132*	−0.126*
	(0.049)	(0.051)	(0.052)	(0.053)
Father-in-law alone coresident	−0.100	−0.097	−0.091	−0.083
	(0.068)	(0.072)	(0.072)	(0.073)
N	1005	1005	1005	1005
R^2	0.065	0.067	0.069	0.072
II. Measurement error: Husband's traits, household size, wealth and land variables				
	(1)	(2)	(3)	(4)
	No measurement error	Reliability Ratio = 0.9	Reliability Ratio = 0.8	Reliability Ratio = 0.75
Both parents coresident	−0.069	−0.074	−0.064	−0.052
	(0.050)	(0.054)	(0.055)	(0.058)
Mother-in-law alone coresident	−0.139**	−0.146**	−0.142**	−0.136*
	(0.049)	(0.053)	(0.053)	(0.054)
Father-in-law alone coresident	−0.100	−0.103	−0.097	−0.090
	(0.068)	(0.073)	(0.073)	(0.074)
N	1005	1005	1005	1005
R^2	0.065	0.071	0.073	0.076
III. Measurement error: All economic variables				
	(1)	(2)	(3)	(4)
	No measurement error	Reliability Ratio = 0.9	Reliability Ratio = 0.8	Reliability Ratio = 0.75
Both parents coresident	−0.069	−0.074	−0.088	−0.133
	(0.050)	(0.054)	(0.063)	(0.087)
Mother-in-law alone coresident	−0.139**	−0.146**	−0.166**	−0.217**
	(0.049)	(0.053)	(0.057)	(0.077)
Father-in-law alone coresident	−0.100	−0.103	−0.109	−0.130
	(0.068)	(0.073)	(0.075)	(0.079)
N	1005	1005	1005	1005
R^2	0.065	0.071	0.082	0.103

Note: In addition to the economic variables, regressions include controls for demographic and attitude variables, and state dummies. Column (1) assumes no measurement error in the economic variables and has a reliability ratio of one. In Panel I, only wealth and land variables are assumed to be measured with error, with reliability ratios ranging from 0.9 in Column (2) to 0.75 in Column (4). In columns (2), (3), and (4) of Panel II, husband's traits and household size are assigned a uniform reliability ratio of 0.9, while the reliability ratio of wealth and land variables ranges from 0.9 to 0.75. In Panel III, all the economic variables are assigned the same reliability ratio. Standard errors weighted by the NFHS survey weights are in parentheses. †,*, and ** indicate statistical significance at the 10%, 5% and 1% levels.

mother-in-law crowded out similar needs of the pregnant daughter-in-law in a joint family setting (Das Gupta, 1999). The shift in power from the mother-in-law to daughter-in-law, over the life cycle, could also explain the larger beneficial effects observed in mother-in-law only coresident households (Vlassoff and Vlassoff, 1980). However, related analyses on the influence of power on the 'mother-in-law effect' by comparing outcomes in father-in-law headed households and husband-headed households found no statistically significant differences (Varghese, 2009b).

It is possible that coresidence with the mother during pregnancy may be more beneficial than coresidence with the mother-in-law; however, the exploration of that difference is beyond the scope of this study. Compared to residence under a nuclear family structure, coresidence with the mother-in-law was found beneficial highlighting an avenue for programmatic interventions.

We focused on the rural areas of some of the poorest states in North India, rather than a national analysis, because of stronger policy relevance. These states, sometimes clubbed together under the acronym 'BIMARU', coined from the first letter of the first four states on the list, meaning sick in Hindi, lag behind the rest of the country in terms of maternal and child health. Moreover, the recently published NFHS-4 data show the state of maternal health and healthcare in rural areas continues to lag behind their urban counterparts despite improvements (Table 8.7 for iron supplementation and Table 10.21.1 for anemia, International Institute for Population Sciences (IIPS) and ICF, 2017) and non-nuclear household structure continues to be highly prevalent in rural India (Table 2.11 on household composition, International Institute for Population Sciences (IIPS) and ICF, 2017) indicating the continued relevance of the topic from public health and programmatic perspectives.

Furthermore, we compared the North Indian study sample to a South Indian sample to assess the breadth of the 'mother-in-law effect' across the country. The mother-in-law alone coresident households were more common in the South but the regions were similar in terms of coresidence during pregnancy and the first year after child birth as well as the prevalence of moderate to severe anemia during pregnancy. Since the iron supplementation rate was much higher in the South to begin with; it is probably not surprising we found a stronger beneficial effect of the mother-in-law in the North on women's iron supplementation. This finding also suggests maternal health programs targeting the mother-in-law in rural North India may be particularly beneficial. However, further analysis is required to assess the external validity of our findings.

Programs should also pay special attention to women in nuclear families who do not have a coresident mother-in-law as a beneficial resource. Results indicate that non-coresident women in the study sample suffered from the highest rates of moderate to severe anemia and lowest rates of iron supplementation.

7. Conclusion

In a highly patriarchal society such as India, and many Middle Eastern, African, and East Asian countries, coresidence with the mother-in-law is ubiquitous during the early years of marriage. During the period when women have to make crucial fertility decisions, they are under the supervision of the mother-in-law. The coresidence literature documents both adverse and beneficial consequences of coresiding with the mother-in-law in different cultures. This study used data from NFHS-3 and several empirical strategies to account for potential bias in assessing the *causal effect* of coresidence with in-laws on maternal health measured by levels of anemia and ante-natal care in terms of iron supplementation in rural India.

In the principal analysis sample of rural women in North India in 2005–2006, we find that the mother-in-law was a potentially valuable resource during pregnancy – living with the mother-in-law reduced the likelihood of moderate to severe anemia by 13.2 percentage points (p-value < 0.01). However, under joint coresidence, the beneficial effect dropped to 8.5 percentage points (p-value < 0.05). Non-coresident women had the worst anemia outcomes. Moreover, women living with the mother in-law were 16.8 percentage points more likely to receive iron supplementation (p-value < 0.01) and 6.4 percentage points more likely to receive iron supplementation for 90 days (p-value < 0.05). These results, while on the one hand indicates the value of coresidence with the mother-in-law, on the other, highlights the need for safe

Table 9
Differences between North and South Indian states.

I. Prevalence of Coresidence

	First time pregnant		Pregnant		Child below 1 year		All women	
	North	South	North	South	North	South	North	South
Both parents coresident	53.38 (3.32)	41.05* (4.32)	35.29 (1.61)	34.65 (2.80)	35.71 (1.27)	35.11 (2.40)	21.95 (0.40)	13.44** (0.43)
Mother-in-law alone coresident	12.79 (2.21)	20.55† (3.57)	13.37 (1.13)	18.62* (2.35)	11.28 (0.86)	15.95* (1.84)	11.87 (0.31)	13.50** (0.43)
Father-in-law alone coresident	8.93 (2.00)	4.66 (1.98)	5.35 (0.75)	3.04† (1.06)	5.34 (0.59)	2.52** (0.79)	4.84 (0.21)	2.58** (0.20)
Neither parent coresident	24.89 (2.88)	33.74† (4.35)	45.98 (1.68)	43.70 (3.01)	47.68 (1.33)	46.43 (2.51)	61.33 (0.47)	70.47** (0.57)
N	282	142	1058	310	1704	444	12910	7081

II. Prevalence of anemia and iron supplementation

	Moderate to severe anemia (pregnant women)		Iron supplementation (women with a child under 1)		Iron supp. for 90 days (women with a child under 1)	
	North	South	North	South	North	South
Both parents coresident	30.61 (2.67)	24.39 (4.35)	57.62 (2.22)	80.83** (3.46)	11.69 (1.37)	33.36** (3.94)
Mother-in-law alone coresident	28.01 (4.20)	32.23 (6.72)	54.65 (4.07)	70.52* (5.88)	13.78 (2.83)	38.51** (6.14)
Father-in-law alone coresident	26.90 (6.12)	20.01 (13.14)	47.77 (5.68)	92.80** (7.07)	10.94 (3.59)	39.10 (14.91)
Neither parent coresident	40.75 (2.52)	40.61 (4.77)	46.05 (1.92)	81.18** (2.95)	6.78 (0.87)	40.43** (3.60)
N	1005	290	1686	433	1,686	433

Note: Summary statistics are weighted by their NFHS survey weights. †,*, and ** indicate statistical significance of the difference in means between North and South at the 10%, 5% and 1% levels. Linearized standard errors are in parentheses.

Table 10
Difference-in-difference type estimation of change in coresidence effects across regions.

	Moderate to severe anemia	Iron supplementation	Iron supplementation for 90 days
Both parents coresident*North	0.059 (0.076)	0.028 (0.060)	0.052 (0.053)
Mother-in-law coresident*North	−0.055 (0.096)	0.174* (0.082)	0.080 (0.076)
Father-in-law coresident*North	0.089 (0.146)	−0.172† (0.102)	−0.021 (0.134)
Both parents coresident	−0.119† (0.071)	0.000 (0.056)	−0.030 (0.053)
Mother-in-law alone coresident	−0.063 (0.086)	−0.113 (0.070)	−0.012 (0.071)
Father-in-law alone coresident	−0.178 (0.132)	0.138† (0.085)	0.040 (0.130)
North Indian state	−0.014 (0.056)	−0.199** (0.044)	−0.237** (0.037)
N	1294	2056	2056
R^2	0.054	0.151	0.203

Note: Robust standard errors are clustered at the PSU level, and weighted by the NFHS survey weights. †,*, and ** indicate statistical significance at the 10%, 5% and 1% levels.

motherhood programs to pay particular attention to improving post-natal iron supplementation among women from nuclear families.

Future research should consider alternative empirical strategies such as instrumental variables to provide additional support for a causal relationship between coresidence with mother-in-law and beneficial maternal health outcomes with more current data. Directly targeting the mothers-in-law from joint families (White, 2009; Aubel et al., 2004; Karmacharya et al., 2017), and women from nuclear families through awareness generation messages could potentially improve ante-natal care and maternal health. The salience of targeting programs according to household structure becomes more pronounced relative to the benefits of women's education, one of the major determinants of maternal health and ante-natal care uptake. For maternal anemia, not only is the magnitude of 'mother-in-law effect' larger, its impact would also be more immediate. Thus, targeted awareness generation can help pregnant women who have already exited the educational system.

Declarations of interest

None.

Conflicts of interest

None declared.

Ethical approval

Not required. The study involves secondary data analyses of the National Family Health Survey 2005–2006.

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