American Journal of Epidemiology
Vol. 167, No. 10
DOI: 10.1093/aje/kwn049
Advance Access publication March 26, 2008

Original Contribution

Domestic Violence and Chronic Malnutrition among Women and Children in India

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Received for publication October 27, 2007; accepted for publication February 13, 2008.

Domestic violence has harmful physical and psychological health correlates, but there is little evidence regarding a relation between domestic violence and malnutrition. To investigate this relation, the authors analyzed data from 69,072 women aged 15–49 years and 14,552 children aged 12–35 months in the 1998–1999 Indian National Family Health Survey. Physical domestic violence victimization was self-reported by the women. Aspects of nutritional status included in this study were anemia and underweight. Anemia was measured with a blood test for hemoglobin. Underweight was calculated from anthropometric measurements and was determined as body mass index for women, and it included stunting and wasting for children. Results indicate associations of multiple incidents of domestic violence in the previous year with anemia (odds ratio = 1.11, 95% confidence interval: 1.04, 1.18) and underweight (odds ratio = 1.21, 95% confidence interval: 1.13, 1.29) in women and a suggested relation among children. Possible mechanisms for this relation include withholding of food as a form of abuse and stress-mediated influences of domestic violence on nutritional outcomes. These findings indicate that reducing domestic violence is important not only from a moral and intrinsic perspective but also because of the instrumental health benefits likely to accrue.

anemia; body mass index; child nutrition disorders; domestic violence; India; malnutrition; women

Abbreviations: CI, confidence interval; OR, odds ratio.

Malnutrition is the leading risk factor for mortality in the world, contributing to nearly 12 percent of all deaths and 16 percent of all disability-adjusted life years lost globally (1) and one third of all disability-adjusted life years lost in low-income countries (2). Anemia is a risk factor for a number of health outcomes, including poor cognitive development, weakened resistance to infection, maternal mortality, pre- and perinatal loss, stunting, and endocrine disruption (3). Nutritional anemia results from inadequate availability of micronutrients required for hemoglobin synthesis, accounting for 841,000 deaths and 35,057,000 disability-adjusted life years lost annually, predominantly in low-income countries (4). Alternatively, hemolytic anemia results from the premature destruction of red blood cells before their normal 120-day lifespan has been reached (5). Underweight due to energy deficiency, another form of chronic malnutrition, is associated with poor birth outcomes, inability to breastfeed, suppressed immune function, and elevated risk of death in women (6). Underweight among children annually accounts for 3,748,000 deaths and 9.5 percent of all disability-adjusted life years lost worldwide (7).

The burden of chronic malnutrition falls disproportionately on developing countries, including India. In 1998–1999, anemia afflicted 74 percent of children and 52 percent of women of childbearing age in India, while 47 percent of children and 36 percent of women of childbearing age were underweight (8). Recent estimates suggest that prevalence of underweight remains virtually unchanged (46 percent for children, 33 percent for women of childbearing age), while anemia increased (79 percent for children, 57 percent for women of childbearing age) (8).

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Although biomedical and socioeconomic risk factors for malnutrition in India are well known (3, 9–11), the role that psychosocial factors play in anemia and underweight is less understood. Exposure to domestic violence is a psychosocial factor that may be associated with anemia and underweight for women as well as their children. Domestic violence increases psychological stress among Indian women (12, 13), and witnessing maternal domestic violence increases psychological stress among children (14). Psychological stress increases oxidative stress (15–18) and metabolic levels (19), risk factors for anemia and underweight. Domestic violence could also increase the risk of poor nutritional outcomes through environmental circumstances such as the withholding of food by abusive family members (20).

Exposure to domestic violence is highly prevalent worldwide (21, 22), particularly in south Asia (23–25), and is associated with disadvantaged socioeconomic (23, 24, 26–29), demographic (30–32), and contextual (33–35) characteristics. This widespread exposure to domestic violence indicates that abuse may exacerbate the negative influence that cumulative disadvantage has on nutritional status. We are aware of only one study, based on a community sample of rural women and children (36), that has examined this relation in India. Drawing upon the most recent nationally representative data with objective measures of anemia and underweight, we investigated the extent to which domestic violence predicts the likelihood of being malnourished among women and children in India.

MATERIALS AND METHODS

Data

We utilized the 1998–1999 Indian National Family Health Survey, a nationally representative cross-sectional study of 92,447 households (37). Trained data collectors interviewed an adult member in each selected household to obtain demographic information about the household and its family members, achieving a household response rate of 98 percent. From these households, the data collectors conducted face-to-face interviews with 90,303 ever-married women aged 15–49 years and took anthropometric measurements and blood samples. The women's survey had a response rate of 96 percent and provided information on domestic violence. We excluded women who were pregnant, nonmarried, or missing information on anemia, body mass index, domestic violence, and other predictor variables, yielding a final sample of 69,072 women located in 3,190 primary sampling units in 26 Indian states. Primary sampling units, hereafter termed neighborhoods, were villages or village clusters in rural areas and census enumeration districts in urban areas.

Each woman was also questioned about the births of her youngest two children born in the previous 3 years, yielding a sample of 33,026 children. Anthropometric measurements and blood samples were taken from those children who were both alive and present in the household. Children who were less than age 12 months, had died, or for whom information on anemia, anthropometric measurements, maternal domestic violence, and other covariates was missing were excluded from the analysis, yielding a sample of 14,552 children in 3,027 neighborhoods within 26 Indian states.

Outcome measures

We analyzed two outcomes for the women—underweight and anemia—and five outcomes for the children—anemia, low height for age (stunting), low weight for height (wasting), low weight for age (underweight), and low body mass index for age. The anthropometric outcome variables measuring children were selected to provide a complete assessment of nutritional status (38). Specifically, stunting is a measure of chronic undernutrition, wasting is a measure of acute caloric deficiency, and weight for age and body mass index for age provide a general picture of overall nutritional status accounting for age (38, 39). Women and children were weighed with a solar-powered scale accurate to within 100 g and were measured with an adjustable measuring board accurate to within 1 mm (37). For the women, binary variables were created to define underweight and severe underweight as a body mass index of less than 18.5 kg/m^2 and of less than 16.0 kg/m^2, respectively (40). For the children, binary variables were created to define stunting, wasting, low weight for age, and low body mass index for age. Each anthropometric measure of child malnutrition was defined as more than two standard deviations (moderate) or more than three standard deviations (severe) below the mean scores determined by the World Health Organization (41).

Anemia status was determined by using the concentration of hemoglobin in capillary blood. After a finger prick, the first two drops of blood were removed. The third drop of blood was drawn into a cuvette for analysis using the HemoCue system (37). For women, binary variables were used to define anemia and severe anemia as a blood hemoglobin level of less than 12.00 g/dl and less than 7.00 g/dl, respectively (42). For children, the analogous levels for anemia and severe anemia were less than 11.00 g/dl and less than 7.00 g/dl (3).

Exposure

Women's experience of domestic violence was the main exposure of interest in this study. Although abuse can take many forms, we conceptualized domestic violence as physical abuse. We created a categorical exposure variable to measure whether the woman reported being physically abused by a family member more than once in the previous 12 months, once in the previous 12 months, since age 15 years but not in the previous 12 months, or never since age 15 years. The exposure in the children's sample was based on which domestic violence category the child's mother reported.

Covariates

We included several socioeconomic and demographic variables: age, religion, caste, education, living standard, employment status, urban-rural status, illness, breastfeeding, number of children, and decision-making autonomy (table 1). Age was specified in 5-year categories. Religion

TABLE 1. Descriptive information on the samples of married women aged 15–49 years and of children aged 12–35 months in the 1998–1999 Indian National Family Health Survey

Variable	Women's sample		Children's sample	
	No. of subjects	%	No. of subjects	%
Total	69,072	100.0	14,552	100.0
Domestic violence				
Never	56,022	81.1	11,665	80.2
More than 1 year ago	6,201	9.0	1,192	8.2
Once in the past year	1,891	2.7	485	3.3
More than once in the past year	4,958	7.2	1,210	8.3
Location				
Large city	7,698	11.1	1,446	9.9
Small city	4,432	6.4	817	5.6
Town	9,625	13.9	1,792	12.3
Village	47,317	68.5	10,497	72.1
Gender				
Female	69,072	100.0	6,920	47.6
Male	0	0.0	7,632	52.5
Religion				
Hindu	54,140	78.4	10,826	74.4
Muslim	7,677	11.1	1,912	13.1
Christian	3,792	5.5	1,058	7.3
Sikh	1,735	2.5	350	2.4
Other/missing	1,728	2.5	406	2.8
Caste				
Scheduled caste	11,711	17.0	2,729	18.8
Scheduled tribe	8,183	11.9	2,189	15.0
Other backward class	20,429	29.6	4,176	28.7
General	28,749	41.6	5,458	37.5
Education				
No formal schooling	33,628	48.7	6,883	47.3
1–5 years	11,689	16.9	2,406	16.5
6–8 years	8,905	12.9	2,074	14.3
9–10 years	8,353	12.1	1,839	12.6
11–12 years	3,019	4.4	647	4.5
≥13 years	3,478	5.0	703	4.8
Occupation				
Not working	44,039	63.8	9,857	67.7
Nonmanual	3,403	4.9	500	3.4
Agricultural	15,684	22.7	3,212	22.1
Manual	5,946	8.6	983	6.8
Living standard (quintile)				
First (lowest)	12,391	17.9	2,911	20.0
Second	13,401	19.4	3,191	21.9
Third	14,200	20.6	3,213	22.1
Fourth	14,563	21.1	2,941	20.2
Fifth (highest)	14,517	21.0	2,296	15.8
Recent illness				
No	65,187	94.4	7,031	48.3
Yes	3,885	5.6	7,521	51.7
Decision-making autonomy (no. of aspects)				
0	5,430	7.9	1,508	10.4
1	15,771	22.8	3,581	24.6
2	12,140	17.6	2,514	17.3
3	12,213	17.7	2,343	16.1
4	23,518	34.1	4,606	31.7
Child's age (months)				
12–17			4,084	28.1
18–23			3,279	22.5
24–29			3,812	26.2
30–35			3,377	23.2
Maternal age at birth (years)				
12–19			3,148	21.6
20–29			5,843	40.2
30–39			3,524	24.2
40–49			2,037	14.0
Birth order				
First			4,281	29.4
Second			3,987	27.4
Third			2,569	17.7
Fourth or greater			3,715	25.5
Age (years)				
15–19	4,677	6.8		
20–24	11,265	16.3		
25–29	14,053	20.4		
30–34	12,864	18.6		
35–39	11,116	16.1		
40–44	8,685	12.6		
45–49	6,412	9.3		
Birth in the past year				
No	59,085	85.5		
Yes	9,987	14.5		
Currently breastfeeding				
No	50,613	73.3		
Yes	18,459	26.7		
No. of children				
0	5,735	8.3		
1	9,277	13.4		
2	15,329	22.2		
3	14,280	20.7		
≥4	24,451	35.4		
Anemia				
No	34,967	50.6	4,338	29.8
Yes	34,105	49.4	10,214	70.2
Severe anemia				
No	68,122	98.6	13,851	95.2
Yes	950	1.4	701	4.8
Underweight				
No	47,106	68.2	12,196	83.8
Yes	21,966	31.8	2,356	16.2
Severe underweight				
No	65,196	94.4	13,819	95.0
Yes	3,876	5.6	733	5.0
Wasting				
No			8,338	57.3
Yes			6,214	42.7
Severe wasting				
No			12,039	82.7
Yes			2,513	17.3
Stunting				
No			6,024	41.4
Yes			8,528	58.6
Severe stunting				
No			9,668	66.4
Yes			4,884	33.6
Low body mass index for age				
No			12,828	88.2
Yes			1,724	11.9
Severe low body mass index for age				
No			13,973	96.0
Yes			579	4.0

Table continues

was grouped as Hindu, Muslim, Christian, Sikh, or other. Caste was based on the identification of the household head as belonging to a scheduled caste, scheduled tribe, other backward class, or the general class. Scheduled castes are those whose members have suffered the greatest burden of deprivation within the caste system (43). Scheduled tribes include approximately 700 officially recognized social groups that have historically been geographically and socially isolated from the rest of India (44). Other backward class is a legislatively defined group representing those who have historically suffered significant deprivation, but not as severe as scheduled castes and tribes. General class is a residual category traditionally viewed as better-off than the above groupings.

Education of the woman was defined in terms of the following categories, each representing significant milestones in the formal Indian education system: 0 years, 1–5 years, 6–8 years, 9–10 years, 11–12 years, or 13 or more years. Living standard, defined in terms of material possessions, is a reliable and valid measure of household material well-being or wealth (45). Each person was assigned a living standard score based on a combination of the responses for 19 different household characteristics, such as the quality of the home and ownership of a bicycle, that were weighted according to a factor analysis procedure (46). The analytic models used quintiles of these weighted scores. Employment was classified according to whether the woman was not working or was working in a manual, nonmanual, or agricultural profession. Information from the 1991 Indian National Census was used to create categories defining whether each neighborhood was in an urban area of over 1 million people (large city), an urban area of between 100,000 and 1 million people (small city), an urban area of less than 100,000 people (town), or a rural area (village).

A binary illness variable measured whether a woman suffered from one or more of the following conditions: tuberculosis currently, malaria in the previous 3 months, or jaundice in the previous 12 months. A binary breastfeeding variable measured whether the woman was currently breastfeeding a child. Number of children born included all livebirths and was categorized as none, one, two, three, or four or more. Decision-making autonomy was a categorical variable indicating the number of types of family decisions a woman participated in making, including what to cook, whether to obtain health care, whether to purchase jewelry or other household items, and whether to visit and stay with her relatives (47).

In the analyses of the children's data set, we included a number of covariates analogous to those in the women's data set: rural/urban residence, religion, caste, maternal education, maternal employment, living standard, and maternal decision-making autonomy. The analyses additionally included gender, age, maternal age at birth, birth order, and recent illness. A binary gender variable distinguished boys and girls. Child age was measured in 6-month categories. Maternal age at birth was categorized as 12–19, 20–29, 30–39, and 40–49 years. Birth order determined whether the child was the first, second, third, or greater than third livebirth from the same mother. A binary illness variable indicated whether the mother reported that the child had had a fever, cough, or diarrhea in the previous 2 weeks.

Statistical analysis

To adjust for clustering of observations at multiple levels, data were analyzed by using logistic multilevel modeling procedures (48), the strengths and relevance of which are well described (49–51). We specified a three-level model for each binary response (y, severely anemic or not) for individual i living in neighborhood j in state k of the form, $\pi_{ijk} : y_{ijk} \sim$ Bernoulli (1, π_{ijk}). The probability π_{ijk} was related to a set of predictors, X, and a random effect for each level, by a logit-link function as Logit $(\pi_{ijk}) = \log [\pi_{ijk}/(1 - \pi_{ijk})] = \beta_0 + \beta X + u_{0jk} + v_{0k}$. The linear predictor on the right-hand side of the equation consisted of a fixed part ($\beta_0 + \beta X$) estimating the conditional coefficients for the exposure variable (and covariates) and two random intercepts attributable to neighborhoods (u_{0jk}) and states (v_{0k}), with each assumed to have an independent and identical distribution and variance estimated at each level. All models were created by using penalized quasi-likelihood approximation with second-order Taylor linearization as implemented in MLwiN 2.02 software (52, 53).

Human subjects

Study details were approved by the Harvard School of Public Health Institutional Review Board. Data collection, including informed consent, was performed by the International Institute of Population Sciences under the direction and supervision of staff of Measure DHS, a project overseen by the US Agency for International Development, in accordance with principles outlined in the Declaration of Helsinki (54).

RESULTS

Approximately 19 percent of women reported domestic violence, and 19.8 percent of the children had mothers who reported domestic violence (table 1). Women suffered high rates of malnutrition, with nearly half having anemia (severe: 1.4 percent) and nearly a third being underweight (severely: 5.6 percent). Children also experienced high levels of malnourishment: 70 percent had anemia (severe: 4.8 percent), over half were stunted (severely: 33.6 percent), 42.7 percent were wasted (severely: 17.3 percent), 16.2 percent were underweight for age (severely: 5.0 percent), and 11.9 percent had low body mass index for age (severely: 4.0 percent).

In unadjusted models, women who reported more than one instance of domestic violence in the previous year had a substantially increased likelihood of having anemia (odds ratio (OR) = 1.22, 95 percent confidence interval (CI): 1.14, 1.30; p for trend < 0.0001) and severe anemia (OR = 1.54, 95 percent CI: 1.25, 1.91; p for trend < 0.0001). Although adjustment for demographic variables attenuated these associations, reporting more than one instance of domestic violence in the previous year was still found to be strongly associated with anemia (OR = 1.11, 95 percent CI: 1.04, 1.18; p for trend = 0.01) and severe anemia (OR = 1.27, 95 percent CI: 1.02, 1.57; p for trend = 0.04) (table 2). In unadjusted models, women who reported more than one

TABLE 2. Odds ratios and 95% confidence intervals for anemia and underweight, by report of domestic violence, among married women aged 15–49 years in the 1998–1999 Indian National Family Health Survey

Domestic violence	Unadjusted		Adjusted*		Unadjusted		Adjusted*	
	OR†	95% CI†	OR	95% CI	OR	95% CI	OR	95% CI
	Any anemia				Severe anemia			
Never (reference)	1.00		1.00		1.00		1.00	
More than 1 year ago	1.01	0.95, 1.07	0.97	0.92, 1.03	1.14	0.92, 1.42	1.01	0.81, 1.26
Once in the past year	1.06	0.96, 1.17	0.99	0.90, 1.09	1.29	0.91, 1.85	1.12	0.78, 1.60
More than once in the past year	1.22	1.14, 1.30	1.11	1.04, 1.18	1.54	1.25, 1.91	1.27	1.02, 1.57
p for trend	<0.0001		0.01		<0.0001		0.04	
	Any underweight				Severe underweight			
Never (reference)	1.00		1.00		1.00		1.00	
More than 1 year ago	1.12	1.05, 1.19	1.01	0.95, 1.07	1.28	1.14, 1.44	1.10	0.98, 1.23
Once in the past year	1.38	1.25, 1.53	1.16	1.05, 1.28	1.30	1.06, 1.58	1.11	0.91, 1.36
More than once in the past year	1.51	1.41, 1.61	1.21	1.13, 1.29	1.48	1.31, 1.67	1.20	1.06, 1.35
p for trend	<0.0001		<0.0001		<0.0001		0.001	

* Models were adjusted for rural/urban location, age, religion, caste, education, employment, living standard, recent birth, current breastfeeding, number of children born, decision-making autonomy, and affliction with recent major illness.

† OR, odds ratio; CI, confidence interval.

instance of domestic violence in the previous year also had an increased likelihood of being underweight (OR = 1.51, 95 percent CI: 1.41, 1.61; p for trend < 0.0001) and severely underweight (OR = 1.48, 95 percent CI: 1.31, 1.67; p for trend < 0.0001). Adjustment for demographic variables attenuated the strength of the associations, but they remained strong for both underweight (OR = 1.21, 95 percent CI: 1.13, 1.29; p for trend < 0.0001) and severe underweight (OR = 1.20, 95 percent CI: 1.06, 1.35; p for trend < 0.001) (table 2).

The associations between domestic violence and nearly all nutritional outcomes were in the same direction and of the same approximate strength for children as they were for women (table 3). In unadjusted models, maternal report of multiple instances of domestic violence in the previous year was found to be associated with anemia (OR = 1.27, 95 percent CI: 1.08, 1.48; p for trend = 0.001) and severe anemia (OR = 1.50, 95 percent CI: 1.17, 1.93; p for trend = 0.002), but adjustment reduced these associations substantially (OR = 1.06, 95 percent CI: 0.91, 1.24; p for trend = 0.37 and OR = 1.26, 95 percent CI: 0.97, 1.63; p for trend = 0.12, respectively). In unadjusted models, associations of maternal report of multiple instances of domestic violence in the previous year with all anthropometric measures of nutritional status were statistically significant. Although adjusting for demographic characteristics reduced the strength of the associations between maternal report of multiple instances of domestic violence in the previous year and all anthropometric measures of malnutrition among children, the relation remained marked for wasting (OR = 1.18, 95 percent CI: 1.03, 1.35; p for trend = 0.02), stunting (OR = 1.14, 95 percent CI: 0.99, 1.31; p for trend = 0.04), severely underweight for age (OR = 1.34, 95 percent CI: 1.05, 1.70; p for trend = 0.01), low body mass index for age (OR = 1.21, 95 percent CI: 1.01, 1.46; p for trend = 0.08), and severely low body mass index for age (OR = 1.50, 95 percent CI: 1.15, 1.95; p for trend = 0.0006).

Additional analyses were performed by using data on children less than 12 months of age. However, none of these associations approached traditional levels of statistical significance.

DISCUSSION

The results from this study of two large, nationally representative data sets provide evidence for a relation between domestic violence and malnutrition among women and children in India. These findings persisted, even after adjusting for geographic variation and a number of demographic characteristics, including multiple domains of socioeconomic status, that are strong confounders of domestic violence and chronic malnourishment. These findings also exhibited a dose-response relation, with frequent and recent abuse found to be associated with the highest probability of poor nutritional outcomes, particularly among women. To put our findings in context, a review of studies investigating the effect of administration of intestinal anthelmintic drugs on hemoglobin found that mass treatment of communities for intestinal parasites decreases the prevalence of anemia by 1.1–12.4 percent in adults (55), indicating that preventing domestic violence could be just as effective as this pharmaceutical approach in combating anemia among women.

We offer two explanations for the positive association between exposure to domestic violence and malnutrition among women and children. The first relates to empowerment. Perpetrators of domestic violence often use several types of abuse, such as physical and psychological, to control behavior of their family members (56). The withholding of food is a documented form of abuse in Indian households

TABLE 3. Odds ratios and 95% confidence intervals for anemia and underweight, by maternal report of domestic violence, among children aged 12–35 months in the 1998–1999 Indian National Family Health Survey

Maternal domestic violence	Unadjusted		Adjusted*		Unadjusted		Adjusted*	
	OR†	95% CI†	OR	95% CI	OR	95% CI	OR	95% CI
	Anemia				Severe anemia			
Never (reference)	1.00		1.00		1.00		1.00	
More than 1 year ago	1.01	0.87, 1.17	0.94	0.81, 1.10	1.12	0.84, 1.49	1.02	0.76, 1.35
Once in the past year	1.26	1.00, 1.60	1.16	0.91, 1.47	1.09	0.72, 1.67	0.99	0.65, 1.52
More than once in the past year	1.27	1.08, 1.48	1.06	0.91, 1.24	1.50	1.17, 1.93	1.26	0.97, 1.63
p for trend	0.001		0.37		0.002		0.12	
	Wasting				Severe wasting			
Never (reference)	1.00		1.00		1.00		1.00	
More than 1 year ago	1.21	1.06, 1.38	0.98	0.86, 1.12	1.06	0.89, 1.26	0.86	0.72, 1.02
Once in the past year	1.36	1.12, 1.65	1.06	0.87, 1.30	1.30	1.01, 1.66	1.03	0.81, 1.32
More than once in the past year	1.66	1.45, 1.89	1.18	1.03, 1.35	1.45	1.24, 1.69	1.05	0.90, 1.23
p for trend	<0.0001		0.02		<0.0001		0.69	
	Stunting				Severe stunting			
Never (reference)	1.00		1.00		1.00		1.00	
More than 1 year ago	1.15	1.01, 1.31	0.94	0.82, 1.08	1.13	0.99, 1.30	0.99	0.93, 1.04
Once in the past year	1.57	1.27, 1.93	1.25	1.01, 1.55	1.44	1.18, 1.76	0.98	0.90, 1.06
More than once in the past year	1.54	1.34, 1.76	1.14	0.99, 1.31	1.48	1.30, 1.69	0.97	0.92, 1.03
p for trend	<0.0001		0.04		<0.0001		0.28	
	Underweight for age				Severe underweight for age			
Never (reference)	1.00		1.00		1.00		1.00	
More than 1 year ago	1.17	0.99, 1.38	1.05	0.89, 1.25	1.04	0.79, 1.38	0.95	0.71, 1.26
Once in the past year	1.18	0.92, 1.53	1.03	0.80, 1.34	1.50	1.04, 2.16	1.34	0.92, 1.94
More than once in the past year	1.37	1.17, 1.61	1.11	0.94, 1.30	1.62	1.28, 2.05	1.34	1.05, 1.70
p for trend	<0.0001		0.21		<0.0001		0.01	
	Low body mass index for age				Severe low body mass index for age			
Never (reference)	1.00		1.00		1.00		1.00	
More than 1 year ago	1.15	0.94, 1.40	1.07	0.87, 1.30	1.17	0.86, 1.58	1.09	0.80, 1.49
Once in the past year	1.04	0.76, 1.42	0.93	0.68, 1.28	1.79	1.21, 2.64	1.65	1.11, 2.45
More than once in the past year	1.44	1.20, 1.73	1.21	1.01, 1.46	1.71	1.32, 2.22	1.50	1.15, 1.95
p for trend	0.0002		0.08		<0.0001		0.0006	

* Models were adjusted for rural/urban location, gender, child's age, maternal age at birth, religion, caste, education, employment, living standard, birth order, maternal decision-making autonomy, and affliction with recent illness.

† OR, odds ratio; CI, confidence interval.

and is likely correlated with the perpetration of physical violence (20). An inadequate diet resulting from this withholding of food through psychological or emotional abuse could mediate the relation between physical domestic violence and nutrient deficiencies that cause anemia and underweight. Additionally, domestic violence is strongly associated with a woman's inability to make decisions for herself and her family, including the choice of types and quantities of food that a woman prepares as she cares for herself and her children (36). This might also explain why no significant associations were found between maternal report of domestic violence and nutritional outcomes in children less than 12 months of age, since a majority of these children in India are breastfed (57), and thus their feeding is more closely controlled by their mothers. Although a measure of decision-making autonomy was included in our models, this measure of autonomy does not have a temporal component. That is, it may be that many women who reported participation in family decision making exercise this power at times but only at the will of their husbands, and that this participation in decision making can be curtailed as a form of abuse.

The second explanation is that the link between domestic violence and nutritional deficiencies may also involve a mediating effect of psychological stress. Women who experience domestic violence tend to have higher levels of psychological stress (58)—a relation that has been documented among south Asian women (12, 59). Children who have witnessed domestic violence in their homes are also more likely to experience psychological stress (14, 60, 61).

There are physiological reasons why psychological stress may be associated with anemia. Psychological stress is a risk factor for oxidative stress (15–18), a term describing a number of chemical reactions that produce free radicals and other organic molecules capable of damaging living tissue (62). This oxidative stress can destroy red blood cells prematurely, acting as a potential cause of hemolytic anemia (63, 64). Additionally, although acute stressful incidents temporarily increase blood levels of both hemoglobin and erythrocytes, chronic stress has been found to result in long-term reductions, suggesting that stress interferes with protein synthesis required to create new red blood cells (65).

Psychological stress could also be linked to underweight status. Most research in food-rich environments in industrialized nations has documented a link between chronic stress and obesity mediated by metabolic changes (66) or behavioral adjustments (67) that promote the depositing of abdominal adipose. However, chronic stress also increases metabolic rate and energy expenditure (19, 68, 69), a process that could cause weight loss in a person with a fixed and limited caloric intake. That psychological stress may be associated with underweight in a low-income country is consistent with the results of a longitudinal study from the United Kingdom finding that, under stressful conditions, lean subjects tend to lose weight while overweight subjects tend to gain weight (70).

We note several important caveats to the findings presented here. First, although psychological, emotional, and sexual abuse constitute a substantial proportion of all domestic violence incidents (56, 71, 72), this information was not available in the current study. Our results present the relation between malnutrition and physical domestic violence, but it could be that other forms of abuse have different associations. Another caveat involves the measurement of domestic violence with a single global question. Previous research has found that behaviorally specific questions asking, for example, whether a woman has been slapped, punched, or kicked result in higher rates of reported domestic violence than the global question used in this survey (73). A local study from Karnataka state also found that over half of all women would keep quiet about it if abused (74). In addition, our analysis investigated only physical domestic violence and could not address other forms of abuse. These circumstances may account for the fact that the prevalence of domestic violence reported in this sample is lower than that previously found in India (12). However, by adjusting our models for a number of important socioeconomic and demographic variables including wealth, education, occupation, religion, and caste, we worked to limit the influence of bias introduced by social patterning of reliability of domestic violence reports on our results. A third caveat relates to the cross-sectional nature of the data. Although we attempted to address the idea of causal direction as best we could with the temporal reporting of domestic violence, it still was not possible to distinguish whether any reported abuse preceded attainment of the current nutritional status. Longitudinal research is called for to untangle this question.

In conclusion, domestic violence adversely impacts numerous health outcomes in India, including gynecologic morbidity (75, 76), contraceptive use (77), asthma (78), tobacco use (79), attempted suicide (13), and early child mortality (80). To our knowledge, this is the first large, nationally representative study using objective measures of malnutrition and measurement of multiple covariates to show a robust association between domestic violence and the likelihood of malnutrition among women and children. Additional adverse health effects of domestic violence suggest that public policy interventions to reduce domestic violence not only are fundamentally important from a moral and intrinsic perspective (81) but that there is a clear case to focus on reducing domestic violence given the instrumental health benefits that are likely to accrue.

ACKNOWLEDGMENTS

S. V. Subramanian is supported by the National Institutes of Health Career Development Award (NHLBI 1 K25 HL081275).

The authors acknowledge the support of Macro International Inc. (Washington, DC) for providing access to the data. They also acknowledge Amy Cohen for her invaluable assistance with programming and data management.

Leland Ackerson led the analysis, interpretation, and writing of the manuscript. S. V. Subramanian conceived the study and contributed to analysis, interpretation, and writing of the manuscript. Both authors reviewed and approved the final manuscript.

Conflict of interest: none declared.

REFERENCES

1. Murray CJ, Lopez AD. Global mortality, disability, and the contribution of risk factors: Global Burden of Disease Study. Lancet 1997;349:1436–42.
2. Mason JB, Musgrove P, Habicht JP. At least one-third of poor countries' disease burden is due to malnutrition. Bethesda, MD: Disease Control Priorities Project, Fogarty International Center, National Institutes of Health, 2003. (Working paper no. 1).
3. WHO. Iron deficiency anaemia assessment, prevention, and control: a guide for programme managers. Geneva, Switzerland: World Health Organization, 2001.
4. Stoltzfus RJ. Iron deficiency: global prevalence and consequences. Food Nutr Bull 2003;24(suppl):S99–103.
5. Turkoski BB. Tired blood. Part 2. Orthop Nurs 2003;22:363–8.
6. Shetty PS, James WPT. Body mass index: a measure of chronic energy deficiency in adults. Rome, Italy: Food and Agriculture Organization of the United Nations, 1994. (FAO food and nutrition paper 56).

7. Rodgers A, Ezzati M, Vander Hoorn S, et al. Distribution of major health risks: findings from the Global Burden of Disease study. PLoS Med 2004;1:e27.
8. IIPS. 2005–2006 National Family Health Survey (NFHS-3) national fact sheet: India (provisional data). Mumbai, India: International Institute for Population Sciences, 2007.
9. Stoltzfus RJ, Dreyfuss ML. Guidelines for the use of iron supplements to prevent and treat iron deficiency anemia. Washington, DC: International Life Sciences Institute, 1998.
10. Subramanian SV, Kawachi I, Davey Smith G. Income inequality and the double burden of under- and overnutrition in India. J Epidemiol Community Health 2007;61:802–9.
11. Subramanian SV, Davey Smith G. Patterns, distribution, and determinants of under- and overnutrition: a population-based study of women in India. Am J Clin Nutr 2006;84:633–40.
12. Kumar S, Jeyaseelan L, Suresh S, et al. Domestic violence and its mental health correlates in Indian women. Br J Psychiatry 2005;187:62–7.
13. Vizcarra B, Hassan F, Hunter WM, et al. Partner violence as a risk factor for mental health among women from communities in the Philippines, Egypt, Chile, and India. Inj Control Saf Promot 2004;11:125–9.
14. Kitzmann KM, Gaylord NK, Holt AR, et al. Child witnesses to domestic violence: a meta-analytic review. J Consult Clin Psychol 2003;71:339–52.
15. Epel ES, Blackburn EH, Lin J, et al. Accelerated telomere shortening in response to life stress. Proc Natl Acad Sci U S A 2004;101:17312–15.
16. Hapuarachchi JR, Chalmers AH, Winefield AH, et al. Changes in clinically relevant metabolites with psychological stress parameters. Behav Med 2003;29:52–9.
17. Irie M, Asami S, Nagata S, et al. Relationships between perceived workload, stress and oxidative DNA damage. Int Arch Occup Environ Health 2001;74:153–7.
18. Sivonova M, Zitnanova I, Hlincikova L, et al. Oxidative stress in university students during examinations. Stress 2004;7:183–8.
19. Seematter G, Guenat E, Schneiter P, et al. Effects of mental stress on insulin-mediated glucose metabolism and energy expenditure in lean and obese women. Am J Physiol Endocrinol Metab 2000;279:E799–805.
20. Raj A, Livramento KN, Santana MC, et al. Victims of intimate partner violence more likely to report abuse from in-laws. Violence Against Women 2006;12:936–49.
21. Garcia-Moreno C, Jansen HA, Ellsberg M, et al. Prevalence of intimate partner violence: findings from the WHO multicountry study on women's health and domestic violence. Lancet 2006;368:1260–9.
22. Hassan F, Sadowski LS, Bangdiwala SI, et al. Physical intimate partner violence in Chile, Egypt, India and the Philippines. Inj Control Saf Promot 2004;11:111–16.
23. Bates LM, Schuler SR, Islam F, et al. Socioeconomic factors and processes associated with domestic violence in rural Bangladesh. Int Fam Plan Perspect 2004;30:190–9.
24. Martin SL, Tsui AO, Maitra K, et al. Domestic violence in northern India. Am J Epidemiol 1999;150:417–26.
25. Burton B, Duwury N, Varia N. Domestic violence in India: a summary report of a multi-site household survey. Washington, DC: International Center for Research on Women, 2000.
26. Khosla AH, Dua D, Devi L, et al. Domestic violence in pregnancy in North Indian women. Indian J Med Sci 2005;59:195–9.
27. Panda P, Agarwal B. Marital violence, human development and women's property status in India. World Dev 2005;33:823–50.
28. Peedicayil A, Sadowski LS, Jeyaseelan L, et al. Spousal physical violence against women during pregnancy. Br J Obstet Gynaecol 2004;111:682–7.
29. Ackerson LK, Kawachi I, Barbeau EM, et al. Effects of individual and proximate educational context on Intimate Partner Violence (IPV): a population-based study of women in India. Am J Public Health 2008;98:507–14.
30. Krishnan S. Do structural inequalities contribute to marital violence? Ethnographic evidence from rural South India. Violence Against Women 2005;11:759–75.
31. Krishnan S. Gender, caste, and economic inequalities and marital violence in rural South India. Health Care Women Int 2005;26:87–99.
32. Naved RT, Persson LA. Factors associated with spousal physical violence against women in Bangladesh. Stud Fam Plann 2005;36:289–300.
33. Koenig MA, Ahmed S, Hossain MB, et al. Women's status and domestic violence in rural Bangladesh: individual- and community-level effects. Demography 2003;40:269–88.
34. Koenig MA, Stephenson R, Ahmed S, et al. Individual and contextual determinants of domestic violence in North India. Am J Public Health 2006;96:132–8.
35. Ackerson LK, Subramanian SV. State gender inequality, socioeconomic status and intimate partner violence in India: a multilevel analysis. Aust J Soc Issues (in press).
36. Sethuraman K, Lansdown R, Sullivan K. Women's empowerment and domestic violence: the role of sociocultural determinants in maternal and child undernutrition in tribal and rural communities in South India. Food Nutr Bull 2006;27:128–43.
37. International Institute for Population Sciences and ORC-Macro. National Family Health Survey India 1998/1999: India. Mumbai, India: Andhra Pradesh International Institute for Population Sciences, 2000.
38. Black RE, Allen LH, Bhutta ZA, et al. Maternal and child undernutrition: global and regional exposures and health consequences. Lancet 2008;371:243–60.
39. Waterlow JC. Classification and definition of protein-calorie malnutrition. Br Med J 1972;3:566–9.
40. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet 2004;363:157–63.
41. WHO. WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. Geneva, Switzerland: World Health Organization, 2006.
42. WHO. The prevalence of anemia in women: a tabulation of available information. Geneva, Switzerland: World Health Organization, 1992.
43. Subramanian SV, Nandy S, Irving M, et al. The mortality divide in India: the differential contributions of gender, caste, and standard of living across the life course. Am J Public Health 2006;96:818–25.
44. Subramanian SV, Davey Smith G, Subramanyam M. Indigenous health and socioeconomic status in India. PLoS Med 2006;3:e421.
45. Filmer D, Pritchett LH. Estimating wealth effects without expenditure data—or tears: an application to educational enrollments in states of India. Demography 2001;38:115–32.
46. Rutstein SO, Johnson K. The DHS wealth index: DHS comparative reports 6. Calverton, MD: ORC Macro, 2004.
47. Moursund A, Kravdal O. Individual and community effects of women's education and autonomy on contraceptive use in India. Popul Stud (Camb) 2003;57:285–301.
48. Goldstein H. Multilevel statistical models. London, United Kingdom: Arnold, 2003.

49. Blakely T, Subramanian SV. Multilevel studies. In: Oakes JM, Kaufman JS, eds. Methods in social epidemiology. San Francisco, CA: Jossey-Bass, 2006:316–40.
50. Subramanian SV. The relevance of multilevel statistical methods for identifying causal neighborhood effects. Soc Sci Med 2004;58:1961–7.
51. Subramanian SV, Jones K, Duncan C. Multilevel methods for public health research. In: Kawachi I, Berkman LF, eds. Neighborhoods and health. New York, NY: Oxford University Press, 2003:65–111.
52. Goldstein H, Rasbash J. Improved approximations for multilevel models with binary responses. J R Stat Soc (A) 1996; 159:505–13.
53. Rasbash J, Steele F, Browne W, et al. A user's guide to MLwiN, version 2.0. Bristol, United Kingdom: Centre for Multilevel Modelling, 2005.
54. World Medical Association. Ethical principles for medical research involving human subjects. Declaration of Helsinki. 2004. (http://www.wma.net/e/policy/b3.htm). (Accessed March 5, 2008).
55. Gulani A, Nagpal J, Osmond C, et al. Effect of administration of intestinal anthelmintic drugs on haemoglobin: systematic review of randomised controlled trials. BMJ 2007;334:1095.
56. Pence E, McDonnell C. Power and control wheel. Duluth, MN: Domestic Abuse Intervention Project, 1984.
57. Malhotra R, Noheria A, Amir O, et al. Determinants of termination of breastfeeding within the first two years of life in India: evidence from the National Family Health Survey-2 (NFHS-2). Matern Child Nutr (in press).
58. Briere J, Jordan CE. Violence against women: outcome complexity and implications for assessment and treatment. J Interpers Violence 2004;19:1252–76.
59. Fikree FF, Bhatti LI. Domestic violence and health of Pakistani women. Int J Gynaecol Obstet 1999;65:195–201.
60. Campbell JC, Lewandowski LA. Mental and physical health effects of intimate partner violence on women and children. Psychiatr Clin North Am 1997;20:353–74.
61. Finkelstein J, Yates JK. Traumatic symptomatology in children who witness marital violence. Int J Emerg Ment Health 2001;3:107–14.
62. Halliwell B. Free radicals, antioxidants, and human disease: curiosity, cause, or consequence? Lancet 1994;344:721–4.
63. Lang F, Lang KS, Lang PA, et al. Mechanisms and significance of eryptosis. Antioxid Redox Signal 2006;8:1183–92.
64. Sivilotti ML. Oxidant stress and haemolysis of the human erythrocyte. Toxicol Rev 2004;23:169–88.
65. Mischler K, Fischer JE, Zgraggen L, et al. The effect of repeated acute mental stress on habituation and recovery responses in hemoconcentration and blood cells in healthy men. Life Sci 2005;77:1166–79.
66. Kyrou I, Chrousos GP, Tsigos C. Stress, visceral obesity, and metabolic complications. Ann N Y Acad Sci 2006;108: 77–110.
67. Dallman MF, Pecoraro NC, la Fleur SE. Chronic stress and comfort foods: self-medication and abdominal obesity. Brain Behav Immun 2005;19:275–80.
68. Seematter G, Dirlewanger M, Rey V, et al. Metabolic effects of mental stress during over- and underfeeding in healthy women. Obes Res 2002;10:49–55.
69. Seywert AJ, Tappy L, Gremion G, et al. Effect of a program of moderate physical activity on mental stress-induced increase in energy expenditure in obese women. Diabetes Metab 2002;28:178–83.
70. Kivimaki M, Head J, Ferrie JE, et al. Work stress, weight gain and weight loss: evidence for bidirectional effects of job strain on body mass index in the Whitehall II study. Int J Obes (Lond) 2006;30:982–7.
71. Heise L, Garcia-Moreno C. Violence by intimate partners. In: Krug EG, Dahlberg LL, Mercy JA, et al, eds. World report on violence and health. Geneva, Switzerland: World Health Organization, 2002.
72. Watts C, Zimmerman C. Violence against women: global scope and magnitude. Lancet 2002;359:1232–7.
73. Ellsberg M, Heise L, Pena R, et al. Researching domestic violence against women: methodological and ethical considerations. Stud Fam Plann 2001;32:1–16.
74. Rao V. Wife-beating in rural south India: a qualitative and econometric analysis. Soc Sci Med 1997;44:1169–80.
75. Sudha S, Morrison S, Zhu L. Violence against women, symptom reporting, and treatment for reproductive tract infections in Kerala state, southern India. Health Care Women Int 2007;28:268–84.
76. Stephenson R, Koenig MA, Ahmed S. Domestic violence and symptoms of gynecologic morbidity among women in North India. Int Fam Plan Perspect 2006;32:201–8.
77. Stephenson R, Koenig MA, Ahmed S. Domestic violence and contraceptive adoption in Uttar Pradesh, India. Stud Fam Plann 2006;37:75–86.
78. Subramanian SV, Ackerson LK, Subramanyam MA, et al. Domestic violence is associated with adult and childhood asthma prevalence in India. Int J Epidemiol 2007;36: 569–79.
79. Ackerson LK, Kawachi I, Barbeau EM, et al. Exposure to domestic violence associated with adult smoking in India: a population based study. Tob Control 2007;16:378–83.
80. Ahmed S, Koenig MA, Stephenson R. Effects of domestic violence on perinatal and early-childhood mortality: evidence from north India. Am J Public Health 2006;96:1423–8.
81. Jejeebhoy SJ, Cook RJ. State accountability for wife-beating: the Indian challenge. Lancet 1997;349(suppl 1):sI10–2.