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Relationship of maternal knowledge of anemia with maternal and child anemia and health-related behaviors targeted at anemia among families in Indonesia

Ellie S. Souganidis[1], **Kai Sun**[1], **Saskia de Pee**[2], **Klaus Kraemer**[3], **Jee-Hyun Rah**[3], **Regina Moench-Pfanner**[4], **Mayang Sari**[5], **Martin W. Bloem**[2], and **Richard D. Semba**[1]

[1]Department of Ophthalmology, Johns Hopkins University School of Medicine, 400 N. Broadway, M015, Baltimore, Maryland, USA [2]Nutrition Service, Policy, Strategy and Programme Support Division, World Food Programme, Rome, Italy [3]Sight and Life, Basel, Switzerland [4]Global Alliance for Improved Nutrition (GAIN), Geneva, Switzerland [5]Helen Keller International, New York, NY, USA

Abstract

Objectives—Our specific aim was to characterize maternal knowledge of anemia and its relationship to maternal and child anemia and to behaviors related to anemia reduction.

Methods—We examined the relationship between maternal knowledge of anemia and anemia in the mother and the youngest child, aged 6–59 mo, in 7,913 families from urban slums and 37,874 families from rural areas of Indonesia. Knowledge of anemia was defined based upon the mother's ability to correctly name at least one symptom of anemia and at least one treatment or strategy for reducing anemia. Hemoglobin was measured in both the mother and the child.

Results—In urban and rural areas, respectively, 35.8% and 36.9% of mothers had knowledge of anemia, 28.7% and 25.1% of mothers were anemic (hemoglobin <12 g/dL), and 62.3% and 54.0% of children were anemic (hemoglobin <11 g/dL). Maternal knowledge of anemia was associated with child anemia in urban and rural areas, respectively, (Odds Ratio [O.R.] 0.90, 95% Confidence Interval [C.I.] 0.79, 1.02, $P = 0.10$; O.R. 0.93, 95% C.I. 0.87, 0.98, $P = 0.01$) in multivariate logistic regression models adjusting for potential confounders. There was no significant association between maternal knowledge of anemia and maternal anemia. Maternal knowledge of anemia was significantly associated with iron supplementation during pregnancy and child consumption of fortified milk. There was no association of maternal knowledge of anemia with child deworming.

Conclusions—Maternal knowledge of anemia is associated with lower odds of anemia in children and with some health behaviors related to reducing anemia.

Keywords

anemia; children; knowledge; mothers; Indonesia

Correspondence: Richard D. Semba, MD MPH, Johns Hopkins School of Medicine, 400 N. Broadway, M015, Baltimore, MD 21287; Tel 1-410-955-3572, Fax 1-410-502-1759; rdsemba@jhmi.edu.

Introduction

Iron deficiency anemia is the leading cause of anemia worldwide, accounting for approximately 50% of the total prevalence (1,2). Iron deficiency can result in impaired cognition, decreased physical capacity, and reduced immunity as well as impaired psychomotor and cognitive development in children (3–5). Pregnant women are particularly at risk for iron deficiency anemia because of blood volume expansion during pregnancy (6) and the need to support the fetus and placenta (7). In women of childbearing age, blood loss due to childbirth or menses can also be a contributing factor to the development of iron deficiency anemia (8).

The increased risk of iron deficiency anemia during pregnancy has motivated government ministries in many developing countries to implement policies providing iron supplementation for pregnant and lactating women (9). In Indonesia, it is a government recommendation for women to receive iron supplements during pregnancy and the post-partum period (9). The most recently available national survey data from Indonesia indicate that the prevalence of anemia has declined in pregnant women and women of reproductive age to rates of 40% and 27.9%, respectively. However, the anemia prevalence in children aged 0–59 months has increased from 40% to 48.1%, with a prevalence rate of greater than 55% in children less than 24 months of age (10).

Despite the implementation of large-scale programs targeted towards pregnant women and women of reproductive age, the prevalence of anemia remains high (11). Factors that limit the success of iron supplementation include inadequate supply, delivery, and distribution systems, limited access to health care providers and prenatal care, ineffective social marketing, and overall poor monitoring and evaluation of supplementation programs (11–13). The knowledge and attitudes women hold regarding anemia may also play a role in the limited success of these programs. In a survey conducted in eight developing countries, anemia was more commonly recognized by its symptoms instead of by a disease name or clinical diagnosis (9). Only half of women considered these symptoms to be of concern, and many women who took iron supplements, primarily provided through prenatal care, did not understand the reason for treatment (9). Negative attitudes towards iron supplementation, derived from side effects, concerns with the tablet’s bad taste, or fears of adverse outcomes, could facilitate non-compliance, even if the benefits of iron supplementation are known.

Maternal knowledge of anemia is important because of its potential to encourage women to take iron supplements during pregnancy and after childbirth, affecting the iron status of both the mother and the child. In a small study in southern Israel, the presence of anemia in infants and level of maternal knowledge were inversely related, with low knowledge of anemia leading to a 12-fold increase in prevalence of anemia in infants compared to women with higher levels of knowledge (14).

Increased consumption of animal source foods is an additional health-related behavior that could be encouraged by maternal knowledge of anemia. Benefits of consuming animal source foods include dietary diversity, relatively higher bioavailable forms of micronutrients, and overall better maternal nutrition affecting both the mother and child during pregnancy and lactation (15–17).

Strategies to reduce the prevalence of anemia in children have focused on consumption of fortified milk by the child and administration of deworming medications. Consumption of fortified milk has already proven to be an effective strategy to reduce anemia in children and has been the basis for mandatory fortification of powdered milk with iron, vitamins, and other minerals in Indonesia in the mid-1990s (18). The use of deworming medications in endemic areas has also been shown to help improve iron status in children at high risk for anemia-related morbidity and mortality by reducing the chronic intestinal blood loss associated with hookworm and other parasitic infections (19). There is currently no nationwide deworming policy in Indonesia for children under the age of five. However, deworming medications are administered by small pilot projects in some areas or by parents who suspect that their child is infected.

Our specific aim was to characterize mother's knowledge of anemia and its relationship to anemia in mothers and children and to behaviors related to the reduction of anemia. We hypothesized that women with greater knowledge of anemia would be less likely to be anemic themselves and to have anemic children. We also hypothesized that women with greater knowledge of anemia would be more likely to adopt behaviors aimed at reducing anemia, such as taking iron supplements during pregnancy, having their children consume fortified milk, having their children take deworming medication, and having higher consumption of animal-source foods in the household. To address these hypotheses, we examined the relationship between a mother's knowledge of anemia with the prevalence of anemia in mothers and their children from rural areas and urban slums in Indonesia. We also examined the relationship between a mother's knowledge of anemia and health behaviors that are known to reduce anemia.

Subjects and methods

The study subjects consisted of mothers and children from rural areas that participated in the Nutritional Surveillance System (NSS) in Indonesia from March 1999 to August 2003 and mothers and children from urban slum areas that participated in the NSS from January 1999 to July 2003. The present study was based upon a secondary data analysis of existing NSS data. The NSS was established by the Ministry of Health, Government of Indonesia, and Helen Keller International in 1995 (20). The nutritional surveillance system was based upon UNICEF's conceptual framework on the causes of malnutrition (21) with the underlying principle to monitor public health problems and guide policy decisions (22). The NSS used stratified multistage cluster sampling of households in subdistricts of administrative divisions of the country in rural areas and slum areas of large cities. Data were collected from approximately 40,000 randomly selected households every quarter and involved five major urban poor populations from slum areas in the cities of Jakarta, Surabaya, Makassar, Semarang, and Padang, and the rural population from the provinces of Lampung, Banten, West Java, Central Java, East Java, the island of Lombok (West Nusatenggara), and South Sulawesi. The present study involved households during a period of the NSS in which specific questions were included regarding maternal knowledge of anemia. The analyses are derived from surveys that specifically contained information on anemia in the mother and child and information on maternal knowledge of anemia.

For each child in the family, data were collected on whether the child had consumed industrially produced milk products in the previous week, the commercial brand of the product, and how much money was spent on the milk product in the previous week. Data were also collected on whether the child received a deworming medication in the previous six months. Hemoglobin was measured in mothers and children in the family using a HemoCue© instrument (HemoCue AB, Angelholm, Sweden) and women were also asked whether they took iron supplementation during their last pregnancy.

In each household, data were gathered regarding the expenditures in the previous week. Expenditure and price variables were collected in Indonesian rupiah. For this analysis, expenditures are presented in US dollars using monthly exchange rates from 2000–2003 available through the Bank of Canada (23). Expenditure on food in this analysis was grouped into three categories: plant source foods (fruit, vegetables, and other plant sources), animal source foods (beef, chicken, poultry, fish, eggs, and milk), and grain source foods (rice and other non-processed staple foods).

The study protocol complied with the principles enunciated in the Helsinki Declaration (24). Written, informed consent was obtained from all participants. The nutritional surveillance system in Indonesia was approved by the Ministry of Health, Government of Indonesia. The plan for secondary data analysis was approved by the Institutional Review Board of the Johns Hopkins University School of Medicine.

The study was limited to children aged 6–59 months because the interpretation of low hemoglobin in children under the age of 6 months is difficult (25). For families with more than one child, aged 6–59 months, the analysis was limited to the youngest child only (i.e. families with more than one child were not counted more than once, since anemia tends to cluster within families). Anemia was defined as hemoglobin <11 g/dL in children and <12 g/dL in non-pregnant women according to World Health Organization criteria (1,26). Pregnant women were not included in the study.

Weekly per capita household expenditure was used as the main indicator of socioeconomic status. Crowding was defined as households where more than four individuals were eating from the same kitchen. Maternal smoking was not used in the analyses because the prevalence of maternal smoking in Indonesia was <0.7% (26). Paternal smoking was included in the analysis as it is known to divert precious household income from food to tobacco and exacerbate malnutrition among women and children (27, 28).

Mothers were asked “Have you ever heard about anemia?” and additional questions regarding anemia if they answered in the affirmative. Mothers were asked to name symptoms of anemia and how the symptoms ought to be addressed. Participants were scored as having knowledge of anemia if they mentioned one of the following symptoms: pale face, weakness/fatigue, pale eyes, pale arm/nail, or headache. Mothers were also scored as knowing about anemia if they were able to provide one of the following treatments: take iron tablet/capsule/vitamin, consume iron-fortified foods, or visit a doctor/midwife/other health worker.

Chi-square tests were used to compare categorical variables between groups. Multivariate logistic regression models were used to examine the relationship between risk factors and anemia clustering. Variables were included in the multivariate models if significant in univariate analyses. $P < 0.05$ was considered significant. Covariance matrices were used to examine for multicollinearity among independent variables in the models. In multivariate models, maternal education but not paternal education was used because of high collinearity between maternal and paternal education. Data analyses were conducted using SAS Survey (SAS Institute, Cary, NC).

Results

The prevalence of anemia in mothers (hemoglobin <12 g/dL) and children (hemoglobin <11 g/dL) from urban slums and rural areas are displayed in Table 1. In urban slums, 28.7% of mothers and 62.3% of children were anemic whereas in rural areas, 25.1% of mothers and 54.0% of children were anemic. The prevalence of anemia in mothers and children from urban slums and rural areas in relation to demographic, socioeconomic, and health-related factors are shown in Tables 2 and 3, respectively. Of 7,913 mothers from urban slums, 35.8% had knowledge of anemia whereas 36.9% of 37,874 rural mothers had knowledge of anemia.

For both urban and rural mothers, factors that were associated with higher odds of anemia in the mother included older maternal age, lower paternal education, mother being underweight, greater number of children in the family, younger child age, paternal smoking, and more than four members sharing the same kitchen. Lower maternal education was also associated with higher odds of anemia in the mother in rural areas. For both urban and rural families, factors associated with lower odds of anemia in the mother included mother being overweight or obese, presence of an improved latrine in the household, greater consumption of plant source foods, and high quintile of per capita household expenditure. Maternal knowledge of anemia, consumption of fortified milk by the child, iron supplementation by the mother during her last pregnancy, and greater consumption of animal source foods were also associated with lower odds of anemia in the mother in rural areas.

For both urban and rural mothers, factors that were associated with a higher odds of anemia in the child included older maternal age, lower maternal and paternal education, mother being underweight, greater number of children in the family, younger child age, female gender of the child, paternal smoking, and more than four members sharing the same kitchen. Greater consumption of grain source foods was also associated with higher odds of anemia in the child in rural areas. For both urban and rural families, factors associated with a lower odds of anemia in the child included mother being overweight or obese, consumption of fortified milk by the child, deworming of the child, presence of an improved latrine in the household, greater consumption of plant source and animal source foods, and high quintile of per capita household expenditure.

Separate multivariate logistic regression models were used to examine the relationship between maternal knowledge of anemia and anemia in the mother in both rural and urban environments (Table 4). In the final multivariate logistic regression models, maternal knowledge of anemia was not significantly associated with anemia in the mother in either rural or urban areas, when adjusting for other covariates. Factors associated with higher odds of anemia in mothers from rural areas and urban slums in the multivariate models included mother being underweight, greater number of children in the family, and more than four individuals eating from the same kitchen. Older maternal age was also associated with higher odds of anemia in the mother in rural areas. Factors associated with lower odds of anemia in mothers from rural areas and urban slums included mother being overweight or obese and older child age. Higher maternal education and consumption of fortified milk by the child were also associated with lower odds of anemia in mothers from rural areas. Increased consumption of plant source foods was associated with lower odds of anemia in mothers from urban areas.

Similarly, separate multivariate logistic regression models were used to examine the relationship between maternal knowledge of anemia and anemia in the child in urban and rural settings (Table 5). In the final multivariate model, maternal knowledge of anemia was significantly associated with lower odds of anemia in the child in families from rural areas (P=0.01) but not in children from urban slums ($P = 0.10$). Factors associated with higher odds of anemia in the child in both rural and urban environments included greater number of children in the family and children who were female. Older maternal age and maternal underweight were also associated with higher odds of anemia in the child in rural areas. Factors associated with lower odds of anemia in the child from rural areas and urban slums included older child age and consumption of fortified milk by the child. Higher maternal education and mother being obese were also associated with lower odds of anemia in children from rural areas. Mother being overweight and households with an improved latrine were associated with lower odds of anemia in children from urban areas.

We examined the relationship between maternal knowledge of anemia and four behaviors related to reducing the risk of anemia: iron supplementation during pregnancy, consumption of fortified milk by the child, deworming of the child, and higher consumption of animal source foods. In urban slums, 85.7% of mothers used iron supplementation during pregnancy, 21.5% of children received deworming medication, and 47.9% of children consumed fortified milk. In rural areas, 84.0% of mothers took iron supplementation during pregnancy, 17.9% of children received deworming medication, and 35.3% of children consumed fortified milk. Separate multivariate logistic regression models were used to examine the relationship of maternal knowledge of anemia to maternal iron supplementation, deworming, child consumption of fortified milk, and consumption of animal source foods in families from urban slums and rural areas (Table 6). In both urban and rural areas, maternal knowledge of anemia was associated with higher odds of consumption of fortified milk by the child and iron supplementation during the mother’s last pregnancy. Maternal knowledge of anemia was also associated with higher odds of per capita consumption of animal source foods by families in rural areas.

Discussion

The present study shows that maternal knowledge of anemia is not protective against anemia in the mother herself but was found to be protective against anemia in the child in rural families and of borderline significance in urban families. There are other factors in addition to maternal knowledge that may play an important role in anemia among mothers and children. For example, the study also showed an association between the consumption of fortified milk and availability of improved latrines with anemia. This study also shows that maternal knowledge of anemia was associated with the consumption of fortified milk by the child and iron supplementation during the mother's last pregnancy in rural and urban families, but not with the use of deworming medication in the child. Maternal knowledge of anemia was also significantly associated with consumption of animal source foods in rural families but not in urban families.

To our knowledge, this is the first population-based study to address the relationship between maternal knowledge of anemia and anemia in the mother. The lack of a protective effect of maternal knowledge of anemia may suggest that although women may understand the consequences of anemia on their health, they may not have the means to effectively reduce their risk for developing anemia. Although there were multiple risk factors associated with higher odds of anemia in the mother, weight was the only variable that could be more directly controlled by the mother.

Maternal knowledge of anemia was associated with the use of iron supplements during pregnancy in both urban and rural areas. In the present study, 85.7% of mothers in urban slums and 84.0% of mothers from rural areas used iron supplementation during their last pregnancy. As previously described, barriers to iron supplementation can have a marked effect on adherence, warranting new efforts to develop more accessible and well-accepted supplementation programs. The use of sprinkles of microencapsulated ferrous fumarate was examined in a controlled trial in Ghanaian children as a potential method to increase adherence by reducing unpleasant side effects associated with ferrous sulfate drops (29). Additional follow-up studies suggested that the sprinkles were as equally efficacious as traditional iron supplementation (30). However, there are similar challenges regarding distribution of the sprinkles, suggesting the need for large-scale distribution programs, more effective health policy, and stronger social marketing strategies. Information, education and communication (IEC) programs have also been developed in an effort to improve the effectiveness of iron supplementation and have been implemented in Indonesia (31,32).

Consumption of fortified milk by the child was also protective against anemia in the child in both rural and urban areas and was significantly associated with maternal knowledge of anemia. These results are consistent with previous interventional studies showing a decrease in the prevalence of anemia in children who consume fortified milk (33,34). Increased efforts to distribute fortified milk could be accomplished by reinforcing its effectiveness through IEC programs or through other forms of social marketing. Efforts could also be made to increase the bioavailability of iron in fortified milk. In the past, ascorbic acid at concentrations between 100–800 mg/l was shown to enhance the effectiveness of iron absorption in fortified milk (35). Similar advancements could allow for children to benefit from fortified-milk even if they are only able to consume a smaller volume or are less compliant.

Maternal knowledge of anemia was significantly associated with consumption of animal source foods in rural areas. However, resource-poor settings make increased consumption of animal source foods a difficult strategy to implement. Household food-processing and preparation methods such as thermal processing, mechanical processing, soaking, fermentation, and germination/malting have been shown to enhance the bioavailability of micronutrients in plant source foods (36). Therefore, a diet consisting of modified plant source foods combined with a small portion of animal source foods could be an effective strategy to improve micronutrient bioavailability and dietary diversity (37).

In rural areas, maternal knowledge of anemia was protective against anemia in children. These findings are consistent with results from a study in Southern Israel, which found an inverse relationship between maternal knowledge of anemia and the presence of anemia in the child (14). Maternal knowledge of anemia and its associated health risks in children also motivated women to tolerate negative side effects associated with iron supplements (9). This further supports the value of maternal knowledge of anemia and suggests that there could be a variety of ways a mother’s knowledge could impact a child’s serum iron status.

The strengths of the present study include the large sample size, the population-based sampling, the general corroboration of findings between families from rural areas and urban slums, and the availability of detailed health surveillance data from each family. The limitations of the study are the cross-sectional design, which limits causal interference. As with any epidemiological study, it is not possible to measure all factors that may influence a mother’s knowledge of anemia or the prevalence of anemia in mothers and their children, and there may be unmeasured confounding factors. In the future, a controlled intervention study of improving maternal knowledge of anemia might yield the strongest evidence for a putative effect of maternal knowledge of anemia on both maternal and child anemia. The wording of the survey may also have been a limitation of the study because knowledge of anemia was only assessed in mothers who claimed to have previously heard of anemia; this suggests that some mothers were never asked about their knowledge of anemia even though it may have been relevant. Furthermore, the survey did not address the mothers’ access to health care in general and specifically for screening and treatment of anemia or the availability of services in the nearest primary health care center to each household. Finally, the findings from this study cannot necessarily be extrapolated to other settings in developing countries, as the present study was conducted in areas that were not endemic for malaria, except for one small area of Lombok.

The apparent protective effect of maternal knowledge of anemia on the prevalence of anemia in the child suggests that further insight is needed into whether increased education of mothers regarding anemia will reduce anemia in the child. The Indramayu Project, a social marketing campaign previously conducted in two sub-districts of Central Java, was aimed at improving the availability of iron supplements, conducting monthly health days, and promoting iron supplementation during pregnancy through maternal education (38). A significant increase in the average number of tablets taken during pregnancy was observed following the two-year campaign, suggesting that educational and social marketing techniques such as posters, leaflets, counseling cards, and local radio broadcasts may have played a role in improving iron supplementation rates (38).

The significant association of maternal knowledge of anemia with both consumption of fortified milk by the child and consumption of animal source foods by the mother also suggest two important focus areas for treatment and prevention of anemia. Further research is needed to determine whether there are other health-related behaviors targeted at anemia that are associated with maternal knowledge of anemia and whether these behaviors are effective strategies that can influence the prevalence of anemia in the population at large.

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Table 1

Sample demographics, socioeconomic, and health-related factors in mothers and children from urban slums and rural areas[1]

Characteristic[2]		**URBAN**		**RURAL**	
		N	**% or Mean (SD)**	**N**	**% or Mean (SD)**
Mother anemic	Yes	2127	28.7	9066	25.1
	No	5274	71.3	27006	74.9
Child anemic	Yes	4922	62.3	20885	55.2
	No	2982	37.7	16916	44.8
Mother heard about anemia	Yes	6886	87.0	30823	81.4
	No	1027	13.0	7051	18.6
Mother knows symptom of anemia[3]	Yes	3526	51.2	18754	60.8
	No	3366	48.8	12097	39.2
Mother knows treatment of anemia[4]	Yes	5155	74.8	21163	68.6
	No	1738	25.2	9674	31.4
Maternal age, y	≤24	2103	26.6	10874	28.7
	25–28	1982	25.0	9247	24.4
	29–32	1748	22.1	8246	21.8
	33+	2080	26.3	9487	25.1
Maternal education, y	0	357	4.5	1936	5.1
	1–6	3530	44.7	19624	52.1
	7–9	1917	24.3	8168	21.7
	≥10	2090	26.5	7928	21.1
Paternal education, y	0	154	2.0	1409	3.9
	1–6	2674	34.7	16791	46.7
	7–9	1916	24.9	7198	20.0
	≥10	2965	38.4	10585	29.4
Maternal body mass index (kg/m^2)	18.5 to <25	4870	62.2	25912	68.8
	<18.5	919	11.7	4595	12.2
	≥25 to <30	1645	21.0	6117	16.2

Characteristic[2]		URBAN		RURAL	
		N	% or Mean (SD)	N	% or Mean (SD)
	≥30	398	5.1	1060	2.8
Number of children, 6–59 months of age	1	6719	84.9	33277	87.9
	2	1146	14.5	4451	11.7
	3+	48	0.6	146	0.4
Age of youngest child, 6–59 months of age	6–11	1402	17.7	7157	18.9
	12–23	2468	31.2	11824	31.2
	24–35	1934	24.4	9245	24.0
	36–47	1360	17.2	6074	16.5
	48–59	749	9.5	3571	9.4
Sex of youngest child, 6–59 months of age	Male	4127	52.2	19591	51.7
	Female	3786	47.8	18283	48.3
Child consumes fortified milk	Yes	3496	48.2	13534	35.7
	No	3755	51.8	24339	64.3
Father is a smoker	Yes	5649	72.5	27437	73.9
	No	2141	27.5	9712	26.1
Household has improved latrine	Yes	6586	83.3	18733	49.5
	No	1319	16.7	19131	50.5
Mother took supplements in last pregnancy	Yes	1821	85.6	9642	84.2
	No	307	14.4	1803	15.8
Weekly per capita expenditure	Grain source food	7905	.33 (.29)	37816	.38 (.39)
	Animal source food	7905	.35 (.32)	37824	.28 (.30)
	Plant source food	7904	.45 (.32)	37805	.35 (.26)
Number of household members eating from same kitchen	2–4	4297	54.4	20590	45.6
	>4	3608	45.6	17232	54.4
Weekly per capita household expenditure, quintile	1	795	10.0	6018	15.9
	2	1004	12.7	6340	16.8
	3	1345	17.0	7211	19.1

Characteristic[2]		**URBAN**		**RURAL**	
		N	**% or Mean (SD)**	**N**	**% or Mean (SD)**
	4	1847	23.4	8218	21.7
	5	2914	36.9	10037	26.5

[1] Total of 7,401 mothers and 7,904 children from urban areas and 36,072 mothers and 37,801 children from rural areas.

[2] Missing data for selected variables (urban/rural): maternal age (0/20), maternal education (19/218), paternal education (205/1891), maternal BMI (81/190), age of youngest child (0/3), child consumes fortified milk (662/1), father is a smoker (123/725), household has improved latrine (8/10), mother took supplements in last pregnancy (5785/26429), number of household members eating from same kitchen (8/52), weekly per capita household expenditure, quintile (8/50)

[3] Mother can name one of the following symptoms: pale face, weakness/fatigue, pale eyes, pale arm/nail, or headache

[4] Mother can name one of the following treatments of anemia: take iron tablet/capsule/vitamin, consume iron-fortified foods, or visit a doctor/midwife/other health worker

Table 2

Demographic, socioeconomic, and health-related factors associated with anemia in mothers from urban slums and rural areas

Characteristic		URBAN					RURAL				
		Mother anemic		Mother not anemic		***P***	Mother anemic		Mother not anemic		***P***
		N	% or Mean (SD)	N	% or Mean (SD)		N	% or Mean (SD)	N	% or Mean (SD)	
Mother knows about anemia[1]	Yes	730	34.3	1924	36.5	0.08	3235	35.7	10111	37.4	0.003
	No	1397	65.7	3350	63.5		5831	64.3	16895	62.6	
Maternal age, y	≤24	547	25.7	1401	26.6	0.005	2429	26.8	7954	29.5	<0.0001
	25–28	504	23.7	1345	25.5		2094	23.1	6649	24.6	
	29–32	447	21.0	1182	22.4		1901	21.0	5912	21.9	
	33+	629	29.6	1346	25.5		2636	29.1	6479	24.0	
Maternal education, y	0	114	5.4	224	4.3	0.08	587	6.5	1263	4.7	<0.0001
	1–6	968	45.6	2320	44.1		4880	54.2	13880	51.7	
	7–9	502	23.6	1282	24.4		1848	20.5	5926	22.1	
	≥10	541	25.5	1431	27.2		1691	18.8	5787	21.5	
Paternal education, y	0	52	2.5	91	1.8	0.01	425	5.0	930	3.6	<0.0001
	1–6	709	34.5	1781	34.6		4159	48.5	11883	46.3	
	7–9	550	26.8	1260	24.5		1659	19.3	5198	20.2	
	≥10	745	36.2	2018	39.2		2331	27.2	7679	29.9	
Maternal body mass index (kg/m^2)	18.5 to <25	1353	64.0	3206	61.5	<0.0001	6413	71.0	18289	68.1	<0.0001
	<18.5	309	14.6	576	11.0		1330	14.7	3145	11.7	
	≥25 to <30	361	17.1	1163	22.3		1132	12.5	4579	17.1	
	≥30	90	4.3	271	5.2		161	1.8	839	3.1	
Number of children, 6–59 months of age	1	1750	82.3	4515	85.6	0.0008	7689	84.8	24002	88.9	<0.0001
	2	358	16.8	731	13.9		1323	14.6	2921	10.8	
	3+	19	0.9	28	0.5		54	0.6	83	0.3	
Age of youngest child, 6–59 months of	6–11	439	20.6	926	17.6	0.004	1995	22.0	5048	18.7	<0.0001
	12–23	625	29.4	1694	32.1		2921	32.2	8452	31.3	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.004	[illegible]	[illegible]	[illegible]	[illegible]	<0.0001

Characteristic		URBAN					RURAL				
		Mother anemic		Mother not anemic		*P*	Mother anemic		Mother not anemic		*P*
		N	% or Mean (SD)	N	% or Mean (SD)		N	% or Mean (SD)	N	% or Mean (SD)	
age	12–23	625	29.4	1694	32.1		2921	32.2	8452	31.3	
	24–35 36–47	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	
	48–59	212	10.0	457	8.7		765	8.4	2523	9.3	
Sex of youngest child, 6–59 months of age	Male	1091	48.7	2771	47.5	0.33	4650	51.3	13987	51.8	0.41
	Female	1036	51.3	2503	52.5		4416	48.7	13019	48.2	
Child consumes fortified milk	Yes	923	46.9	2329	48.4	0.26	2807	31.0	9940	36.8	<0.0001
	No	1047	53.1	2486	51.6		6259	69.0	17065	63.2	
Father is a smoker	Yes	1540	74.0	3723	71.5	0.03	6655	74.9	19484	73.6	0.01
	No	540	26.0	1481	28.5		2225	25.1	7005	26.4	
Household has improved latrine	Yes	1729	81.3	4434	84.2	0.003	4192	46.3	13686	50.7	<0.0001
	No	397	18.7	833	15.8		4871	53.7	13314	49.3	
Mother took iron supplements in last pregnancy	Yes	468	84.6	1246	86.0	0.4	2355	82.2	6785	85.2	0.003
	No	85	15.4	202	14.0		508	17.8	1182	14.8	
Weekly per capita expenditure	Grain source food	2125	.32 (.27)	5269	.33 (.29)	0.17	9057	0.38 (.38)	26963	0.38 (.39)	0.53
	Animal source food	2125	.35 (.30)	5269	.36 (.33)	0.17	9057	.26 (.28)	26967	.29 (.30)	<0.0001
	Plant source food	2125	.42 (.29)	5268	.47 (.33)	<0.0001	9054	.32 (.24)	26951	.36 (.26	<0.0001
Number of household members eating from same kitchen	2–4	1083	51.0	2316	44.0	<0.0001	5417	59.8	14227	52.8	<0.0001
	>4	1042	49.0	2953	56.0		3639	40.2	12739	47.2	
Weekly per capita household expenditure, quintile	1	258	12.1	490	9.3	<0.0001	1700	18.8	4036	15.0	<0.0001
	2	308	14.5	627	11.9		1683	18.6	4372	16.2	
	3	375	17.6	877	16.6		1770	19.5	5134	19.0	

Characteristic		**URBAN**					**RURAL**				
		Mother anemic		**Mother not anemic**		***P***	**Mother anemic**		**Mother not anemic**		***P***
		N	**% or Mean (SD)**	**N**	**% or Mean (SD)**		**N**	**% or Mean (SD)**	**N**	**% or Mean (SD)**	
	4	469	22.1	1268	24.1		1868	20.6	5976	22.2	
	5	715	33.6	2007	38.1		2036	22.5	7449	27.6	

[1] Mother's knowledge of anemia based upon the ability to name a symptom of anemia (pale face, weakness/fatigue, pale eyes, pale arm/nail, or headache) and a treatment of anemia (take iron tablet/capsule/ vitamin, consume iron-fortified foods, or visit a doctor/midwife/other health worker).

Table 3

Demographic, socioeconomic, and health-related factors associated with anemia in children from urban slums and rural areas

Characteristic		URBAN					RURAL				
		Child anemic		Child not anemic		*P*	Child anemic		Child not anemic		*P*
		N	% or Mean (SD)	N	% or Mean (SD)		N	% or Mean (SD)	N	% or Mean (SD)	
Mother knows about anemia[1]	Yes	1745	35.5	1088	36.5	0.35	7692	36.8	6264	37.0	0.69
	No	3177	64.5	1894	63.5		12193	63.2	10652	63.0	
Maternal age, y	≤24	1386	28.2	714	23.9	<0.0001	6518	31.2	4343	25.7	<0.0001
	25–28	1217	24.7	762	25.6		5084	24.4	4135	24.5	
	29–32	1088	22.1	657	22.0		4432	21.2	3801	22.5	
	33+	1231	25.0	849	28.5		4841	23.2	4627	27.4	
Maternal education, y	0	224	4.6	132	4.4	<0.0001	1167	5.6	763	4.5	<0.0001
	1–6	2309	47.0	1219	41.0		11118	53.5	8463	50.3	
	7–9	1191	24.3	722	24.3		4483	21.6	3669	21.8	
	≥10	1186	24.1	902	30.3		4000	19.3	3921	23.3	
Paternal education, y	0	108	2.2	45	1.5	<0.0001	870	4.4	535	3.3	<0.0001
	1–6	1752	36.6	918	31.6		9456	47.9	7290	45.1	
	7–9	1180	24.6	734	25.2		3951	20.0	3235	20.0	
	≥10	1752	36.6	1211	41.6		5466	27.7	5107	31.6	
Maternal body mass index (kg/m^2)	18.5 to <25	3099	63.6	1764	59.8	<0.0001	14378	69.1	11482	68.3	<0.0001
	<18.5	624	12.8	294	10.0		2864	13.8	1722	10.2	
	≥25 to <30	931	19.1	713	24.2		3080	14.8	3027	18.0	
	≥30	219	4.5	179	6.1		478	2.3	580	3.5	
Number of children, 6–59 months of age	1	4056	82.4	2657	89.1	<0.0001	17834	85.4	15377	90.9	<0.0001
	2	831	16.9	313	10.5		2942	14.1	1503	8.9	
	3+	35	0.7	12	0.4		109	0.5	36	0.2	
Age of youngest child, 6–59 months of age	6–11	1057	21.5	343	11.5	<0.0001	5295	25.4	1845	10.9	<0.0001
	12–23	1716	34.9	748	25.1		7720	37.0	4079	24.1	
	24–35	1149	23.3	782	26.2		4468	21.4	4762	28.2	

Characteristic		**URBAN**					**RURAL**				
		Child anemic		**Child not anemic**		***P***	**Child anemic**		**Child not anemic**		***P***
		N	**% or Mean (SD)**	**N**	**% or Mean (SD)**		**N**	**% or Mean (SD)**	**N**	**% or Mean (SD)**	
	36–47	684	13.9	676	22.7		2315	11.1	3748	22.2	
	48–59	316	6.4	433	14.5		1087	5.2	2479	14.7	
Sex of youngest child, 6–59 months of age	Male	2630	53.4	1493	50.1	0.004	11326	45.8	8224	48.6	<0.0001
	Female	2292	46.6	1489	49.9		9559	54.2	8692	51.4	
Child consumes fortified milk	Yes	1989	43.9	1502	55.5	<0.0001	6479	31.0	7040	41.6	<0.0001
	No	2545	56.1	1206	44.5		14405	69.0	9876	58.4	
Child received deworming	Yes	995	20.2	702	23.6	0.0004	3313	15.90	3451	20.4	<0.0001
	No	3925	79.8	2275	76.4		3451	84.1	13433	79.6	
Father is a smoker	Yes	3582	73.8	2060	70.4	0.001	15359	74.9	12027	72.5	<0.0001
	No	1272	26.2	867	29.6		5135	25.1	4556	27.5	
Household has improved latrine	Yes	4017	81.7	2561	85.9	<0.0001	9936	52.4	8761	51.8	<0.0001
	No	899	18.3	419	14.1		10944	47.6	8150	48.2	
Weekly per capita expenditure	Grain source food	4916	0.33 (0.28)	2980	0.34 (0.31)	0.21	20856	0.38 (0.38)	16887	0.39 (0.40)	0.02
	Animal source food	4916	0.35 (0.32)	2980	0.37 (0.32)	0.004	20859	0.27 (0.29)	16892	0.29 (0.31)	<0.0001
	Plant source food	4916	0.44 (0.31)	2979	0.48 (0.33)	<0.0001	20850	0.34 (0.25)	16882	0.36 (0.27)	<0.0001
Number of household members eating from same kitchen	2–4	2287	46.5	1319	44.3	0.05	11521	55.2	9027	53.4	0.0005
	>4	2629	53.5	1661	55.7		9335	44.8	7866	46.6	
Weekly per capita household expenditure, quintile	1	522	10.6	272	9.1	0.007	3687	17.7	2317	13.7	<0.0001
	2	654	13.3	350	11.7		3641	17.5	2678	15.6	
	3	855	17.4	488	16.4		4046	19.4	3145	18.6	
	4	1125	22.9	720	24.2		4389	21.0	3819	22.6	

Characteristic		URBAN					RURAL				
		Child anemic		Child not anemic		*P*	Child anemic		Child not anemic		*P*
		N	% or Mean (SD)	N	% or Mean (SD)		N	% or Mean (SD)	N	% or Mean (SD)	
	5	1760	35.8	1150	38.6		5096	24.4	4933	29.2	

[1] Mother's knowledge of anemia based upon the ability to name a symptom of anemia (pale face, weakness/fatigue, pale eyes, pale arm/nail, or headache) and a treatment of anemia (take iron tablet/capsule/vitamin, consume iron-fortified foods, or visit a doctor/midwife/other health worker).

Table 4

Multivariate model describing the odds of anemia associated with maternal knowledge of anemia and other potential risk factors in mothers from urban slums and rural areas

Characteristics		Urban			Rural		
		O.R	95% C.I	P	O.R	95% C.I	P
Mother knows about anemia[1]		0.90	0.78, 1.02	0.10	0.96	0.90, 1.03	0.24
Maternal age, y	≤24	1.00	---	---	1.00	---	---
	25–28	0.94	0.79, 1.12	0.51	1.08	0.99, 1.18	0.09
	29–32	0.93	0.77, 1.12	0.44	1.11	1.01, 1.21	0.03
	33+	1.12	0.93, 1.35	0.24	1.47	1.34, 1.61	<0.0001
Maternal education, y	0	1.00	---	---	1.00	---	---
	1–6	0.87	0.64, 1.18	0.36	0.91	0.78, 1.06	0.21
	7–9	0.90	0.65, 1.24	0.50	0.86	0.73, 1.01	0.07
	≥ 10	0.86	0.62, 1.19	0.36	0.84	0.71, 0.99	0.04
Maternal body mass index (kg/m^2)	18.5 to <25	1.00	---	---	1.00	---	---
	<18.5	1.43	1.18, 1.73	0.0003	1.24	1.13,1.36	<0.0001
	≥25 to <30	0.75	0.64, 0.89	0.0008	0.75	0.68, 0.82	<0.0001
	≥30	0.86	0.64, 1.16	0.32	0.57	0.46, 0.70	<0.0001
Number of children, 6–59 months of age	1	1.00	---	--	1.00	---	---
	2	1.22	1.01, 1.47	0.04	1.27	1.15, 1.40	<0.0001
	3+	1.60	0.70, 3.68	0.27	2.03	1.27, 3.23	0.003
Age of youngest child, 6–59 months of age	6–11	1.00	---	---	1.00	---	---
	12–23	0.74	0.62, 0.88	0.001	0.87	0.80, 0.95	0.002
	24–35	0.90	0.74, 1.09	0.30	0.79	0.72, 0.87	<0.0001
	36–47	0.86	0.69, 1.06	0.16	0.86	0.77, 0.96	0.008
	48–59	1.06	0.82, 1.37	0.66	0.81	0.71, 0.92	0.001
Child consumes fortified milk		1.01	0.89, 1.15	0.90	0.88	0.82, 0.94	0.0004
Father is a smoker		1.04	0.90, 1.20	0.57	1.01	0.94, 1.09	0.81

Characteristics		**Urban**			**Rural**		
		O.R	**95% C.I**	**P**	**O.R**	**95% C.I**	**P**
Household has improved latrine		0.86	0.73, 1.01	0.07	0.96	0.89, 1.02	0.21
Weekly per capita animal source food expenditure		0.90	0.72, 1.12	0.34	0.93	0.82, 1.06	0.30
Weekly per capita plant source food expenditure		0.65	0.51, 0.82	0.0004	0.86	0.72, 1.01	0.06
More than 4 individuals eating from same kitchen		1.17	1.01, 1.36	0.03	1.21	1.12, 1.29	<0.0001
Weekly per capita household expenditure, quintile	1	1.00	---	---	1.00	---	---
	2	0.95	0.73, 1.24	0.70	1.04	0.93, 1.16	0.52
	3	0.97	0.75, 1.26	0.82	1.03	0.92, 1.15	0.62
	4	0.88	0.68, 1.14	0.34	1.00	0.89, 1.13	0.98
	5	0.93	0.71, 1.21	0.56	0.97	0.85, 1.11	0.68

[1] Mother's knowledge of anemia based upon the ability to name a symptom of anemia (pale face, weakness/fatigue, pale eyes, pale arm/nail, or headache) and a treatment of anemia (take iron tablet/capsule/vitamin, consume iron-fortified foods, or visit a doctor/midwife/other health worker).

Table 5

Multivariate model describing the odds of anemia in children from urban slums and rural areas in association with maternal knowledge of anemia and other potential risk factors

Characteristics		Urban			Rural		
		O.R	95% C.I	P	O.R	95% C.I	P
Mother knows about anemia[1]		0.90	0.79, 1.02	0.10	0.93	0.87, 0.98	0.01
Maternal age, y	≤24	1.00	---	---	1.00	---	---
	25–28	0.96	0.82, 1.12	0.60	0.96	0.89, 1.04	0.31
	29–32	1.04	0.88, 1.24	0.63	0.99	0.91, 1.07	0.79
	33+	0.87	0.73, 1.04	0.13	0.89	0.82, 0.96	0.004
Maternal education, y	0	1.00	---	---	1.00	---	---
	1–6	1.08	0.80, 1.45	0.63	0.90	0.78, 1.04	0.14
	7–9	0.87	0.64, 1.18	0.37	0.85	0.72, 0.99	0.03
	≥ 10	0.74	0.55, 1.02	0.06	0.76	0.64, 0.89	0.0006
Maternal body mass index (kg/m^2)	18.5 to <25	1.00	---	---	1.00	---	---
	<18.5	1.07	0.88, 1.29	0.51	1.23	1.12, 1.34	<0.0001
	≥25 to <30	0.77	0.67, 0.89	0.0003	1.00	0.93, 1.08	0.96
	≥30	0.82	0.64, 1.07	0.14	0.82	0.70, 0.96	0.01
Number of children, 6–59 months of age	1	1.00	---	---	1.00	---	--
	2	1.46	1.21, 1.76	<0.0001	1.24	1.13, 1.36	<0.0001
	3+	0.99	0.40, 2.45	0.98	1.30	0.78, 2.14	0.31
Age of youngest child, 6–59 months of age	6–11	1.00	---	---	1.00	---	---
	12–23	0.79	0.66, 0.94	0.009	0.71	0.65, 0.77	<0.0001
	24–35	0.57	0.47, 0.69	<0.0001	0.37	0.34, 0.40	<0.0001
	36–47	0.38	0.31, 0.47	<0.0001	0.25	0.22, 0.27	<0.0001
	48–59	0.29	0.23, 0.37	<0.0001	0.17	0.15, 0.19	<0.0001
Sex of youngest child, 6–59 months of age	Male	1.00	---	---	1.00	---	---
	Female	1.19	1.06, 1.33	0.003	1.27	1.21, 1.35	<0.0001
Child consumes fortified milk		0.68	0.60, 0.76	<0.0001	0.76	0.72, 0.81	<0.0001

Characteristics		Urban			Rural		
		O.R	95% C.I	P	O.R	95% C.I	P
Father is a smoker		1.03	0.91, 1.17	0.63	1.02	0.96, 1.09	0.49
Household has improved latrine		0.79	0.67, 0.93	0.004	0.96	0.90, 1.02	0.19
Weekly per capita animal food expenditure		0.91	0.75, 1.11	0.34	0.95	0.85, 1.06	0.35
Weekly per capita plant food expenditure		0.81	0.65, 1.01	0.06	0.93	0.82, 1.07	0.31
More than 4 individuals eating from same kitchen		0.98	0.85, 1.12	0.76	1.04	0.98, 1.11	0.21
Weekly per capita household expenditure, quintile	1	1.00	---	---	1.00	---	---
	2	1.00	0.77, 1.39	0.98	0.98	0.88, 1.09	0.71
	3	1.14	0.89, 1.46	0.30	1.10	0.99, 1.22	0.08
	4	1.07	0.84, 1.37	0.59	1.05	0.95, 1.17	0.34
	5	1.10	0.85, 1.42	0.48	1.07	0.95, 1.17	0.24

[1] Mother’s knowledge of anemia based upon the ability to name a symptom of anemia (pale face, weakness/fatigue, pale eyes, pale arm/nail, or headache) and a treatment of anemia (take iron tablet/capsule/vitamin, consume iron-fortified foods, or visit a doctor/midwife/other health worker).

Table 6

Multivariate logistic regression models describing the relationship of maternal knowledge of anemia with health-related behaviors targeted at anemia.[1]

Health-related behavior	**Urban**			**Rural**		
	O.R	**95% C.I**	***P***	**O.R**	**95% C.I**	***P***
Mother took iron supplementation in last pregnancy	1.65	1.16, 2.35	0.005	1.41	1.20, 1.65	<0.0001
Child consumes fortified milk	1.20	1.07, 1.35	0.002	1.21	1.13, 1.28	<0.0001
Child received deworming medication	1.02	0.88, 1.17	0.82	1.03	0.96, 1.11	0.41
Consumption of animal source foods	1.07	0.94, 1.21	0.31	1.13	1.06, 1.22	0.0004

[1] All models adjusted for maternal age, maternal education, child age, child sex, number of household members eating from same kitchen, weekly per capita household expenditure, and province.