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Household Food Insecurity, Mother's Feeding Practices, and the Early Childhood's Iron Status

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ABSTRACT

Background: Health consequences of food insecurity among infants and toddlers have not been fully examined. The purpose of this study was to assess the relationship between household food insecurity, mother's infant feeding practices and iron status of 6–24 months children.

Methods: In this cross-sectional study, 423 mother-child pairs were randomly selected by multistage sampling method. Children blood samples were analyzed for hemoglobin and serum ferritin concentrations. Household food security was evaluated using a validated Household Food Insecurity Access Scale. The mother's feeding practices were evaluated using Infant and Young Child Feeding practice variables including: The duration of breastfeeding and the time of introducing of complementary feeding.

Results: Based on the results, of the studied households only 47.7% were food secure. Mild and moderate-severe household food insecurity was 39.5% and 12.8%, respectively. Anemia, iron deficiency (ID), and iron deficiency anemia were seen in 29.1%, 12.2%, and 4.8% of children, respectively. There was no significant association between household food insecurity; mother's feeding practices and child ID with or without anemia.

Conclusions: We found no association between household food insecurity and the occurrence of anemia in the 6–24 months children. However, these findings do not rule out the possibility of other micronutrient deficiencies among the food-insecure household children.

Keywords: Feeding practices, household food insecurity, infants and toddlers, iron status, mothers

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INTRODUCTION

Household food insecurity defined as "limited or uncertain availability of food or limited or uncertain ability to acquire acceptable foods in socially acceptable ways,"[1] has been associated with health problems among adults and children.[2,3] It is established that proper diet

and feeding practices have an efficient role in growth and development in early childhood.[4] Duration of breastfeeding, the time of introducing of complementary feeding, and compliance with infant feeding suggestions are important factors to ensure obtaining appropriate foods in the early years of life.[5] However, all these factors may be adversely affected by household food insecurity.[3,6] Studies have shown that strategies used by households to combat food insecurity can affect infant feeding practices.[7] In food insecure households, mothers show less positive behaviors when feeding their children.[5,7] It has also been shown that in the context of food insecurity when adequacy and accessibility of food are impaired, mother's decision making for infant feeding is also disrupted.[8]

In Iran, a considerable imbalance between energy and nutrient contents of the foods consumed in the households is observed. While high intake of foods with low nutrient density is reported at all income levels and over-consumption of energy-dense foods is evident among more than a third of households, food insecurity is common among 20% of the population.[9] Household food insecurity can result in decreased nutrient intake and micronutrient deficiency.[10-12] Food insecurity during the first 3 years of life may have substantial negative effects on subsequent physiological, behavioral, and cognitive development.[13] Food-insecure children may be unable to obtain safe and adequate food[1] that leads to lower intakes of nutrients including iron.[14-16]

Iron deficiency (ID) and ID anemia (IDA) are considered as the major public health problems and the most common nutritional deficiencies around the world.[17,18] Infants and young children have a high risk for developing ID because they have a high demand for iron due to rapid growth.[19] IDA can be associated with functional impairments that affecting mental and psychomotor development and it has a significant effect on the health and development of children.[20,21]

In Iran, 30–50% of women and children suffer from IDA.[22] It is estimated that 43.9% of children are anemic, and 29.1% have IDA, in southwest Iran;[23] the prevalence in Southern Iran is estimated 19.7% in under 5-year-old children.[24]

The research focusing on iron and health-related outcomes has been narrow in coverage of food-insecure children.[7,15,25] A study by Skalicky *et al.* found that household food insecurity is related to ID and IDA in children aged 6–36 months.[26] Some other studies have reported no significant relationship between child food insecurity and ID.[27] Alaimo *et al.*[7] reported that low-income children were more likely to have ID than high-income children. A recent study permitted clearer evaluation of the determinants and outcomes of child food insecurity.[28]

On the other hand, there is evidence that household food insecurity affects parenting behaviors with adverse outcomes for children.[29] Mothers in food-insecure households have more problems in infant feeding. They are more likely to have unhealthy eating patterns themselves while children in these families consume more low cost, less nutritious, and high energy foods. Therefore, children from food-insecure households are at an increased risk of being overweight and micronutrient deficient.[9]

Infant feeding practices make the early feeding environment because infants depend on parents' foods choices.[30,31] Very few studies have explained the relationship between maternal feeding practices and infant and young children iron status, in the context of food security research. Therefore, it is necessary to examine the practices of breastfeeding, complementary feedings, and their effects on child's iron status. This study was carried out to evaluate the association among household food insecurity, maternal-infant feeding practices, and the body iron status in children aged 6–24 months.

This study can expand the existing body of knowledge about a link among inappropriate food access in households, mother's feedings behaviors, and child iron status. Considering the critical role of women in the households, the findings can provide basis for developing intervention programs to modify mother's infant feeding behaviors, even with existing household food insecurity and would enable an improved targeting of resources, including micronutrient supplementation and fortification programs.

METHODS

Subjects

In this cross-sectional study, 423 mothers and their children aged 6–24 months in Varamin (a city at South East of Tehran with about 220,000 inhabitants) were recruited through multistage sampling method. Based on population density of the health centers, households in each district were selected.

Informed signed a consent to participate in the study was obtained from all participants. The study protocol was approved by Ethics Committee of the National Nutrition and Food Technology Research Institute (NNFTRI), Tehran, Iran.

Procedure

According to a predetermined schedule, face-to-face interviews were conducted with the mothers in the

urban health centers. Data collection was conducted in early 2014. The research team consisted of trained nutritionists with communication skills. Prior to the survey, a pilot study was carried out to review the questionnaires and practice field work. Data were collected using a questionnaire with three sections including: Sociodemographics; Household Food Insecurity Access Scale (HFIAS) and mother's feeding practices.

a. Demographics and socio-economic data, including gender and age of the head of the household, family size, number of children, household head, and the interviewee's educational level and occupation; and the household residential status were collected
b. Household food security was evaluated by HFIAS, a 9-item questionnaire, which had been already validated for Iranians.[32,33] The questionnaire asks whether a specific condition associated with the experience of food insecurity ever occurred during the previous 30 days. The questionnaire includes perceptions about food insecurity. Based on HFIAS questionnaire scores, households were grouped into four categories of food access insecurity: Secure (0–1), mildly food insecure (2–7), moderately food insecure (8–14), and severely food insecure (15–27). Households with severe food security were combined into moderate food insecure groups because of the small number of severe food insecurity category and labeled as "moderate-severe food insecurity"
c. Mother's feeding practices were evaluated using WHO Infant and Young Child Feeding practice indicators,[34] including: (a) Duration of breastfeeding, (b) time of the introducing of the complementary feeding, and (c) the meal frequency during the day. Mother's feeding practices were categorized into three levels: Appropriate (>16 scores), partly appropriate (12–16 scores), and poor maternal feeding practices (<12 scores).

Blood sampling and analysis

A venous nonfasting blood sample (3 ml) was drawn from each child by a trained laboratory technician. Blood samples were divided into tubes either with or without the anticoagulant, ethylenediaminetetraacetic acid. The samples were transported within 4 h to the laboratory of the City Health Network for measurement of hemoglobin (Hb) concentration using a cell counter. Serum-clot activator tubes were centrifuged at 800 ×*g* for 10 min at room temperature. Sera were aliquoted into 500 ml prelabeled micro-tubes and kept frozen at −20°C. Frozen serum samples were transported in a cold box to the laboratory of Nutrition Research at NNFTRI, for further analyses. Serum concentration of ferritin (Ferr) was measured by the enzyme-linked immunosorbent assay (ELISA) using commercial kits (Ferritin AccuBind® ELISA Microwells Monobind Inc., USA). Iron status was classified in three categories: (1) Anemia (with Hb <11 g/dl), ID defined as ferritin <12 ng/ml,[35] and IDA defined as Hb <11 g/dl in combination with ferritin <12 ng/ml.[36]

Anthropometry

Children and mothers' weight and height were measured using standard methods of WHO, to the nearest 0.1 kg with a Seca electronic scale (Seca 876 Hamburg, Germany) and 0.1 cm with a stadiometer (Seca 213), respectively, while the subjects had a light clothing and barefoot.[37,38] For the children, the recumbent length was measured using an infantometer on an adjustable child length measuring board with a precision of 0.1 cm. Body mass index (BMI) was calculated by dividing body weight (kg) to height squared (m^2). Mothers' BMI <18.49, between 18.5 and 24.9 between "25–29.9" and >30 were categorized as underweight, normal weight, overweight, and obesity, respectively.[39]

Statistical analysis

Data were analyzed using SPSS (version 22.0; SPSS Inc., Chicago, IL, USA). Descriptive data analyses included examining frequencies, means, and standard deviation for study variables. The significance level was defined as $P < 0.05$. Analyses were performed by using independent samples *t*-test, Fisher's exact test, Chi-square test, analysis of variance, and Pearson correlations. Multiple linear regressions were used to assess the relationship between food insecurity, mother's feeding practices, and child iron status.

RESULTS

The study sample included 423 children with mean age 15.1 ± 5.7 months, weight 10.5 ± 1.7 kg, height 78.3 ± 6.5 cm; and their mothers with mean age 28.1 ± 5.2 years, weight 66.3 ± 13.4 kg, height 160.3 ± 5.7 cm, and BMI 25.7 ± 4.8 kg/m^2. Characteristics of the study participants according to household food security status are presented in Table 1. Food security, mild, and moderate-severe food insecurity were observed in 47.7%, 39.5%, and 12.8% of the households, respectively. Of the households, 70.7% were residents in urban areas. Family size between "4 and 5" was observed in 51.8% of the households. Maternal BMI in the moderate-severe food insecure households was insignificantly higher, compared to those with mild food insecurity and food secures. Of the studied mothers, 96.7% were housewives. Age at delivery in 89.6% was "18–30 year." About 71.9% of mothers were lactating, and 87.2% did not take any supplements. Mother's education level was higher in food secure households (30.0%). Of the children, 53.9% were male. About 70% and 82.5% of children did not have acute respiratory infections and diarrhea, in the past month, respectively. The frequency of using iron supplements in children was 79.6%.

The prevalence of breastfeeding was 78.6%, including 38.1% of food secure, 30.5% of mild, and 10.0% of

Table 1: Mothers and infant and toddlers profile characteristics based on household food security status

Variables	Household food security status				*P*
	Food secure (n_1=202)	Mild FI (n_2=167)	Moderate and severe FI (n_3=54)	Total (n=423)	
Household variables					
Household food security status (%)	47.7	39.5	12.8	100	-
Area at residence, urban (%)	31.4	30.3	9.0	70.7	-
Family size, 4-5 (%)	20.3	22.7	8.5	51.8	-
Mothers variables					
Mother age, year (mean±SD)	27.4±5.0	28.7±5.4	27.9±4.6	28.1±5.2	0.049
Mother BMI (kg/m^2) (mean±SD)	25.8±4.6	25.6±4.9	26.5±5.5	25.8±4.8	NS
BMI, between 18.5 and 25 (%)	20.1	19.4	6.4	46	-
Mother job, housewife (%)	45.6	38.8	12.3	96.7	-
Mother literacy, diploma, and above (%)	30.0	18.2	3.5	51.8	-
Age at delivery, 18-30 year (%)	42.9	35.5	11.1	89.6	-
Physiological status, lactating (%)	33.6	29.6	8.7	71.9	-
Poor mother feeding practices, score (mean±SD)	8.4±1.9	8.2±2.1	6.9±2.7	8.2±2.1	0.014
Poor maternal feeding practices (%)	18.0	15.8	4.5	38.3	-
Infant variables					
Infant gender, boy (%)	24.6	22.7	6.6	53.9	-
Infant age, months (mean±SD)	15.1±5.8	15.0±5.5	15.6±6.0	15.1±5.7	NS
Infant BMI (mean±SD)	16.8±1.9	16.9±1.8	16.6±1.6	16.8±1.7	NS
Infant BMI, (normal)/below 95 (%)	42.3	34.9	12.1	89.3	-
Hb (g/dl) (mean±SD)	11.5±0.9	11.6±1.0	11.4±1.3	11.5±1.0	0.45
Ferritin (ng/ml) (mean±SD)	64.5±59.1	58.0±56.2	53.1±47.9	60.6±56.7	0.86
Acute respiratory infection, (yes) (%)	5.2	10.2	2.1	17.5	-
Diarrhea, (yes) (%)	11.8	12.8	5.5	30.0	-
Using iron supplement	38.2	32.0	9.4	79.6	-
IYCF practice[a]					
Exclusive breastfeeding under 6 months (%)	41.6	33.8	10.2	85.3	-
Breastfeeding at time of survey (6-24 months) (%)	38.1	30.5	10.0	78.6	-
Introduction of complementary feeding, after 6 months of age (%)	27.9	27.4	8.9	64.2	-
Meal frequency during a day, more than 3 (%)	26.9	18.4	5.7	51.0	-

[a]Variables are defined based on WHO guidelines on infant and young child feeding practices.[34] BMI=Body mass index, SD=Standard deviation, FI=Food insecurity, Hb=Hemoglobin, IYCF=Infant and Young Child Feeding, NS=Not significant, WHO=World Health Organization

moderate-severe food insecure households. Appropriately, for 64.2% of children complementary feeding was started after 6 months of age. Of the studied children, 51% were given more than three meals for a day.

Appropriate, partly appropriate, and poor maternal feeding practices were observed in 3.1%, 58.6%, and 38.3% of the mothers, respectively. Poor feeding practices were seen in 18.0%, 15.8%, and 4.5% in food secure, mild food insecure, and moderate-severe food insecure mothers. Statistically significant differences were observed in mean poor feeding practices between food secure (8.4 ± 1.9), mild food insecure (8.2 ± 2.1), and moderate-severe food insecure mothers (6.9 ± 2.7), P = 0.014.

Anemia, ID and IDA were seen in 29.1, 12.2, and 4.8% of children, respectively. In urban areas, as compared to the rural areas, the prevalence of anemia (22.6 vs. 6.6%, P = 0.016), ID (6.3 vs. 3.7%), and IDA (2.9 vs. 0.5%) were all higher. The occurrence of anemia was higher in girls than in boys (15.5 vs. 13.6%), while ID (7.4 vs. 4.8%), and IDA (2.9 vs. 1.9%) were higher in boys than in girls. There were no any significant differences in Anemia, ID and IDA between boys and girls. As shown in Table 2, anemia (14.2%) in food secure, ID (5.8%), and IDA (2.1%) in mildly food insecure children were more prevalent than in other groups. However, the difference was not significant.

As shown in Table 3, there was no significant correlation between food security and mother's feeding practices and serum ferritin and Hb. In addition, there was no association between household food insecurity and child ID with or without anemia.

Based on Table 4, multiple linear regression analysis showed that a unit increase in mother feeding practices (such as continued breastfeeding beyond 12 months) led

Table 2: Iron status of the studied children based on household food security status

Iron status	*n* (%)			
	Household food security status			Total
	Food security	Mild FI	Moderate and severe FI	
Anemia: Hb <11 (g/dl)	54 (14.2)	40 (10.5)	17 (4.5)	111 (29.1)
ID: Ferritin <12 (ng/ml)	19 (5)	22 (5.8)	5 (1.3)	46 (12.2)
IDA: Hb <11 (g/dl) + ferritin <12 (ng/ml)	7 (1.9)	8 (2.1)	3 (0.8)	18 (4.8)

FI=Food insecurity, Hb=Hemoglobin, ID=Iron deficiency, IDA=Iron deficiency anemia

Table 3: Correlation between household FI, mother's feeding practices, and child iron status

	Household FI score	Mother's feeding practices	Child Hb	Child serum ferritin
Household FI score	1			
Mother's feeding practices	−0.079	1		
Child Hb	−0.014	0.025	1	
Child serum ferritin	−0.019	−0.063	−0.055	1

FI=Food insecurity, Hb:=Hemoglobin

to 1.303 ng/ml decrease in serum ferritin. However, the association was not significant. Household food insecurity was not associated with child serum ferritin.

DISCUSSION

The present study aimed to determine the relation between the iron status of children under the age of 2, maternal feeding practices, and household food insecurity. We found that: (1) There was no significant relationship between child blood Hb level and serum ferritin concentration; (2) There was no significant relationship between household food insecurity, child iron status, and maternal feeding practices; (3) There was no significant relation between maternal feeding practices and child iron status.

The relationship between child hemoglobin level and serum ferritin

In this study, no significant relation was observed between child Hb concentration and serum ferritin level. In the children under study, anemia, as defined by Hb concentrations (29.1%), which was less than the WHO's threshold (40%), was considered as a serious public health problem.[35] Association between Hb concentration and child iron status may occur via multiple pathways.[40,41] In general, child iron intake through continued breastfeeding is low. On the other hand, increased caloric intake by eating high amounts of cereals containing iron absorption inhibitors can lead to reduced iron bioavailability.[42] Finally, after a child reaches the age of 1, child and mother's dietary qualities will become alike since they share the same economic and social environments.[42,43] Studies by White in the United States and Thurlow in Thailand revealed that ID is a nonmajor factor for anemia during childhood.[44,45] It has been shown that the risk of anemia caused by ID depends on the complex interactions between dietary iron content (type of diet), iron bioavailability (breastfeeding duration and appropriate complementary feeding practices), increased iron intake (growth rate), and improper loss of iron (infections and parasitic diseases).[46]

The relationship between household food insecurity and infantile iron status

Our results were in accordance with Skalicky *et al.* and Nisar *et al.* studies that showed no relationship between food insecurity and child Hb concentration.[26,47] Conversely, Miller *et al.* showed anemia risk occurrence caused by ID in children of 3–5-year-old growing in food-insecure households is about 11 times higher than those of food-secure households.[14]

Skalicky *et al.*'s study results showed that children in households with moderate and severe food insecurity were more than twice as likely to have IDA as children in food secure households. Moreover, he stated other household's characteristics can be risk factors of child iron levels.[26] The study conducted by Park *et al.* displayed children in extremely food-insecure households not only get involved in ID twice those growing in mildly food-insecure households, but also suffer from IDA to the same extent.[48]

Various studies have demonstrated food insecurity has no significant effects on anemia and thus anemia may occur due to ID, inefficient iron absorption or physiological increased requirement.[49] In low and middle income countries, such factors as damage to crops and agricultural productions resulting from climatic changes,[50] continuing economic crises in the world associated with weakening of socio-economic developments, and worsening of food insecurity conditions can threaten public health and aggravate childhood's anemia.[51]

The relationship between food insecurity and mother's feeding practices

In the current study, no significant relationship was found between food insecurity and mother's feeding behaviors. The rates of proper mother's feeding practices, including continued breastfeeding and complementary feeding after 6 months within appropriate times per

Table 4: Multiple linear regression analysis of the relationship between household FI, mother's feeding practices, and the child's iron status[1]

Dependent variable	Independent variables	Unstandardized coefficients		Standardized coefficient	*P*	95% CI for *B*		R^2
		B	SE	Beta		Lower bound	Upper bound	
Hb	FI	−0.003	0.013	−0.012	0.814	−0.028	0.022	0.001
	Mother feeding practices	0.007	0.015	0.024	0.644	−0.023	0.038	
Ferritin	FI	−0.391	0.881	−0.023	0.658	−2.122	1.341	0.005
	Mother feeding practices	−1.303	1.053	−0.066	0.217	−3.373	0.768	

[1]All of the regression analyses controlled for mother age, BMI, occupation, education level, infant age and gender. BMI: Body mass index, FI: Food insecurity, Hb: Hemoglobin, CI: Confidence interval, SE: Standard error

day were higher in food-insecure households compared to food-secure families. Similarly, the Third National Family Health Study in India revealed that average breastfeeding durations in affluent and low-income families were 20.8 and 27.7 months, respectively.[52] In that population, breastfeeding persistency in the second year of child life may indicate that the children from poor families are at risk of inadequate complementary feeding or represent mothers' attempts to provide sufficient food in response to food insecurity. Unlike this study, Bronte-Tinkew *et al.* showed breastfeeding durations of food-insecure mothers are less than those of food-secure mothers. Their findings demonstrated food insecurity before the age of two would be a hurdle for parental and child interactions influencing the main growth aspects such as public health and overweight.[53] Furthermore, Webb-Girard *et al.* indicated that families are experiencing food insecurity, the campaign against the barriers of exclusive breastfeeding.[54]

The WHO recommends mothers to exclusively breastfeed their babies for the first 6 months of life and follow continued complementary breastfeeding from the ages of 6 months to 2 years so as to satisfy their babies' additional needs for energy, iron, zinc, and other minerals.[55]

The relationship between household food insecurity, mother's feeding practices, and child iron status

Studies have shown that breast milk contains a considerable amount of bioavailable iron, whose concentration decreases gradually with time.[56] According to the researches, carried out, continued breastfeeding[57] and maternal anemia[58] are associated with increasing risk of ID and IDA in infants and toddlers. Furthermore, in infants up to 6 months of age, iron requirements for growth and red blood cell development increase. Therefore, exclusive breastfeeding is insufficient and supplemental sources are needed.[59]

Although Meinzen-Derr *et al.* showed that infants under the age of 1 are only breastfed and anemic mothers have depleted iron stores,[57] serum ferritin levels in children with continuing breastfeeding did not reduce up to the age of 2 based on the results of the current study. Since nearly 80% of the studied children received supplemental iron, it seems that the problem (decreased ferritin) is not exacerbated with continued receiving of breast milk by children. In addition, unlike Pasricha *et al.*'s study, no significant relationship was observed between child serum ferritin levels and household food insecurity.[60] The difference could be due to the fact that 68% of mothers in Pasricha *et al.*'s study were anemic, and the children received low supplemental iron if any.

In general, the correlation between breastfeeding persistency in the second year of life and decreased child serum iron concentration has not been well described, especially within the developing nations.

Strengths and restrictions

This study had some limitations. First, the cross-sectional design prevented the determination of cause-effect relationships. Second, measurements of other variables affecting child iron status were not possible since the amounts of blood needed were higher than the maximum size accepted by the community. Third, assessment of maternal feeding practices was done based on reports from mothers and mother's feeding behaviors were not directly observed. One of the strength points of this study was a high level of community participation. Given the socio-economic similarities of the study population with those of the other parts of the country, results of this research can be generalized to other ethnic or geographical groups across the region and the country.

CONCLUSIONS

Although this study showed the relationship between household food insecurity and mother's feeding status and child serum iron level is not significant, continued breastfeeding in children may lead to their risks of IDs and thus it is necessary to monitor the implementation of the iron supplementation programs, food fortification, and nutritional education within the population. Moreover, not only maternal iron status should be improved during pregnancy and lactation through foods and supplements containing enough iron contents, but also complementary

feeding associated with iron-rich foods must be initiated together with continuing breastfeeding after the age of 6 months.

Suggestions

Longitudinal studies are necessary to identify the exact pathways between household food insecurity and parental feeding behaviors, especially mothers and assessment of their consequences on child nutritional health. Other quantitative and qualitative studies are needed to clarify better the impacts of continued breastfeeding on children's nutritional status in food-insecure households of various ethnic groups with different cultures.

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