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Prevalence and predictors of iron-deficiency anemia: Women's health perspective at reproductive age in the suburb of dried Urmia Lake, Northwest of Iran

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Abstract:

BACKGROUND: Dried Urmia Lake in the northwest of Iran is a major regional source of sodium and toxic metal aerosols which may cause numerous health problems. The aim of this study was to evaluate iron-deficiency anemia (IDA) and some related risk factors among women of reproductive age in the suburb of dried Urmia Lake to provide the information about the problem to the health-care providers.

METHODS: This cross-sectional study was conducted on 278 healthy nonpregnant, nonlactating women aged 18–45 years, living in the rural area of the Salmas city, closest to the Urmia Lake between February and June 2017. The study participants were selected using a stratified random sampling method with proportional allocation from seven villages. A general questionnaire was completed for each participant to collect sociodemographic information and a 3-day dietary recall questionnaire to obtain daily dietary intakes. IDA was defined as a hemoglobin (Hb) level of <12 g/dl and ferritin concentration of <15 μg/l. Spearman's correlation coefficient and Fisher's exact test were applied to determine sociodemographic factors associated with the serum Hb and ferritin levels.

RESULTS: The prevalence of overall anemia (Hb <12 g/dl) was 7.9%. IDA was determined in 4.3% and iron deficiency (ID) in 19.1% (serum ferritin <15 μg/l) of the participants. There was a significant positive correlation between serum Hb concentrations and the mean daily intakes of protein and iron ($P < 0.001$). Similarly, a significant positive correlation was observed between serum ferritin levels and body mass index ($P < 0.001$). Significant inverse associations were found between Hb concentrations and the number of pregnancies and children ($P < 0.001$), as well as the number of family members ($P < 0.05$).

CONCLUSIONS: Results indicated a mild prevalence of IDA and a relatively high rate of ID among studied participants. Educational programs are needed to improve nutritional habits as well as the use of contraceptives to promote women's health.

Keywords:

Aerosols, health, Iran, iron-deficiency anemia, reproductive-age women

Introduction

Anemia is one of the most common public health problems which affects a great part of the world's population, especially in developing countries.[1] Iron deficiency (ID) is the most common cause of anemia which accounts for approximately half of all anemia cases globally.[2] Women of reproductive age are at a particularly

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high risk of developing ID anemia (IDA) and subsequent adverse health consequences including increased risk of adverse pregnancy outcomes, negative maternal and neonatal outcomes, and impaired physical performance. Based on the World Health Organization (WHO), the overall prevalence of IDA in women of reproductive age is 29.4%. This rate is 28% in Iran.[3] Etiologies of IDA vary among different populations, depending on variables such as age, gender, nutritional status, socioeconomic status, and environmental factors.[4]

Environmental pollution is one of the greatest serious public health risks that the world is facing today.[5,6] Saline lake desiccation can be considered as one of the important sources of environmental pollutants, mainly heavy metals. Such conditions were reported in the Aral Sea region in Kazakhstan, in which the surfaces of the resulting lakebed have become active sources of salt and dust of toxic metals, vulnerable to wind erosion.[7-9] The population living in the Aral Sea region faces numerous health issues, with high prevalence of anemia, respiratory diseases, cancers, and birth defects being among the most commonly reported health problems.[10]

Lake Urmia in the northwest of Iran is one of the largest saline lakes worldwide. In recent decades, the lake area has decreased by 90% which represents a major regional aerosol source and threatens the health of surrounding communities.[11] Studies on heavy metals and sodium concentrations in the leaves of local deciduous trees reported large amounts of toxic metals content such as lead, arsenic, and cadmium.[12] It has been shown that heavy metals in the blood can negatively interfere with iron homeostasis and lead to ID which could be reversed by provision of iron and subsequent increase in expression and activity of iron importers.[13-17] On the other hand, depletion of water used for irrigation has made widespread agricultural and ecological disruption which can contribute to poverty and poor nutrition, which could worsen the health issues.

Despite the numerous studies conducted on the lake's water regime, water level fluctuations, and mineral properties,[11,18] there are no reports of the long-term socioeconomic consequences and possible effects of aerosol exposure around Lake Urmia on health issues such as IDA. Considering women as a more vulnerable group to health hazards, this study was carried out to identify the prevalence of IDA and some related risk factors among women of reproductive age in the suburb of dried Lake Urmia to provide the information about the problem to the health-care providers to investigate an appropriate attempt.

Methods

Study design and subjects

This cross-sectional study was conducted on 278 healthy nonpregnant and nonlactating women aged 18–45 years, living in the rural area of the Salmas city, closest to the Lake Urmia, between February and June 2017. The study participants were randomly selected using a stratified random sampling method with proportional allocation from seven villages which considered as strata. The sample size of the study was calculated based on the information obtained for the prevalence of anemia among women in a study done by Bateni *et al*.[19] By considering 95% confidence and taking 23.6% as the prevalence rate of anemia, the sample size was computed to be 278.

The study sample excluded those women who reported abortion in the past 6 months; those diagnosed with hepatic diseases; those who had infectious diseases, surgery, and blood transfusion currently; those who were taking medication or nutritional supplements; and those diagnosed with thalassemia or other types of anemia.

Data collection

The data collected consisted of three sections: (a) sociodemographic data such as age, height, weight, marital status, employment, family income, literacy, medical history, and number of children, abortion, and family members; (b) dietary data; and (c) laboratory results carried out on each participant.

A researcher-made general questionnaire was used to collect sociodemographic information by interviewing with the participants, which is considered to have high validity and reliability because the answers were not qualitative. Anthropometric characteristics (weight and height) were measured for all participants by a trained nutritionist. Weight was measured in light clothing by a Seca scale (Seca Ltd., Hamburg, Germany) to the nearest 0.1 kg. Height was also measured without shoes with a precision of 0.1 cm. Body mass index (BMI) was calculated as weight (kg) divided by squared height (m^2). Dietary data were obtained by a 3-day 24-h dietary recall[20] to estimate each participant's daily dietary intake by a trained dietitian asking them to report all the foods and drinks they had consumed during the day before the interview (including 2 weekdays and 1 weekend day).

Blood samples (5–7 cc) were obtained after a 12-h overnight fast for hematological tests. Two milliliters were collected and stabilized in EDTA tubes for measuring hemoglobin (Hb) concentration using the commercial cyanmethemoglobin method (Pars Azmoon Inc. Kit, Iran) immediately after blood sampling. The additional blood samples (3–5 cc) were centrifuged at 3500 rpm for 10 min for serum separation and then

were immediately stored at −70°C until performing the analyses. Serum levels of ferritin were measured by enzyme-linked immunosorbent assay (Ferritin ELISA Kit, ORGENTEC, Germany).

IDA was defined as a Hb level of <12 g/dl[21] and ferritin concentration of <15 μg/l.[22]

Data analysis

Data analysis was performed using the SPSS software version 17 (SPSS Inc., IL, Chicago, USA). Data were presented as frequency (percentage) for categorical variables and mean (standard deviation) for numeric variables. Spearman's correlation coefficient and Fisher's exact test were applied to determine various socioeconomic and demographic factors associated with anemia. Modified Nutritionist 4 software (First Databank, Hearst Corp., San Bruno, CA, USA) was then used to analyze the dietary data. The level of statistical significance was set at $\alpha = 0.05$.

Results

Sociodemographic, anthropometric, and reproductive information

A total of 278 women aged 18–45 years participated in the study and were included in the final analysis. The mean age of the participants was 35.36 ± 8.49 years. Most were married (85.25%) and homemakers (98.5%). Regarding educational status, about 41% of them were illiterate. The mean monthly household income of the majority (70.14%) was <100 US Dollars. The mean weight and BMI of the study participants were 68.21 ± 13.77 kg and 28.13 ± 5.48 kg/m^2, respectively. The average number of children was 2.06 ± 1.16, and the average number of miscarriage or abortion was 0.42 ± 0.91 [Table 1].

Table 1: Sociodemographic, anthropometric, and reproductive information of healthy nonpregnant and nonlactating women, Iran, 2017 (*n*=278)

Variables	Summary statistics
Age (year), mean±SD	35.36±8.49
Weight (kg), mean±SD	68.21±13.77
BMI (kg/m^2), mean±SD	28.13±5.48
Number of children, mean±SD	2.06±1.16
Number of abortion, mean±SD	0.42±0.91
Number of family members, mean±SD	4.04±0.68
Literacy, frequency (%)	
Illiterate	114 (41)
Primary school	108 (38.84)
High school	44 (15.82)
Upper	12 (4.31)
Family income, frequency (%)	
<100$	195 (70.14)
101-200$	70 (20.17)
201-300$	6 (2.15)
301-400$	2 (0.71)
>400$	5 (1.79)
Marital status, frequency (%)	
Single	41 (14.74)
Married	237 (85.25)
Employment, frequency (%)	
Employed	4 (1.43)
Unemployed	274 (98.56)

BMI=Body mass index, SD=Standard deviation

Anemia prevalence

Table 2 shows the overall prevalence of anemia among the study participants based on Hb and ferritin concentrations. In 7.9% of the participants, the Hb level was determined to be below 12 g/dl. Analysis of serum ferritin levels showed that 19.1% of the women had serum ferritin levels below 15 μg/l. IDA, defined as serum ferritin <15 μg/l and Hb <12 g/dl, was found in 4.3% of the participants.

Table 2: Overall anemia prevalence among the healthy nonpregnant and nonlactating women, Iran, 2017 (*n*=278)

Variables	Frequency (%)
Hb <12 (g/dl)	22 (7.9)
Hb ≥12 (g/dl)	256 (92.1)
Ferritin <15 (μg/l)	53 (19.1)
Ferritin ≥15 (μg/l)	225 (80.9)
Hb <12 (g/dl) and ferritin <15 (μg/l)	12 (4.3)

Hb=Hemoglobin

Dietary intakes

Table 3 shows the daily intakes of energy, macronutrients, and iron among the study participants. The mean daily intakes of energy and iron were 1966.3 ± 731.86 kcal and 17.51 ± 7.98 mg, respectively. Insufficient energy intakes were found in 11.9% based on <75% estimated average requirement, and 26.6% of the participants had insufficient intakes of iron based on <75% recommended dietary allowance of 18 mg/day.

Table 3: Daily dietary intakes of energy, macronutrients, and iron among healthy nonpregnant and nonlactating women, Iran, 2017 (*n*=278)

Variables	Summary statistics
Energy (kcal/d), mean±SD	1966.30±731.86
<75% EAR, frequency (%)	43 (11.90)
≥75% EAR, frequency (%)	245 (88.10)
Carbohydrate (g/d), mean±SD	306.55±224.37
Protein (g/d), mean±SD	83.20±14.0
Fat (g/d), mean±SD	72.48±25.01
Iron (mg/d), mean±SD	17.51±7.98
<75% RDA, frequency (%)	74 (26.60)
≥75% RDA, frequency (%)	204 (73.40)

RDA=Recommended dietary allowance, EAR=Estimated average requirement, SD=Standard deviation

Correlates of anemia

There was a significant positive correlation between serum Hb concentrations and the mean daily intakes

of protein and iron. Similarly, a significant positive correlation was observed between serum ferritin levels and weight and BMI. No significant association was found between Hb concentrations and anthropometric measurements. Significant inverse associations were observed between Hb concentrations and the number of pregnancies and children, as well as the number of family members [Table 4]. Literacy, job, economic status, and marital status did not reveal any significant association with IDA [Table 5].

Discussion

In the present study, among a random sample of 278 nonpregnant and nonlactating women, 19.1% of the women had serum ferritin levels below 15 µg/l which indicates depleted iron stores. The study results also indicated a mild prevalence of unspecified anemia (7.9%), based on the anemia criteria (Hb level of <12 g/dl) defined by the WHO.[19] Frequent pregnancies, number of family members, and inadequate intakes of iron and protein were the main risk factors related to anemia in the study participants.

Table 4: Serum hemoglobin and ferritin concentrations correlations with demographic and dietary intakes among healthy nonpregnant and nonlactating women, Iran, 2017

Variables	Hb (mg/dl)	Ferritin (µg/l)
Age (years)	−0.07	0.01
BMI (kg/m^2)	−0.06	0.15*
Number of family members (*n*)	−0.14†	−0.03
Number of children (*n*)	−0.16*	−0.07
Number of abortion (*n*)	−0.07	0.06
Dietary intakes		
Iron (mg/d)	0.15*	0.09
Energy (kcal/d)	−0.09	0.09
Carbohydrate (g/d)	−0.06	0.11
Protein (g/d)	0.15*	0.07
Fat (g/d)	0.04	0.06

*P<0.001, †P<0.05. Hb=Hemoglobin, BMI=Body mass index

Table 5: Socioeconomic correlations with anemia among healthy nonpregnant and nonlactating women, Iran, 2017

Variables	Nonanemic, *n* (%)	Anemic (IDA), *n* (%)	*P**
Literacy			
Illiterate	107 (93.9)	7 (6.1)	0.25
Primary school	104 (96.3)	4 (7.3)	
High school	44 (100)	0 (0)	
Upper	11 (91.7)	1 (3.8)	
Family income			
<100$	184 (94.4)	11 (5.6)	0.55
101-200$	69 (98.6)	1 (1.4)	
201-300$	6 (100)	0 (0)	
301-400$	2 (100)	0 (0)	
>400$	5 (100)	0 (0)	
Marital status			
Single	40 (97.5)	1 (2.4)	0.33
Married	224 (94.5)	13 (5.4)	
Employment			
Employed	4 (100)	0 (0)	1.00
Unemployed	262 (95.6)	12 (4.4)	

*Fisher's exact test. IDA: Iron-deficiency anemia

The rate of anemia in our study is significantly lower than that found by a prior study among a sample of reproductive-age women in rural areas of Tabas, the center of Iran, which reported a prevalence of anemia of 13.8% (defined as Hb <12 g/dl) in 2013.[23] This value is also lower than the values found among reproductive-age women in urban and rural areas of Iran which the prevalence of anemia was reported to be 33% in 2001.[24] However, a more recent study in 2015 in the northeast of Iran reported the prevalence of 16% of anemia in females of 15–54 years old.[25] It seems that the prevalence of anemia has been improved over the years in Iran, which is probably because of obligatory iron supplements given to the adolescent schoolgirls and pregnant women by the health-care centers, free of charge. In the study by the WHO, the prevalence of anemia was 47.5% in African, 17.8% in American, and 32.4% in Eastern Mediterranean nonpregnant women. Another study in rural areas of South India reported the prevalence of 34.83% of anemia in reproductive-age women.[6]

Based on the WHO, the overall prevalence of IDA in women of reproductive age is 29.4%. Research in an Indian setting reported a prevalence of IDA of 44.0% among female university students.[26] Widespread IDA has also been found among female students in other developing countries such as Bangladesh, where 63.3% of a female student sample was found to have IDA.[27] In contrast, in Australia, a developed country, only a 3% prevalence of IDA was found in a sample of female university students.[18] However, all of these surveys noted considerable regional, ethnicity, and environmental factor variations.

We found a lower frequency of IDA (4.3%) among reproductive-age women which was far less than we expected. It would seem that the prevalence of anemia in the suburb of dried Urmia Lake is similar to that of the Aral Sea region of Kazakhstan. However, in a nationwide survey of 1303 women at the age of 15–49 years living in Kazakhstan, the estimated prevalence of IDA was reported to be 43.8% among pregnant women and 39.0% among nonpregnant women.[28] The low prevalence of IDA in our participants, as stated earlier, may be related to the programs applied in primary health-care centers and schools by Iran's Ministry of Health, which has a long-term planning and interventions to reduce the prevalence of anemia among vulnerable groups.

However, ID which was detected in 19.1% of the women remains an important health problem.

Repeated pregnancies and short birth intervals deplete iron stores that subsequently may contribute to anemia, explaining the association of higher parity with anemia. The present research confirmed that the number of pregnancies and family members were predisposing factors to anemia. Sadeghian *et al*.[23] found a significantly higher rate of anemia among women with more than two pregnancies. Similar studies in Ethiopia[29] and India[30] also documented such an association between pregnancy numbers and the risk of anemia. Thus, empowering women in terms of contraception and pregnancy intervals would have positive contributions to avert the problem.

Our results indicated a significant positive correlation of ferritin and not Hb, with participants' weight and BMI. Alquaiz *et al*.[31] also found that women with high BMIs had 5% less risk of developing anemia as compared to those with low BMIs. However, a study by Eftekhari *et al*.[32] demonstrated decreased serum ferritin levels in obesity. It seems that increased BMI within the normal range is related to adequate nutrition and being underweight is associated with a range of health risks related to poor nutrition. On the other hand, obesity and excessive adipose tissue have been associated with increased risk of ID[33] which may be masked by high serum ferritin levels as a result of obesity-associated inflammation.[34] In the present study, most of the study participants were within the normal weight and overweight ranges and were not obese. Therefore, a direct correlation between ferritin and BMI would be expected.

Despite the relatively high ratio of illiterate women (41%) in our study, we did not find any relationship between anemia and literacy. Similarly, Sadeghian *et al*.[23] did not find any association between literacy and anemia in rural areas of Tabas city in Iran. This may also be due to the iron supplementation program provided by Iran's Ministry of Health in primary health-care centers to reduce the prevalence of anemia among vulnerable groups.

Although some other studies have revealed a relationship between family income and anemia,[23,35,36] we did not find any correlation. In consistency with our finding, a recent study in rural areas of Jordan has reported no significant association between the socioeconomic status and the prevalence of anemia among pregnant women.[37] Martinez *et al*.[38] conducted a study on the effects of socioeconomic factors influencing anemia development in Afghanistan. In terms of wealth distribution, they reported that women who survive through agriculture and animal breeding have a lower prevalence of anemia. Our study did not find a statistically significant difference in the prevalence of anemia based on income level. However, women with more daily intakes of protein and iron had a significantly lower rate of anemia which supports the findings of Martinez *et al*. indirectly.

To our knowledge, this is the first study that reports the information about the socioeconomic and ecological consequences of Lake Urmia desiccation on health issues including IDA to make the relevant contributions to avert the problem. However, some limitations are inherent in the present research. First, no causal associations could be established between the influencing factors and IDA due to the cross-sectional nature of the study. Second, the possibly toxic levels of heavy metals in the blood sample of the study participants were not assessed to indicate the relationship of aerosol exposure with anemia.

These study findings suggest a need for education and awareness strategies designed to improve nutritional habits by encouraging the consumption of rich sources of iron and protein in the diet, as well as contraceptive use to make positive health contributions to avert the IDA.

Conclusions

This study indicated a mild prevalence of IDA and a relatively high rate of ID among women of reproductive age in the rural populations of dried Urmia Lake based on the WHO prevalence-based classification.[21] Frequent pregnancies, number of family members, and inadequate intakes of iron and protein were the main risk factors related to anemia in the study participants. Longitudinal studies are needed to evaluate the health status of people who are lived in the studied area which would help to build greater understanding of health problems related to the lake desiccation.

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Conflicts of interest

There are no conflicts of interest.

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