Original Article

Prevalence of Iron Deficiency with and Without Anemia Among Immigrant' People in Al-Azrakeen Area, Sana'a City, Yemen

Dekra A El-Aghbary [1], PhD, Rashad A Thabet [2], PhD, Ebtesam M Al-Zabedi [2], PhD, Aref N Al-Afif [1], MSc.

[1]Department of Medical Microbiology & Immunology, Faculty of Medicine & Healh Sciences, Sana'a University, Sana'a, Yemen.
[2]Department of Applied Biochemistry, Faculty of Medicine & Healh Sciences, Sana'a University, Sana'a, Yemen.

*Corresponding author: Dekra A El-Aghbary; *dekra_ali2003@yahho.com*

Abstract

Background: The prevalence of iron deficiency with or without anemia is still remains the common clinical problem worldwide. Iron deficiency with and without anemia may be more prevalent among migrants due to disadvantaged life conditions. The aim of this study was to estimate the prevalence of iron deficiency with and without anemia among immigrants in Al-Azrakeen area, Sana'a City. **Subjects and Methods:** Out of 2300 immigrant population in Al-Azrakeen area, 223 participants were randomly chosen, aged from 5 to 50 years (134 children and 89 adults). The study included measurement of hematological parameters and serum iron indices. All data were analyzed using SPSS version 26. **Results:** The prevalence of iron deficiency among the total immigrant population, adult and children was 21.5%, 19.1% and 23.1%, respectively. While the prevalence of IDA among total immigrants, adults and children was 6.7%, 4.5% and 8.2%, respectively. Statistically signifcant association was observed between iron deficiency anemia and age of immigrant adults (p=0.05). **Conclusion:** This study concludes that iron deficiency and iron deficiency anemia are prevalent among immigrants in Al-Azrakeen area, Sana'a City, Yemen. Children are at higher prevalence of developing iron deficiency with or without anemia.

Keywords: *iron deficiency anemia, serum ferritin, serum iron, immigrants, Yemen.*

Introduction

Iron is a funadamental micronutrients involved in the formation of haemoglobin, myoglobin and various oxygen-carrier enzymes. Iron deficiency (ID) with or without anemia is the most nutritionally prevalent deficiency in both developed and undeveloped countries. It may cause loss of strength and tiredness, impaired immune response, poor cognitive functioning, and behavior problems (social/emotional). Iron deficiency anemia (IDA) is a form of anemia due to the lack of sufficient iron to form normal red blood cells. ID and IDA may result from the interplay of increased iron requirements, limited external supply and increased blood loss [1,2]. The prevalence of ID with and without anemia varies between sex, age groups, and geography. In developed countries, it is especially high in the elderly [3], while pregnant women and children represent the most cases in undeveloped countries [4,5,6]. Nearly half of anemia occurrences in the developing countries is assumed to be attributable to ID with an approximate incidence of 500-600 million occurences worldwide [7,8]. However, the prevalence of ID is twice as high as that of IDA throughout the world [9].

Migrants are more prone to develop ID with or without anemia among their native population, particularly in developing countries and in low socioeconomic population [10,11]. As Yemen is considered as a developing country as well as low socioeconomic population as a result of poverty and war and according to UN agencies, about half of Yemen's population lives below the poverty line [12]. Most of the previous studies on ID and IDA in Yemen were conducted on school children and pregnant women [13-15]. Yet there is no information about the prevalence of IDA among immigrant's Yemeni. Consequently, the current study aims to determine the prevalence of ID and IDA among immigrant' adults and children in Al-Azrakeen area, Sana'a City.

Subjects and Methods

From December 2022 to April 2023, we conducted a cross-sectional study among a population of immigrants aged from 5 to 50 years that living in the Al-Azrakeen area in Sana'a City, Yemen. The study included measurements of hemoglobin (Hb) indices, serum iron indices (serum iron and ferritin), calculation of total iron binding capacity (TIBC) and transferrin saturation (TSAT) in blood drawn from 223 subjects.

Definition of Subjects

ID individuals were with normal Hb levels according to the age of participants and mean corpuscular hemoglobin (MCH) in the lower limit of normality (normal range 28-35pg) or high red blood cell distribution width (RDW) (normal range 11-15%), low serum ferritin <30 ng/ml for adult male, and <13 ng/ml for adult female. As regards children with ID serum ferritin <4 ng\mL for children at age 5-6 years, <7 ng\mL for girls and <14 ng\mL for boys at age 7-12 years, <13 ng\mL for girls and <14 ng\mL at age 13-17 years. The

main laboratory finding for ID is a low serum ferritin in the absence of inflammation, however, normal serum ferritin does not exclude ID, therefore, all subjects should be tested with TSAT <20% as a case of iron-deficient [16].

Individuals with IDA were considered in adult males who had Hb < 13 g/dl with serum ferritin < 30ng/ml, Hb<11.5g/dl for adult females with serum ferritin < 13 ng/ml. Children with IDA at age 5-6 years should have Hb <11.5g/dL with serum ferritin < 4 ng\mL (in boys and girls) while children aged from 7 to 12 years should have Hb <11.5 g/dL with serum ferritin < 7 ng/ml for girls, and Hb < 11.5 g/dL with serum ferritin < 14ng\ml for boys. Children with IDA at aged 13-17 years should have Hb < 11.5 g/dL with serum ferritin <13ng\mL for girls, and for boys Hb < 11.5 g/dL with serum ferritin < 14ng\ml. All subjects with IDA have MCH < 27 pg, and TSAT < 20%. In addition, the diagnosis of IDA was confirmed by the high levels of RDW > 15% and the presence of microcytic hypochromic erythrocytes in blood film; except in case of co-existing vitamin B12 or folate deficiency [9,16].

Eligibility: Inclusion Criteria: All children aged 5-17 years and all adult people aged 18-50 years, no evidence of chronic blood loss, normal serum albumin and normal C-reactive protein (CRP).

Exclusion Criteria: We exclude people who: < 5 years and over 50 years, pregnant women. People who had bleeding, chronic diseases or any inflammatory disease. Sample size was calculated using Epi info. at confidence interval 95%. According to the total immigrant population of Al-Azrakeen area that is 2500 persons (40% adults, children 60%). The sample size was 223 individuals; as follows: 134 subjects from children (60.1%) and 89 persons for adults (39.9%). Data was collected through a face-to-face interview by a predesigned questionnaire for this study that included demographic data and lab investigation.

Sample Collection: Five ml of venous blood was drawn in the morning aseptically from each of the participants. Samples will be divided into two tubes; two ml into an EDTA-treated evacuated tube for hematological examination (complete blood count and blood film) and three ml of blood was separated on the day of sampling to serum for the estimation of iron indices. A complete blood count (CBC) which includes red blood cells (RBC), Hb, hematocrit (HCT), mean cell volume (MCV), MCH, RDW was analyzed within 4 to 6 hours of blood sampling using Siemens Advia 2120 Hematology Analyzer. For iron indices, the quantitative determination of iron and unsaturated iron binding capacity (UIBC) in serum were determined using the Beckman Coulter SYNCHRON System. The quantitative determination of serum ferritin was determined by Cobas e 411 Roche, Germany. TIBC was calculated by summing serum iron and serum UIBC.17 TSAT was calculated by dividing the iron concentration by the TIBC (TSAT = SI / TIBC *100) [18].

Statistical Analysis: Data analysis was done using the statistical program, SPSS Version 26 software (IBM Corporation, New York, NY, USA). For potential associated risk factors, Chi square, odds ratio and 95% CI were calculated. A $p \leq 0.05$ was considered statistically significant.

Ethical Approval: Oral and written informed consent was taken from the participants or from the child's parents.

Results

As shown in Table 1, this study included 223 immigrants age from 5 to 50 years More than half of participants were females (51.1%). Also, 51.1% have a job. 57% of participants have family members from 7 to 11 while only 18% of them have family members from 12 to 15. Most of total participants (48.9%) have a duration of stay in the camp between one and twenty months. As regards the immigrant' adults, out of 89 participants more than half of them (55.1%) were females and having an age between 18-28 years (52.9%). Nearly less than half of adult participants (48.3%) were have a job and have family members of 2-6. As regards the duration of stay in the camp, most of them (45%) stay between 1-20 months.

Out of 134 children' participants, 51.5% were males and 48.5% were females. Most of immigrant' children (82.1%) having an age between 5-11 years. Nearly more than half (53%) of children' fathers have a job. Most of the children (65.7%) were living with family members between 7 and 11 person and about half of them (51.5%) stay in the camp for 1-20 months.

Prevalence of iron deficiency
The overall prevalence of ID is 21.5% among total immigrants, more than the half (56.2%) of them were females. While the prevalence of ID among immigrant' adults was 19.1%, most of these (76.5%) were females. In contrast, the prevalence of ID among children was 23.1% and more than half of (54.8%) children with ID were male (**Table 2**).

Prevalence of iron deficiency anemia
Of 223 participants, 6.7 % of total immigrants are suffering from IDA from whom 53.3% were females. However, the prevalence of IDA in immigrant' adults was 4.5%, most of them (75%) were females. The highest prevalence of IDA (8.2%) was found among immigrant' children; more than half (54.5%) of them were boys (**Table 2**).

As illustrated in Table 3 there were no association between ID and the studied risk factors that were sex, age, have a job, family members and, duration of stay in the camp among total immigrants (p = 0.42, 0.33, 0.62, 0.36, 0.95; respectively), among immigrant' adults (p = 0.09, 0.83, 034, 0.92, 0.68; respectively), or among immigrant' children (p = 0.67, 0.44, 0.16, 0.40, 0.38; respectively).

Table 4 shows that there were no association between IDA among total immigrants and all risk factors; sex, age, have a job, family members and, duration of stay in the camp (p = 0.86, 0.54, 0.13, 0.96, 0.61; respectively). However, there was only association between IDA and age of emigrant adults (p = 0.05). While among immigrant' children, there were not any association between IDA and the studied risk factors (p = 0.83, 0.66, 0.09, 0.30, 0.26; respectively).

Table 1: Demographic and general characteristic data of the emigrant' people in Al-azrakeen area, Sana'a City, Yemen

Character		Total immigrants	Immigrant's adult	Immigrant's children
N0. (%)				
Sex	Male	109 (48.9)	40 (44.9)	69 (51.5)
	Female	114 (51.1)	49(55.1)	65(48.5)
Age groups (years)	5-11	28 (12.6)		110 (82.1)
	12-17	106 (47.5)		24 (17.9)
	18-50	89 (39.9)	39.9	
	18-28		47 (52.9)	
	29-39		36 (40.4)	
	40-50		6 (6.7)	
Have a job	Yes	114 (51.1)	43 (48.3)	71(53)

	No	109 (48.9)	46 (51.70	63 (47)
Family members	2-6	78 (35)	43(48.3)	35 (26.1)
	7-11	127 (57)	39 (43.8)	88 (65.7)
	12-15	18 (8)	7(7.9)	11 (8.2)
Duration (Months)	1-20	109 (48.9)	40 (45)	69 (51.5)
	21-40	70 (31.4)	31 (34.8)	39 (29.1)
	41-60	34 (15.2)	14 (15.7)	20 (14.9)
	61-80	4 (1.8)	3 (3.4)	6 (4.5)
	81-96	6 (2.7)	1 (1.1)	71 (53)
Total		223 (100)	89 (100)	134 (100)

Table 2: Prevalence of Iron Deficiency and iron deficiency anemia among immigrants in Al-azrakeen area, Sana'a City, Yemen

Subjects	Sex	ID	IDA
All subjects	No. (%)		
	Male	21 (43.8)	7 (46.7)
	Female	27 (56.2)	8 (53.3)
Total		48 (21.5)	15 (6.7)
Adult	Male	4 (23.5)	1 (25)
	Female	13 (76.5)	3 (75)
Total		17 (19.1)	4 (4.5)
Child	Male	17 (54.8)	6 (54.5)
	Female	14 (45.2)	5 (45.5)
Total		31 (23.1)	11 (8.2)

Table 3: Association **of iron deficiency and some risk factors among immigrants in Al-azrakeen area, Sana'a City, Yemen.**

Risk factors	Total immigrants (223) ID No (%)	Non-ID	OR (95% CI)	X^2	P	Immigrant's adult (85) ID No (%)	Non-ID	OR (95% CI)	X^2	P	Immigrant's children (134) ID No (%)	Non-ID	OR (95% CI)	X^2	P
Sex															
Male	21 (43.8)	88 (50.3)	0.77 (0.40-1.46)	0.64	0.42	4 (23.5)	36 (50)	0.31(.09-1.03)	2.89	0.09	17 (54.8)	52 (50.5)	1.19 (0.53-2.67)	0.18	0.67
Female	27 (56.2)	87 (49.7)				13 (76.5)	36 (50)				14 (45.2)	51 (49.5)			
Age (years) Total immigrants															
5-11	9 (18.8)	19 (10.9)									24 (77.4)	86 (83.5)	0.68 (0.25-1.82)	0.60	0.44
12-17	22 (45.8)	84 (48)		2.22	0.33						7 (22.6)	17 (16.5)			
18-50	17 (35.4)	72 (41.1)													
Adult immigrants															
18-28						8 (47.1)	39 (54.2)		0.38	0.83					
29-39						8 (47.1)	28 (38.9)								
40-50						1 (5.9)	5 (6.9)								
Have a job															
Yes	23 (47.9)	91 (52)	0.85 (0.45-1.61)	0.25	0.62	10 (58.8)	33 (45.8)	1.69 (.58-4.93)	0.93	0.34	13 (41.9)	58 (56.3)	0.56 (0.25-1.26)	1.98	0.16
No	25 (52.1)	84 (48)				7 (41.2)	39 (54.2)				18 (58.1)	45 (43.7)			
Family members															
2-6	15 (31.2)	63 (36)		2.02	0.36	8 (47.1)	35 (48.6)		0.16	0.92	7 (22.6)	28 (27.2)		1.86	0.40
7-11	31 (64.6)	96 (54.9)				8 (47.1)	31 (43.1)				23 (74.2)	65 (63.1)			
12-15	2 (4.2)	16 (9.1)				1 (5.9)	6 (8.3)				1 (3.2)	10 (9.7)			
Duration (Months)															
1-20	22 (45.8)	87 (49.7)				6 (35.3)	34 (47.2)		2.33	0.68	16 (51.6)	53 (51.5)			
21-40	15 (31.2)	55 (31.4)		0.72	0.95	8 (47.1)	23 (31.9)				7 (22.6)	32 (31.1)		3.06	0.38
41-60	8 (16.7)	26 (14.9)				3 (17.6)	11 (15.3)				5 (16.1)	15 (14.6)			
61-80	1 (2.1)	3 (1.7)				0 (0)	3 (4.2)				3 (9.7)	3 (2.9)			
81-96	2 (4.2)	4 (2.3)				0 (0)	1 (1.4)								

χ2: Chi Square ≥ 3.9 (significant); OR: Odds ratio > 1 at risk; CI: Confidence intervals 95%; p: Probability value ≤ 0.05 (significant) *

Table 4: Association of iron deficiency anemia and some risk factors among immigrants in Al-azrakeen area, Sana'a City, Yemen

Risk factors	Total immigrants (223) IDA No (%)	Non-IDA	OR (95% CI)	X^2	P	Immigrant's adult (85) IDA No (%)	Non-IDA	OR (95% CI)	X^2	P	Immigrant's children (134) IDA No (%)	Non-IDA	OR (95% CI)	X^2	P
Sex															
Male	7 (46.7)	102 (49)	0.91 (0.32-2.59)	0.03	0.86	1 (25)	39 (45.9)	0.39 (.04-3.93)	0.09	0.76	6 (54.5)	63 (51.2)	1.14 (0.33-3.94)	0.04	0.83
Female	8 (53.3)	106 (51)				3 (75)	46 (54.1)				5 (45.5)	60 (48.8)			
Age (years) Total immigrants															
5-11	2 (13.3)	26 (12.5)									8 (72.7)	102	0.55 (0.13-2.24)	0.19	0.66
12-17	9 (60)	97 (46,6)		1.24	0.54						3 (27.3)	(82.9)			
18-50	4 (26.7)	85 (40.9)										21 (17.1)			
Adult immigrants															
18-28						0 (0)	47 (55.3)		6.17	0.05					
29-39						4 (100)	32 (37.6)								
40-50						0 (0)	6 (7.1)								
Have a job															
Yes	11 (73.3)	103 (49.5)	2.80 (0.86-9.09)	2.29	0.13	2 (50)	41 (48.2)	1.00 (0.14-7.38)	0.00	1.00	9 (81.8)	62 (50.4)	4.43 (.09-21.33)	2.86	0.09
No	4 (26.7)	105 (50.5)				2 (50)	44 (51.8)				2 (18.2)	61 (49.6)			
Family members															

			χ2	p			χ2	p			χ2	p
2-6	5 (33.3)	73 (35.1)			0 (0)	43 (50.6)	5.37	0.07	5 (45.5)	30 (24.4)		
7-11	9 (60)	118 (56.7)	0.08	0.96	4 (100)	35 (41.2)			5 (45.5)	83 (67.5)	2.74	0.30
12-15	1 (6.7)	17 (8.2)			0 (0)	7 (8.2)			1 (9.1)	10 (8.1)		
Duration (Months)												
1-20	7 (46.7)	102 (49)			3 (75)	37 (43.5)	1.81	0.77	4 (36.4)	65 (52.8)		
21-40	7 (46.7)	63 (30.3)	2.71	0.61	1 (25)	30 (35.3)			6 (54.5)	33 (26.8)	4.01	0.26
41-60	1 (6.7)	33 (15.9)			0 (0)	14 (16.5)			1 (9.1)	19 (15.4)		
61-80	0 (0)	4 (1.9)			0 (0)	3 (3.5)			0 (0)	6 (4.9)		
81-96	0 (0)	6 (2.9)			0 (0)	1 (1.2)			0 (0)			

χ2: Chi Square ≥ 3.9 (significant); OR: Odds ratio > 1 at risk; CI: Confidence intervals 95%; p: Probability value ≤ 0.05 (significant) *

Discussion

This is the first study that provides information on the prevalence of ID and IDA among immigrants of Al-Azarkeen area, Sana'a city, Yemen. A global population of about 25% is affected by ID, which affects 1.6 billion people [19]. According to previous studies, the prevalence of ID is between 2% and 20%, with the prevalence higher among immigrants [10,20,21]. Our study found that ID prevalence among immigrants (adults and children) in Al-Azarkeen area was 21.5% without a significant difference between males (43.8%) and females (56.2%) p=0.42. The prevalence of ID among total immigrants was similarly with prevalence of ID among immigrants from developing countries to developed countries. Among newly arrived western, central, and eastern African refugees to Australia, 20% had ID [22].

While our study resulted in a prevalence of 19.1% among immigrant adults. Previous studies [23,24] found that the prevalence of ID among females was statistically significantly higher than among males. Although in our study, it was found to be higher among women (76.5%) than men (23.5%) but without significant differences (p=0.09). However, our result is in agreement with a study that reported the prevalence of ID among immigrated females in developing countries (46%) was higher than that in developed countries6. Many studies showed low prevalence of ID in developed countries; in Italy when Morrone *et al.* [11] found that the prevalence of ID among immigrated women was only 22.7 %, in Northeast Thailand reported that the prevalence of ID among non-pregnant women, aged between 18-45 years [25,26] and in women of reproductive age in Lao, PDR was 28.4% [27]. Moreover, US study resulted in prevalence rates of 19% in Afro-American females, 22% in Mexicans, and 10% in Caucasian women [28] which are all less than our prevalence. Female illiteracy and socioeconomic customs, as well as menstruation, further exacerbate the problem in Yemen; especially in developing countries, females receive lower quality diets compared to males [29,30].

Children are the most affected group by ID due to increased iron demands for rapid growth and general cognitive development. Moreover, children are mostly affected by the unfavorable conditions of migration [3-7,31,32,33]. In addition, malaria and other infectious diseases in developing countries produce a systemic inflammatory response such as diarrhea and pneumonia that may contribute to the burden of ID through raising hepcidin and thus preventing iron absorption [34]. The global rate of ID in developing countries has been shown that 46% of school age children are iron deficient [6]. In this study the prevalence of ID among immigrated children age from 5 to 17 years was 23.1%; without any significant difference between boys (54.8%) and girls (45.2%) p = 0.67. A similar prevalence of ID was reported in earlier studies in adolescent girls age between 15-17 years in rural northeast Thailand [26] and in South Asia that show the prevalence of ID in children is from 18 to 21% [33]. In contrast, our prevalence was lower than that of the prevalence of children age from 5 to 7 years conducted in Mathpah area, Sana'a city, Yemen which is 31.5% [15]. However, our result is consistent with this study that found there is no difference between boys and girls regarding the prevalence of ID [15].

Until now, IDA is still the most prevalent and common type of anemia in the developing and developed countries. Nearly 50% of cases of anemia overall were attributable to ID throughout the world [3,16,32]. IDA, probably the most common cause of anemia in immigrant' population. In developing countries, the groups most commonly affected are children and women; however, refugees of both sexes and all age groups are at risk [35]. In the current study, the prevalence of IDA among the total immigrant' population (adult and child) of Al-Azarkeen area was 6.7%. Our prevalence was lower than that of the prevalence of IDA among immigrants (22.1%) in western Australia [36]. In this study, it was found that there is no statistically significant difference between males (53.3%) and females (46.7%) p=0.86. IDA prevalence among immigrant females age from 5 to 50 years (53.3%) was more than two times higher than among immigrant females age from 14 to 60 years (22.7 %) living in Rome, Italy [11]. In addition, a US study showed a prevalence rate of 19% for Afro-American women and a prevalence rate of 22% for Mexican women [37].

Whereas the prevalence of IDA in immigrant' adults was 4.5%; 25% were males and 75% females, also without any significant difference between them p=0.76. This result was nearly in similar with the prevalence of IDA in Jordan that is accounted for 68% of anemic females and 38% of anemic males were suffering IDA [38]. On the other hand, our result is higher than that of other studies; WHO estimate IDA among women of reproductive age ranges from 18% to 48% in six world regions [39,40]. In fact, the prevalence of IDA in developing countries among adult females is higher than that in developed ones [6] which is consistent with our result; our prevalence of IDA among women (75%) is nearly seventh-fold than that in immigrant' women aged 15 to 59 years (11.3%) in Western countries [6,11,28] and among reproductive age women (13.2%) in Northeast Thailand [25]. However, Canadian study found that prevalence of IDA in immigrant' women of reproductive age of East Indian origin was 16% [41].

Naturally, children are mostly affected by unfavorable conditions. It has been reported that about 750 million worldwide are suffering from IDA, and it is considerably more prevalent in developing countries [11,16]. Among preschool children, the prevalence of IDA was ranging from 21% to 68% in six world regions [39] while IDA affects only 18% of children in industrialized countries6. Surprisingly, a study from Canada has reported that IDA among Canadian infants and young children ranged from 1.5% to 79% [42]. In the Middle East region, the reported prevalence of IDA in rural and urban people varies from 17 to 70% among preschool children; 12.6–50% among school children; 14-42% among adolescents [14,34].

In Yemen, previous studies revealed that a high prevalence of IDA among Yemeni children aged ≤ 15 years in rural areas (34.2%), among school children in Aden governorate was 19.3%, among pediatric patients who received blood transfusion (54.4%) and children (aged 25-48 months) was 37.0% [14,43,44]. It accounted for 70.2% of the anemic cases in Yemeni rural [14]. Our prevalence of IDA was 8.2% among immigrant' children aged from 5 to 17 years in Al-Azarkeen area, Sana'a that was higher than the prevalence of children aged from 5 to 7 years in Mathpah area, Sana'a city, Yemen (3.9%) [15]. This means that the prevalence of IDA among adolescents in Sana'a City is higher than that among young age children. In the present study, there is no significant difference (p=0.83) between the prevalence of IDA among boys (54.5%) and girls (45.5%). However, the prevalence of IDA in Yemeni rural children was significantly higher prevalence among the girls (49.5%) than the boys (17%) [14]. The differences in prevalence

among girls are may be due to the smaller sample size and a common source of food among immigrant children. In contrast, previous studies from Kenya and Zanzibar found that the prevalence of IDA was significantly higher in boys than girls which is consistent with our result [45,46].

In general, the prevalence of ID (21.5%) and IDA (6.7%) among the migrant population of Al-Azarkeen area, Sana'a City, Yemen was high. Low socioeconomic conditions and low quality of food for the population in Yemen may be the explanation. As expected, children and adolescents are recognized as a population that is vulnerable to ID and IDA, the prevalence of ID (23.1%) and IDA (8.2%) among children was higher than that among adults (19.1% and 4.5%; respectively) which is agree with the results from earlier studies among immigrants and native population [10,39]. Beside the increased requirements of nutrition for growth, and the increased iron requirements for myoglobin in muscles and hemoglobin in the blood [47], the main risk factors for ID and IDA are low iron intake, poor absorption of iron related to diets high in phytate or phenolic compounds lack of awareness of ID, and nutritional status [39,48,49]. However, other previous cross-sectional studies found no association between ID and the phenolic-containing compounds including tea and coffee [25,50].

Overall, the high prevalence of ID and IDA among immigrants in Al-Azrakeen area, Sana'a City, Yemen could be linked to low family's income and poverty which resulted in insufficient nutrition and inadequate health care as well as educated states. Moreover, Yemen is classified among the lower middle-income countries with > 50% of the population living below the poverty line and having a very low purchasing power [12]. In addition, Yemen has been under war for more than 8 years; this may lead to food and water scarcity, widespread poverty and economic stagnation.

Our questionnaire concerned personal data (age) and social conditions (employment, family members, and period of migration). Unfortunately, no data on income or economic situation were collected, because the reliability of responses was unverifiable. A prospective study in a population of immigrant infants aged 6-12 months reported that among the most significant predictors for ID are unemployment and duration of migration11. However, in the current study age, employment, family members and period of migration were not associated with ID ($p > 0.05$). As regards the association of IDA, there was only an association of IDA with age of emigrant' adults ($p = 0.05$).

Conclusion

In conclusion, the observed prevalence of ID with and without anemia among emigrant of Al-Azrakeen area in Sana'a City was high. Low socioeconomic conditions as well as low quality of food can explain this phenomenon. In immigrant' children, the prevalence was higher than that among immigrant's adults. This is indicative of the importance of proper iron supplementation in this population to reduce the risk of ID. Furthermore, there is a need for further research into the causes of ID in this population, as well as the development of effective strategies for its prevention. In addition, proper health education increases knowledge about the factors for the development of this nutritional deficiency.

Declarations

Ethical Approval and Consent to participate

Not Applicable.

Availability of supporting data

All data available from the corresponding author upon reasonable request.

Competing interests

author declare that there is no conflict of interest.

Funding Statement

The authors have no conflicts of interest to declare.

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