Journal of Scientific Research & Reports
4(3): 265-273, 2015; Article no.JSRR.2015.030
ISSN: 2320-0227

SCIENCEDOMAIN ***international***
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Assessment of Iron Status and Its Relation to Diet and Lifestyle among Adolescents in the Gaza-Palestine

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Authors' contributions

This work was carried out in collaboration between the two authors. Author OSAN designed the study, wrote the protocol. Authors OSAN and MOJ wrote the first draft of the manuscript. Author MOJ managed the literature searches, Authors OSAN and MOJ analyses of the data. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JSRR/2015/11593
Editor(s):
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Complete Peer review History: http://www.sciencedomain.org/review-history.php?iid=712&id=22&aid=6519

Original Research Article

Received 23rd May 2014
Accepted 14th July 2014
Published 13th October 2014

ABSTRACT

Aims: Iron deficiency (ID) especially among adolescents still considered a major challenge for health and nutrition sectors of governmental and non-governmental institutes in the Gaza strip. The present study aimed to assess iron nutritional status and its relation to adolescents' dietary habits and life style in the Gaza Strip.
Study Design: A cross sectional study.
Place and Duration of Study: Gaza Strip, Palestine, between March 2009 and May 2009.
Methodology: A total of 276 adolescents aged 12-15 years of 7th, 8th and 9th grades were selected randomly. Besides the recording of anthropometric measurements, a questionnaire for collecting information on dietary habits and physical activities was used. Hemoglobin was measured as a general biomarker of general-micronutrient status. Serum iron was also assessed

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Results: The frequency of iron deficiency (ID) was 23.6%. ID was more prevalent among females (31.4%) than males (15.9%). The overall anemia between both genders was 34.5%. The frequency of high body mass index was 29%. About 49% of females live in sedentary life style. A statistically significant difference was found between serum iron vs. animal foods consumption and low active adolescents.

Conclusion: Adolescents were suffered from overweight, obesity and stunting. ID is prevalent among adolescents in Gaza Strip. Serum iron was affected by consumption of animal foods and associated with the lifestyle of adolescents.

Keywords: Iron; haemoglobin; adolescent; nutritional assessment; Gaza.

1. INTRODUCTION

Micronutrients deficiency is considered a worldwide public health problem. It has received increasing attention from scientists and health professionals than macronutrient deficiency. Most of these deficiencies are sub-clinical, and so deserve to be called “hidden hunger” [1]. Today; more than two billion people in the world are estimated to be deficient in essential vitamins and minerals, particularly vitamin A, iodine, iron and zinc. Most of these people live in low-income countries and are typically deficient in more than one micronutrient, which affect general biomarkers such as the haemoglobin level (i.e. anemia prevalence). Deficiencies occur when people do not have access to micronutrient-rich foods such as fruit, vegetables, animal products and fortified foods, usually because they are too expensive to buy or are locally unavailable [2]. Iron deficiency (ID) is the most common nutrient deficiency and anemia, as an indicator of iron deficiency affects nearly 2 billion people worldwide [3].

Adolescence is considered the second important period of physical growth in the life cycle after the first year. For many adolescents, inadequate quantity and quality of food are the prime determinants of nutrition problems. Good nutrition during adolescence is critical to cover the deficits suffered during childhood and should include nutrients required to meet the demands of physical and cognitive growth and development [4].

The Gaza Strip covers about 365 km² and with a total population mounting to about 1,416,543 individuals it is one of the most densely populated places on the earth (about 3,881 inhabitants/ Km²) [5]. The Palestinian population pyramid in 2008 showed a high proportion of individuals under the age of 15 years (48%) [6]. Eight percent of families in Gaza Strip rely on humanitarian aid compared to 63% in 2006 [7].

The current critical and devastated situation in Gaza Strip as a result of the chronic unstable internal and external political situation leads to a dramatic decline in the health and nutrition services, which finally entails serious problems in nutrition among the most vulnerable group including adolescents. This cross sectional study is the first to assess the nutritional status of the essential micronutrient iron, serum iron level and its relationships to dietary habit, anthropometric measures and physical activity among adolescents aged 12-15 years old in the Gaza Strip. Few researchers correlated the nutritional status with physical activities among the same age in occupied Palestine and showed that boys are more active than girls [8-10]. Iron deficiency has important implication on physical activity where low iron level contribute to reduce the physical activity [11,12]. The aim of the current study in Palestine differed from the other studies as the nutritional status of iron was highlighted and correlated to dietary habit, anthropometric measures and physical activity.

2. METHODOLOGY

2.1 Study Design

A cross sectional study was conducted in March 2009 to May 2009. In each governorate, two preparatory schools of United Nation for Relief Working Agency (UNRWA); one for males and the other for females, were nominated purposively by the area general director of UNRWA. All selected schools were obtaining a daily meal for each student for a year.

2.2 Study Population

The target population of the present study was early adolescent pupils aged 12 to 15 years old of both sexes that were attending the preparatory school in the Gaza Strip. A total of 63,400 pupils are enrolled in UNRWA schools at 7th, 8th and 9th grades.

2.3 Sampling

The sample size was calculated according to Epidemiology Information software package (Epi Info™, last version 3.5.1, 2008) based on: a desirable confidence limit of 95%; an estimated prevalence of iron deficiency of 30% among neighbouring countries [13]. The calculated sample was 287 subjects.

2.4 Data Collection

An approved and written formal letter to conduct the study was obtained from Head Quarter of UNRWA then it was handed to the Head Teacher of each school for facilitating the study progress. A systematic stratified random sample was selected according to gender and grade in each region. Pupils were randomly selected from 7th, 8th and 9th grades in each school when one classroom of each grade was selected randomly during the teaching period. About 18 students were selected systematically, every third, from the students' name list. The aim of the study was explained to all assembled students. An oral acceptance from each subject was obtained preliminary. Each selected pupil was given a separate informed consent and the first part of a coded questionnaire to be filled in and signed by his or her parents.

2.5 Questionnaire

The questionnaires were distributed to the participants and were filled face to face by the researchers. They included information on the food frequency, physical activity and dietary habits.

A food frequency questionnaire (FFQ) adapted to suit the dietary habits among adolescents in the Gaza Strip [14]. The FFQ measured the frequency of consumption of usual food items during the last three months. The response was categorized into (1) three times or more weekly, (2) less than three times weekly and (3) rarely/never. The participants were asked how often and how long they practiced a specific leisure activity. The responses categories were daily, weekly and minutes at each time. Physical activity was classified according to the time spent in each physical activity and type of physical activity. All times spent in a specific daily physical activity in 24 hours were summarized and the result was multiplied by a specific factor for the respective physical activity. The net results were summed up to give a specific score. According to this score, the physical activity was classified into (1) Sedentary (2) Low active (3) Active and (4) Very active [14].

2.6 Anthropometric Measures

Pupils were asked to take off their shoes and any heavy clothes and stand vertically. Weight was recorded to the nearest 0.1 kg using an electronic personal weighing scale (Model: Seca 881, Hamburg, Germany). Height was recorded to the nearest 0.5 cm using a special height scale developed for this purpose by World Health Organization (WHO), UNRWA and ministry of health office in the Gaza Strip. BMI was calculated as weight (kg) divided by height (m^2) square. Cut-off values that were used for classification of the anthropometric indicators was according to (WHO 2007), underweight is considered at BMI for age less than 5th percentile, while overweight and obese at BMI equal or more than 85th percentile. Stunting (height for age) at height less than 3rd percentile [15].

2.7 Blood Specimen Collection and Analysis

A blood sample of 5 ml was collected from the vein of the forearm via venipuncture (using a disposable sterile syringe and stainless steel needle 23 G). About 4 ml of the blood was placed in a coded red caped vacutainer collecting tubes (Improvacuter®, no additives) for serum iron analysis. The rest of the blood sample (1 ml) was placed in a coded EDTA tube for determining haemoglobin (Hb) concentration. The vacutainer collecting tubes were directly kept in a portable cold keeping container (2 to 8℃). After 2 hours, the vacutainer tubes were centrifuged at 3000 rpm for 10 minutes. One ml of serum was separated and collected in coded polyethylene plastic tubes, which in turn was stored at -18℃ until determination of serum iron concentration. The coded EDTA tubes were transferred after 2 hours to a private lab for determination of Hb. Samples were coded with numbers recorded on questionnaires, vacutainers, polyethylene plastic and EDTA tubes.

Serum iron analysis was performed in Palestinian Medical Relief Society laboratories in the Gaza Strip. Measurement of serum iron was based on a colorimetric method by using computerized chemical chemistry auto analyser equipment (Mindray BS-200, Shenzhen, China) and specified colorimetric determination kits (Global diagnostic) of serum iron. Standard 100µg/dl was treated as a sample for iron. A specified control (known concentration) of bovine assayed serum (Randox) was used for adjustment. Iron absorption was measured at 600 nm against a reagent blank. The machine operation was taken into consideration before starting the analysis. Serum iron deficiency was considered at values of < 50µg/dl for both, males and females [16].

Computerized Complete Blood Count (CBC) equipment (Mindray Auto hematology analyzer BC-3000) was used for determination of Hb. According to WHO/CDC the cut-off values of Hb corresponding to anaemia were set at 12.5 g/dl for males and 11.8 g/dl for females [17].

2.8 Statistical Analysis

The data was analyzed by using a software Statistical package for science (SPSS version 13, SPSS Inc., Chicago, IL). A descriptive analysis was used to describe the general characters of the study population. Chi square tests were used to describe the anthropometrics and physical activities differences between males and females. Serum iron was tabulated with dietary habit, anthropometric measures and physical activity categories. The level of significance was established for P values≤0.05.

3. RESULTS

3.1 Characteristics of the Sample

A total of 335 adolescents of both sexes aged 12-15 years were invited to participate in the present study. Anthropometric data was obtained from 296 respondents (88.4% response rate) and 276 of them completed the FFQ and physical activity questionnaire. Blood samples were available and Iron analysis was done only for 174 respondents since some of respondents (102 out of 276) refused blood collection process. The total sample was selected based on the percentage of representation of population in the Gaza Strip.

Table 1 shows the general description of the sample. The mean age of the sample was 13.7 (±SD = 0.9) years. Moreover, mean height and weight were 155.5 cm (±8.2, SD) and 47.5 kg (±10.6 SD), whereas mean BMI was 19.6 kg/m² (±3.4, SD). The mean serum iron concentration was 86.8 (±37.6, SD) µg/dl and the mean Hb concentration was 12.4 (±1, SD) g/dl.

3.2 Anthropometric Measures

3.2.1 BMI for age and stunting

Table 2 shows that the overall prevalence of underweight and high body mass index (Overweight and obesity) between both sexes was 7.6% and 29%, respectively. High body mass was more prevalent among females than males in the Gaza Strip. The prevalence of high body mass index among the females and the males was 35% and 22.8%, respectively.

Underweight was more prevalent among the males (8.1%) than the females (7.1%). However there were no statistically significant differences between genders and BMI for age (P>0.05). The overall prevalence of stunting between both genders was 7.6%. Stunting was relatively more prevalent among the males than the females. The prevalence of stunting among the males was 8.8% and among the females was 6.4%.

However there was no statistically significant differences observed between genders and stunting (P>0.05).

3.2.2 Physical activity pattern

Table 3 illustrates that the overall prevalence of sedentary and very active lifestyle among adolescents students attendants was 33.8% and 14.2%, respectively. Physical activity pattern was highly different among the genders. Nearly half of the females (48.7%) live in a sedentary lifestyle and most of them (86.7%) had a sedentary or low activity lifestyle pattern. On the other hand, the males were more active and more than half of them (55.5%) were physically active and very active.

A strong statistical significant difference (P<0.001) was observed in physical activity pattern among the adolescents students attendants.

Table 1. General descriptive data

Variable	Males		Females		Total	
	N	Mean SD	N	Mean SD	N	Mean SD
Age (years)	136	13.7±0.8	140	13.7±0.9	276	13.7±0.9
Weight (kg).	146	47.1±11	150	47.8±10.0	296	47.5±10.6
Height (cm)	146	156.8±9.5	150	154.3±6.5	296	155.5±8.2
BMI	146	19.1±3.2	150	20.1±3.4	296	19.6±3.4
Serum Fe level (µg/dl)	88	87.9±33.2	86	85.8±41.9	174	86.8±37.6
Hb concentration (mg/dl)	88	12.8±0.9	86	12.1±1.0	174	12.4±1.0

Descriptive analysis, SD: Standard Deviation, N: Number, BMI: Body Mass Index, Hb: Hemoglobin

Table 2. Prevalence of anthropometric categories of the study subjects

Variables	Males N (%)	Females N (%)	Both sexes N (%)	P-value
BMI for age				
Underweight	11 (8.1)	10 (7.1)	21 (7.6)	
Normal	94 (69.1)	81 (57.9)	175 (63.4)	0.082
High body mass index	31 (22.8)	49 (35.0)	80 (29.0)	
Total	136	140	276	
Height for age				
Stunted	9 (6.4)	12 (8.8)	21 (7.6)	
Normal	127 (93.6)	128 (91.2)	255 (92.6)	0453
Total	136	140	276	

Chi square test, statistically significant at P-value < 0.05

Table 3. Physical activity characteristics among the study subjects

Variables	Males N (%)	Females N (%)	Both sexes N (%)	P-value
Physical activity				
Sedentary	27 (18.5)	73 (48.7)	100 (33.8)	
Low active	38 (26.0)	57 (38.0)	95 (32.1)	
Active	40 (27.4)	19 (12.7)	59 (19.9)	0.001
Very active	41 (28.1)	1 (0.7)	42 (14.2)	
Total	146	150	296	

Chi square test, statistically significant at P-value < 0.05

3.2.3 Serum iron level in relation to Hb, anthropometry and physical activity

Table 4 indicates that nearly 17.8% of the pupils who were characterized as overweight had low serum iron levels, whereas about 36.4% of the underweight pupils (low BMI for age) had low serum iron level (P>0.05). It was found that only 38.5% of the pupils who were stunted had low serum iron levels (P>0.05). Approximately two thirds of respondents who had low haemoglobin levels had low serum iron levels.

Table 5 shows significant differences in serum iron levels by physical activity pattern. A high percentage (40%) of respondents living a sedentary life style had low serum iron level. On the other hand, only 3.8% who practiced heavy physical activity lifestyle had low serum iron levels (P<0.05).

3.2.4 Serum iron level and consumption of animal products

Table 6 shows that 60% of respondents with minimal milk drinking had low serum iron levels. A positive statistical significant relationship was observed between serum iron level and frequency of milk consumption. Serum iron concentration was also higher in those consuming other animal food items three times and more weekly than in subjects who consumed them less frequently. Frequent intake of these food items except chicken and fish had a statistical significant relationship with serum iron level.

Table 4. Relationship of serum iron level with anthropometry and Hb

Variables	Total	Serum fe level		P-value
	N=174	Low %	Normal %	
BMI for age				
Underweight	12	36.4	63.6	
Normal	116	24.8	75.2	0.382
High body mass	46	17.8	82.2	
Height for age				
Stunted	13	38.5	61.5	0.192
non stunted	161	22.4	77.6	
Hemoglobin level				
Low	60	66.7	33.3	0.048
Normal	114	39.1	60.9	

Chi square test, statistically significant at P-value < 0.05

Table 5. Relationship of serum iron level with physical activity

Variables	Total	Serum Fe level		P-value
	N=174	Low %	Normal %	
Physical activity				0.002
Sedentary	66	37.9	62.1	
Low active	47	21.3	78.7	
Active	35	14.3	85.7	
Very active	26	3.8	96.2	

Chi square test, statistically significant at P-value < 0.05

Table 6. Relationship between serum iron levels and consumption of animal products

Variables	Total	Serum iron level		P-value
	n=174	Low (%)	Normal (%)	
Milk				0.003
≥ 3 times / week	150	19.3	80.7	
< 3 times / week	14	42.9	57.1	
Never/ rarely	10	60.0	40.0	
Egg				0.006
≥ 3 times / week	101	15.8	84.2	
< 3 times / week	34	26.5	73.5	
Never/ rarely	39	41.0	59.0	
Meat and its products				0.006
≥ 3 times / week	96	14.6	85.4	
< 3 times / week	45	31.1	68.9	
Never/ rarely	33	39.4	60.6	
Chicken				0.655
≥ 3 times / week	28	21.4	78.6	
< 3 times / week	116	22.4	77.6	
Never/ rarely	30	30.0	70.0	
Fish products				0.890
≥ 3 times / week	41	22.0	78.0	
< 3 times / week	58	22.4	77.6	
Never/ rarely	75	25.3	74.7	
Liver				0.05
≥ 3 times / week	23	17.4	82.6	
< 3 times / week	42	11.9	88.1	
Never/ rarely	109	29.4	70.6	

Chi square test, statistically significant at P-value < 0.05

4. DISCUSSION

This study aimed to assess iron nutritional status and its relation to adolescents' dietary habits and life style in the Gaza Strip.

The overall prevalence of serum iron deficiency was high (23.6%). Moreover, a significant statistical relationship was observed between serum iron level and Hb with more than two thirds of the subjects who had low serum iron levels had low Hb levels. Prevalence was much higher than the estimated results conducted in the North America region (United States and Canada) where it was found 3.5% and 6% [18]. A recent study conducted among late adolescents aged 14-22 years showed that lower prevalence of ID was 9.6%. Moreover, mean Hb is highly affected by many SES and nutritional determinants [19].

The results of this study indicated that anemia still a common problem among adolescents in the Gaza Strip and must be considered as a serious public health problem. According to WHO cut-off points for anemia among early adolescents, a very high prevalence of anemia in this age group was found (34.5%). However, prevalence was lower than the one reported previously among the same age group in the Gaza Strip where the overall prevalence of anemia among adolescents 12-15 years in Gaza city and north governorate was 49.6%. Anemia prevalence was high in both girls and boys (51.3% vs. 47.9%) [9] Other studies in the Gaza Strip showed a high prevalence of anemia among adolescents that reached 33.5% [12] also comparing to the neighbour country (Egypt), it was found to be 44.5% and 46.6% [17,20].

A recent study in the Gaza Strip showed that the mean Hb level (13.39±1.57) among adolescents aged 14-22 years [19] was higher than the mean Hb in this study, which may be due to the age differences and differing dietary habits of the age groups. However, the results revealed the seriousness of the problem as anemia is common among different age groups and genders in the Gaza Strip but it is worth to highlight that the decrease in anemia prevalence among adolescents in this study could result from the consumption of daily meals supplied by UNRWA in its schools. Moreover, nearly half of the adolescents eat red meat and its products more than three times weekly and nearly one quarter eat it once or twice weekly. This could also be due to the food aid supporting the population in the Gaza Strip after the Israeli offensive in December 2008- January 2009.

On the other hand, the prevalence of anemia (low Hb) among refugee adolescents aged 12-14 years in two developing countries (Kenya and Nepal) was found to be higher (46% and 24%, respectively) than the present results. In addition, higher prevalence of serum ID was found among the same group [21]. Serum iron level had a strong relationship to physical activity pattern, which was most strongly observed among females. This study was consistent with a Mexican study showed that the less active women have iron deficiency anemia and with Jalambo et al, who showed a statistical significant relationship between less active female students and anemia [11,12]. However, iron has important role in formation of Hb and many hemoproteins that are directly involved in oxygen consumption and energy production in the body cells. Thus, any shortage in hemoproteins will lead to decrease in cellular growth and work capacity.

5. LIMITATION OF THE STUDY

- The study sample was only collected from UNRWA schools i.e. all the respondents are refugees receive different food items from UNRWA feeding centers.
- Over or under estimation were received about food frequency or physical activity.
- Some of parent's respondents refused the blood samples collection.
- The designed questionnaire used for physical activities was self prepared and evaluated by public health professors but not a slandered questionnaire.

6. CONCLUSION

Iron deficiency is considered as a public health problem among adolescents. Serum iron level is closely related to dietary habits. A positive relationship was observed between serum iron level and BMI, frequency of meat consumption, and physical activity. In general, adolescents have a trend toward a sedentary life style, which is common among females but males have a more active and very active life style.

CONSENT

All authors declare that written informed consent was obtained from the respondents for publication. Confidentiality of data and privacy were respected at all times.

ETHICAL APPROVAL

The research received ethical approval from Helsinki committee.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=712&id=22&aid=6519