Assessment of Zinc and Iron Status among Malnourished Children under 5 Years Old in Gaza City

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Abstract

Background: *Malnutrition in children often begins at birth and is associated with retarded physical and cognitive development. Micronutrients are essential for healthy growth and development.*

Objective: *To investigate zinc and iron status among malnourished children under 5 years in Gaza city.*

Methodology: *This cross sectional study consisted of 149 malnourished children under 5 years old from both sexes. Questionnaire interview with parents was used. Anthropometric measurements (weight, length and height) were taken. Blood samples were drawn for determination of serum Zinc and iron|. Statistical analysis was performed using SPSS version 18.0.*

Results: *The study population was (149) cases; (53.7%) males and (46.3%) females. It was found that (61.7%) of the children were moderately underweight, (40%) of them were moderately stunted and about forty one percent (40.9%) of the study population were mildly wasted. The majority of surveyed children (91.3%) received immediate breastfeeding and more than two third (71.1%) of them were breast fed exclusively. The mean levels of serum zinc and iron were (79.8±15.6, 76.4±29.9, respectively). There were no statistically significant in zinc and iron levels according to gender, number of household, source of income, monthly income (NIS) and type of home. While there was significant association between length of breastfeeding period and serum iron levels. In contrast, there was no significant association between immediate breastfeeding, exclusive breastfeeding length of breastfeeding period, age of introducing infant formula, age of introducing complementary food with serum Zn levels.*

Recommendations: *Childhood malnutrition among children under 5 years appears to be a public health problem in GS and interventions to improve children nutritional status must be in concern.*

Keywords: Zinc, Iron, Malnutrition, Gaza City

Introduction

Child malnutrition may be defined as a pathological state resulting from inadequate nutrition, including under-nutrition (protein-energy malnutrition) due to insufficient intake of energy and other nutrients; over-nutrition (overweight and obesity) due to excessive consumption of energy and other nutrients. WHO defined malnutrition as the cellular imbalance between supply of nutrients and energy and the body's demand for them to ensure growth, maintenance and specific functions [1].

Malnutrition is estimated to contribute to more than one third of all child deaths, although it is rarely listed as the direct cause. The causes of malnutrition are complex and multifaceted. In developing countries; dietary factors (intake of dietary supplements (iron and vitamin A and D) exclusive breast feeding for (4-6) months, complementary feeding at (6) months, maternal education, maternal mental health, and family socioeconomic and environmental factors (deprivation, social support, and hygiene) all may be associated with malnutrition [2]. In addition, lack of access to highly nutritious foods, especially rising food prices, poor feeding practices such as inadequate breastfeeding, offering the wrong foods, and not ensuring that the child gets enough nutritious food, contribute to malnutrition. Infection – particularly frequent or persistent diarrhoea, pneumonia, measles and malaria – also undermines a child's nutritional status [3].

Prevalence of Malnutrition

Malnutrition in children often begins at birth and is associated with retarded physical and cognitive development. This, in turn, yields serious implications for the overall national development agenda. Palestine is an exception as malnutrition appears among children under-five. Between the years 2000 and 2010, prevalence of malnutrition rose by (41.3%) on the national level while Gaza Strip demonstrated a huge increase of (60.0%). Currently, (11) out of (100) children under-five suffer chronic malnutrition including (11.3%) in the West Bank (WB) and (9.9%) in Gaza Strip (GS) [4].

In September 2015, UNICEF, WHO and World Bank Group released updated joint child malnutrition estimates for the 1990 to 2014 period in which (159) million children around the world were stunted and (50) million were wasted. In addition, more than half of all stunted children under (5) lived in Asia and more than one third lived in Africa. While almost all wasted children, under 5 lived in Asia and Africa [5].

The prevalence of malnutrition among Saudi children younger than 5 years old was as follows: the prevalence of moderate and severe underweight was (6.9%) and (1.3%), respectively; the prevalence of moderate and severe wasting was (9.8%) and (2.9%), respectively; finally, the prevalence of moderate and severe stunting was (10.9%) and (2.8%), respectively. Egypt Demographic and Health Surveys (EDHS) in 2008 found that; (29%) of children under the age of five were stunted and (14%) were severely stunted; (7%) of were wasted and (3%) were severely wasted; (6%) were underweight. Nutritional status of (124) children aged (6-7) years old in Elshagalwa village basic school in Nile state, North Sudan assessed that; (5.6%) were moderately wasted; (11.3%) were moderately underweight, whereas (4%) were found to be severely stunted and (16.9%) moderately stunted [6].

The deterioration in nutritional status of Palestinian children has become well recognized at both national and international levels. Results of a nutrition survey carried out in August 2002 found (13.2%) of children in the Gaza Strip suffering from acute malnutrition. This compares unfavourably with survey figures from 1995, where only (5.7%) of children, under 5 years were acutely malnourished [7]. In addition, the Palestinian Multiple Indicator Cluster Survey (MICS) carried out in 2014 by the PCBS revealed that) 7.4%) of children under the age of five in Palestine suffer from moderate and severe stunting. The percentage was (7.7%) in the WB and (7.1%) in GS. Furthermore, (1.4%) of children suffer from moderate and severe underweight (1.5% in the WB and 1.3% in GS). And (1.2%) of children suffer from moderate and severe wasting. The percentage was (1.7%) in the WB and (0.7%) in GS [8].

In 2011, PCBS showed that 11 out of 100 children under five suffer from chronic malnutrition including (11.3%) in the West Bank and (9.9%) in Gaza Strip. In addition, the rates of underweight climbed in 2006 and dropped back in 2010 reaching a national rate of (3.7%) for the WB and GS [8]. In 2007, the overall prevalence of both acute and chronic malnutrition among children aged 6 to 59 months was (3.4%), (10.7%) in the GS and WB, respectively [9]. According to the annual report of AEI Benevolent Association in GS, the prevalence of stunting among children aged (6-59) months was (42.3%) and the prevalence of wasting was (11.5%) [1].

Micronutrient

Micronutrients are defined as nutrients that are only needed by the body in minute amounts. Micronutrients, which include vitamin A, zinc and iron, are essential for healthy growth and development. Deficiency of these micronutrients can lead to serious health problems, including wasting, reduced resistance to infectious diseases, iron deficiency anemia, blindness, lethargy, reduced learning capacity, mental retardation and in some cases to death [1].

Zinc

Zinc is one of the trace elements important in human nutrition and metabolism, participating in all major biochemical pathways and playing multiple roles in the perpetuation of genetic material, including transcription of DNA, translation of RNA, and ultimately cellular division [10]. Zinc is required by more enzymes in the body than all trace minerals combined. It is needed to catalyze chemical reactions, to ensure proteins and cell membranes work properly, to read DNA instructions, to ensure cell signaling, and to ensure hormone release and nerve impulse transmission [11].

The bioavailability of zinc is higher in animal products due to the absence of compounds that inhibit absorption (i.e. phytates and oxalates) and the presence of certain amino acids (i.e. cysteine and methionine) that improve absorption. Good animal sources: goat, beef, shellfish, liver, eggs. Good plant sources: whole grains, peanuts, legumes. Breast milk is a good source of zinc for the infant but is not affected by maternal status. Supplements are recommended by WHO and UNICEF to treat acute childhood diarrhea [12]. Bhaskaram et al revealed that children suffering from severe protein energy malnutrition however had plasma zinc levels indicating zinc deficiency. Such children showed improvement in their zinc status when zinc supplements were provided along with rehabilitation diets.

Another study showed that the levels of serum zinc was found to be significantly low in children with severe malnutrition and there was a significant positive correlation between serum zinc and height-for- age [13, 14]. In this regard, Golden observed that a low plasma zinc concentration was strongly associated with nutritional edema but not with the degree of edema or the plasma albumin concentration. In the absence of edema, there were significant relationships between plasma zinc concentrations and stunting, skin ulceration, and wasting.

Iron

Iron is a micronutrient that is essential to the structure of every cell in the body, but particularly red blood cells (haemoglobin), which transport oxygen in the blood to tissues in the body. In addition, iron is also a key component in proteins in muscle tissue and is critical for the normal development of the central nervous system [15]. Iron is rich in foods such as Meats, poultry and fish; fortified cereals and oatmeal; legumes (e.g. soybeans and lentils); leafy greens and seeds (e.g. sesame and pumpkin) [15, 16]. Showed that there was found a significant difference between malnourished children with "free" serum iron and the control group in which "free" iron was not found. Another study conducted on 50 cases of malnourished children of age range between 1 to 5 years revealed that serum iron level and transferrin saturation was high among all patients with malnutrition while TIBC was lower than standard level in all patients [17]. Studied the iron status in malnourished children among the 50 study children of different age groups 15 patients were 1 to 2 years, 18 patients were 2 to 3 years, 10 patients were 3 to 4 years and 7 patients were at 4-5 years of age groups. Iron status were measured among the different types of malnutrition where serum iron level and transferrin saturation was high among all patients with malnutrition while TIBC was lower than standard level in all patients.

The Nutritional Situation in Palestine

Nutritional Assessment of the West Bank and Gaza Strip, 2003 revealed that (81.3%) of children aged (1-3) years old in the WB and (88.7%) of them in GS were deficient in daily iron intake. While the prevalence of zinc intake deficiency among children aged (1-3) years old in WB and GS was (95.0%) and (95.2%), respectively [18]. In 2003, a survey showed that intakes of folate and zinc in children aged (1-5) years old were low below (80%) of RDAs. In 2004, the prevalence of anemia among children aged (12-59) months ranged from (14%) to (22%) in the WB, while it reached (31%) in the of north GS [19].

In 2013, the Palestinian MoH decided together with UNICEF, with the scientific cooperation of the University of Vienna, to conduct a representative cross sectional study on the micronutrient status, prevalence and causes of nutritional anemia, coverage and use of flour fortification, salt iodization, micronutrient supplements and life style and behavioural aspects of breastfeeding, physical activity, smoking and frequency of food consumption and anthropometric characteristics. The study was carried out on children (6–59) months, (7–12) years, adolescents (15–18) years and pregnant women (18–43) years. The results of the laboratory assessment showed that high prevalence of low serum concentrations, iron and zinc status in all studied population groups. Moreover, in children aged (6-59) months mild anemia was found in (11–25%) and moderate anemia in (6-8%), whereas boys were more affected than girls and children in the GS more affected than those in the WB did. Furthermore, zinc status assessed through the serum level was on average above the reference level (9.9) µmol/L only in children from the WB. In the GS, (67.2%) of boys and (75.2%) of girls had serum zinc levels below the sufficiency threshold compared to (42.2%) and (36.0%), respectively, in the WB [20].

Justifications of the Study

- Globally, malnutrition is the most important risk factor for illness and death. In this regard, through the visit of the researcher to Ard El Insan Palestinian Benevolent Association, it was noticed that the majority of the children are malnourished, meaning that malnutrition is a serious public health problem in Gaza Strip and this study finding requires further investigation.
- On the other side, few studies have been carried out on micronutrients in Gaza Strip without evaluating the role of micronutrients and their relation with other factors. Therefore, this study was conducted to assess this issue

Objective of the Study

a. General Objective :

To assess status of zinc and iron in malnourished children under 5 years attending AEI services in Gaza city.

b. Specific Objectives :

1. To identify socio-economic and economical factors and their relation to zinc and iron deficiency of the children.
2. To identify relation between nutritional history and serum levels of zinc and iron for the children.
3. To asses other malnutrition parameters such as weight, height and physical growth among the children.
4. To study the relation between serum levels of zinc and iron with malnutrition parameters of the children.

Methodology

This cross-sectional study was applied among malnourished children under 5 years old in Gaza city. The sample size was consisted of (149) malnourished children (male and female) who were attending AEI services in the Gaza center. The study was conducted during the period from October 2015 to June 2016.

Questionnaire Interview

A meeting interview was used for filling the questionnaire (Annex 2). The questionnaire was based on AEI Benevolent Association questions. The questionnaire included questions about child personal data (area, age, and sex); occupation of children parents; socioeconomic status (family income, source of income, number of household and type of home); child anthropometric measurements (bodyweight, length/height) and child nutrition history (immediate breast-feeding, exclusive breast-feeding, duration of breastfeeding and introducing each of infant formula and complementary food).

Blood Sample Collection and Processing

The blood sample collection process began with blood collection at AEI, followed by immediate processing at stationary laboratories. The samples then transported to storage at (-20°) C in the central laboratories. Five ml venous blood samples were obtained from each child and divided into EDTA tube (1.0 ml) and vacutainer plain tube (4.0 ml). Vacutainer plain tubes were left for short time to allow blood to clot, and then clear serum samples were obtained by centrifugation at 1000 rpm for 20 minutes. The separated serum was placed in plain tubes and sealed. Samples that used within 5 days were stored at 2-8OC, otherwise samples stored at -20OC to avoid loss of bioactivity and contamination.

Anthropometric Measurements

Anthropometric measurements (weight and height) of the children were measured by a well-trained nurse to determine their nutritional status. Weight was measured in kg (to the nearest 100 grams) using an electronic digital scale (Seca model 770; Seca Hamburg, Germany) and its accuracy was periodically verified using reference weights. The child was weighed in light clothing, by determining the mean weights of light clothes dressed, and a correction for the clothing was made during weighing by subtracting 100 grams from each children weight.

Length was measured in cm (measured to the nearest mm) using a pediatric measuring board. Children were measured in a recumbent position (lying down). The software program for assessing growth and development of the world's children was used to make comparisons to the reference standards. The software program combines the raw data on the variables (age, sex, and length, weight) to compute a nutritional status index such as weight-for-height, weight-for-age and height-for-age.

Biochemical Analysis

Zinc assay

Zinc was analyzed by spectrophotometric methods, using a colorimetric biochemistry auto analyzer system (Chem.Well, Awareness Technology Inc.).

Reference values

Serum or plasma 60-107 µg/dl

Iron assay

Iron was analyzed by spectrophotometric methods, using a colorimetric

Biochemistry auto analyzer system (Chem.Well, Awareness Technology Inc.).

Reference values

Serum or plasma 60-170 µg/dl

Data Analysis

Data processing and analysis was carried out using the Statistical Package for Social Sciences (SPSS) version 18.0. The cross tabulations and the one-way ANOVA test tests at a significance level of (5%) were used to investigate the statistical correlation between the zinc and iron levels with other factors. Range as minimum and maximum values were used.

Results

Socio-demographic Characteristics of the Study Population

Table (1) shows the study population was (149) cases; (53.7%) males and (46.3%) females. Their age between (1-2) years was (79.9%), (2-3) years was (8.1%) and more than (3) years was (10.7%). About forty-two percent of the study population's family consisted of (1-5) members, while (43%) consisted of (6-10) members, (11.4%) of them consisted of (11-15) members, and (3.4%) consisted of more than 16 members. About forty six percent (45.6%) of the study population's families did not have an income source, while about twenty nine percent (28.9%) of the families' heads were employed, (24.8%) of them were freelancers, and (0.7%) of them were owners.

In addition, (43.6%) of the surveyed children's family didn't get monthly salary, while (27.5%) of them got less than (500) NIS, fifteen percent (14.8%) got a salary between (500-1000) NIS, (13.4%) got a salary between (1000-3000) NIS, and just one of them (0.7%) got more than (5000)NIS. Thirty eight percent of the surveyed children's families owned their homes, while (9.4%) of them were rented apartment, while twenty five percent (24.8%) lived in apartment and (24.8%) of them lived in a home.

Table 1: Socio-demographic Characteristics of the Study Population

Variable	No.	%
Gender		
Male	80	53.7
Female	69	46.3
Total	149	100.0
Age (Year)		
<2	119	79.9
2-3	12	8.1
>3	16	10.7
Missing Values	2	1.3
Total	149	100.0
Number of household		
1-5	63	42.3
6-10	64	43.0
11-15	17	11.4
More than 15	5	3.4
Sources of Income		
Employee	43	28.9
Free profession	37	24.8
Owner	1	0.7
Unemployed	68	45.6
Relief receiver	0	0. 0
Monthly income (NIS)		
No income	65	43.6
< 500	41	27.5
500 - 1000	22	14.8
1000 - 3000	20	13.4
>3000	1	0.7
Home		
Owned	57	38.3
Rented	14	9.4
Flat	37	24.8
House	37	24.8
Missing Values	4	2.7

Anthropometric Assessment Measurements of the Study Population

An anthropometric measurement of children participating in the study is shown in table (2). About (5%) of children were found to have weight less than (5) kg. While more than two third of them (69.1%) had weight between (5-8) kg and twenty six percent of children their weight were more than (8) kg. In addition, results showed that only four children (2.7%) their height less than (60) cm. Furthermore, high percentage of children in the study had height in the range of (60-80) cm. While (16.8%) of them, their height were more than (80) cm.

a. Weight for Age (W//A) :

Table (2) shows that normal values based on the z-score (≥-1z to ≤+1z) were not found in the study sample. On the other hand it was found that (11.4%) of children were mildly underweight (≥-2z to <-1z), (61.7%) moderately underweight (≥-3z to <-2z) and twenty seven percent of them (26.8%) severely underweight (<-3z).

b. Length-Height for Age (L-H//A):

Table (2) shows that normal values based (≥-1z to ≤+1z) were observed in about sixteen percent (16.1%) of children. In turn, the prevalence of stunting was higher in study sample which (26.2%) mildly (≥-2z to <-1z), (40%) moderately (≥-3z to <-2z) and (17.4%) severely stunted (<-3z).

c. Weight for Length-Height (W//L-H):

Table (2) shows that the percentage of children with a normal weight for length-height was (13.4%). In addition, forty one percent (40.9%) of the children were mildly wasted (≥-2z to <-1z), third percent of sample (32.9%) was moderately (≥-3z to <-2z) and thirteen percent (12.8%) were severely wasted (<-3z).

Table 2: Anthropometric Assessment Measurements of the Study Population.

Anthropometric Measurements	No.	%
Body weight (kg)		
<5	7	4. 7
5-8	103	69.1
>8	39	26.2
Total	149	100.0
Length/Height (cm)		
<60	4	2.7
60- 80	120	80.5
>80	25	16.8
Degree of weight for age W//A (SD)		
-1 to 4	-	-
-2.0 to -1.01	17	11.4
-3.0 to -2.01	92	61.7
< -3	40	26.8
Degree of length-height for age L-H//A (SD)		
-1 to 4	24	16.1
-1.01 to -2.0	39	26.2
-2.01 to 3.0	59	39.6
<-3	26	17.4
Missing Values	1	7
Degree of weight for length-height W//L-H (SD)		
-1 to 4	20	13.4
-1.01 to -2.0	61	40.9
-2.01 to 3.0	49	32.9
<-3	19	12.8
Missing Values	0	0.0

3. Nutritional History of the Study Population

The nutrition history of study sample is shown in table (3). It is clear that the majority of surveyed children (91.3%) received immediate breastfeeding, while 8.7% did not breastfed immediately. More than two third (71.1%) of the children were breast fed exclusively, while (28.9%) did not receive exclusive breastfeeding.

Five children (3.4%) had breastfeeding period less than one month, while (45%) had between (1-10) months, (40.3%) had period of breastfeeding between (10-20) month and just four children had b. It was also found that (49%) of the children were received infant formula with age less than (6) months. While (9.4%) of them gave infant formula between (6-12) months and just (4) children were given infant formula after the first year. Moreover, more than half of study population (54.4%) were received complementary foods with age less than (6) months and twenty eight percent of them at age between (6-12) months. While just (2) malnourished children were given complementary foods after the first year.

Table 3: Nutritional History of the Study Population.

Variable	No.	%
Immediate breastfeeding		
Yes	136	91.3
No	13	8.7
Total	149	100.0
Exclusive breastfeeding		
Yes	106	71.1
No	43	28.9
Total	149	100.0
Length of breastfeeding period (month)		
<1	5	3.4
1-10	67	45.0
11-20	60	40.3
>20	6	4.0
Missing Values	11	7.4
Total	149	100.0
Infant formula (month)		
<6	73	49.0
6-12	14	9.4
>12	4	2.7
Missing Values	58	38.9
Total	149	100.0
Complementary foods (month)		
<6	81	54.4
6-12	42	28.2
>12	2	1.3
Missing Values	24	16.1
Total	149	100.0

Serum Levels of Zinc and Iron of the Study Population

Table (4) shows that the least and highest value for the levels of zinc and iron of the sample study.

Table 4: Serum Levels of Zinc and Iron of the Study Population.

Micronutrients	Mean
Zinc (µg/dL) Mean ± SD Range	79.8±15.6 (48-130)
Iron (µg/dL) Mean ± SD Range	76.4±29.9 (40-160)

Socio-demographic Characteristics and Serum Iron Levels of the Study Population

Table (5) shown socio-demographic and serum iron levels of the study population. the statistical test pointed on no statistically significant in iron levels according to gender, number of household, source of income, monthly income (NIS) and type of home (P>0.05).

Socio-demographic Characteristics	No.	Iron (µg/dl) Mean ±SD (Min-Max)	P-value
Gender			
Male	80	73.8±27.6(40-160)	0.258
Female	69	79.4±32.4(40-160)	
Total	149	76.4±29.9 (40-160)	
Number of Household			
1-5	63	76.8±28.4 (40-150)	0.444
6-10	64	74.9±31.1 (40-160)	
11-15	17	84.7±32.4 (45-150)	
16-20	5	61.6±24 (40-90)	
Total	149	76.4±29.9 (40-160)	
Source of Income			
Employee	43	75.3±31 (40-160)	1.700
Free Profession	37	69.9±22.3 (40-120)	
Owner	1	40	
Unemployed	68	81.2±32.3 (40-160)	
Total	149	76.4±29.9 (40-160)	
Monthly Income (NIS)			
No Income	65	81.8±32.9 (40-160)	0.288
<500	41	72.9±24.2 (40-130)	
500-999	22	66.6±25.9 (40-130)	
1000-2999	20	76.5±33.5 (40-160)	
>3000	1	80.0	
Total	149	76.4±29.9 (40-160)	

Home			
Owned	57	74.8±26.6 (40-150)	
Rented	14	81.9±29.7 (50-140)	
Flat	37	69.2±28.4 (40-150)	0.261
House	37	81.9±34.5 (40-160)	
Total	145	75.9±29.6 (40-160)	

Table 5: Socio-demographic and Serum Iron Levels of the Study Population.

Anthropometric Assessment Measurements and Serum Iron Levels of the Study Population

Table (6) shows the relation between anthropometric measurements and serum iron levels of the study ppopulation. It is clear that there was insignificant association between degree of each of the W//A, L-H//A and W//L-H with serum iron levels.

Table 6: Anthropometric Assessment Measurements and Serum Iron Level of the Study Population

Anthropometric Measurements	No.	**Iron (µg/dl)** Mean ±SD (Min-Max)	P-value
Degree of W//A (SD)			
-1.01 to -2.0	17	75.7±34.6 (40-150)	
-2.01 to 3.0	92	77.1±29.1 (40-160)	0.930
<-3	40	75±30.5 (40-160)	
Total	149	76.4±29.9 (40-160)	
Degree of L-H//A (SD)			
-1 to 4	24	77.8±32.9 (40-150)	
-1.01 to -2.0	39	72±29.2 (40-160)	
-2.01 to 3.0	59	77.3±30.8 (40-160)	0.738
<-3	26	79.9±27.5 (40-122)	
Total	148	76.4±30 (40-160)	
Degree of W//L-H (SD)			
-1 to 4	20	70.5±25.7 (40-120)	
-1.01 to -2.0	61	80.9±29.6 (40-160)	
-2.01 to 3.0	49	74.9±29.8 (40-150)	0.440
<-3	19	71.8±35.2 (40-160)	
Total	149	76.4±29.9 (40-160)	

Nutrition History and Serum Iron Levels of the Study Population

The relation between nutrition history and serum iron levels is shown in table (7). There was no significant association between immediate breastfeeding and exclusive breastfeeding with serum iron levels. While there was significant association between length of breastfeeding period and serum iron levels.

Table 7: Nutrition History and Serum Iron Levels of the Study Population.

Nutrition History	No.	**Iron (µg/dl) Mean ±SD (Min-Max)**	P-value
Immediate Breastfeeding			
Yes	136	76.5±29.9 (40-160)	
No	13	74.9±31 (40-130)	0.856
Total	149	76.4±29.9 (40-160)	
Exclusive Breastfeeding			
Yes	106	78±30.9 (40-160)	
No	43	72.5±27.2 (40-150)	0.314
Total	149	76.4±29.9 (40-160)	
Length of Breastfeeding Period (month)			
<1	5	69.4±35 (40-130)	
1-10	67	68.3±23.8 (40-130)	
11-20	60	81.1±32.5 (40-160)	0.001
>20	6	111.3±25.1 (83-150)	
Total	138	75.7±29.7 (40-160)	
Age of Introducing Infant Formula(month)			
<6	73	73.5±29 (40-160)	
6-12	14	83.3±37.4 (40-150)	
>12	4	79±23.5 (44-94)	0.526
Total	91	75.2±30.1 (40-160)	
Age of Introducing Complementary Foods (month)			
<6	81	78.5±29.2 (40-160)	
6-12	42	74.4±31.1 (40-160)	
>12	2	114.5±7.8 (109-120)	0.167
Total	125	77.7±29.9 (40-160)	

Socio-demographic Characteristics and Serum Zinc Levels of the Study Population

Table (8) shows that there was an insignificant association between gender, number of household, source of income, monthly income and home with serum zinc levels.

Socio-demographic Characteristics	No.	Zinc (µg/dl) Mean ±SD (Min-Max)	P-value
Gender			
Male	80	78.9±15.3 (50-130)	0.425
Female	69	80.9±16 (48-120)	
Total	149	79.8±15.6 (48-130)	
Number of Household			
1-5	63	78±14.3 (52-120)	0.116
6-10	64	79.7±16.1 (48-130)	
11-15	17	88±17.7 (64-116)	
16-20	5	76.1±9.4 (64-89.6)	
Total	149	79.8±15.6 (48-130)	
Source of Income			
Employee	43	80.6±16.2 (52-130)	0.610
Free Profession	37	79±14.8 (48-110)	
Owner	1	60	
Unemployed	68	80.1±15.8 (50-120)	
Total	149	79.8±15.6 (48-130)	
Monthly Income (NIS)			
No Income	65	79.9±16.1 (50-120)	0.761
<500	41	78.5±14.7 (48-110)	
500-999	22	79.5±14.7 (53.3-110)	
1000-2999	20	81.8±17.5 (52-130)	
>3000	1	97.3	
Total	149	79.8±15.6 (48-130)	
Home			
Owned	57	77.1±15.1 (48-116)	0.253
Rented	14	79.1±18.4 (5 6-120)	
Flat	37	81.0±11.1 (58.7-105)	
House	37	83.6±18.8 (50-130)	
Total	145	80.0±15.7 (48-130)	

Table 8: Socio-demographic and Serum Zinc Levels of the Study Population.

Anthropometric Assessment Measurements and Serum Zinc Levels of the Study Population

Table (9) presents the relation between anthropometric measurements and serum level of zinc. It is clear that there was insignificant association between degree of each of the W//A, L-H//A and W//L-H with serum zinc level, where the p-value > 0.05.

Table 9: Anthropometric Assessment Measurements and Serum Zinc Levels of the Study Population

Anthropometric Measurements	No.	Zinc (µg/dl) Mean ±SD (Min-Max)	P-value
Degree of W//A (SD)			
-1.01 to -2.0	17	72.3±17 (48-97.3)	0.099
-2.01 to 3.0	92	80.4±15.1 (55-120)	
<-3	40	81.6±15.5 (58.7-130)	
Total	149	79.8±15.6 (48-130)	
Degree of L-H//A (SD)			
-1 to 4	24	77.1±15.8 (48-110)	0.838
-1.01 to -2.0	39	80.3±13.5 (50-105)	
-2.01 to 3.0	59	80.3±17.2 (55-130)	
<-3	26	79.4±14.2 (55-110)	
Total	148	79.6±15.4 (48-130)	
Degree of W//L-H (SD)			
-1 to 4	20	81.8±15.8 (56-110)	0.630
-1.01 to -2.0	61	79.4±16.2 (55-120)	
-2.01 to 3.0	49	78.2±13.9 (48-110)	
<-3	19	83.2±17.7 (53.3-130)	
Total	149	79.8±15.6 (48-130)	

Nutrition History and Serum Levels of Zinc of the Study Population

The results showed that there was no significant association between immediate breastfeeding and exclusive breastfeeding with serum zinc level. In addition, there were insignificant associations between three other variables namely (length of breastfeeding period, age of introducing infant formula, age of introducing complementary foods) with serum zinc level.

Table 10: Nutrition History and Serum Zinc Levels of the Study Population.

Nutrition History	No.	Zinc (µg/dl) Mean ±SD (Min-Max)	P-value
Immediate Breastfeeding			
Yes	136	80.2±15.8 (48-130)	0.370
No	13	76.1±12.4 (60-100)	
Total	149	79.8±15.6 (48-130)	
Exclusive Breastfeeding			
Yes	106	80.7±16.2 (48-130)	0.303
No	43	77.8±13.8 (56-116)	
Total	149	79.8±15.6 (48-130)	
Length of Breastfeeding Period (month)			
<1	5	77.5±9.4 (62-85.3)	0.105
1-10	67	78.3±14.4 (53.3-110)	
11-20	60	80.1±17.2 (48-130)	
>20	6	94.7±12.7 (82-116)	
Total	138	79.8±15.7 (48-130)	
Age of Introducing Infant Formula(month)			
<6	73	80.3±16.7 (50-130)	0.350
6-12	14	82.8±13.9 (48-97.3)	
>12	4	69.5±11.8 (55-84)	
Total	91	80.2±16.2 (48-130)	
Age of Introducing Complementary Foods (month)			
<6	81	79.5±15.1 (50-130)	0.580
6-12	42	81.1±15.4 (48-120)	
>12	2	90±28.3 (70-110)	
Total	125	80.2±15.3 (48-130)	

Discussion & Conclusion

Socio-demographic Characteristics of the Study Population

The results showed nearly equal percentage of the males and females among children under 5 years. This characterizes the Gazan community that has almost equal percentages of males and females [8]. PCBS estimated that the population of GS totalled (1.82) million of which (925) thousand males and (895) thousand females. In addition, the majority of the surveyed children had family members ranged from (1-10) [22]. PCBS reported that the majority of Palestinian households have children.

It was also observed that more than forty-five per cent of the families' heads were not employed [23]. PCBS reported that the unemployment rate was about forty per cent in GS. On the other hand, about forty-two of the children participants belong to families with monthly income less than (1000) NIS. This indicates that, there was a considerable proportion of families in the GS who did not have adequate monthly income, which reflected the state of poverty in the Palestinian community [24]. Middle East Monitor reported that the Israeli siege imposed on the GS for a decade has damaged the enclave's economy. Moreover, thirty-eight per cent of the surveyed children's families owned their homes, while about (9.4%) of them rented apartments. This finding is consistent with GS situation characteristics, where people prefer to live in their owned houses and abstained from renting ones, unless they would not have any other choice [25].

Anthropometric Assessment Measurements of the Study Population

Measured weight, length/height as well as the age and weight for length /height were used to assess the prevalence of underweight, stunting and wasting. It was found that (11.4%) of surveyed children were mildly underweight, more than a half of them were moderately and twenty-seven percent were severely underweight. The causes of malnutrition are complex and multifaceted. In developing countries; dietary factors (intake of dietary supplements (iron, VA and D), exclusive breast- feeding for (4-6) months, complementary feeding at 6 months), maternal education, maternal mental health, family socioeconomic and environmental factors (deprivation, social support and hygiene) all may be associated with malnutrition. In addition, maternal mental health has been shown to suffer with exposure to war-related violence [26].

Moreover, prevalence of stunting was higher in study sample which (26.2%) mildly, (40%) moderately and (17.4%) severely stunted (<-3z). Studies showed that there was a strong relationship between a child's age, family size, birth interval and stunting. In communities that have little access to/and contact with health care, children are more vulnerable to malnutrition as a consequence of inadequate treatment of common illnesses, low immunization rates, and poor antenatal care. Poor environmental sanitation, including insufficient safe water supply, also puts children at risk of infection, which increases susceptibility to malnutrition [27]. In addition, chronic malnutrition was a disease of poverty in Gaza, where the World Bank estimated that Gaza had the highest rate of unemployment in the world (43%) among adults and (60%) among youth. The diet of Palestinians in Gaza is largely focused on bread, meaning that many people lack the variety and nutritional components needed to remain healthy [28].

The data analysis also revealed that about forty-one per cent of the children were mildly wasted, thirty-three per cent were moderately and thirteen per cent were severely wasted. Children become wasted when they lose weight rapidly, usually as a direct result of a combination of infection and diets that do not cover nutritional needs. In addition, other reasons may cause wasting such as: poor access to appropriate; timely and affordable health care; inadequate caring and feeding practices (e.g. exclusive breastfeeding or low quantity and quality of complementary food); poor food security – not only in humanitarian situations, but also an ongoing lack of food quantity and diversity, characterized in many resource-poor settings by a monotonous diet with low nutrient density, together with inadequate knowledge of patterns of food storage, preparation and consumption; and lack of a sanitary environment including access to safe water, sanitation and hygiene services [29].

Nutritional History of the Study Population

In the current study (91.3%) of the study sample received immediate breastfeeding and (71.1%) of them were breast fed exclusively. This finding is consistent with the Palestinian Family Health Survey which indicated that (97.5%) of children received breastfeeding, more than half of infants (65%) started breastfeeding in the first hour after birth, (9.0%) had breastfeeding six hours or more after their birth for one reason or another [30]. Other cross-sectional study evaluated data of (690) clinic files from (3) refugee camps in Nablus, Palestine in (2007) and revealed that about (70%) of infants aged (0–6) months were exclusively breastfed and only (14.3%) were exclusively formula fed [31]. Another survey found exclusive breast-feeding prevalence of (86.5%), (66.7%), and (25.3%) among infants 1, 3, and 6 months old [21].

About half of the children participating in the study (49%) received infant formula with age less than 6 months (the majority in the first month) that was for several reasons such as: the mother was pregnant, child refused the breastfeeding, inadequate child from breast milk and the mother was employed. Moreover, more than half of study population (54.4%) received complementary foods with age less than 6 months. The previous study conducted in GS showed that (24.9%) of children up to 2 years old received complementary feeding before the age of three months while (55%) received complementary feeding between ages of (3-5) months [32].

Serum Levels of Zinc and Iron of the Study Population

Current study results showed that normal values of serum zinc and iron levels. It is known that vitamin A, zinc and iron are micronutrients of known public health importance. However, the intake of micronutrients (such as zinc, iodine, vitamin A, iron, folate and selenium) from dietary sources (green leafy vegetables, soy beans, seasonal fruit, milk, dairy products, fish, eggs, chicken and other food stuffs) will prevent the occurrence of common day to day infections in children, enable the society produce healthy children with solid foundation and ensure optimal human resource development [33].

Relation between Socio-demographic Characteristics with Serum Iron and Zinc Levels of the Study Population

The statistical test pointed on no statistically significant in iron and zinc level according to gender, number of household, source of income, monthly income (NIS) and type of home. This study finding consists with previous study, which showed that there was no significant difference between family size and family income with iron deficiency and no significant differences between boys and girls with iron deficiency anemia [34, 35]. On the other hand, a previous study conducted among school children in a rural setting in North-Central Nigeria showed that the socio-economic status (SES) of subjects had an effect on their serum zinc level as those from the lower SES had significantly lower serum zinc than their counter-parts from the middle and higher SES [36].

Relation between Anthropometric Assessment Measurements with Serum Iron and Zinc Levels of the Study Population

The results of the current study found an insignificant association between degree of each of the W//A, L-H//A and W//L-H with serum iron and zinc levels. Meta-analyses of randomized controlled intervention trials were conducted to assess the effects of vitamin A, iron, and multimicronutrient interventions on the growth of children < 18 y old. Iron interventions also had no significant effect on child growth [37]. In this regard, a previous study concluded that none of the iron-status indicators in children aged 5-12 years were associated with linear growth in girls and higher iron status, as indicated by ferritin and mean corpuscular volume (MCV), is related to slower linear growth in iron-replete school-Age boys [38]. A meta-analyses (2009) of single and multiple nutrient interventions in the children under 5 years of age showed that zinc had no significant effect on height or weight gain [39]. Another previous study conducted to investigate the effect of supplemental zinc on the growth and serum zinc concentrations of prepubertal children revealed that there was no significant effect of zinc on weight-for-height indexes [10].

Relation between Nutrition History with Serum Iron and Zinc Levels of the Study Population

In the present study, there were no significant associations between immediate breastfeeding, exclusive breastfeeding, age of introducing each of infant formula and complementary foods with serum Iron and zinc levels for malnourished children participants in the study. While there was significant association between length of breastfeeding period and serum iron levels. A cross-sectional study of healthy children aged 1 to 6 years (median age 36 months) showed that the relationship between total breastfeeding duration and iron deficiency anemia did not meet statistical significance [40].

In this context, infants who are exclusively breast-fed for >6 mo in developing countries may be at increased risk of anemia, especially among mothers with a poor iron status [41, 42]. Observed that at 6 month, mean (±SD) fractional iron absorption from human milk was relatively low with no significant difference between iron-supplemented and UN supplemented infants. At 9 month, iron absorption from human milk remained low in iron-supplemented infants but was higher in UN supplemented infants). Unexpectedly, iron absorption at 9 month was not correlated with iron status but was significantly correlated with intake of dietary iron, including supplemental iron [43]. On the other hand, Zakout revealed that (74.5 %) of stunted children, who were weaned had zinc deficiency. More than, there is no statistical significant difference between weaning age and serum zinc level among the participants (stunted and non-stunted children). In addition, a randomized, prospective trial was conducted to identify the effect of timing of introduction of complementary foods on iron and zinc status of formula fed infants at 12, 24, and 36 months of age showed that the early introduction group consumed slightly less zinc than the late introduction group at 5 months and 6 months, and the serum zinc concentration was not associated with dietary zinc. Furthermore, both groups had normal serum zinc concentrations at 12, 24, and 36 months and there were no differences between groups [44].

Conclusion

Childhood malnutrition among children under 5 years appears to be a public health problem in GS and interventions to improve children nutritional status must be in concern. So, the following recommendations are suggested:

- Protocols that include micronutrient practices, based both on Palestinian needs and on international standards.
- Frequent testing of micronutrients for malnourished children and other risky groups.
- Raising the level of nutritional knowledge among health professionals and their staff on the health of children.
- Presence of nutritionist in each school to provide nutritional advice to children.
- Further studies are needed to study independently the role of micronutrients in the prevention and therapy of disease, and other age groups should be considered.

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