Impact of Early Life Giardiasis on Growth, Nutritional Status, and Serum Trace Elements in Children

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Abstract

Giardia lamblia is considered the most common intestinal parasite in humans world-wide. Giardiasis is a major health problem with a great morbid effect on children's physical and cognitive development. ***The aim of this work*** *was to evaluate the effect of giardiasis on children's growth, assess the serum levels of zinc, copper, and iron, also to study the relation between giardia infections and breastfeeding.* ***Methods:*** *this was a cross-sectional study carried out on 200 children (1-3 years). They were recruited from the outpatient clinics of Al-Zahraa university hospital and National Nutrition Institute. 100 children were infected with giardiasis and 100 were healthy All the studied children were subjected to full history taking, complete clinical examination, anthropometric measures, complete blood count, stool analysis, and estimation of serum level of zinc, copper, and iron.* ***Results:*** *this study revealed an increase in giardiasis in patients with low socioeconomic levels. The prevalence of malnutrition among infected patients as regards Waterlaw's classification was 55% wasted, 42% stunted, and 42% were wasted & stunted. Anemia is more frequent in patients with giardiasis. There is a significant decrease in the level of serum zinc in infected children which was associated with high rates of diarrhea. Also, there was a significant decrease in serum iron. A statistically significant relation was found between children who received breast milk and protection against giardiasis.* ***Conclusion:*** *Giardiasis is regarded as a serious public health problem, as it causes iron-deficiency anemia, growth retardation in children, and other physical health problems.*

Keywords: *children-giardiasis-growth-copper-iron-zinc*

INTRODUCTION

Gastrointestinal parasites are important cause of morbidity and stunting among children in developing countries ***(Long et al., 2007).*** Giardia lamblia is considered the most common intestinal parasite in humans worldwide ***(El Basha et al., 2016)*** and one of the top four contributors to stunting, globally ***(Rogawski et al., 2018).*** It has an estimated prevalence rate of 20–30% in developing countries and 2–5 % in developed countries. In Egypt, the reported prevalence rates vary between 10 and 35 % ***(Fahmy et al., 2015).*** Clinical giardiasis is especially prevalent in children under the age of five, immunocompromised patients, and the elderly **(*Ogawski et al., 20017).*** Giardiasis is a major health problem as it has a great morbid effect on children's physical and cognitive development ***(Younes et al., 2015).*** The negative impact of Giardiasis on growth was explained by decrease food intake because of anorexia and poor absorption of macro and micronutrients e.g., zinc and copper ***(Matos et al., 2008).***

Exclusively breastfed infants have a lower risk for parasitic infections. Breast-feeding should be considered as an effective way of preventing Giardia infections and should be promoted in regions where G. lamblia is highly endemic ***(Kutty, 2014).*** Breast milk controls the proliferation and growth of intestinal cells and the healing of tissues damaged by epithelial disruption or ulcers due to giardiasis. This can be facilitated by the abundant growth factors present in colostrum. Also, anti-Giardia factors in breast milk prevent the establishment of infection and reduce parasite load by inhibiting parasite attachment to the intestinal epithelium by opsonization and phagocytosis of Giardia trophozoites ***(Alasil and Kutty, 2015).***

Early detection and treatment of Giardia infection are especially important to obtain optimal levels of the growth, development, immune response, and intellectual ability of children ***(Sadraei et al., 2007).*** The **aim** of this work was to evaluate the effect of giardiasis on children's growth and evaluate the serum levels of Zinc, Copper, and Iron in children infected with Giardia lamblia, also to assess the relation between giardia infections and breastfeeding.

PATIENTS AND METHODS

This is a cross-sectional comparative study, carried out on 200 children aged (1-3 years). They were recruited from the outpatient clinics of Al-Zahraa university hospital and National Nutrition Institute during the period from April 2017 to January 2019.

Children were divided into two groups: Group I (patient group): This group comprised 100 patients infected with giardiasis which was documented by stool analysis and Group II (control group): This group comprised 100 healthy children matched age and sex with the group I.

Children with other parasitic infections and those who were complaining of chronic gastrointestinal diseases (e.g. malabsorption syndrome or malignant disorders or any other chronic disease that may affect mineral absorption) are excluded from the study. Also, children who were complaining of blood loss (may affect iron status) and those with a recent intake of mineral supplementations (iron, zinc, and copper), were excluded.

Methods:

All the studied children were subjected to the following:

- Full history taking according to a pre-designed questionnaire with stress on age, sex, residence, socio-economic standard, housing conditions, health care behavior risk factors, and type of feeding. (breast-feeding or artificial feeding).

Assessment of the social class of the family was estimated according to ***Fahmy and El Sherbeni (1983)***. The socio-economic scoring in this study sample consisted of the score of occupation, education, and social class; the latter included the income, crowding index, and sanitation score. Social class was then categorized as following: High (social score =25-30), Middle (social score =20- less than 25), and Low (social score =15- less than 20).

- Complete clinical examination to exclude any associated illness with stress on vital signs, signs of anemia (presence of pallor), and anthropometric measures.

Anthropometric measures are measured according to standardized methods of the World Health Organization ***(WHO, 1995)***. Measurements taken included: The Childs weight, length or height, and head circumference and their Z-score. Z-score (or SD-score) = (observed value - median value of the reference population) / standard deviation value of reference population.

- Measurement of weight**:** The body weight was measured using the Platform scale. ***(Ghalli et al., 2002).***

- Measurement of height or length: The height was measured to the nearest centimeter, row data were entered separately to the WHO Growth charts for age and sex ***(Ghalli et al., 2002).***

- Head circumference measurement**:** Head circumference was measured using a plastic measuring tape ***(De Onis et al., 2007).***

- Assessment of growth according to Waterlaw's classification.

Investigations

All the studied populations were subjected to the following tests: Complete Blood Count (CBC), stool analysis, and serum zinc, copper, and iron. These investigations were done at outpatient clinic laboratory in National Nutrition Institute (NNI).

Collection of Specimens:

- Stool samples: fresh fecal specimens were collected in sterile clean stool cups labeled with the patient's serial number, name, age, sex.
- 5ml venous blood samples were withdrawn and divided into 2 specimens: 2 ml of venous blood samples were collected in EDTA vacutainer tubes for doing a complete blood picture. And 3 ml of cubital venous blood samples were collected in sterile plain vacutainer tubes for biochemical assays of serum levels of zinc, copper, and iron. The serum was separated by centrifugation (3000 rpm for 5 min) immediately and analysis was done by using a semi- automated spectrophotometer (Kenza, Biolabo, France).

Methods of the assay:

-Complete blood count: Done automatically by blood counter (Diagon Ltd D- cell 60- Hungary). Reference ranges for children aged from (2-5 years) were obtained according to ***Bain et al. (2011).***

-Serum zinc was measured by the colorimetric method, (Crest Biosystems) according to (***Makino. 1991***). The normal values of Zn range between (70-160 µg/dl) ***(Taylor, 1998).***

-Serum copper was measured by the colorimetric method. (Crest Biosystems), according to (***Akita and Yiamashita, 1989***). The normal values of Cu range between (70-130 µg/dl).

-Serum iron was measured by ferrozine/ magnesium carbonate method (Coral Clinical Systems), according to (***Siedel et al., 1984***). The normal values of Fe range between (50-120µg/dl),

Stool examination:

Parasitological examination of fecal samples for detection of Giardia cyst and/ trophozoite on the same day of collection.

- Microscopical examination: regarding stool consistency (formed, soft, lose or watery), odor (fecal or offensive), color (clay, yellowish, greenish, brownish or black), component elements as (blood, mucus, pus, tissue elements or undigested food) ***(Cheesbrough, 2005).***
- Microscopical examination: by direct wet smear and by formol – ether sedimentation concentration technique. Direct wet smear was performed using iodine and lacto-phenol cotton blue. Afterward, formalin-ethyl acetate sedimentation was done to the stool sample and examined by direct wet smear (as previous) and Modified Ziehl-Neelsen stain ***(Garcia, 2007).***

Ethical considerations:

An informed consent was obtained from the parents of the children before getting them involved in the study according to the rules of the ethics committee of the Faculty of Medicine, Al-Azhar University. The steps of the study, the aim, the potential benefits, and hazards all were discussed with the parents.

Statistical Analysis

Data were collected, coded, revised, and entered the Statistical Package for Social Science (IBM SPSS) version 20. The data were presented as numbers and percentages for the qualitative data, mean, standard deviations, and ranges for the quantitative data with parametric distribution and median with interquartile ranges (IQR) for the non-parametric data. ***Chi-square test*** was used in the comparison between two groups with qualitative data and ***Fisher exact test*** was used instead of the Chi-square test when the expected count in any cell found less than 5 ***(Fisher, 1934)***. The comparison between two independent groups with quantitative data and parametric distribution was done by using the Independent t-test while the comparison between two groups with non-parametric data was done by using the Mann-Whitney test. ***Spearman correlation coefficients*** were used to assess the relationship between two quantitative parameters in the same group.

RESULTS

Table (1): shows that 60% of the patients' group was males, 68% live in rural areas, 42% of them with low socioeconomic levels. There was a statistical difference between cases and controls as regards the presence of sanitary water supply and Waste disposal.

Table (2): shows that 58 % of patients group eat junk food, 62% of them did not wash their hands before eating, and 68% of them did not wash vegetables before eating. While there was no statistically significant difference as regards the presence of a refrigerator.

Table (3): shows 78% of the patient group and 89% of the control group were received breast milk in their live (no significant difference) while 42% of the control group compared to only 7% of the patient group were still on breastfeeding (highly significant difference).

Fig. (1): shows that the most common clinical presentation in the patients' group was the loss of appetite (64.00%), recurrent abdominal pain (61.00%), followed by abdominal distension (57.00%), diarrhea (38.00%), fever (5.0%) and lastly (4.00%) have vomiting.

Table (4): shows that there is a statistically significant decrease in z-score for weight, height, and head circumference in the patient group than the control group.

Table (5): shows that (55.00%) of the patients' group were wasted, (42.00%) of them were stunted and (42.00%) of them were wasted & stunted while in the control group only 11% were wasted, 6% were stunted, and 6% were wasted and stunted.

Table (6): shows that there was a highly statistically significant decrease in Hemoglobin, MCV, MCH in patients group than the control group, while there was no statistically significant difference as regards Red blood cells, platelets, white blood cells between the patients and control group.

Table (7): shows that there was a highly statistically significant decrease in the level of serum zinc, and iron, while no statistically significant difference in the level of serum copper in patients' group than the control group.

Table (8): shows that there was a highly statistically significant correlation between the level of serum zinc and height, but there was no statistically significant correlation between the level of serum zinc and other anthropometric measures in the patient group. There was no statistically significant correlation between the level of serum copper and anthropometric measures in patients. There was a statistically significant correlation between the level of serum iron with weight in the patient group.

Table (9): shows that there was a statistically significant relation between the level of serum zinc with intermittent diarrhea and loss of appetite in the patient group, while there was no statistically significant relation with other studied clinical manifestations in the patient group. There was no statistically significant relation between the level of serum copper and studied clinical manifestations. There was a statistically significant relation between serum levels of iron with loss of appetite, while there was no statistically significant relation between serum level of iron with diarrhea, vomiting, abdominal pain, abdominal distension, and fever in the patient group.

DISCUSSION

Giardiasis is one of the most common human intestinal protozoal infections reported worldwide and children are especially affected ***(Thompson, 2004).*** The parasite infects nearly 2% of adults and 6% to 8% of children in developed countries. Nearly 33% of people in developing countries have had giardiasis ***(WHO, 2015).***

In developing countries, the infection is highly endemic and contributes to malnutrition, which may affect growth and later cognitive function in children ***(Hanevik et al., 2014).*** It is regarded as a serious public health problem, as it causes iron deficiency anemia, micronutrient deficiencies as (Zinc, Magnesium, and Selenium), protein-energy malnutrition (PEM), and growth retardation in children associated with diarrhea and malabsorption syndrome ***(Acosta et al., 2014).***

In the current study, found that Giardiasis is more frequent in males than in females. This is in agreement with ***Dib et al. (2008) and*** **Al-*Mekhlafi et al. (2013)*** who found in their study that the prevalence of giardiasis is slightly higher in males than in females, which was explained by the increased outdoor activity of young males with increased risk of exposure and lack of good hygiene and false habits and believes. However, this result is not in agreement with that of ***Lebwohl et al. (2003) and Abou-Shady et al. (2011)*** who reported that there is no significant difference between both sexes in liability of infection.

This study revealed that there was a statistically significant increase of giardiasis in patients living in rural areas (68% of our cases) than that living in urban areas (32%). These results agree with other studies done by ***Akl et al. (2009)*** who found that the prevalence of giardiasis in rural areas was higher than that of urban areas. The high prevalence of giardiasis in rural communities in Egypt may be due to the following: human feces are often used as agricultural fertilizer, there is no central sewage disposal system and potable water is used for drinking and cooking in some villages, water from the Nile is commonly used for washing and bathing and these sociocultural habits are difficult to be changed. Also, warm climate, humid atmosphere, muddy nature of the soil, and consumption of large quantities of raw vegetables without washing, were all factors which help in the transmission of giardiasis and other parasites.

In this study, found that there is a statistically significant increase of giardiasis in patients with low socioeconomic levels (42%) than with middle (30%) and high (28%) socioeconomic level. This result is in agreement with ***Hamed et al. (2013),*** who reported a prevalence of (49.4% and 25%) of infection among low and middle socioeconomic level children respectively as most families of lower socioeconomic level are of a big family number, the parents are usually illiterate, and they have a poor sanitary condition. Epidemiological studies carried out in different countries have shown that the socio-economic level of the society may affect the incidence of giardiasis; control strategies of local managements involving improved infra-structure for both drinking water and sewage system, education of the society to improve personal hygiene and sanitation have been related to reduced incidence of giardiasis ***(Kvalsvig, 2003).*** In our study, bad housing sanitary measures attribute to infection. (42%) of patients who live in houses with no sanitary water supply or waste disposal (44%) were infected with giardia. Our results are in accordance with the studies of ***Hamed et al. (2013) and Östan et al. (2007)*** who cleared that intestinal giardiasis is transmitted directly through the contaminated water, soil, and food by feces, or indirectly through unsanitary living conditions. ***Hamed et al. (2013)*** support our results that poor personal hygiene encourages person-to-person transmission also, poor food handling hygienic measures encourage transmission.

In the present study, the most common symptom among infected children was loss of appetite, followed by recurrent abdominal pain, abdominal distension, diarrhea, fever, and lastly vomiting. This agrees with ***Abou-Shady et al. (2011)*** who found that recurrent abdominal pain was the predominant symptom followed by diarrhea. Also, ***Bauomy et al. (2010)*** reported higher prevalence of loss of appetite, followed by abdominal pain, and diarrhea. On the other hand, ***Robertson et al. (2010)*** reported that giardiasis is a self- limited illness, and most often the infections are asymptomatic. Giardia intestinalis can produce diarrheal disease with intestinal malabsorption and marked weight loss. In infants and young children, impairment of growth and development is one of the common symptoms ***(Lin et al., 2013).*** In our study, we found that there is a highly significant decrease in Z-score of weight (median of Z-score = -0.49), height (-0.17), and head circumference (-0.24) in infected children with giardiasis than non-infected children.

The negative impact of G. intestinalis infection on anthropometric status can be explained by jeopardized food intake due to anorexia and poor absorption of macro and micronutrients due to mucosal injury. The infection can thus have a worse impact on preschool-age children, in whom nutritional needs are higher due to the intense linear growth and weight gain in this phase of life ***(Ventura et al., 2013).*** Research results agree with that of ***Abou-Shady et al. (2011)*** who showed that giardiasis affects children's weight, height, and HC in Egypt. These results are in agreement with the studies of ***Al-Mekhlafi et al. (2013)*** in Malaysia, ***Matos et al. (2008)*** in Brazil, ***Demirci et al. (2003)*** in Turkey who found that there was a significant difference in weight, height and HC in infected children with giardiasis compared with non-infected children.

In this study the prevalence of malnutrition among patients as regards Waterlaw's classification was (55%) of infected children were wasted, (42%) were stunted and (42%) were wasted & stunted. This result agrees with ***Yones et al. (2015)*** who found high prevalence of wasting (71.6%) and stunting (61.3%) among infected children.

In the current study, found that there was a statistically significant decrease in hematological parameters; Red blood cells, Hemoglobin, MCV, MCH, and MCHC in patients group than the control group so anemia is more frequent in patients with giardiasis than non-infected children. This agrees with the reports of ***Calvao et al. (2011) and Obaid (2013).*** In this study, the mean hemoglobin level (<11gm/dl) was more frequent in infected children compared to non-infected children. This agrees with ***Baghaei (2015) and Calvao et al. (2011)*** who found that anemia was more frequent in infected children with giardiasis compared to non-infected children. This also agrees with ***Yones et al. (2015)*** who reported that anemia was more prevalent among parasitically infected children in Egypt. In this study, found that there is no increase in the level of eosinophil in the patient group than the control group. Current result agrees with ***Faubert (2000),*** who recorded that giardia infection does not cause a change in the number of eosinophils. Because Giardia is not invasive, eosinophilia, peripheral, or fecal leukocytosis do not occur ***(Baldi et al., 2009).***

In present study, assessed the effects of giardiasis on serological levels of zinc, copper, and iron. Giardiasis produces malabsorption and so it affects their absorption from the small intestine especially zinc and iron. Trace elements as zinc (Zn), copper (Cu), and iron have a significant task in metabolic function and tissue maintenance ***(Kadir and Ali, 2011).*** It has been reported that blood levels of iron and zinc might decrease in children infected with giardiasis ***(Abou-Shady et al., 2011***As regards zinc, the normal values range between (70-160μg/dl) ***Fedor et al. (2017).*** However, in our study, we found that there is a significant decrease in the level of serum zinc in children infected with giardiasis than that of the controls. Current result agrees with ***Yones et al. (2015) and Abou-Shady et al. (2011)*** who reported a significant decrease in serum zinc levels in Egyptian children with giardiasis.

As regards the relation between the level of serum zinc and clinical manifestations in infected children, we found that there was a statistically significant relation between the decreased level of serum zinc with high rates of diarrhea and loss of appetite in the patient group. Zinc is especially vital for the immune system, and its depletion is associated with a decline in lymphocyte and thymus functions. Because of its role in immune system functions, zinc deficiencies make infants suffer from acute diarrhea ***(Gammoh and Rink, 2017).*** Epidemiological studies indicate an association between relatively low zinc concentrations and increased diarrheal morbidity. ***(Tran et al., 2015).***

As regards copper, the normal values range between (70-130μg/dl) ***(Fedor et al. 2017).*** In our study, as regards Copper, there was no significant difference in the serum Cu between the two groups. Present result agrees with ***Abou-Shady et al. (2011) and Demirci et al. (2003).*** They stated that absorption of Cu through the whole small intestine and to a lesser extent through large intestine may be responsible, in addition to lower recommended dietary intake about 0.9 mg/day which is very close to the lower limit of 1 mg/day found in the diet. Result in present study was not in agreement with ***Yones et al. (2015)*** who found that there was a significant increase in the serum Cu in children infected with giardia than that of the controls.

As regards iron, the normal values range between (50-120 μg/dl) ***(Fedor et al., 2017).*** In our study, we found that there is a highly significant decrease in the level of serum iron in children infected with giardiasis than that of the controls. These results agree with ***Yones et al. (2015), Abou-Shady et al. (2011), and Demirci et al. (2003)*** who found that the serum iron levels decreased significantly ($p<0.05$) in children with giardiasis compared to the non-infected group.

The WHO (2007) reaffirms its recommendation of exclusive breastfeeding for 6 months, continued breastfeeding with the introduction of complementary foods, and continuation of breastfeeding thereafter for one year or even longer as desired by mother and infant. Exclusively breastfed infants had a lower risk for parasitic infections. Breast-feeding should be considered as an effective means to prevent Giardia infections and should be encouraged in regions where G. lambia is highly endemic ***(Kutty, 2014).*** In this study, found that there is a relation (non-significant) between children who receive breast milk in their lives and protection against giardiasis and statistically significant relation between children who receive breast milk now and protection against giardiasis

($p<0.014$). In a study conducted in Mexico, a 5-fold protective effect of exclusive breastfeeding was demonstrated compared with no breastfeeding among infants 0–18 months old ***(Morrow et al., 1992).***

Giardiasis is regarded as a serious public health problem, as it causes iron-deficiency anemia, growth retardation, and other physical health problems, but It is also relatively easy to control. Evidence suggests that treating children may increase their height, and weight improves iron stores, and reduces iron-deficiency anemia ***(Acosta et al., 2014).***

CONCLUSION

Giardiasis is more common among low socioeconomic classes and in rural areas. It affects the growth of children as evidenced by a significant decrease in z-score for weight, height, and head circumference in the infected children. Serum zinc and iron were significantly decreased in the patient group. Children receiving breast milk are more protected against giardia infection.

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Table (1): Demographic data of patients and the control group

Parameters		Patient group (No.=100)		Control group (No.=100)		Chi-square test	
		No.	**%**	**No.**	**%**	**X^2/t***	***P***
Sex	Female	40	40.0%	52	52.0%	2.899	0.089
	Male	60	60.0%	48	48.0%		
Age (months)	Mean ± SD	26.23	7.03	25.07	6.67	1.197*	0.233
Residence	Rural	68	68.0%	51	51.0%	5.996	0.014#
	Urban	32	32.0%	49	49.0%		
Socioeconomic	High	28	28.0%	45	45.0%	16.788	<0.001#
	Medium	30	30.0%	39	39.0%		
	Low	42	42.0%	16	16.0%		
Sanitary water supply	No	42	42.0%	16	16.0%	16.416	<0.001#
	Yes	58	58.0%	84	84.0%		
Waste disposal	No	44	44.0%	20	20.0%	13.235	<0.001#
	Yes	56	56.0%	80	80.0%		

* Independent t-test P > 0.05: Non-significant P < 0.05: Significant. P < 0.01: Highly significant.

Table (2): Comparison between patient group and control group regarding Junk food eating, washing hands, the presence of a refrigerator, and washing vegetables (health care behavior risk factors).

Parameters		Patient group (No.=100)		Control group (No.=100)		Chi-square test	
		No.	**%**	**No.**	**%**	**X^2**	***P*-value**
Junk food eating	No	42	42.0%	61	61.0%	7.227	0.007#
	Yes	58	58.0%	39	39.0%		
Washing hands	No	62	62.0%	35	35.0%	14.593	<0.001#
	Yes	38	38.0%	65	65.0%		
Presence of refrigerator	No	19	19.0%	13	13.0%	1.339	0.247
	Yes	81	81.0%	87	87.0%		
Washing vegetables	No	68	68.0%	35	35.0%	21.800	<0.001#
	Yes	32	32.0%	65	65.0%		

$\chi 2$: Chi-square test

Table(3): Comparison between patient group and control group regarding receiving breast milk generally and still on breast feeding now

Parameters		Patient group (No.=100)		Control group (No.=100)		Chi square test	
		No.	**%**	**No.**	**%**	**X^2**	**P-value**
Breast feeding generally	No	22	22.0%	11	11.0%	4.169	0.124
	Yes	78	78.0%	89	89.0%		
Still on breast feeding	No	73	93.0%	52	58.0%	6.082	0.014
	Yes	05	7.0%	37	42.0%		

$\chi 2$: Chi-square test

Table (4): Comparison between the patient group and the control group regarding weight, height, and HC (z- score).

Parameters	Patient group (No.=100)	Control group (No.=100)	Mann- Whitney	
	Median (IQR)	**Median (IQR)**	**Z**	**P-value**
Weight (Z score)	-0.49 (-0.95 -0.09)	0.43 (-0.34 - 1.01)	-4.951	<0.001
Height (Z score)	-0.17 (-0.78 -0.45)	0.24 (-0.37 - 1.06)	-3.199	>0.001
HC (Z score)	-0.24 (-0.87 - 0.39)	0.39 (-0.24 - 1.02)	-4.242	<0.001

Table (5): Comparison between the two studied groups as regards Water-law's classification.

Parameters		Patient group (No.=100)		Control group (No.=100)		Chi-square test	
		No.	**%**	**No.**	**%**	**X^2**	**P-value**
Wasted	No	45	45.0%	89	89.0%	43.894	<0.001
	Yes	55	55.0%	11	11.0%		
Stunted	No	58	58.0%	94	94.0%	35.526	<0.001
	Yes	42	42.0%	6	6.0%		
W&S	No	58	58.0%	94	94.0%	35.526	<0.001
	Yes	42	42.0%	6	6.0%		

$\chi 2$: Chi-square ($\chi 2$) test

Table (6): Comparison between the patient group and the control group regarding CBC.

Parameters	Patient group (No.=100)		Control group (No.=100)		Independent t-test	
	Mean	**SD**	**Mean**	**SD**	**t**	**P-value**
RBC ($x10^6$/ mm^3)	4.28	0.51	4.39	0.69	-1.245	0.215
MCV (fl)	75.15	4.72	77.95	4.79	-4.712	<0.001
MCH (pg)	24.28	3.28	25.74	2.23	-3.686	<0.001
HB (gm/dL)	10.77	1.29	11.62	0.98	-5.228	<0.001
Platelets ($x10^3$ / mm^3)	344.83	95.32	338.17	91.33	0.505	0.614
WBC ($x10^3$ / mm^3)	8.47	2.32	8.44	2.31	0.092	0.927

Table (7): Comparison between Patient group and Control group regarding serum Zn, Cu, and Fe.

Parameters	Patient group (No.=100)		Control group (No.=100)		Independent t-test	
	Mean	**SD**	**Mean**	**SD**	**t**	**P-value**
Zn (mg/dl)	76.81	15.80	103.29	26.95	-8.474	<0.001
Cu (mg/dl)	104.66	19.57	105.89	18.16	-0.461	0.645
Fe (mg/dl)	73.33	28.16	88.15	21.78	-4.163	<0.001

Table (8): Correlation between level of serum Zn, Cu, and Fe and anthropometric measures in the patient group

Anthropometric measures	Zn in patient group		Cu in patient group		Fe in patient group	
	r	***P***	**r**	***P***	**r**	***P***
Weight (kg)	-0.015	0.883	0.045	0.658	0.211	0.035
Height (cm)	0.956	<0.001	0.035	0.728	0.108	0.284
Head circumference (cm)	0.105	0.299	0.018	0.855	0.046	0.648

Table (9): the relation between serum Zn, Cu, and Fe level and clinical manifestations in the patient group

Clinical manifestations		Zn in patient group (mg/dl)		Cu in patient group (mg/dl)		Fe in patient group (mg/dl)	
		Mean± SD	***P***	**Mean± SD**	***P***	**Mean± SD**	***P***
Vomiting	No	77.13±15.9	0.331	104.75±19.8	0.823	73.08±28.3	0.670
	Yes	69.25±12.5		102.50±13.5		79.25±27.0	
Intermittent diarrhea	No	85.65±12.81	<0.001	106.11±19.08	0.346	73.66±27.71	0.881
	Yes	62.39±7.31		102.29±20.37		72.79±29.25	
Abdominal pain	No	80.06±15.77	0.124	102.67±19.10	0.418	72.79±29.25	0.317
	Yes	74.98±15.65		105.93±19.92		71.07±28.31	
Abdominal distension	No	80.23±15.02	0.060	103.88±19.38	0.732	75.44±28.42	0.518
	Yes	74.23±16.02		105.25±19.86		71.74±28.11	
Loss of appetite	No	81.33±14.89	0.021	107.81±18.15	0.230	80.11±26.51	0.046
	Yes	73.92±15.80		102.89±20.25		69.89±29.24	
Fever	No	77.05±16.08	0.506	104.73±19.89	0.883	72.67±28.49	0.312
	Yes	72.20±8.64		103.40±13.50		85.80±18.58	

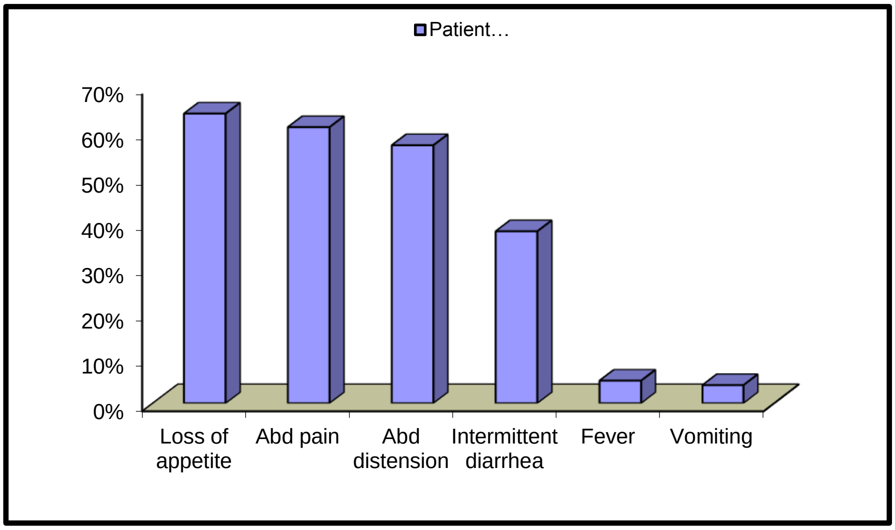

Fig. (1): Clinical manifestations of the patient group.

تأثير الاصابة المبكرة بالجيارديا على النمو، و الحالة الغذائية،ونسبة المعادن فى الدم لدى الأطفال

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الملخص العربى

تعتبر االجيارديا من أكثر الطفيليات المعويه شيوعا في البشر فى جمبع أنحاء العالم. كما أن لها تأثير سلبي كبير على النمو البدنى و العقلى للأطفال. الهدف من هذا البحث هو تقييم تأثير طفيل الجيارديا على نمو الأطفال و تقييم معدلات الزنك و النحاس و الحديد لدى الأطفال المصابين بداء الجيارديا، و كذالك لدراسة العلاقة بين عدوى الجيارديا و الرضاعة الطبيعية. طريقة البحث: أجريت الدراسة على ٢٠٠ طفل (٣-١ سنوات) ١٠٠ طفل منهم مصاب بالجيارديا (مجموعة المرضى)، و ١٠٠ طفل سليم (مجموعة ضابطة). وقد خضع جميع الأطفال لأحذ التاريخ المرضى، تقييم الطبقة الاجتماعية للعائلة،و الفحص السريرى الكامل، و قياسات الوزن و الطول و محيط الرأس، و و تحليل البراز،و صورة دم كاملة، و تقدير مستوى الزنك و النحاس و الحديدفى الدم. النتائج: كشفت هذه الدراسة عن زيادة معدل الاصابة بالجيارديا فى الأطفال الذين يعانون من انخفاض المستويات الاجتماعية و الاقتصادية (٦٨٪ من المرضى يعيشون فى المناطق الريفية).و أدى انتشار سوء التغذية بين المرضى أن ٥٥٪من الأطفال المصابين يعانون من النحافة، و ٤٢٪من التقزم، و ٤٢٪ يعانون من النحافة و التقزم. فيما يتعلق بالفحوصات المعملية، وجد زيادة معدل فقر الدم فى الأطفال المصابين بالجيارديا بالمقارنه بالأصحاء. و هناك انخفاض كبير فى مستوى الزنك فى الدم فى المرضى بالمقارنة بالأطفال الاصحاء. و يرتبط انخفاض مستوى الزنك فى الدم بارتفاع معدلات الاسهال و فقدان الشهية. و هناك انخفاض كبير فى مستوى الحديد لدى اللأطفال المصابين بالجيارديا كما وجدت علاقة ذات دلالة احصائية بين الأطفال الذين يتلقون الرضاعة الطبيعية و الحماية من الاصابة بالجيارديا. الخلاصة: تعتبر الاصابة بالجباردبا مشكلة صحية عامة خطيرة مما لها تأثير سلبي على صحة الأطفال الجسدية.

الكلمات المفتاحية: *الأطفال، الجيارديا، النمو، الحديد، الزنك، النحاس*