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A Body Shape Index Versus Body Mass Index in the Assessment of Nutritional Status Among Egyptian Primary School Children Infected with Intestinal Helminthiasis

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Abstract: *Background:* School-age children are more predisposed and vulnerable to helminths infections which adversely affect their nutritional status. The A Body Shape Index (ABSI) has been developed as possible improved alternatives to BMI and WC in the assessment of nutritional status. *Objectives:* To detect the prevalence of helminths infections among school children and to assess nutritional status using ABSI and BMI parameters for them. *Methods:* A cross-sectional survey was carried out. A total of 500 primary school children (age: 6-12 years) from two randomly selected rural and urban schools were enrolled in the study. One fecal sample was collected from each participant after their exposure to interview and anthropometric measurement. The coprological diagnosis was performed by three different methods; direct simple smear, simple precipitation and Kat-Katz techniques. *Results:* The overall prevalence of intestinal parasites was 25.8%. Enterobius vermicularis, Hymenolepis nana then hookworm infection (39.5%, 38% then 22.5%) Infection was significantly associated with lower age, females, rural schools and among low social classes than others. There was a significant impairment of the anthropometric measures, especially weight, height and body mass index among infected children. ABSI showed higher AUC than BMI. *Conclusions:* School health programs should provide regular inspection, supervised school meals and health education.

Keywords: ABSI, Intestinal Helminthiasis, Malnutrition

1. Introduction

Intestinal parasites are among the most widespread infections and remain an important cause of morbidity and mortality particularly in developing countries [1]. The prevalence of infection vary from country to country with the highest prevalence in low income countries where the infections are strongly associated with poverty, very low hygienic conditions, high population density, and tropical and subtropical climate which are the major factors for the transmission of such intestinal parasites [2].

School-age children are more predisposed to helminths infections compared to other age groups [3]. Negative effects of helminths infections include diminished physical fitness, growth retardation, and delayed intellectual development and cognition [4].

Globally an estimated 100 million people have been reported to have experienced stunting or wasting as a result of helminths infections [5]. The nutritional status of infected subjects is affected by a decrease in food intake and/or an increase in nutrient wastage as a result of blood loss, vomiting or diarrhea [6]. These effects can lead to or aggravate protein energy malnutrition, anemia, and other nutrient deficiencies.

Intestinal parasitic infections have been shown to have a pronounced negative impact on various anthropometric indices [7].

Published data about the impact of intestinal parasitism on the nutritional status of primary school children in our community are extremely rare. The aim of the current work was to assess the prevalence of intestinal helminthic infections among primary school aged children in two (rural and urban) primary schools, their impact on the nutritional status of those children and to make recommendations for control.

ABSI is able to account for a person's body shape as it uses height and weight to measure body fat, but along with those two factors, it takes into account waist circumference. It's well known that there's brown and white fat in the body. Brown fat helps to insulate the body. But with aging, it turns into white fat, which stores energy, resides in the abdomen and leads to obesity [8].

2. Aim of the Study

To detect the prevalence of helminths infections among school children and to assess the effect of this on the nutritional status using ABSI and BMI parameters.

3. Subjects and Methods

Sample type: Simple random sample.

Sample size equation: N= $(Z^2 * P*Q)/(E^2)$ [Z=1.96, P= No of affected pop, Q=1-p and E error=0.05%].

This was a cross sectional study that was conducted in Toukh Center, Egypt and included 500 primary school children. Two randomly selected primary schools were willing to participate in the study with one school located in rural and one in urban areas (from each school 250 students were randomly selected). The study was carried out as a school-based survey including children between the ages of 6 and 12 years old of both sex. Pupils who had congenital malformations, chronic illness and/or physical handicap, also children who had received any anthelminthic drugs in the last 3 months preceding the stool sample collection were excluded from the study. A structured questionnaire including sex, age, residence and socioeconomic status was distributed to the guardian(s) of each child. Meetings were held with community members to explain the purpose and the design of the study. Students were instructed to deposit one fecal sample of each child into the container and return it to school on the morning of the same day.

4. Parasitological Survey

A total of 500 fecal samples were collected in polyethylene containers in the morning of the same day and examined using direct simple smear, simple precipitation and a Kato-Katz thick smear method [9]. Each smear was examined twice by two different laboratory personnel.

5. Anthropometric Measurements

Body weight was recorded with a portable electronic scale to the nearest 100 g. Measures were expressed as weight for age (WFA), height for age (HFA) and weight for height (WFH) according to Egyptian growth charts[10] and WHO [11] parameters. Underweight, Stunting, and wasting were defined by values below the 3^{rd} centile line for WFA, HFA, and WFH respectively.

Body Mass Index (BMI) was calculated as the weight in kilograms divided by the square of height in meters. Children were classified according to BMI into [normal (>18.5), mild (17-18.4), moderate (16-16.9) and severe (< 16) malnutrition [12].

Mid upper arm circumference (MUAC) was measured on the left arm at the level of the upper arm midpoint mark. The measurement was then taken to the nearest 0.1 cm [13].

ABSI was calculated using the following formula [8]: $ABSI=WC/(BMI^{2/3}Height^{1/2})$.

6. Ethical Considerations

The present study was approved by the Ethical Committee of Faculty of Medicine, Benha University, Egypt. Written informed consent was obtained from all parents or the legal guardians of the children participating in the study.

7. Statistical Analysis

The collected data were summarized in terms of mean ±SD for quantitative data and frequency and percentage for categorical data. Student t test, ANOVA test, chi square test and the test of proportion (Z-test) were used for analysis of data. Receiver operating characteristics (ROC) curve was used to compare accuracy of BSI and BMI. A P-value <0.05 was considered statistically significant. All statistical analysis was carried out using the computerized Statistical Package for Social Science (SPSS; Version 20.0 for Windows, SPSS Inc., Chicago, IL).

8. Results

Among the 500 children, 50.8% were males, and 49.2% were females (Table 1) with a 1.03 sex ratio. The prevalence of parasitic infection was 48.8% in males and 51.2% in females which points to non-significant difference.

This study showed a considerably high level of intestinal parasitism. A total of 129/500 (25.5%) children were infected. Majority of the parasitic infections were for those transmitted by autoinfection as E. *vermicularis* (39.5%) recorded the highest prevalence rate followed by *H. nana* (38.0%), the least prevalence rate was recorded for hookworm (22.5%).

Obviously, infection was recorded among all age groups but with high prevalence in the younger ages (Table 2). A significant difference regarding residence and social class was observed as 62.8% of infected group were belonged to rural area and 78.3% belonged to low social class.

Regarding the anthropometric measures, weight, height and BMI were significantly related to infection as 12.4%, 4.6% and 9.3% respectively of infected students were belonged to <25 centile group in comparison to 0.3%, 0.0% and 0.3% of non-infected students. Mid arm circumference/cm and skin fold thickness/mm were significantly lower among infected than among non-infected group. The form of infection was insignificantly differ regarding sex, residence or social class, but it showed significant age difference (p<0.05) (Table 3).

Table 1. *Participants' characteristics.*

	No (500)	%
Gender		
Male	51	50.8
Female	246	49.2
Male/female	1.03	
Residence		
Urban	250	50.0
Rural	250	50.0
Social class		
High	0	0.0
Moderate	186	37.2
Low	314	62.8
Helminthes infestation		
Yes	129	25.8
No	371	74.2
Type of parasite (129)		
E. vermicularis	51	39.5
H nana	49	38.0
Hookworm	29	22.5

Table 2. *Comparison between infected and non infected subjects.*

	Not infected	Infected	Test	P value	OR(95%CI)
Parasitic infestation	(371)	(129)			
Gender (n& %)					
Male	191(51.5)	63(48.8)	#0.268	0.61	0.9(0.603-1.34)
Female (ref)	180(48.5)	66(51.2)			
Age/Y (mean ±SD)	8.68±1.8	8.6±1.9	^0.429	0.67	(-0.45)-(029)
Residence (n& %)					
Rural	169(45.5)	81(62.8)	#11.38	0.001**	2.02(1.34-3.04)
Urban (ref)	202(54.5)	48(37.2)			
Social class (n& %)					
Low	213(57.4)	101(78.3)	#17.9	0.001**	2.68(1.68-4.27)
Moderate (ref)	158(42.6)	28(21.7)			
Weight /kg					
>75 centile	187(50.4)	21(16.3)	¥6.8	0.001**	
50-75 centile	164(44.2)	58(45.0)	¥0.15	0.88	
25-49 centile	19(5.1)	34(26.4)	¥6.75	0.001**	
<25 centile	1(0.3)	16(12.4)	¥6.55	0.001**	
mean ±SD	33.5±7.5	31.2±6.03	^3.49	0.001**	(-3.6)-(-1.0)
Height /cm					
>75 centile	287(77.4)	96(74.4)	¥0.68	0.48	
50-75 centile	84(22.6)	24(18.6)	¥0.96	0.34	
25-49 centile	0(0.0)	3(2.3)	¥2.9	0.003**	
<25 centile	0(0.0)	6(4.6)	¥4.2	0.001**	
mean ±SD	133.3±9.08	132.9±7.8	^0.48	0.32	(-2.03)-(1.23)
BMI(kg/m^2)					
Normal	169(45.6)	22(17.1)	¥5.7	0.001**	
Mild	181(48.8)	65(50.4)	¥1.4	0.16	
Moderate	20(5.4)	30(23.3)	¥5.8	0.001**	
Severe	1(0.3)	12(9.3)	¥5.6	0.001**	
mean ±SD	18.5±2.2	17.6±1.6	^4.96	0.001**	(-1.26)-(-0.55)
ABSI (mean ±SD)	0.063 ±0.021	0.047±0.012	^10.54	0.001**	(-0.02—0.01)
Mid arm circumference/cm (mean ±SD)	18.5±2.6	17.6±2.2	^3.52	0.001**	(-1.4)-(-0.40)
Skin fold thickness/mm (mean ±SD)	15.6±2.8	14.5±2.6	^3.91	0.001**	(-1.65)-(-0.55)

#= Chi square test, ^=Student t test, ¥=Z test, **=highly significant

Table 3. *Differences between different forms of parasitic infections.*

	E. vermicularis	*H. nana*	Hookworm	Test	P value
Parasitic infestation	(51)	(49)	(29)		
Gender (n& %)					
Male	25(49.0)	23(46.9)	15(51.7)	#0.17	0.92
Female	26(51.0)	26(53.1)	14(48.3)		
Age /Y (mean ±SD)	8.41±1.9	8.46±1.53	9.52±1.81	∞4.3	0.016*
Residence (n& %)					
Urban	22(43.1)	16(32.7)	10(34.5)	#1.3	0.52
Rural	29(56.9)	33(67.3)	19(65.5)		
Social class (n& %)					
Moderate	10(19.6)	12(24.5)	6(20.7)	#0.37	0.83
Low	41(80.4)	37(75.5)	23(79.3)		

#= Chi square test, ∞=F test, *= significant

Figure (1) declared that using ROC curve to compare between ABSI and BMI revealed that ABSI was more accurate [(AUC (95%CI) =0.784(0.669-0.899)] than BMI [0.692(0.595-0.788)] with more sensitivity and specificity regarding ABSI (85%, 81.8%) versus BMI (79%, 68.2% respectively).

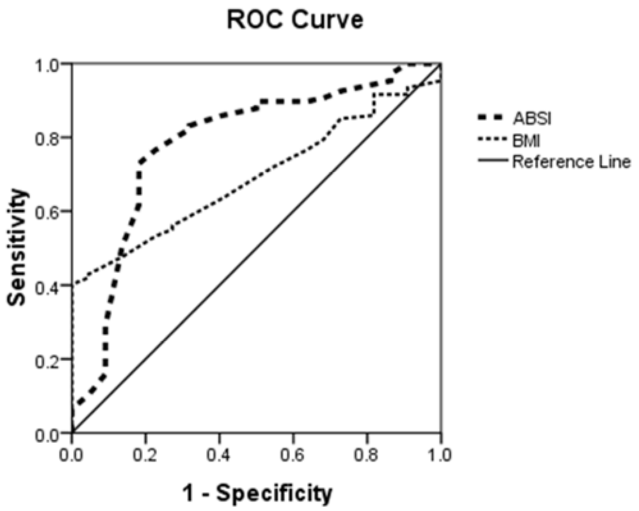

Figure 1. *Receiver operating characteristics (ROC) curve of ABSI and BMI.*

9. Discussion

Parasitic infections have been shown to have deleterious effects on host nutritional status. In developing countries, the association of parasitic infections and malnutrition is well recognized. [14]. Many studies reported the close association between malnutrition and intestinal parasitic infection [7].

The prevalence of intestinal parasitic infection among children enrolled in this study was 25.8%% (129/500). This corroborates finding by other researchers who reported that among primary school children from El-Minia (29.3%) [15]. A higher rate of infection was recorded by El-Gammal et al. [16] and El-Masry et al. [17] who reported that the prevalence of parasitic infections among Egyptian school children in Tamouh and rural school students in Sohag governorate villages were 60.2% and 88.5%, respectively. Globally, the prevalence of these parasites varies from one country to another. Reports on intestinal parasites have shown prevalence rates of 28.7% in Yemen, 19.3-27.3% in Iran, 12.4% in Lebanon, 16.6-74.6% in the Gaza Strip (Palestine), 28.5% in Jordan, 42.5% in Syria, 31.4-32.2% in Saudi Arabia, 17.0-90.4% in Sudan, 33.9% in Qatar, 31.8-37.2% in Turkey, and in Cambodia (25.7%) [18, 19]. In contrast, it was notably high in studies conducted in Thailand (68.1%), Nepal (71.2%) India (29.2% and 63.94%) [20].

E. vermicularis (39.5%), H. nana (38%) and hookworm (22.5%) were found to be the most prevalent parasites in this study. The high rates of *E. vermicularis and H. nana* observed in the current study indicate the poor hygienic practices of school children in the study area that represent an important risk factor for autoinfection and facilitate their transmission to others [21]. These results come in agreement with the result of Amare and his colleagues [22] who reported 22.7% prevalence of intestinal parasites among primary school children from Northwest Ethiopia with A. lumbricoides, H. nana and Hook worm were found to be the most prevalent parasites.

The disparity between different studies could be attributed to many factors including variation in selection of the enrolled study population, the sensitivity of coproparasitological techniques used or the skill of the investigator. The finding recorded in the present study emphasizes the former interpretation.

Analysis of the socio-demographic profile showed no statistical significant difference except for residence and social class that showed highly significant statistically difference. Children attending rural school and those from low social levels had a higher risk of being infected with helminth infections (62.8%) compared to those in the urban one (37.2%). The high prevalence of parasitic infection in rural areas may be attributed to lack of personal hygiene, shortage of clean water supplies, poor social standards, indiscriminate defecation have greatly contributed to high prevalence rate reported among attendants of rural areas [23], 24].

Age did not significantly affect the prevalence of intestinal parasitic infections. However, younger children appeared to be highly predisposed to intestinal parasitic infections than older ones (mean age was 8.68 y). Children of these age groups often spend more of their leisure time outdoors, playing in garbage dumps and may also eat indiscriminately with unwashed hand or eat discarded contaminated food. Older children may be more careful hence they become more able to avoid such infections than younger ones. The lower infection rate observed in older children may be contributed to their hygiene concern about their looks as compared to the lower age group and hence they become more able to avoid as much as possible what would lead them to one being infected.

Regarding Gender, in spite of the lack of statistically significant association, females had a relatively higher prevalence than males; the possible explanation of this result is that females are more exposed to potential domestic sources of transmission of such infections, like food preparation, fetching water and disposal of waste than their male counterpart. However, the influence of gender on parasitic infection prevalence is inconclusive depending on other probable environmental and regional factors.

Under nutrition continues to be a cause of ill health and premature mortality among children in developing countries [25]. Because parasitic infections may cause anorexia and poor absorption of nutrients and promote the deviation of nutrients to the organism's defense mechanisms; thereby contributing to the onset or exacerbation of weight and height deficits, as well as to specific nutritional deficiencies [26].

In the current work, the anthropometric parameters (mean body mass index, weight, height and mid arm circumference) showed a remarkable difference of nutritional status between infected and uninfected children. The study revealed that, the anthropometric measures, weight, height and BMI were significantly related to infection as 12.4%, 4.6% and 9.3% of infected students respectively were belonged to <25 centile group and they were attributable to the potential effects of intestinal helminths infections, in comparison to 0.3%, 0.0% and 0.3% of non-infected students respectively. Mid-arm circumference/cm and skin fold thickness/mm were significantly lower among infected than among non-infected group. The form of infection was insignificantly different regarding sex, residence or social class, but it showed significant age difference. Our study is in agreement with previous reports showing that the nutritional status among school children is significantly associated with parasitic infection [13, 15, 27]. On the other hand, other researchers deny this association in Nigeria [28]. The possible explanation of this disparity might be that both malnutrition and parasitic infection exist to a level of public health significance in the studied localities, probably interacting synergistically and with other associated dietary and socioeconomic factors [29].

In 2012, a new index known as ABSI was developed. its values appeared superior to measurements of WC and BMI for predicting premature death [10]. Other studies also found that ABSI can predict morbidity and mortality during patient follow-up periods [30].

10. Conclusion

The overall prevalence of intestinal parasites in the current study was 25.8 %. The prevalence of the parasitic infections in both sexes as well as, among the various age groups suggested that sex and age were not predetermining factors for parasitic infections in our study, while rural residence and low social class may be probable contributing factors. Anthropometric measures showed a remarkable difference in nutritional status between infected and uninfected children. ABSI could be used with BMI in the detection of nutritional status. Intestinal parasitic infections represent a major problem among primary school children in our community particularly in rural areas with low social class and seem to play a contributory role in the occurrence of childhood malnutrition. Steps should be taken to control both of these important health problems, through functional school health programs that provide regular inspection, deworming, supervised school meals and health education.

Abbreviations

Weight for age (WFA), Height for age (HFA) and Weight for Height (WFH); Body Mass Index (BMI), A body shape index (ABSI) CI: Confident interval; %: Percent.

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Authors' Contributions

ME and NA conceived, designed and performed the experiments. ME analyzed the data. ME and NA wrote the paper, read and approved the final version of the manuscript.

Competing Interests

The authors declare that they have no competing interest.

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