Bulletin of High Institute of Public Health
Vol. 42 No. 1 [2012]

# Anthropometric Status, Anemia and Intestinal Parasitic infections among Primary School Children in Alexandria, Egypt.

Nesrin K Abdel Fatah*, Laila M Nofal **

**ABSTRACT**

**BACKGROUND:** In developing countries, malnutrition is a major health problem with prevalence ranges of 4-46%. Early childhood malnutrition is irreversible and intergenerational, with adverse consequences on adult health. **OBJECTIVES:** This study aimed to determine the current prevalence and some associated risk factors of anemia, anthropometric indices and intestinal parasitic infection among primary school children in Alexandria, Egypt. **METHODS:** A cross sectional study was carried out on 330 school children aged 6-12 years, attending governmental primary schools, in Alexandria. The sample was selected using a multistage random cluster sampling technique. Nutritional status of these children was determined using age and the anthropometric parameters of weight and height. z-scores of height-for-age, weight-for-age and weight-for-height were computed. Epi Info 2000 software was used to evaluate the anthropometric results of each individual. Cyanmethaemoglobin method and two Kato thick smear technique were employed to identify blood hemoglobin and parasites respectively. Data were analyzed using appropriate descriptive, univariate and multivariate logistic regression methods. **RESULTS:** Underweight, stunting, wasting, anemia and intestinal parasitoses were 4.2%, 3%, 3.7%, 84.5% and 33.6 % respectively. Parasites encountered during the study were Ascaris lumbricoides (24.6%), Trichuiris trichiura (19.6 %), and Enterobius vermicularis (3%) respectively. Based on multiple logistic regression analyses, the main risk factor for stunting was the presence of parasitic infection (OR = 4.85; 95%CI=1.23-19.12). The risk factors for anemia were age ≥10 years (OR = 8.79; 95% CI = 2.01- 38.35), and presence of parasitic infection (OR= 2.26; 95% CI = 1.07- 4.82), while the risk factors for parasitic infection were age 8 -10 years (OR = 1.94; 95% CI = 1.13 - 3.34; P = 0.02),and age ≥10 years (OR = 1.99; 95% CI = 1.05 - 3.79; P = 0.035), anemia (OR= 2.1; 95% CI = 0.99- 4.44; P = 0.054) and stunting (OR = 4.33; 95% CI = 1.05 - 17.83; P = 0.042). **CONCLUSION:** Findings from this study are strongly suggestive that intestinal parasitic infections and malnutrition exist in school children residing in Alexandria and constitute a major health problem that needs to be addressed immediately to reduce morbidity and mortality**.**

**Key words:** Malnutrition, anemia, parasitic infections, primary school children, and stunting.

## INTRODUCTION

School children face many health problems such as malnutrition, anemia and parasitic infections that compromise their physical development, school attendance and ability to learn.[1] Those problems constitute a major health burden in developing countries, with infants and children being the most vulnerable

*Department of Nutrition, High Institute of Public Health, Alexandria University
**Department of Biostatistics, High Institute of Public Health, Alexandria University

groups.[2] Indicators of malnutrition include wasting, stunting and being underweight. Stunting or low height-for-age (HAZ), is thought to be a good indicator of malnutrition and represents a status of chronic nutritional stress.[3]

The World Health Organization had estimated that the overall prevalence of stunting has fallen in developing countries from 47% in 1980 to 33% in 2000. Stunting in school age children is common in developing countries with the stunting prevalence being higher in primary schools. Malnutrition in Egypt is increasing after steady decrease in the prevalence of stunting that Egypt has experienced from the late 1970s till 2000. [4] The situation is likely to have further deteriorated since the continuing political instability following the Egyptian revolution at the start of 2011. Parasitic infections, anemia and malnutrition are prevalent and of public health concern especially among the low income groups living in rural areas in Egypt. According to the nutritional survey conducted by Tawfik in 2004 among school age children (6-12years), the prevalence of stunting was 11.6%.[5] It was estimated that 30% of the world's total population are anemic.[6] In Egypt, nearly 50% of all school aged children are anemic. [7]

In endemic areas, school age pupils suffered from the greatest burden of parasitic infections. The disease burden is mainly manifested as nutritional stress and associated with poor appetite, food indigestion, malabsorption, impaired growth and anemia.[8] The intensity and type of parasitic infection contribute to its effect on nutrition.[9] The synergistic occurrence of helminthiasis, anemia and malnutrition exert a negative effect on growth and development of the affected person.[10]

To our knowledge, malnutrition and anemia exist in school children residing in Alexandria Governorate, as elsewhere in Egypt, and constitute a major health problem that needs to be addressed immediately to reduce morbidity and mortality.[11] Few studies were carried out to study the nutritional status and parasitic infections among that age group in Egypt. That is why the aim of this study was to determine the current prevalence and some associated risk factors of anemia, anthropometric indices and intestinal parasitic infection among primary school children in Alexandria, Egypt.

## SUBJECTS AND METHODS

### Study design and setting

A cross-sectional survey was carried out in Alexandria governmental primary schools, Egypt; from September to November 2011.

### Study population, sample size and sampling technique

The study population consisted of school children aged 6 - 12 years. The sample size was calculated using Epi-Info. Based on an estimated prevalence of 50% (that gives the maximum sample size), a 95% confidence level, an 8% degree of precision and a design effect of 2, the minimum required sample size was found to be 301 and was rounded to 330. To ensure that the sample size is big enough to detect a significant effect, a power analysis was conducted with program G. Power for each of the studied outcome measures (anaemia, stunting and parasitc infection) was done and was found to be above 80% which is sufficient to detect a significant effect. For example, to study infection as a risk factor of anemia, assuming that 30% of the sample were infected and that prevalence of anemia among those infected and those non infected was 90 and 75% respectively, the power was found to be 90%. To study infection as a risk factor of stunting, assuming that 30% of the sample was infected and that prevalence of stunting among those infected and those non infected was 10 and 2% respectively, the power was found to be 84%. To study anaemia as a risk factor of infection, assuming that 80% of the sample was anemic and that prevalence of infection among those anaemic and those non anemic was 40 and 20% respectively, the power was found to be 88%.

A multistage random cluster sampling technique was used to select the study sample. In the first stage, Alexandria was divided into 8 districts and one district was randomly selected (El-Amreya District). In the second stage, two schools (clusters) were randomly selected from the selected district based on the probability proportional to size (El-Betash mixed primary school and Belal Ben Rabah School). In the third stage, one class was randomly selected from each of the different grades (grade 1 to grade 5) and 33 children were then randomly selected from each selected class. A total of 330 children were thus included in our study.

**Data collection**

Data about socio-economic level (age,sex, residence, family size, number of rooms, level of education , occupation of parents and household income) were collected by interviewing students or their parents using a predesigned questionnaire. Crowding index was calculated using family size and number of rooms of every pupil's house.

**Anthropometric measurements**

All measurements were carried out according to the criteria described by Gibson.[12] Body weight and height were measured. Weights of the school children were recorded using a scale to the nearest 0.1 kilograms (kg). Heights were measured to 0.1 centimeters (cm). School children were instructed to wear minimum clothing and no shoes. Age was calculated from the date of birth in school records to the date of visit.

**Laboratory methods**

Stool samples were examined by the Kato-Katz technique (thick smear 41.7 mg). Containers for collection of stools were dispensed to each class and labeled separately for school children. School children were asked to collect and deliver samples of their faeces to school the next day. Kato slides were examined to detect and count any parasitic infection eggs.[13] Hemoglobin (Hb) was determined by the cyanmethaemoglobin method[14] to detect anemic school children. Blood samples were collected by finger prick. The blood was immediately diluted with Drapkins solution and read using a spectrophotometer within 6 hours of being diluted.

**Data management**

- Three Anthropometric indices, height for age, weight for age, and weight for height were calculated using Epi Info 6 (CDC) software. The values were assessed with reference to the National Centre for Health Statistics (NCHS) and the WHO values and expressed as differences from median in standard deviation units or z-scores.
- Children were classified as stunted, underweight and wasted if z-scores of height for age, weight for age and weight for height were less than -2 standard deviation below NCHS/WHO median.[15]
- Children were classified as anemic if the hemoglobin concentration was less than 11.5 g/dL [16]

Anemia was further classified into three grades according to Hb concentration [16]

| | |
|---|---|
| Mild | 10 - 11.5 g/dL |
| Moderate | 7 - 10 g/dL |
| Severe | < 7 g/dL |

- Parasitic infections were expressed as the number of eggs per gram stool (EPG). Two Kato-Katz slides were prepared from each stool sample. Infection intensity was defined as number of eggs/gram (EPG) of faeces using the World Health Organization criteria: light, moderate or heavy intensity infection for Ascariasis, Trichuriasis and Hookworm eggs.[17]

  For T. trichiura: light intensity infection means1-999 EPG, moderate to heavy intensity ≥1000 EPG.

  For Ascariasis: light intensity infection means 1-4999 EPG, moderate to heavy intensity ≥5000 EPG.

- Calculation and scoring of socioeconomic level was based on the Modified Social Score for family social leveling (Modified by Fahmy and Sherbini 1983).[18] The social levels were then classified as:

  High social score 38-46

  Middle social score 23-38

  Low social score <23

**Statistical analysis**

Data analysis was performed using the SPSS software version 17.0 for Windows (SPSS, Chicago, IL, USA). The distribution of quantitative data was examined using the Shapiro-Wilk test and was found to be normal. The independent t-test was used to examine the difference in Hb, weight and height between groups (infected and non infected children). Chi-squared test or Fisher's exact test whichever appropriate was used to examine the differences for proportions of anemic, stunted, underweight and wasted among infected and non-infected children. Univariate logistic regression analysis was used to identify the independent variables significantly related to the outcomes (anemia, stunting and parasitic infection) among the studied children. Crude odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. All variables found to be significant were then included in stepwise multiple logistic regression analysis. The final model was interpreted by using adjusted ORs and 95% CIs. The level of significance of 0.05 was used for all the statistical tests.

**Ethical considerations:**

There were no conflicts of interest. This work received no specific grant from any funding agency in the public, commercial or not for profit sectors. This study was conducted according to the guidelines laid down for medical research involving human subjects and was approved by the Ethics Committee of the High Institute of Public Health, Alexandria University, Egypt. All measurements were taken and kept confidential. School children and their parents were informed about the objective of the study and had the right to accept or refuse to participate. An informed written consent was taken from their parents.

## RESULTS

### Sample characteristics

A total of 330 school children (151 boys and 179 girls), aged 6-12 years with a mean age 8.5± 1.5 years participated in the study. About three quarters of these children were of low socioeconomic score. All children were able to provide complete information (questionnaire, stool samples, blood samples, and physical examination)

### Children's under nutrition

The mean weights and heights of the study subjects were 27.07±8.15 kg and 127.88±9.75 cm respectively. The prevalence of stunting, wasting and underweight was 3 %, 3.7 % and 4.2 % respectively. (Table 1)

### Children's anemia

The mean hemoglobin level of the studied school children was 10.63±0.84 g/dL, and 84.5% of them were found to be anemic. No school children had severe anemia (HB < 7 g/dl), while 74.1%of anemic school children had mild grade of anemia and 25.9% had moderate grades. (Table 1, Fig. 1)

**Table1: Distribution of the studied sample according to nutritional characteristics and parasitic infection.**

| Variable | Total sample (n=330) | Infection No (n=219) | Infection Yes (n=111) | P |
|---|---|---|---|---|
| **Anemia** | 84.5% (n=279) | 80.6 | 91.0 | **0.024**■ |
| **Wasting@** | 3.7% (n=10) | 4.9 | 1.1 | 0.175■ |
| **Underweight** | 4.2% (n=14) | 3.7 | 5.4 | 0.564■ |
| **Stunting** | 3.0% (n=10) | 1.4 | 6.3 | **0.019**■ |
| **Hemoglobin (mean±SD)** | 10.63±0.84 | 10.76±0.81 | 10.37±0.85 | **0.000**□ |
| **Weight** | 27.07±8.15 | 26.73±7.76 | 27.75±8.87 | 0.282□ |
| **Height** | 127.88±9.75 | 127.53±9.52 | 128.57±10.19 | 0.359□ |

■ *Chi-square or Fisher's exact test whichever appropriate*
□ *Independent samples t test*
@ n = 273 where 57 school children had height > 145 cm for ♂ or > 137 for

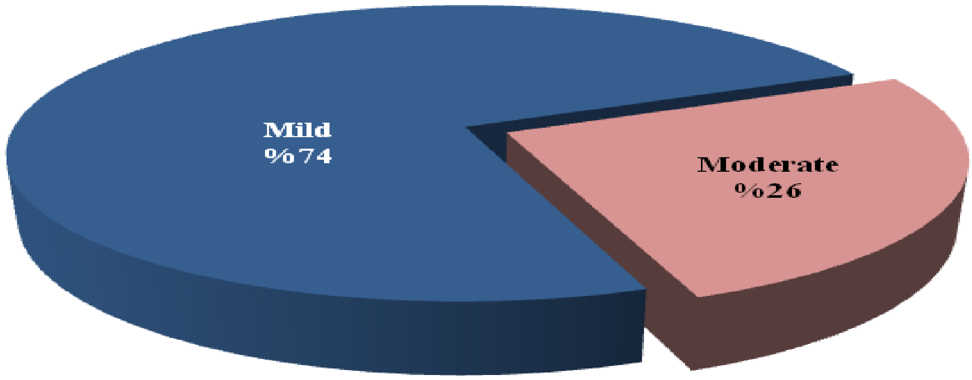


**Figure (1) : Grades of anemia among studied school children**

### Children's parasitic infection

Results showed that 33.6% of studied school children were infected with parasites. The prevalence of parasitic infections such as Ascaris lumbricoids, Entrobious vermicularis and Trichuris trichura infections were 24.8%, 3% and 19.6% respectively (Figure 2). Among those, about a quarter of the infections by Ascaris lumbricoides and 3.1% of those by Trichuris trichiura were of moderate to heavy intensities. (Table 2)

**Table 2: Univariate analysis for the potential risk factors of anemia among studied sample,**

| Variables | Anemia Total No.(n=330) | Prevalence | OR | 95% CI | P value |
|---|---|---|---|---|---|
| **Age** | | | | | |
| < 8 | 131 | 77.9 | 1- | | |
| 8 - | 130 | 83.8 | 1.48 | 0.79-2.75 | 0.221 |
| 10+ | 69 | 98.6 | 19.33 | 2.57-145.3 | **0.004*** |
| **Gender** | | | | | |
| Female | 179 | 86.6 | 1 | | |
| Male | 151 | 82.1 | 0.71 | 0.39-1.29 | 0.264 |
| **Socio economic status** | | | | | |
| Moderate & high | 70 | 92.9 | 1 | | |
| Low | 260 | 82.3 | 0.36 | 0.14-0.94 | 0.037 |
| **Infection** | | | | | |
| No | 219 | 80.6 | 1 | | |
| Yes | 111 | 91.0 | 2.33 | 1.12-4.84 | **0.024*** |
| **Ascaris** | | | | | |
| No | 249 | 80.7 | 1 | | |
| Yes | 81 | 96.3 | 6.21 | 1.88-20.52 | **0.003*** |
| **Oxyuris** | | | | | |
| No | 320 | 85.0 | 1 | | |
| Yes | 10 | 70 | 0.41 | 0.10-1.65 | 0.210 |
| **Trichuris** | | | | | |
| No | 265 | 83.4 | 1 | | |
| Yes | 65 | 89.2 | 1.65 | 0.71-3.85. | 0.226 |
| **Ascaris intensity** | | | | | |
| No | 249 | 80.7 | 1 | | |
| Light | 59 | 96.6 | 6.81 | 1.61-28.86 | **0.009*** |
| Moderate | 22 | 95.5 | 5.02 | 0.66-38.21 | 0.120 |
| **Trichuris intensity** | | | | | |
| No | 266 | 83.1 | 1 | | |
| Light | 63 | 95.0 | 1.63 | 0.68-3.81 | 0.283 |
| Moderate | 2 | 95.5 | 1.60 | 0.64-3.81 | 0.999 |
| **Wasting** | | | | | |
| No | 263 | 80.6 | 1 | | |
| Yes | 10 | 100 | 5.1 | 0.67-4.06 | 0.999 |
| **Underweight** | | | | | |
| No | 316 | 84.2 | 1 | | |
| Yes | 14 | 92.0 | 2.44 | 0.31-19.10 | 0.394 |
| **Stunting** | | | | | |
| No | 320 | 84.4 | 1 | | |
| Yes | 10 | 90.0 | 1.67 | 0.21-13.41 | 0.632 |

**Nutritional characteristics and infection:**

The anthropometric and nutritional characteristics of the infected and the non infected children are shown in table 1. It is clear that there is no significant difference ($P>0.05$) in terms of the mean weight and height among them. However, the children who had infections were more stunted compared to those who were non infected (6.1% and 1.4% respectively, P=0.019). Wasting and underweight showed no significant difference. Children who were infected had significantly lower mean hemoglobin concentration compared to those who had negative infections (10.37 g/dL compared to 10.76 g/dL; P = 0.000). Also the children who had infections were more anemic (91%) compared to those who were not infected (80.6%), the difference was statistically significant (P = 0.024). In addition, there was a significantly higher percent of higher grades of anemia among infected group (29.7%) compared to 17.3% among non-infected group (*P* = 0.009). Regarding the type of parasite, 29%, 40%, and 35.4% of infected school children had moderate grade of anemia caused by Ascaris, T. trichiura, and Entrobious vermicularis, so we could conclude that T. trichiura showed higher grades of anemia than Ascaris lumbricoids and entrobious vermicularis (Figure 2).

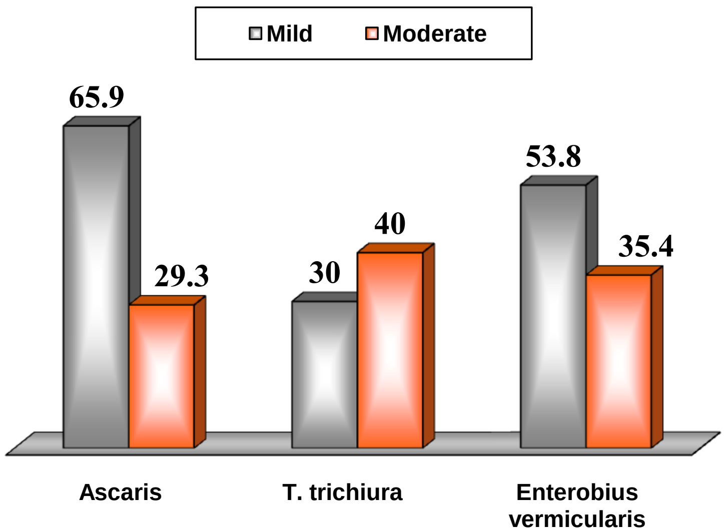


**Figure (2) Parasite infection and grades of anemia**

**Risk factors for anemia**

Examining the association between anemia and the possible risk factors revealed that age ≥10 years (P = 0.004), low socioeconomic score (P= 0.037), presence of parasitic infection (P = 0.024), and positive Ascaris infection (P= 0.003) were significantly associated with anemia (Table 2). Multivariate analysis using logistic regression confirmed that age ≥10 years (OR = 8.79; 95% CI = 2.01- 38.35; P = 0.004), presence of parasitic infection (OR= 2.26; 95% CI = 1.07-4.82; P = 0.034) and low socioeconomic status (OR = 0.32; 95% CI = 0.12- 0.87; P = 0.025) were the main predictors of anemia among the studied children (Table 3).

**Table 3: Multivariate analysis of potential risk factors of anemia among the studied sample.**

| Variables | Anemia | | |
|---|---|---|---|
| | **OR** | **95% CI** | **P value** |
| **Age** | | | |
| < 8 | 1- | | |
| 8 - | 1.27 | 0.67-2.40 | 0.467 |
| 10+ | 8.79 | 2.01-38.35 | 0.004 |
| **Socio economic status** | | | |
| Moderate & high | 1 | | |
| Low | 0.32 | 0.12-0.87 | 0.025 |
| **Parasitic infection** | | | |
| No | 1 | | |
| Yes | 2.26 | 1.07-4.82 | 0.034 |

**Risk factors for stunting**

The association of stunting (as one of the major anthropometric indices) with socioeconomic and health factors among the studied children was examined and the result showed that presence of parasitic infection (P=0.024) was significantly associated with stunting (Table 4). A marginally significant association was found between stunting and age where children ≥10 years were more likely to be stunted compared to those less than 8 years (OR = 5.04; 95% CI =0.95-26.69; P = 0.057). Multivariate logistic regression analysis confirmed that presence of parasitic infection (OR = 4.85; 95% CI = 1.23- 19.12; P = 0.024) is the only predictor of stunting among these children (Table 4).

**Table 4. Univariate analysis of potential risk factors of stunting among the studied sample.**

| Variables | Stunting | | | | P value |
|---|---|---|---|---|---|
| | Total No. | Prevalence | OR | 95% CI | |
| **Age** | | | | | |
| < 8 | 131 | 1.5 | 1- | | |
| 8 - | 130 | 2.3 | 1.52 | 0.25-9.27 | 0.648 |
| 10+ | 69 | 7.2 | 5.04 | 0.95-26.69 | 0.057 |
| **Gender** | | | | | |
| Female | 179 | 3.4 | 1 | | |
| Male | 151 | 2.6 | 0.79 | 0.22-2.83 | 0.711 |
| **Socio economic status** | | | | | |
| Moderate & high | 70 | 1.4 | 1 | | |
| Low | 260 | 3.5 | 2.47 | 0.31-19.87 | 0.394 |
| **Parasitic Infection** | | | | | |
| No | 219 | 1.4 | 1 | | |
| Yes | 111 | 6.3 | 4.85 | 1.23-19.12 | **0.024** |
| **Anemia** | | | | | |
| No | 51 | 2.0 | 1 | | |
| Yes | 279 | 3.2 | 1.67 | 0.21-13.45 | 0.632 |

**Risk Factors for parasitic infection:**

Finally, after examining the association of parasitic infection with the possible risk factors, it was found that age 8-10 years and age≥10 years (P = 0.001 and 0.004 respectively), presence of anemia (P= 0.024) and chronic malnutrition or stunting (P= 0.024) were significantly associated with anemia. (Table 5) Multivariate analysis using logistic regression confirmed that age 8 -10 years (OR = 1.94; 95% CI = 1.13- 3.34; P = 0.02), age ≥10 years (OR = 1.99; 95% CI = 1.05- 3.79; P = 0.035), anemia (OR= 2.1; 95% CI = 0.99- 4.44; P = 0.054) and stunting (OR = 4.33; 95% CI = 1.05- 17.83; P = 0.042) were the main predictors of parasitic infection among these children. (Table 6)

**Table 5: Univariate analysis of potential risk factors of parasitic infection among the studied sample.**

| Variables | Parasitic Infection | | | | P value |
|---|---|---|---|---|---|
| | Total No | Prevalence | OR | 95% CI | |
| **Age** | | | | | |
| < 8 | 131 | 23.7 | | | |
| 8 - | 130 | 38.5 | 2.02 | 1.18-3.45 | **0.010** |
| 10+ | 69 | 43.5 | 2.48 | 1.33-4.63 | **0.004** |
| **Sex** | | | | | |
| Female | 179 | 30.2 | | | |
| Male | 151 | 37.7 | 1.40 | 0.89-2.22 | 0.147 |
| **Socio economic status** | | | | | |
| Moderate & high | 70 | 31.4 | | | |
| Low | 260 | 34.2 | 1.13 | 0.64-1.99 | 0.674 |
| **Anemia** | | | | | |
| No | 51 | 19.6 | | | |
| Yes | 279 | 36.2 | 2.33 | 1.12-4.84 | 0.024 |
| **Wasting** | | | | | |
| No | 263 | 33.1 | | | |
| Yes | 10 | 10 | 0.23 | 0.03-1.80 | 0.180 |
| **Underweight** | | | | | |
| No | 316 | 33.2 | | | |
| Yes | 14 | 42.9 | 1.51 | 0.51-4.43 | 0.458 |
| **Stunting** | | | | | |
| No | 32 | 32.5 | | | |
| Yes | 10 | 70 | 4.85 | 1.23-19.12 | **0.024** |

**Table 6: Multivariate analysis of the potential risk factors of parasitic infection among the studied sample.**

| Variables | Parasitic Infection | | P value |
|---|---|---|---|
| | OR | 95% CI | |
| **Age** | | | |
| < 8 | 1- | | |
| 8 - | 1.94 | 1.13-3.34 | 0.02* |
| 10+ | 1.99 | 1.05-3.79 | 0.035* |
| **Anemia** | | | |
| No | | | |
| Yes | 2.1 | 0.99-4.44 | 0.054 |
| **Stunting** | | | |
| No | | | |
| Yes | 4.33 | 1.05-17.83 | 0.042* |

***P<0.05**

## DISCUSSION

Stunting is defined as height-for-age deviations from the international growth reference standard (National Center for Health Statistics/ World Health Organization).[19] This indicator reflects long term cumulative effects of inadequate food intake and poor health conditions as a result of lack of hygiene and recurrent illness in poor and unhealthy environments. In Egypt, the overall prevalence of stunting among primary school children aged 6-12 years is 11.6 %.[5] This result disagrees with that found in the present study, as a lower percent of stunting was recorded (3%). This finding could be attributed to the setting of the study where Alexandria was not included in that national survey. Meanwhile, the present findings were consistent with the results of a previous study conducted among school children.[20]

It was estimated that up to half of schoolaged children in developing countries are anemic.[21] The findings of the present study indicated that 84.5% of all examined subjects were anemic. This is in agreement with the results obtained in a previous study among primary school children in Egypt.[22] A similar prevalence was reported elsewhere.[23] The high prevalence reported in this study could be related to high rate of parasitic infection and poverty among the study population which contribute to poor access to good diet, and proper healthcare. These results are inconsistent with the findings of Barduagni et al.[24], who reported that among school children from 6-11 years of age living in Upper Egypt, the prevalence of anemia is low and its severity is moderate. This may be due to low prevalence and moderate intensity of intestinal helminthic infections in this region that have been reported in a former study.[25]

Parasites may affect the intake of food; its subsequent digestion and absorption, metabolism and the maintenance of nutrient pools.[26] In the present study, parasitic infections influenced children's anemic status, and there was a significantly higher percent of anemic school children among the infected group. In addition there was a significant difference between the mean hemoglobin level and that of non-infection group ($p < 0.05$). The mean values of all anthropometric measurements were lower in helminth-infected children. These findings were in accordance with that reported by CasapÃa et al.[27]

The present study showed that age >10 years was a significant risk factor for anemia among these school children. This is inconsistent with the findings demonstrated by Calis et al[28] who reported that the pre-school and early school age children had a higher risk of anemia than children over10 years. It is also inconsistent with the findings of a previous study which demonstrated that the prevalence of anemia decreased significantly with age.[29] This may be due to higher prevalence of parasitic infections among older age presented in present study. This finding indicates that there is a need for evaluation of the current routine iron supplementation program and deworming programs by the Ministry of Health in primary health care centers and in non-governmental organizations (NGOs) for school children.

The presence of parasitic infections especially Ascaris infection was also found to be significantly associated with anemia among these subjects. The association between anemia and intestinal parasites has been previously reported.[22,30] However, in a previous study,[29] no association was found between anemia and parasitic infections, probably due to the very low prevalence of parasitic infections. Although ascariasis is known to influence the nutritional status, its impact on anemia is less clear.[31] The worms may ingest proteins and vitamins from their hosts.[32] The strong association between anemia and Ascariasis observed among these children unexpectedly appeared with light intensity of infections and this may be due to presence of other contributory factors such as poverty and poor dietary intake. As a limitation, the present study did not measure the daily iron intake. However, a previous study had shown that the daily iron intake by Egyptian primary school children was only 22% among male children and 13% of females got more than 75% iron RDA.[33].

The evidence showed clearly that most of the studied school children living in poor socio-economic conditions experienced poor health due to undernutrition and intestinal parasitic infections. However, higher socioeconomic status was found to be significantly associated only with anemia among examined subjects (may be due to poor dietary choices, eating less nutrient dense foods but energy dense foods).

One of the largest studies of rural school children in low income countries (Ghana, Tanzania, Indonesia, Vietnam and India) found that the overall prevalence of stunting in all five countries, ranged between 48% and 56%. In all countries, there was a trend for height-for-age to decrease with age, thus as children got older they became shorter and boys in most countries tended to be more stunted than girls.[34]

The present investigation revealed that children below the ages of 10 years were less stunted compared to those ≥10 years, but this did not reach statistical significance (borderline $p= 0.057$). This is in agreement with previous similar studies.[27,35] It has been established that stunted children continue to deviate from normal growth with increasing age. Hence, the risk of becoming stunted continues as children get older. Our study also demonstrated parasitic infection is the only significant predictor of stunting among the children. This is consistent with the findings from previous studies in Egypt,[22] Peru,[27] China,[36] and Tanzania[37].

Parasitic infections are associated with decreased appetite and low food intake, which result in decreased growth rate. Moreover, micronutrient losses and nutrient malabsorption due to ascariasis and blood-loss due to Trichuriasis can lead to iron deficiency anemia and poor growth rate.[38] Our results were in accordance with some studies done in many countries which proved that parasitic infections were associated with stunting in school age children.[39,40] On the other hand, Kandeel in1998[41] did not find any effect of parasitic infections on children' growth, but he attributed this to the recent, light intensity of infection or infection for a short period. Whoever, this finding is inconsistent with Tadesse G study in 2005[42] where the overall prevalence rate of intestinal helminthic infections was not different among children with or without stunting and this may be attributed to the low prevalence of parasitic infection among those children.

On the other hand, due to the cross sectional design of the study, ones cannot be certain whether the infection itself increased the risk for stunting or whether the state of chronic malnutrition increased the susceptibility for acquiring the parasite. The relationship between malnutrition and infection has been found to be synergistic.[43] The combined effects observed when both malnutrition and infection are present at the same time are far more serious than the additive effects resulting when they occur separately. In other words, infections worsen cases of malnutrition and malnutrition worsen the severity of infectious diseases.[44]

As regards the overall percent of intestinal parasitic infections observed in the present work, it was found that 33.6% of the studied school children had infection. This was similar to findings of El-Masry et al who reported a prevalence of 38.5%.[45] However, the present result was less than that reported in Upper Egypt by El-Gammal et al.[46] who reported that the prevalence of parasitic infections among Egyptian school children in Demo villages was 88.5%. Rim et al[47] collected 29,846 stool specimens from primary school children in Laos and the cumulative egg positive rate for intestinal helminthes was 61.9%. These findings were also relatively lower than those previously reported among different regions in Egypt (66%).[22] The high prevalence could be due to the place and living standard of study subjects or due to a reflection of the local endemicity and geographic condition of the study area.

The present work revealed that stunting and presence of anemia were significant risk factors of parasitic infection among those children. This is consistent with the findings of Sorensen et al.[48] Usuanlele et al[20] found no significant associations between anemia and infection categories or status and none was found too with the growth indices, probably because of the few cases of anemia. With respect to personal characteristics and risk factors, we noticed that age groups 8-10 and >10 years were risk factors. This agreed with the findings of El-Masry et al in Sohag in 2007 [45] yet contradicting the study of of Yassin et al in Gaza city in 1999[49] who noted that G. lamblia as the most frequent (62.2%) parasitic infection followed by Ascaris lumbricoides (20.1%) and E. histolytica (13.3%) among young children . This could be attributed to examination of the stool specimens by different tests (direct smear microscopy, zinc sulphate flotation, formol ether sedimentation scotch tape and Kato Katz techniques) which enabled detection of all parasitic infections unlike our study that used only Kato Katz technique that hardly detect the protozoal infections

**Conclusions and Recommendations**

The main conclusion that emerged from the present study was that intestinal parasitic infections and malnutrition exist in primary schoolchildren residing in Alexandria and constitute a major health problem that needs to be addressed immediately to reduce morbidity and mortality. Parasitic infection is significantly associated with anemia and malnutrition, and the severity of subtle morbidity is significantly related to the worm type. In addition, parasitic infection remained significant after statistically controlling confounding variables such as age, sex and socioeconomic standard. So, it is recommended that school health programs should be improved including deworming, feeding and micronutrient iron supplements. In addition, it is important to investigate the impact of parasitic infections on the nutritional status of primary school children in Egypt as well as the possible benefit of deworming on the affected individuals.

## REFERENCES


1. PCD (The Partnership of Child Development): What's new in health and nutrition of the school age child and in school health and nutrition programmes? Part Child Dev. 2000; 1–46.
2. Food and Agriculture Organization of the United Nations. Undernourishment around the world. In: The state of food insecurity in the world 2004. Rome: The Organization; 2004.
3. Stoltzfus RJ, Chway HM, Montresor A, Tielsch JM, Jape JK, Albonico M, et al. Low dose daily iron supplementation improves iron status and appetite but not anemia, whereas quarterly antihelminthic treatment improves growth, appetite and anemia in Zanzibari preschool children. J Nutr. 2004; 134: 348-56.
4. De Onis M, Frongillo EA, Blössner M. Is malnutrition declining? An analysis of changes in levels of child malnutrition since 1980. Bull World Health Organ. 2000; 78(10):1222-33.
5. Tawfik A. A. Prevalence of nutritional stunting in Egypt. Sci Med J ESCME. 2004; 16 (4): 1-78.
6. World Health Organization. Iron deficiency anaemia assessment, prevention and control. Geneva: W HO. 2001.
7. Gordon N: Iron deficiency and the intellect. Brain Dev. 2003; 25:3-8.
8. Crompton DWT, Nesheim MC. Nutritional impacts of Intestinal helminthiasis during the human life cycle. Ann Rev Nutr. 2002; 22:35-59.
9. Thein-Hlaing, Thane-Toe, Than-Saw, Myat-Lay-Kyin, Myint- Lwin. A controlled chemotherapeutic intervention trial on the relationship between Ascaris lumbricoides infection and malnutrition in children. Trans R Soc Trop Med Hyg. 1991; 85: 523-8.
10. Quihui-Cota L, Valencia ME, Crompton DWT, Phillips S, Hagan P, Diaz-Camacho SP, et al. Prevalence and intensity of intestinal parasitic infections in relation to nutritional status in Mexican school children. Trans R Soc Trop Med Hyg. 2004; 98: 653–9.
11. Moussa WA. Nutritional status in Egypt. Final report of the Health Examination Survey. Cairo: Ministry of Health. 1990 (Publication 38/1).
12. Gibson RS. Principle of nutrition assessment. Second edition. Oxford: Oxford University Press; 2005.
13. Katz N, Chaves A, Pellegrino D. A simple device for quantitative stool thick-smear technique in Schistosomiasis mansoni . Rev Int Med Trop Sao Paulo. 1972; 14 397-400.
14. Interventional Nutritional Anemia
15. Kuczmarski RJ, Ogden CL, Guo SS. 2000 CDC growth charts for the United States: Methods and Development. National Center for Health Statistics. Vital Health Statistics. 2002; 11 (246).

16. Stoltzfus RJ, Dreyfuss ML. Guidelines for the use of iron supplements to prevent and treat iron deficiency anemia. Washington DC, International Nutritional Anaemia Consultative Group/WHO/ UNICEF, 1998.
17. World Health Organization. Prevention and control of schistosomiasis and soil transmitted helminthiasis. Report of a WHO Expert Committee. Geneva: WHO. 2002; Tech Rep Ser No. 912.
18. Fahmy SI, El-Sherbini AF. Determining simple parameters for social classifications for health research. Bulletin of High Institute of Public Health. 1983; 13(5): 95-107.
19. De Onis M, Adelheid W, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. Bull WHO. 2007; 85: 660-7.
20. Usuanlele M, Sanchez A. Soil-transmitted helminth infections, nutrition and growth in school age children from rural communities in Honduras. Faculty of Applied Health Sciences Brock University St. Catharines, Ontario 2012.
21. De Macyer EM, Dallman P, Gurney JM. Preventing and controlling iron deficiency anemia through primary health care. Geneva: WHO. 1989.
22. Mustafa N. The association of soil transmitted helminthes and Schistosomiasis with subtle morbidity among primary school children in Kafer El-Sheikh governorate. Thesis, DPH. Alexandria, Egypt: Alexandria University, High Institute of Public Health; 2007.
23. Luo R, Wang X, Zhang L, Liu C, Shi Y, Miller G, et al. High anemia prevalence in Western China. Southeast Asian J Trop Med Pub Health. 2011; 42(5): 1204–13.
24. Barduagni A,S, Ahmed F, Curtale M, Raafat , Mansour E. Anaemia among schoolchildren in Qena Governorate, Upper Egypt. La Revue de Santé de la Méditerranée orientale. 2004; 10 (6).
25. Curtale F. Knowledge, perception and behavior of mothers toward intestinal helminthes in Upper Egypt: implications for control. Health policy and planning. 1998; 13(4): 423–42.
26. Stephenson LS, Latham MC, Ottesen EA. Malnutrition and parasitic helminth infections. Parasitology. 2000; 121: S23-38.
27. Casapia M, Joseph SA, Nunez C, Rahme E, Gyorkos TW. Parasite risk factors for stunting in grade 5 students in a community of extreme poverty in Peru. Int J Parasitol. 2006; 36: 741–7.
28. Calis JC, Phiri KJ, Farragher EB. Severe anemia in Malawian children. New Eng J Med. 2008; 358(9):888–99.
29. Al -Zain B. Impact of Socioeconomic conditions and parasitic infection on hemoglobin level among children in Um-Unnasser Village, Gaza Strip. Turk J Med Sci. 2009; 39 (1): 53-8.
30. Osazuwa F, Ayo OM, Imade P. A significant association between intestinal helminth infection and anemia burden in children in rural communities of Edo state, Nigeria. North Am J Med Sc. 2011; 3(1): 30-4.
31. De Silva BR, Brooker S, Hotez PJ, Montressor A, Engels D, Savioli L. Soil-transmitted helminth infections: Updating the global picture. Trends Parasitol. 2003; 27: 547–51.
32. Hotez PJ, De Silva N, Brooker S, Bethony J. Soil transmitted helminth infections: the nature, causes and burden of the condition (Bethesda, Maryland, Disease Control Priorities Project: Fogarty International Centre, National Institutes of Health; 2003.
33. Hassan HA. Nutritional deficiencies among primary school children in Egypt. Nutrition Institute/ WHO; 1998.
34. Standing Committee on Nutrition (SCN). School age Children: their health and

nutrition. Prepared for the SCN Working Group on Nutrition of School- Age Children. Lesley Drake, Celia Maier, Matthew Jukes and Anthi Patrikios, Partnership for Child Development. Don Bundy, World Bank. Alison Gardner and Carmel Dolan, Nutrition Works. Number 25, December 2002; ISSN 156- 3743.
35. Mostafa KS. Socio-economic determinants of severe and moderate stunting among under-five children in rural Bangladesh. Malay J Nutr. 2011; 17(1): 105-18.
36. Shang YU, Tang LH, Zhou SS, Chen YD, Lin SX. Stunting and soil transmitted helminth infections among school age pupils in rural areas of southern China. Parasit Vectors. 2010; 3: 97.
37. Stoltzfus RJ, Albonico M, Tielsch JM, Chwaya HM, Savioli L. Linear growth retardation in Zanzibari school children. J Nutr. 1997; 127:1099-105.
38. Stephenson LS, Holland CV, Cooper ES. The public health significance of Trichuris trichiura. Parasitol. 2000; 121: S73–S95.
39. Beltrame A, Scolari C, Torti C, Urbani C. Soil transmitted helminth (STH) infections in an indigenous community in Ortigueira, Parana, Brazil and relationship with its nutritional status. Parasitologia. 2002; 44:137-9.
40. Sackey ME, Weigel MW, Armijos RX. Predictors and nutritional consequences of intestinal parasitic infections in rural Ecuadorian children. J Trop Pediatr. 2003; 49: 17-23.
41. Kandeel A. Assessment of growth pattern of Egyptian rural school children at Shebin Al-Kanater, Qalubia, Egypt. M.Sc Thesis in Public Health, Faculty of Medicine, Ain-Shams University; 1998.
42. Tadesse G. The prevalence of intestinal helminthic infections and associated risk factors among school children in Babile town, eastern Ethiopia. Ethiop J Health Dev. 2005; 19 (2):140-7.
43. Schaible UE, Kaufmann SH. Malnutrition and infection: complex mechanisms and global impacts. PLoS Med. 2007; e115.
44. Macalla D. Infection and malnutrition. Medicine. 2009; 37: 525-8.
45. El-Masry H, Ahmed Y, Hassan A, Zaky S, Abd-Allah E, El-Moselhy E, et al. Prevalence, risk factors and impacts of schistosomal and intestinal parasitic infections among rural School Children in Sohag Governorate. The Egyptian Journal of Hospital Medicine. 2007; 29: 616–30.
46. El-Gammal N, Sayed El-Ahl S, Osman FH, Salem HS. Comparative study of parasitic infections among school children in two rural areas in upper Egypt (Demo village) and lower Egypt (Malames village). Egypt J Comm Med. 1995; 3 (1): 25-30.
47. Rim HJ, Chai JY, Min DY, Cho SY, Eom KS, Hong SJ, et al. Prevalence of intestinal parasite infections on a national scale among primary school children in Laos. Parasitol Res. 2003; 91(4): 267-72.
48. Sorensen WC, Cappello M, Bell D, Difedele LM, Brown MA. Polyhelminth Infection in East Guatemalan School Children. J Glob Infect Dis. 2011; 3: 25-31.
49. Yassin MM, Shubair ME, Al-Hindy AI, Jadallah S. Prevalence of intestinal parasites among school children in Gaza city. J Egypt Soc Parasitol. 1999; 29 (2): 365-73.