PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

Pakistan Journal of Nutrition 9 (11): 1094-1099, 2010
ISSN 1680-5194
© Asian Network for Scientific Information, 2010

Relationship Between Malnutrition and Parasitic Infection among School Children in the Adamawa Region of Cameroon

C.M.G. Garba and C.M.F. Mbofung
National School of Agro-industrial Sciences (ENSAI), University of Ngaoundere,
P.O. Box 455, Ngaoundere, Cameroon

Abstract: Malnutrition and parasitic infections are common public health problems of children in developing countries. The prevalence of malnutrition and parasitic infections in school children in the Adamawa region of Cameroon was carried out. Anthropometric measurements consisting of height and weight were measured according to WHO guide lines (WHO, 1983, 1987). Body Mass Index (BMI) which is weight/height^2 for age was used as indicator to determine nutritional status. Examination of stool specimens was done using direct smear examination and concentration techniques and malaria parasitemia was determined microscopically from Giemsa stained blood films. The nutritional status and parasitosis was studied in 1200 (715 boys and 485 girls) school children aged 6 to 17 years. For malnutrition, severe acute malnutrition prevalence and moderate acute malnutrition was recorded respectively as 15.5% and 35.9%. 14.2% of which 64.3% were boys while 35.6% girls were found positive for various parasitic infections with malaria parasite accounting for the highest (64.9%) and hookworm the lowest (18.7%) prevalence rates. The difference in the level of parasitism was found to be statistically significant ($p<0.05$, chi square = 15.5) in the region. Severe and mild malnutrition was more prevalence in girls (12.9% and 46.7% respectively) than in boys (11% and 44.9% respectively). The relationship between the parasitic infection prevalence and nutritional status of the children showed that 98 (57.2%) of the infected children were malnourished ($p<0.05$) and there was no significant difference ($p>0.05$) of malnutrition between infected and non-infected children. The relationship between malnutrition and parasitic infection revealed that the correlation coefficient was 0.85, indicating a moderately strong relationship between the variables. The study confirmed that malnutrition and parasitosis were important child health problems. Therefore, it is recommended that lunch meals, nutrition education, sanitation education, treatment of parasitic infections be added to the school curriculum of school children in the Adamawa region of Cameroon.

Key words: Malnutrition, parasitic infections, school children, Adamawa region

INTRODUCTION

Malnutrition and parasitic infections are common public health problems of children in developing countries. An estimated global infection rate for some parasites has primarily been attributed to the appalling unhygienic and environmental conditions; poverty and over-dispersion of parasites and disease are immediate causes of malnutrition and deaths of young children. They reinforce each other synergistically (UNICEF, 1998). As children are most at risk at an age when they are both growing and learning, parasitic infections potentially threatens a child's overall physical and psychological development and may cause or aggravate malnutrition (Stephension *et al*., 2000).

Globally it is estimated that among preschool-age children in developing countries 183 million are underweight, 226 million are stunted and 67 million wasted (Mitra and Tiwari, 1997). Over 1 billion people mostly in the tropics and sub-tropics are infested with parasites mostly soil transmitted helminths, malaria parasites and about 200 millions are infected with schistosomes (Latham, 1997). Each year, an estimated 300-500 million malaria infections occur with 1.2 million deaths worldwide, 85% of these deaths occur in sub-Saharan Africa. Although malaria was successfully eliminated in many countries with temperate climates during the 1950s, It remains a major killer in Africa (WHO, 1996).

In developing countries where overall rates of infections are high, recent studies have shown that for some parasites, egg counts are likely to be higher among subjects carrying mixed infections than in subjects carrying single species infections (Booth, 1998; Needham, 1998).

Malnutrition is widespread in Cameroon, like in many other developing countries and every year in the developing world, close to 12 million children die of inevitable causes and more than 6 million (55%) of these deaths could be directly or indirectly linked with malnutrition (Louis, 1993).

Corresponding Author: C.M.G. Garba, National School of Agro-industrial Sciences (ENSAI), University of Ngaoundere, P.O. Box 455, Ngaoundere, Cameroon

Intestinal parasites are among the major diseases of public health problems in sub-Saharan Africa. Apart from causing mortality and morbidity, infection with intestinal parasites has been associated with stunting of linear growth, physical weakness and low educational achievement in schoolchildren (Nokes and Bundy, 1993).

In Cameroon, schistosomiasis and soil transmitted helminth infections are important parasitic diseases. Recent estimates indicate that more than 1.7 million people (of a total of 14 millions inhabitants) in the country are infected with either Schistosomes, 5.6 million with *Ascaris lumbricoides*, 6.5 million with *Trichuris trichiura* and 2.6 million with hookworm (Brooker, 2000). However, infections are unevenly distributed within the country. The highest transmission levels of schistosomiasis occur in the northern regions (Tchuente *et al*., 2003).

Malaria and other parasitic infections are known to be the most important causes of morbidity and mortality of pre-school children in the Adamawa province of Cameroon and the whole national territory (Carte De Sante, 1999).

However, there is no information on the prevalence of parasitic infections and nutritional status of school children in Adamawa region of Cameroon. Thus, the present study was undertaken to: 1). Assess the nutritional status of school children using anthropometric indices of height and weight with age by comparing the values obtained from the study with W.H.O recommended standards (functional indicators for malnutrition), 2). Assess the extent of parasitic infection among school children in the Adamawa region and 3) Produce data that can provide reliable information that can enable nutrition and health planners to design a good programme that can improve the health and nutrition status of Cameroonian school children.

MATERIALS AND METHODS

Study site

Sample selection: The sampling strategy used was the four-stage stratified cluster sampling method. The Adamawa region has been divided into five administrative divisions and sub-divisions. The divisions are namely, Mayo Banyo, Faro et Deo, Mbere, Djerem et Vina. The list of all schools in each administrative division and sub-division constituted the sampling frame in the first stage of sampling. Four schools were selected from the list of schools in the sub-divisions of each division using the simple random sampling method to include schools in urban, semi urban and rural areas. In all, 20 randomly selected primary schools and 1200 pupils both boys and girls ages ranging from 6-17 years were randomly selected from each class using random number table.

Study design: After explaining the objectives of the study, to the delegate of Basic Education, delegate of public health, traditional authorities and authorization obtained, parents and teachers and full informed consent obtained, a preliminary visit was made to the 20 randomly selected public primary schools.

There was questionnaire administration and collection of stool and urine samples and thick blood films slides which were transported to local field laboratories (divisional hospital laboratories) for parasitological examination (eggs of *Ascaris lumbricoides*, *Trichuris trichiura*, Hookworms, Schistosomes and cysts of; *Entamoeba histolytica*, *Giardia lamblia* (intestinalis) and malaria parasites). The questionnaire was designed to obtain information on civil status, anthropometric measurements (height and weight), quality drinkable water in schools, sanitation, socio-economic situation of the parents and religious affiliations.

Anthropometric data: Anthropometric measurements such as height and weight were made by a trained investigator following the internationally accepted standard techniques (WHO, 1995). Height and weight measurements were recorded to the nearest 0.1 kg cm and 0.5 kg respectively. The BMI was computed following the standard formula:

$$BMI = \text{Weight (kg)}/\text{Height}^2\ (m^2)$$

BMI for age was used to evaluate the nutritional status of the subjects.

The BMI for age is the most appropriate variable for determining nutritional status for children above 5 years and adolescence (Cole *et al*., 2007).

Collection of stool and urine samples for laboratory examination: Stool samples and urine samples were collected in labeled sterile, screw capped plastic containers and transported to the nearby hospital laboratory for analysis.

From each of the stool specimen, a direct saline smear preparation was made and examined by light microscope for identification of nematode ova and for differential diagnosis of protozoan cyst, lugol's solution was added. Samples that did not reveal any intestinal parasites on direct saline smear, a further search was conducted by formol-ether concentration method. Cellophane tape feacal smear (Kato Katz technique) was used to search for Schistosoma mansoni eggs.

For the search of schistosoma haematobium in urine, visual observation was done by carefully examining the bottled urine specimen for macrohaematuria before carrying out the filtration technique.

Search for malaria parasites: Thick blood films were made from finger pricks of the subjects, stained with Giemsa stain and examined microscopically under the 100x objective. Malaria parasites were counted against 200 leucocytes in thick films to obtain the parasite density.

Statistical analyses: The data obtained was analyzed using the XLSTAT package to bring out possible relationships, dependencies, correspondences (correlations) among the variables in correspondence and multi correspondence analysis. In addition to descriptive statistics, chi-square test were performed to test the significance of the differences among children who are malnourished with or without parasitic infections and ANOVA for both simple and multiple variances. Results were graphically designed using Sigma plot 9.0 package.

RESULTS

1200 primary school children of ages 6-17 years were used in the study with 59.6% (715) made of boys and 40.5% (485) girls. Most of the children, 34.28% (409) were between the ages of 10-12 years while the least, 2.01% (24) were between the ages of 16-17 years. 56.24% (671) were Moslems and 43.75% (522) were Christians. As concerns the socio-economic situations of the parents of the children, 65.46% (781) were farmers, 31.51% (376) were functionaries and 2%(32) were businessmen. The socio-demographic characteristics of the study population is shown in Table 1.

In the region, children between the age range 6-13 that were mostly moderately malnourished. Severe malnutrition prevalence in the school children was 20.8% while moderate malnutrition was 97.1%. Severe malnutrition was higher in girls (23.8%) than in boys (22.3%), while moderate malnutrition was higher in boys (93.1%) than in girls (86.7%). There was no significant difference between sexes of the school children and malnutrition because malnutrition was recorded in both boys and girls ($p>0.05$, $x^2 = 4.0$).

As concerns parasitic infection, a total of 171 (14.2%) of the school children were infected, of which 64.3% (110) were boys while 35.6% (61) were girls. The most infected divisions were Faro et Deo (48.3%) and Djerem (40%) while the least infected was Mbere (<1%) as shown in Table 2. The difference in the level of parasitism was found to be statistically significant in the four infected divisions of the region ($p<0.05$, chi square = 15.5). Malaria parasite infection recorded the highest prevalence rate (64.9%) followed by *Entamoeba histolytica* (61.9%) and *Schistosoma mansoni* (43.8%). The least prevalence rate was recorded for Hookworm (18.7%) as shown in Table 3. Single and multiple type parasitic infections were recorded. The highest single and multiple parasitism was observed in 10-12 age group (15.2%) and (28.6%) respectively and the least in the age group 16-17 (2.9%) as seen in Table 4. Parasitism was significantly different in the different age groups ($p<0.05$; chi square = 12.5). Table 6 shows that, more girls had multiple type parasitic infection (74.1%) than boys while more boys had single type parasitic

Table 1: Socio-demographic characteristics of the study population (n = 1200)

Variable	Category	(% of sample)
Age	5-9	30.17
	10-12	34.28
	13-15	33.52
	16-17	2.01
Sex	1=male	59.6
	2=female	40.5
Profession of parents	1=famers	65.46
	2=government workers	31.51
	3=businessmen	2.00
Religion	1=christians	43.75
	2=muslems	56.24

Table 2: Percentage parasitic/malnutrition prevalences by division

Division	% parasitic prevalence	% Acute malnutrition prevalence
Faro et Deo	48.3	10.00
Djerem	40.0	8.57
Mbere	38.5	54.55
Vina	35.0	4.76
Mayo Banyo	<1%	6.38

Table 3: Percentage of parasitism among infected school children in the Adamawa region

Parasite	Number positive (%)
Schistosoma mansoni	75 (43.8)
Hookworm	32 (18.7)
Entamoeba histolytica	106 (61.9)
Malaria parasite	111 (64.9)

Table 4: Effect of age on the prevalence of parasitic infections in school children in the Adamawa region

Age group (years)	Prevalence P1(%)	Prevalence P2 (%)
5-9 years	11.6 (20)	14.0 (24)
10-12	15.2 (26)	28.6 (49)
13-15	7.6 (13)	21.0 (36)
16-17	0.0 (0)	2.9 (5)

P1 = single type parasitic infections; P2 = Multiple type parasitic infections; p = 0.016; chi square = 12.5

Table 5: Effect of age on the prevalence of malnutrition and parasitic infection in school children

Age range	(n) % BMI-1* P1	(n) % BMI-1* P2
6-9	6 (3.5)	30 (17.5)
10-12	33 (19.2)	75 (43.8)
13-15	2 (1.1)	15 (8.7)
16-18	1 (0.5)	00

BMI-1* = acute malnutrition, P1 = single type parasitic infection, P2 = Multiple type parasitic infection

Table 6: Pattern of Parasitic infection in male and female school children

Sex	% P1	% P2
Boys	30.2 (34)	69.7 (76)
Girls	25.8 (15)	74.1 (46)

P1 = Single type parasitic infection; P2 = Multiple type parasitic infection. p = 0.530; chi sq = 3.8

Table 7: Prevalence of parasites by age groups

Age	% Prevalence *Schistosoma mansoni* (n)	% Prevalence Hookworm (n)	% Prevalence *Entamoeba histolytica* (n)	% Prevalence malaria parasite (n)
6-9	12.2 (21)	9.9 (17)	14.0 (24)	10.5 (18)
10-12	21.6 (37)	12.8 (22)	18.1 (31)	21.6 (37)
13-15	11.6 (20)	12.8 (22)	14.6 (25)	19.8 (34)
16-17	2.9 (5)	2.3 (4)	1.7 (3)	2.3 (4)

infection (30.2%) than girls but the difference was found to be non significant (p>0.05; chi square = 3.8). Malaria parasite and *Shistosoma mansoni* were most prevalent parasitic infections (21.6%) in the age group 10-12 years. In the age group of 13-15 years, malaria parasite was most prevalent 19.8%) and the least parasitic prevalence was recorded in the age group 16-17 years (1.7%) as shown in Table 7. Acute malnutrition was recorded to be most prevalent (43.8%) in children of the age group of 10-12 years having multiple type parasitic infection as shown in Table 5.

The R-Squared (73,6309%) statistics indicates that the model as fitted explains of the variability in BMImal. The correlation coefficient equals 0,858084, indicating a moderately strong relationship between the variables.

Associating malnutrition and parasitic infection at the regional level, infected children of ages 8 and 9 recorded severe malnutrition while moderate malnutrition was recorded in infected girls and non- infected boys of ages 7, infected boys and girls of age group 10-14 and infected boys of ages 15. Moreover the mean Body Mass Index (BMI) for those infected was 17.8 kg/m^2±1,1 with a range of 8.3-22.4, While those non-infected had a mean of 18.3 kg/m^2±2.4 with a range of 10.3-24.4. Severe malnutrition (BMI < 15.3) and moderate malnutrition (BMI = 15.3-18) were recorded to be highest 9.8% and 27.4% in the age group 13-15 and 9.3% and 27.9% respectively in the age group 5-9 as shown in Table 8. However the difference in the presence of malnutrition in the different age groups was found to be non significant (p>0.05, chi square = 16.9) because it was recorded in all age groups. Table 9 shows malnutrition distribution in infected and non-infected children. The prevalence of severe malnutrition at the regional level was higher (11.1%) in infected children than in non-infected children (9.7%) while moderate malnutrition was higher (46.1%) in infected children than non-infected children (43.8%). With infected girls, severe malnutrition was higher (12.9%) than infected boys (11%) and moderate malnutrition also higher (46.7%) in infected girls than in infected boys (44.9%). With non- infected children, severe malnutrition was recorded as higher (10.9%) in girls than in boys (9.2%) while moderate malnutrition was found to be higher (46.2%) in boys than in girls. Table 10 shows the pattern of infection and malnutrition between male and female children. Infection prevalence was higher (64.3%) in boys than in girls while severe malnutrition and moderate malnutrition were more prevalent (11% and 46.7%) respectively in girls.

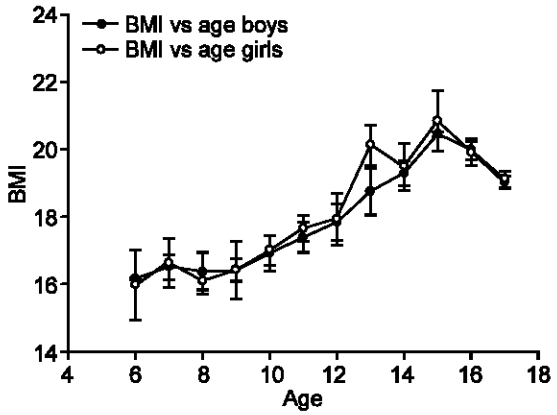

Fig. 1: Regional BMI by age of boys and girls

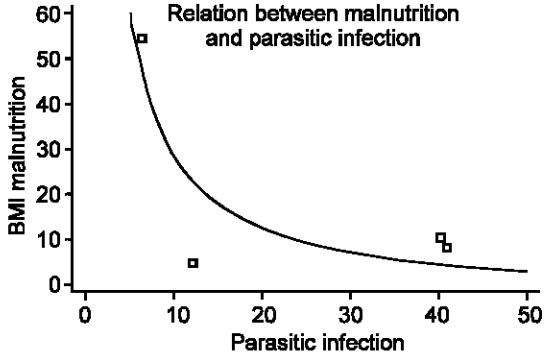

Fig. 2: Relation between malnutrition and parasitic infection

Table 8: The effect of age on the Body mass index of infected children

Age	% BMI-1*	% BMI-1	% BMI-2
5-9	9.3	27.9	62.7
10-12	7.2	26.0	66.6
13-15	9.8	27.4	62.7
16-18	2.5	12.5	62.5

P = 0.905, chi sq = 16.9; BMI -1* (<15.3) = severe malnutrition; BMI-1 (15.3-18) = moderate malnutrition;
BMI-2 (≥18.5) = Normal

DISCUSSION

Undernutrition among children and adolescents is a serious public health problem internationally, especially in developing countries (Pelletier *et al*., 2003; El-Ghannam, 2003; Staton and Harding, 2004). A recent study (Cole *et al*., 2007) has stated that undernutrition is better assessed as thinness (low body mass index for

Table 9: Malnutrition distribution between infected and non-infected children regional malnutrition distribution for boys and girls

Body mass index	No. of infected boys and %	No. of non infected boys and %	No. of infected girls and %	No. of non infected girls and %
Severe malnutrition (<15.3)	12 (11.00%)	54 (9.29%)	8 (12.90%)	48 (10.95%)
Mild malnutrition (15.3-18.5)	49 (44.95%)	269 (46.29%)	29 (46.77%)	177 (40.41%)
Normal (>18.5)	48 (44.03%)	25 (40.40%)	25 (40.32%)	213 (48.63%)

Table 10: Pattern of infection and malnutrition in male and female school children in the region

Sex	Infection (%)	Severe malnutrition (%)	Mild malnutrition (%)
Boys	64.3	11.0	44.9
Girls	35.6	12.9	46.7

age) than as wasting (low weight for height). Prior to this report there were no suitable thinness cut-offs for this age group. They have suggested that these new cut-off points should encourage direct comparison of trends in child and adolescent thinness worldwide. These cut-offs provide a classification of thinness for public health purposes. Nutrition plays a major role in maintaining health and malnutrition appears to generate vulnerability to a wide variety of disease and general ill health. The high prevalence of malnutrition in the Adamawa region (severe malnutrition records 20.8% and moderate malnutrition records 97.1%) most likely reflect the low socioeconomic status of the inhabitants which leads to low dietary intake by the school children due variability in quantity and quality of food supply and food production in the region. This further explains why malnutrition was prevalent in the children of all ages (6-15 years) and significantly different in the different age groups and different divisions of the region ($p<0.05$, chi square = 12.9). Children of the ages 15 years and below appear to be more predisposed to malnutrition than the older ones. The high prevalence of malnutrition in this region was similar to the prevalence of 58.1% reported in the south-west region of Cameroon (Nkuo-Akenji *et al*., 2008).

It has well been noted that not only malnutrition but also parasitic infections, cause serious health problems in many tropical countries. Our study revealed parasitic prevalence rate of 14.2% in this region with malaria parasitic infection being asymptomatic and recording a prevalence rate of 64.9%. this may indicate that the children in this region have acquired the ability to tolerate parasites without having fever or other symptoms. The humid climate observed in the area provides favourable environmental conditions for the development of oval, larval and cyst stages of the parasite (schistosomes, hookworm, Entamoeba and malaria parasites) and their transmission to man. However, this result is consistent with the findings of (Egwunyenga and Ataikiru, 2005) who reported parasitic infection prevalence rate of 54.7% among school children in Nigeria and of (Amuta *et al*., 2009) who reported a prevalence rate of 57.9% of intestinal parasites among school children in Makurdi, Benue state-Nigeria. Although parasitosis is endemic in the tropics, the reasons could be attributable mainly to environmental conditions and poor hygiene, causing significant morbidity such as anaemia, diarrhea and dysentery, malnutrition, mental deficits and poor growth. The mean body mass index showed remarkable difference of nutritional status between infected (11.1%) and non-infected (9.7%) children for severe malnutrition. Children infected with parasites were thinner than the non-infected ones. This could be that parasites produce significant adverse effects on weight gain, thereby inducing a significant contribution to the development of nutritional deficiencies in the group of children studied. However, the malnutrition observed among non-infected children may be due to inadequate food intake that led to poor appetite, metabolic and clinical disturbances as well as their socioeconomic status. The prevalence of infections was higher in boys (64.3%) than in girls (35.6%). This could be attributed to the fact that boys are more often involved in outdoors activities such as playing football and fishing and as such more exposed to infection. The girls showed a higher rate of malnutrition (12.9% for severe malnutrition and 46.75% for moderate malnutrition) than the boys. This could be attributed to limited food supply in many households and traditional feeding practices (scramble for served food thus leading to the phenomenon of the survival of the fittest) and customs that limit the girls consumption of certain energy or nutrient rich foods.

Conclusion: This study shows that there is high prevalence of global malnutrition and parasitic infection and a relationship of malnutrition and parasitic infections among school children in the Adamawa region. Recording malnutrition among non-infected children in the region explains that, there are other causes of malnutrition apart from parasitic infections, such as deficiencies in macronutrients intake (Protein, carbohydrates and fats) and micronutrients (Vitamins and minerals) as well as some other factors that could lead to the development of malnutrition. Therefore investment in education that is not accompanied by investment in health and nutrition of school children is a net loss for a country. If an improved health and amelioration of nutritional status in school children could be done, it will obviously contribute to high enrolments, better school attendance, low rates of dropouts and improved performance in academic work. It is recommended that all schools must have clean toilets, clean drinking water, clean school environment. Lunch

at school should be provided to the children and nutrition education should be added to their school curriculum and local health sectors should make provision for regular examination and treatment for parasitic infections among school children in the Adamawa region of Cameroon.

ACKNOWLEDGEMENT

We thank the ministry of health and the research centre of shistosomiasis and intestinal parasites for the assistance they rendered to us during the field work. The subjects and the school authorities are equally thanked for their cooperation.

REFERENCES

Amuta, E., T. Olusi and R. Houmsou, 2009. Relationship of intestinal parasitic infections and malnutrition among school children in Makurdi, Benue State-Nigeria. The Internet J. Epidemiol., Vol. 7.

Booth, 1998. Display of a positive interaction such that infection intensity of T. trichiura is higher in persons with concurrent A. lumbricoides than those without and vice versa; Available on google.com.

Brooker, 2000. Towards an atlas of human helminth infection in sub-saharan Africa; the use of geographical information systems (GIS). Parasitology today - Elsevier; 2000.

Bulletin of the World Health Organization, 1995. 73: 443-448.

Carte de santé, 1999. Institute de recherché pour le developpement- Camerun.

Cole, T.J., K.M. Flegal, D. Nicholls and A.A. Jackson, 2007. Body mass index cut offs to define thinness in children and adolescents: International survey. BMJ, 335: 194.

Egwunyenga, A. and D.P. Ataikiru, 2005. Soil-transmitted helminthiasis among school age Children in Ethiope East Local Government Area of Delta State, Nigeria. Afr. J. Biotech., 4: 938-941.

El-Ghannam, A.R., 2003. The global problems of child malnutrition and mortality in different world regions. J. Health Soc. Policy, 16: 1-26.

Louis, 1993. Problems with follow up particularly in respect of measurements of infant mortality in developing countries. Int. J., 51-52.

Latham, M., 1997. Human Nutrition in Developing Countries. Food and Nutrition Division FAO Rome, Italy.

Mitra, M. and A. Tiwari, 1997. Malnutrition in preschool children - A study of Brahmin Rawat and Teli preschool children of Raipur. Annual conference of Indian society of human genetics 16th and 18th Dec. 1997 XXIII, New Delhi.

Needham, 1998. Epidemiology of soil transmitted nematode infections in Ha Nam province, Vietmam. Trop. Med. Int. Health, 3: 904-912.

Nokes, C. and D.A.P. Bundy, 1993. Compliance and absenteeism in School children: Implications for helminth control. Trans. R Soc. Trop. Med. Hyg., 87: 148-152.

Pelletier, D.L. and E.A. Frongillo, 2003. Changes in child survival are strongly associated wit changes in malnutrition in developing countries. J Nutr., 133: 107-119.

Staton, D.M. and M.H. Harding, 2004. Protecting child health worldwide. Implementation is the biggest challenge slowing efforts to reduce childhood morbidity and mortality indeveloping countries. Pediatr. Ann., 33: 647-655.

Stephension, L.S., M.C. Latham and E.A. Ottesen, 2000. Malnutrition and parasitic infections. Parasitology, 121: 532-538.

Tchuente, L.A., J.M. Behnke, F.S. Gilbert, V.R. Southgate and J. Vercruysse, 2003. Polyparasitism with Schistosoma haematobium and soil transmitted helminth infections among school children in Loum, Cameroon. J. Trop. Med. Int. Health, 8: 975-986.

UNICEF, 1998. The state of the world's children. Oxford University Press, New York.

WHO, 1995. Physical status: The use and interpretation of anthropometry. Geneva, World Health Organization (WHO Technical Report Series, No. 854).

WHO, 1996. Management of severe malnutrition : A manual for physicians and other senior health workers, Geneva.