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SOIL TRANSMITTED HELMINTH INFECTION AND ITS EFFECT ON NUTRITIONAL STATUS OF CHILDREN IN KASHMIR

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The high prevalence of intestinal helminth infections among children living in developing countries impairs growth in these populations. Present study was aimed at comparing the nutritional status of children infected by soil-transmitted helminths (STH) with that of uninfected children. Stool samples and anthropometric measurements were taken from 382 children. Stool samples were processed by using both simple smear and zinc sulphate concentration methods. Nutritional status was assessed by Waterlow classification. Of the 382 children surveyed, 78.27 % were infected with either *Ascaris lumbricoides* or *Trichuris trichiura*, or both. Children infected with STH were found to be more malnourished than uninfected children. The present study concludes that soil-transmitted helminths are abundant among school children of Kashmir valley, with negative impact on their nutritional status.

Keywords: Children, Nutrition, Helminth, Nematode, Kashmir

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Soil-transmitted helminth infection is a major factor predisposing to poor nutritional status among children of low socioeconomic status in developing countries. However, studies on the impact of soil-transmitted helminth infection on nutritional status are limited (Hall, 1993). Furthermore, most studies on the prevalence of helminth infections focus on preschool children (De Silva et al., 1994). It is also important to determine the prevalence of helminth infections in older children and the effect of helminth infections on their nutritional status. This paper presents data comparing the prevalence of soil-transmitted helminth infections in children of Kashmir valley and the effect of these infections on their nutritional status.

MATERIAL AND METHODS

Kashmir valley, situated at an altitude of 6000 feet, constitutes the major portion of Jammu and Kashmir State India, consisting of 10 districts, namely, Annantnag, Kulgam, Shopian, Baramulla,

Ganderbal, Bandipora, Budgam, Kupwara, Pulwama, and Srinagar with about 46 Tehsils and about 50 towns. The study was carried out in all the 10 districts. This study was conducted from October 2016 to March 2017. Official meetings with the personnel from health services, city councils and schools, as well as parents and school children from the study sites, were carried out in order to explain the protocol of the study. In total 382 children, 219 male and 163 female aged 5–15 yrs. (9.2 ± 2.3) without disabilities and not receiving antiparasitic treatment, were included in the study. Initially 480 children were accepted to participate but 98 were rejected during the study because they had contaminated faecal samples. Written consents were required from both parents in order for the children to participate. Children requiring medical assistance were properly treated or referred to medical specialist. The children's ages were obtained through school records.

Stool examination

Fresh morning stool samples were collected in nylon containers containing 10 ml of 10 % formaldehyde. The containers were labeled, and immediately transported to the parasitology laboratory, Department of Zoology, S. P. College campus, Cluster University of Srinagar, for further processing. The stool specimens were processed using direct smear and zinc sulphate concentration techniques.

Assessment of nutritional status

To study whether there is any relation between the helminth infection and the malnutrition in the children, nutritional status of the infected and normal children was estimated by using Waterlow classification.

Waterlow's Classification

When a child's age is known, measurement of weight enables almost instant monitoring of growth. Measurements of height assess the effect of nutritional status on long-term growth (Waterlow et al., 1977).

Waterlow's classification defines two groups for protein energy malnutrition.

1. Malnutrition with retarded growth, in which a drop in height/age ratio points to chronic condition – shortness or stunting.

2. Malnutrition with low weight for a normal height, in which the weight for height ratio is indicative of an acute condition of rapid weight loss or wasting.

This combination of indicators makes it possible to label and classify children with reference to two poles: children with insufficient but well-proportioned growth and those with a normal height but who are wasted.

Interpretation of indications (Table 1)

$$\text{Weight/Height} = \frac{\text{Weight of the child}}{\text{Weight of the normal child at same height}} \times 100$$

$$\text{Height/Age} = \frac{\text{Height of the child}}{\text{Height of the normal child at same age}} \times 100$$

Weight in children was measured in kilograms to the nearest decimal point, using a spring balance. Height was measured in centimeters to the nearest decimal point, using a measuring tape fixed to a wall.

Table 1. Different categories of children with relation to nutritional status

Nutritional status	Stunting, % age of height/age	Wasting, % age of weight/height
Normal	> 95	>90
Mildly impaired	87.5–95	80–90
Moderately impaired	80–87.5	70–80

Data entry and analysis

A computer program (SPSS 10.05 for windows; SPSS Inc., Chicago, Illinois, USA) was used for data analysis. The chi-square test was used to associate risk factors with infection status. Differences were considered significant when *P* values of less than 0.05 were obtained.

RESULTS

Among 382 children subjected to stool examination, 299 (78.27 %) were infected with either *Ascaris lumbricoides* or *Trichuris trichiura*, or both. Single and mixed type infections were observed almost in equal proportions. 149 (39.0 %) children were infected with a single type of helminth: *Ascaris lumbricoides* was found in 91 (23.82 %) and *Trichuris trichiura* in 58 (15.18 %) children. Mixed type infection by *Ascaris lumbricoides* and *Trichuris trichiura* was observed in 150 (39.26 %) children.

In the present study, nutritional status of the infected and uninfected children was observed (Table 2). It was found that infected children were more prone to malnutrition (158, 52.84 %) than uninfected children (17. 20.48 %) [$P<0.05$]. Children infected with multiple types of helminths were found to be more malnourished (92) than children infected with a single type helminth (65). *Ascaris lumbricoides* is the main helminth responsible for causing malnutrition, when present as a single infecting parasite.

DISCUSSION

The present study found a prevalence of 78.27 % for soil-transmitted helminth infections. These figures, when compared with studies conducted in other parts of the world, show that Kashmir valley is one of the most hyper-endemic regions for intestinal helminthiasis. For example, studies conducted on the frequency distribution of gastrointestinal helminths by Bundy et al. (1988) showed high overall prevalence of 62 % among the urban slum children of Malaysia. Rodriguez et al. (2000) reported high prevalence of 72 % among the school children studying in a public institution in Maracaibo, Venezuela. Legesse and Erko (2004) also noted the high prevalence of 88.2 % among the school children in rural Ethopia, while Kabatereine et al. (2001) reported an overall prevalence of 56 % among the school children of south Uganda.

The high prevalence of soil-transmitted helminth infections is probably a consequence of a low standard of living, poor sanitation, lack of personal hygiene, traditional methods of agriculture, indiscriminate defecation, the use of night soil as fertilizers and other occupational work.

Malnutrition was found to be prevalent in the children of Kashmir valley, but it was found to be more prevalent in children infected by gastrointestinal helminths than in uninfected children. Further, it was also observed that mixed type infection was responsible for causing more malnutrition than single type infection. These figures, when compared to other parts of India (Table 3), show that in Kashmir valley malnutrition is highly prevalent (Ghosh, Shah, 2004) and needs early attention of medical practitioners, social scientists, economists, governmental and non-governmental organizations. The reasons behind malnutrition are

Table 2. Nutritional status of infected and uninfected children

Particulars	Normal (%)	Mild Malnutrition			Moderate Malnutrition			Severe Malnutrition			Total Malnutrition			
		S (%)	W (%)	T (%)	S (%)	W (%)	T (%)	S (%)	W (%)	T (%)	S (%)	W (%)	T (%)	*P* value
Not infected	66 (79.51)	2 (2.4)	13 (15.6)	15 (18.07)	–	2 (2.40)	2 (2.40)	–	–	–	2 (2.4)	15 (18.07)	17 (20.48)	0.001
Infected	141 (47.1)	19 (6.35)	67 (22.40)	86 (28.76)	15 (5.0)	41 (13.71)	56 (18.72)	1 (0.33)	15 (5.01)	16 (5.34)	35 (11.70)	123 (41.13)	158 (52.84)	
Single type infection	84 (56.37)	10 (6.71)	34 (22.81)	44 (29.53)	5 (3.3)	13 (8.72)	18 (12.08)	–	3 (2.01)	3 (2.01)	15 (10.06)	50 (33.55)	65 (43.62)	0.08
Mixed type infection	58 (38.66)	9 (6.0)	33 (22.0)	42 (28.0)	10 (6.6)	28 (18.66)	38 (25.33)	1 (0.66)	11 (7.33)	12 (8.0)	20 (13.33)	72 (48.0)	92 (61.33)	
Infection by *Ascaris*	46 (50.54)	9 (9.89)	23 (25.27)	32 (35.16)	3 (3.2)	8 (8.79)	11 (12.08)	–	2 (2.19)	2 (2.19)	12 (13.18)	33 (36.26)	45 (49.45)	0.2
Infection by *Trichuris*	38 (65.51)	3 (5.17)	9 (15.51)	12 (20.68)	2 (3.4)	5 (8.62)	7 (12.06)	–	1 (1.74)	1 (1.74)	5 (8.62)	15 (25.86)	20 (34.48)	

S – Stunt, W – Waste, T – Total

many, but from present study, it was clear that helminthiasis was one important factor responsible for malnutrition in already nutritionally compromised children. Sivakumar and Reddy (1975) showed that ascariasis causes malabsorption of vitamin A; abnormal fat and increased intestinal transit time, which ultimately leads to malnutrition. Cooper and Bundy (1988) estimated that approximately 10 % of young children living in conditions appropriate for hyperendemic geohelminthic transmission could have growth retardation. Gupta (1990) showed that ascariasis contributes significantly to malnutrition in communities where these conditions coexist.

Table 3. Prevalence of malnutrition in different Indian Cities (Source: Ghosh, Shah, 2004)

City (Year)	Number	Classification	Prevalence, %
Vadodra (2002)	3157	IAP	63 Grade I – 41 Grade II – 20 Grade III – 2
Delhi (2001)	150	IAP	26 Grade I – 11 Grade II – 9 Grade III – 6
Varanasi (2001)	70	WHO	Chronic Energy Deficiency – 51 Stunt – 10
Chandigarh (2000)	1400	IAP	67
Delhi (1997)	630	WHO	Under weight – 58 Stunted – 53 Wasted – 23
Luckhnow	1061	WHO	Under weight – 68 Stunt – 63 Wasted – 26
Srinagar (1997)	584	IAP	60 Grade I – 33 Grade II – 21 Grade III – 6
Calcutta (1994)	1280	IAP	51 Grade I – 28 Grade II – 17 Grade III – 7
Bhopal (1992)	1000	IAP	63 Grade I – 41 Grade II – 15 Grade III – 2
Calcutta (1989)	601	Gomez and WHO	92 Grade I – 40 Grade II – 44 Grade III – 9 Stunt – 81 Wasted – 9

Oberhelman et al. (1998) revealed a correlation between intestinal parasitosis and malnutrition: he found intestinal parasites among children with low WFA (weight for age) (48.5 %) versus those with normal WFA (38.5 %). The presence of *Ascaris* or *Trichuris* in the stool was associated with low WFA in the overall group. Differences in the prevalence of *Trichuris* by nutritional status were especially striking, with *Trichuris* eggs present in 9.9 % of all children with low WFA and in 2.8% of all children with a normal WFA (P=0.00008). Sugunam et al. (1996) also showed that intestinal parasitic infestations contribute significantly to poor growth and malnutrition in children. Stephenson (1999) established that the high prevalence of infections, mostly gut helminth infections among children living in poor areas, impairs linear growth by affecting nutritional status. Hughes et al. (2004) showed that children with helminthiasis and anaemia were found to be 8.7 times more likely to be stunted and 4.3 times more likely to be underweight than non anaemic and non-infected children. Other studies have described how even mild and moderate chronic helminth infection and anaemia impair the physical and mental development in children (Nokes et al., 1992; Hutchinson et al., 1997; Dickson et al., 2000). Reduced food intake, impaired digestion, malabsorption and poor growth are frequently observed in children suffering from ascariasis and trichuriasis (Crompton, Nesheim, 2002).

From the above discussion it is clear that children in communities with rampant intestinal helminth infections are at more risk of becoming malnourished than in those where prevalence of helminth infections is low.

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ГЕОГЕЛЬМИНТЫ И ИХ ВЛИЯНИЕ НА НУТРИТИВНЫЙ СТАТУС ДЕТЕЙ В КАШМИРЕ

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Ключевые слова: дети, питание, гельминты, нематоды, Кашмир

РЕЗЮМЕ

Высокая распространенность инфекций кишечными гельминтами среди детей, проживающих в развивающихся странах, препятствует там росту населения. Целью настоящего исследования было сравнение нутритивного статуса детей, инфицированных геогельминтами, с таковым у неинфицированных детей. У 382 детей были взяты пробы кала и выполнены антропометрические измерения. Для определения зараженности гельминтами применяли стандартные методы копроскопии – нативный мазок кала и флотационный метод обогащения с использованием сульфата цинка. Нутритивный статус оценивался по классификации Ватерлоу (Waterlow et al., 1977). Из 382 обследованных детей 78.27 % были инфицированы либо *Ascaris lumbricoides*, либо *Trichuris trichiura*, либо обоими этими паразитами. Согласно проведенным исследованиям, дети, инфицированные геогельминтами, в большей степени страдают от недоедания, чем неинфицированные. Среди школьников Кашмирской долины широко распространено заражение геогельминтами, что негативно сказывается на их нутритивном статусе.