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Original Article

Effect of *Giardia lamblia* Infection on the Cognitive Function of School children

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Abstract

Background: The association between helminthic parasitic infection and cognitive function has long been recognized, however there are few reports about *Giardia lamblia* infection. This paper describes a study about the effect of G. *lamblia* infection on the cognitive function. **Methods:** One hundred thirty two children infected with *G. lamblia* from Robat Karim south of western Tehran, Iran were compared with 150 children without any parasitic infection. These two groups were identical in socioeconomic and nutritional status. Cognitive function was assessed using, three tests from Wechsler Intelligence Scale for children and one subset of the Clinical Evolution of Language Function. **Results:** Comparison of two groups revealed that uninfected children improved significantly more than children who had *G. lamblia* infection in the tests of Fluency ($P< 0.02$) and Digit-span Forwards/ Backwards ($P< 0.004$). **Conclusion:** Regular stool examination is suggested in areas with low hygienic conditions, since *G. lamblia* infection might be present without any clinical manifestation.

Keywords: *Giardiasis, Cognition, School children,* Giardia lamblia, *Iran*

Introduction

There are several reports regarding association between parasitic infection with impaired cognitive function and educational achievement (1, 2). It has been shown that heavy schistosomisis is associated with poor short-term memory and slower reactions in Tanzanian school children (1). In addition, an improvement in cognitive function following treatment of *Shistosoma japonicum* infection in Chinese primary school children has been reported (2). In an attempt to examine the influence of helminthiasis on cognitive development school children were studied in Jamaica. The functions affected by helminthiasis infection were related to attentiveness and appeared to involve both auditory short-term memory and the scanning and retrieval of long-term memory (3). *Ascaris lumbricoides* infection in primary school children also affected cognitive function (4). Even asymptomatic malaria prasitaemia in schoolchildren in Yeman showed impaired cognitive function and school achievement (5). Furthermore, the effect of helminthes and *Thrichuris trichura* infections on cognitive function has been reported (6).

Several data suggest that parasite infections can affect the nutritional status of infected people, by modifying the key stages of food intake, digestion and absorption (7). The treatment of infected children with *Ascaris lumbricoides* not only improved the nutritional status but also increased the cognitive function and educational achievement (8).

The association between malnutrition in early childhood and cognitive function in *G. lamblia* infected individuals has also been reported (9). It was found that trophozoites of *G. lamblia* might damage the brush brooders of enterocytes and impair activity of mucosal enzymes, par-

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ticularly the disaccharidases causing carbohydrate and fat malabsorption (10). Periodic treatment of *G. lamblia* improved the weight gain of treated children (11).

In this paper we report the results of a blind study to determine the relationship between infection with *G. lamblia* and cognitive function in schoolchildren.

Materials and Methods

Study area The study area, named the sub district of Robat Karim, was located in the southwest of Tehran, Iran. There were slum areas in which environmental sanitation, as well as personal hygiene, was poor.

Patients and control groups The study was reviewed and approved by the Ethical clearance committee of the Ministry of Health. Informed consent for participation in study was obtained from the parents of the children. Children unwilling to participate were excluded from the study. Four primary schools were randomly selected for this study. In the first phase, 332 boys and 268 girls (6-13 yr aged) participated in the study. Stool samples were collected at three times with one day interval and screened for the presence of parasitic infection using the Kato-Kato and direct smear. A group of 150 infected children was considered as test group, of which 132 students were infected with only *G. lamblia* infection, and group of 150 children with no parasitic infection was chosen as control.

Collection of socioeconomic and epidemiologic data Socioeconomic and epidemiologic data were collected by completing a questionnaire from the parents of the children. The questions were targeted to educational and employment status. A description of the environment, the existence of latrines, and water source was recorded.

Anthropometric assessment To classify the nutritional status of school children, the weight - for- height index was used. This was used because this index is a simple screening method for the detection of malnutrition in field study. The percentile of growth charts of the National Center for Health Statistics (NCHS) (12), were used as normal values. The degree of stunting (height/ age) and wasting (weight/ age) was measured base on NCHS Growth Charts. Stunting is considered as the most appropriate indicator of chronic malnutrition. Based on the height for age, nutritional status was divided into 3 groups, below 3^{rd} percentile (score= 1), 3^{rd}-25^{th} percentile (score= 2) and above the 25^{th} percentile (score= 3)

Cognitive function study Cognitive function was assessed by means of tests that measured attention, short-term and long-term memory. The following tests were carried out: Arithmetic measures mathematical knowledge, mental computations, and concentrate Digit Span Forward and Backward (measure attention span and short-term memory) and coding measure motor coordination, speed of - mental operation and short- term memory; these three tests were based on HU Wechsler Intelligence Scale for children (13).

The tests, measure the factor of freedom from distractibility which is the ability to pay attention and to concentrate (14). In addition, the clinical evaluation of language function was assessed. This measures fluency involving motivation, retrieval and the scanning of long - term memory.

Statistical analysis Analysis of variance (ANOVA) and analysis of covariance were used for statistical analysis. In analysis of covariance the covariates were entered first (experimental method). All analyses were done using the SPSS software (SPSS, Inc., Chicago, IL). Statistical significance was assured at $P \leq 0.05$.

Results

Table 1 shows the results of stool samples examination of 300 school children aged 6 to 13 yr. One hundred fifty children with negative stool examination were randomly selected as the control group. One hundred fifty children with positive stool examination for intestinal parasite infection were selected for study. Femal to male ratio were 1 (75 female/ 75 male) and 0.8 (64 female/ 68 male) for control and *Giardia* infected groups, respectively. Eighteen children had co-infection of *G. lamblia* with other helminth parasites, i.e. *Hymenolepis nana* and/or *Ascaris lumbricoides* and were excluded from the study. Therefore, 132 children whose stool examination were found positive for *G. lamblia* without any other parasitic infection were selected for the study. Many of participating students had been severely infected by *G. lamblia* based on the number of *G. lamblia* cyst or trophozoite seen in the stool exam slide.

The results of environmental survey showed that the study area had very poor sanitary conditions. The source of drinking water was investigated and found that 3% of the residents bought their drinking water, 87% got their water from taps and 10% from open wells. The ethnicity of the students was found as follows: 67% Turk, 23% Pars, 5% Kurd, and 5% Afghan. In addition, no difference was found between the test and control groups in terms of socioeconomic situation.

Fig. 1 shows the results of the nutritional status of the two groups of the study, which were classified, based on growth charts of the National Center for Health, Statistics (NCHS). There was no statistically significant difference between *G. lamblia* infected children and healthy ones.

Table 2 shows the results of cognitive function tests in study groups. There was a significant difference between *G. lamblia* infected and uninfected children in fluency and Digit-Span Forwards and Backwards. However, no significant difference was found with other cognitive function tests. There was no significant deference between helminthes infection and cognitive function test in school children (data not shown).

Table 1: Age distribution of the study groups

Study group / Age group(yr)	Control		*Giardia* Infected		Helmint Infected		Total	
	n	%	n	%	n	%	n	%
6 - 7	30	48	32	52	0	0	62	100
8 - 9	59	52.2	49	43.4	5	4.4	113	100
10 -12	56	50	47	41	10	9	113	100
12 - 13	5	42	4	33	3	25	12	100
Total	150	100	132	100	18	100	300	100

Table 2: The results of cognitive function tests of different groups of the study. The data were shown as mean ± SD

Study groups	N	Arithmetic	Fluency	Digit span Forward/backward	Coding
		Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
Control	150	8.44±2.59	4.61±2.64	7.82±2.78	6.35±2.59
Giardia-infected	132	7.9 ±2.73	3.97±2.59	6.76±2.92	6.03±3.34
P. value		N.S	$P< 0.02$	$P< 0.004$	N.S

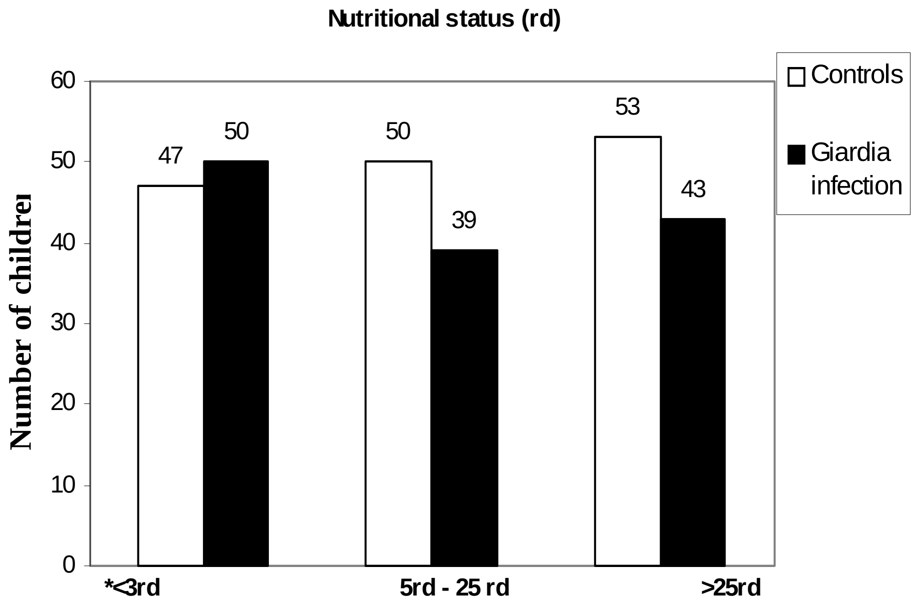

Fig.1: Nutritional status of *G. lamblia* infected and uninfected groups. No significant difference was found between two groups

Discussion

This is the first study on the association between intestinal protozoan-parasitic infection and cognitive function in Iran. There are few reports on *G. lamblia* infection and its relationship with cognitive function. In our study, the cognitive function tests were selected based on age and culture of the children. In addition, the fluency test was adapted to the common knowledge of the children.

In this study the individuals infected with *G. lamblia* showed affected cognitive functions compared to healthy controls. We adjusted all findings for socioeconomic status and schooling. We found that the infection affected short-term memory (auditory memory) and long-term memory. However arithmetic and coding test showed no significant difference between two groups of the study. These data revealed that attention, auditory short-term memory, scanning and long-term memory have been affected by the infection.

Our results are in consonance with previous study showing the effects of parasitic infection *G. lamblia* and *C. parvum*, during infancy on cognition in late childhood (9). We did not find significant relationship between parasite burden and cognitive functions. However, it has been reported that children unable to keep up a good level of performance over the 20 min test period were found to have higher parasite burden (15).

In a survey in 1991, no relationship was found between parasite burden and memory (16). These discrepancies might be due to the diagnostic tests for parasitic infection and the methods used for assessing cognitive functions.

Aim of our study was not to identify the mechanisms by which *Giardia* affects the cognitive functions. It has been proposed that hypovitaminosis A is a major nutritional problem in parasite infections, but the relationship between this deficiency and parasitic infection was not confirmed (17). The underlying mechanism will be an interesting subject for future studies. Taken together, our results in addition to previous reports showed that parasitic infection due to G. *lamblia* was able to affect cognitive function even without decreasing weight-for-age and weight-for-height Z score.

The study region had unsatisfactory sanitary conditions including drinking water and system for wading off sewage wastewater. These conditions may result in high rate of *G. lamblia* infection in schoolchildren.
Conclusively frequent stool exam in regions with unsatisfactory sanitary conditions is critically important for the diagnosis and treatment of such infections.

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