Risk Factors and Relationship Between Intestinal Parasites and the Growth Retardation and Psychomotor Development Delays of Children in Şanlıurfa, Turkey

Türkiye'de, Şanlıurfa'da Bağırsak Parazitleriyle Çocukların Büyüme ve Psikomotor Gelişim Gerilikleri Arasındaki İlişki ve Risk Faktörleri

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ABSTRACT

Objective: The objective of this study was to determine the risk factors for and relationship among parasitic infections, growth retardation, and psychomotor developmental delays in children aged 6 years and below.

Methods: This case–control study was performed in Şanlıurfa in southeastern Turkey between October and December 2007. Data were collected using a structured questionnaire, anthropometry, Ankara Development Screening Inventory, and laboratory analysis of stool specimens.

Results: The most common parasite was *Giardia intestinalis* (42.53%) followed by *Enterobius vermicularis* (27.58%), *Ascaris lumbricoides* (18.39%), *Hymenolepis* nana (5.75%), *Trichuris trichiura* (3.45%), *Escherichia coli* (1.15%), and *Blastocystis* spp. (1.15%). Fifty-eight percent of all children were infected with intestinal parasites; 55.2% had only one parasite, whereas 44.8% had multiple parasites. The children infected with *G. intestinalis* and other intestinal parasites had significantly higher levels of growth retardation and psychomotor development delay than non-infected children. Children with parasitic infections had growth delay up to 2.9 times, general development delay up to 1.9 times, language–cognitive development delay up to 2.2 times, and fine motor development delay up to 2.9 times higher than children without any parasitic infections. However, no significant relationship among intestinal parasites, gross motor development, social-self skills, and development delay was identified. The education level of parents, poor economic situation, number of households, not washing hands, playing with soil, family history of parasitic infection were the significant risk factors for intestinal parasites.

Conclusion: Our study indicates that the presence of either malnutrition or intestinal parasites may put a child in a high-risk group for developmental delays and growth retardation. Therefore, public health interventions can embrace nationwide deworming in children.

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Keywords: Intestinal parasites, malnutrition, growth retardation, psychomotor development delay, children

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ÖZ

Amaç: 6 yaş ve altındaki çocuklarda, bağırsak parazitleriyle büyüme-psikomotor gelişim gerilikleri arasındaki ilişkinin ve risk faktörlerinin belirlenmesi hedeflenmiştir.

Yöntemler: Vaka-kontrol tipindeki araştırma, Türkiye'de, Şanlıurfa'da, Kasım-Aralık 2007'de yapılmıştır. Sosyodemografik özellikler anket, psiko-motor gelişimler Ankara Gelişim Tarama Envanteri, fiziksel gelişimler, yaşa göre boy, yaşa göre ağırlık ve boya göre ağırlık antropometrik göstergeler, dışkı örnekleri laboratuar analizleri kullanılarak değerlendirilmiştir.

This study 's first author is written from the master's thesis was presented as a poster 17th Natioanal Parasitology Congress and Caucasian and Middle East Symposium on Parasitic Diseases, 4-10 September 2011, Kars, Turkey.

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Bulgular: Çalışmada, en sık rastlanan *G. intestinalis*'i (%42,53) sırasıyla *E. vermicularis* (%27,58), *A. lumbricoides* (%18,39), *H. nana* (%5,75), *T. trichiura* (%3,45), *B. hominis* (%1,15), *E. coli* (%1,15) izlemiştir. Çocukların %58'inde bağırsak paraziti saptanmıştır. Bunların %55,2'sinde bir parazit, %44,8'inde çoklu parazit saptanmıştır. *G. intestinalis*'le birlikte başka bağırsak parazitlerinin saptandığı çocuklarda daha fazla büyüme-gelişme geriliği görülmüştür. Bağırsak parazitlerinin fiziksel büyüme geriliğini 2,9 genel gelişim geriliğini 1,9 dil-bilişsel gelişim geriliğini 2,2 ince motor gelişim geriliğini 2,9 kat artırdığı saptanmıştır. Bağırsak parazitleri ile kaba motor-sosyal beceri gelişim geriliği arasında anlamlı ilişki saptanmamıştır. Parazit pozitifliği ile toprakla oynama, anne-baba öğrenimi, ekonomik durum, ailedeki birey sayısı, yanlış el yıkama, ailedeki parazitoz hikayesi arasında anlamlı ilişki saptanırken, ortak çamaşır, yatak kullanma, baba mesleği arasında ilişki saptanmamıştır.
Sonuç: Bu çalışma, bağırsak parazitleri ve malnütrisyonun büyüme-gelişme geriliği için büyük risk faktörü ve çocukların da yüksek risk grubunda olduğunu vurgulamıştır. Bu nedenle, ülke düzeyinde parazit tedavisinin yapılması, malnütrisyonun önlenmesi için halk sağlığı çalışmaları yapılmalıdır. *(Turkiye Parazitol Derg 2015; 39: 270-6)*

Anahtar Kelimeler: Bağırsak parazitleri, malnütrisyon, fiziksel-psikomotor gelişim geriliği, çocuk

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INTRODUCTION

All organisms living in the intestinal ecosystem are known as parasites because they are dependent on to their hosts as they provide food to those organisms for survival (1).

Intestinal parasitic infections are still public health problems in developing countries. The soil-transmitted intestinal helminths *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm infect more than 1 billion people worldwide and are important causes of malnutrition among children (2). Identification of intestinal helminthic infections is considered to be an important public health problem in preschool-aged children (3, 4). Egger *et al.* and Walker *et al*. have reached varying conclusions regarding the age groups at greatest risk and the effect of helminths on growth based on weight or height (2, 5).

As reported elsewhere, millions of children in developing countries are short for their age or underweight for their height and age because of malnutrition and diseases (6, 7).

The objective of this study was to understand how intestinal parasites may affect child growth, language and cognitive skills, fine and gross motor development, social and self-help skills, and nutrition. Also, the study aimed to find answers to some significant questions such as do demographic, environmental, and socioeconomic factors as well as age of children affect the presence and the distribution of intestinal parasites among children in study and control groups?

METHODS

Study population

Against this background, a case-control study was designed to determine whether exposure to parasitic infection is associated with the outcomes of malnutrition as well as development and cognition delays in children aged 6 years and below.

This case-control epidemiological study was conducted to indicate the effect of parasitic infection on the development and cognition of children. This study was conducted during October-December 2007 at the Tilfindir Primary Health Care Center in Şanlıurfa, an underdeveloped region of southeastern Turkey. This study was approved by the Ethics Committee of the Faculty of Medicine at Harran University.

After explaining the aim of the study, an informed consent was obtained from parents. A structured questionnaire was given to each individual to collect socioeconomic, environmental, and sociodemographic data about the children. Ankara Development Screening Inventory had been used. Laboratory analysis of stool specimens were performed by the investigators.

Initially, 100 children without a major congenital malformation, chronic disease, metabolic disease, and surgical operation were enrolled into this study. Also, these children were not born as premature, dysmature, or twins.

The World Health Organisation (WHO) Global Database on Child Growth and Malnutrition uses a Z-score cut-off point of <−2 standard deviations (SD) to classify low weight-for-age (WAZ), low height-for-age (HAZ), and low weight-for-height (WHZ) as moderate and severe undernutrition as well as a Z-score cut-off point of <−3 SD to define severe undernutrition (8).

Children whose WAZ, HAZ, WHZ fell below −2 SD were classified to have acute malnutrition (wasting), chronic malnutrition (growth stunting), or global malnutrition, respectively (9).

In our study, the weight and height of children were measured by investigators using portable scale and stadiometer to separate the case and control groups of children. Children were presented using z-scores based on the WHO Child Growth Standards (9) to determine the case and control groups of children. Fifty of the children having a Z-score of <−3 SD were enrolled into this study as the case group. Fifty of the children without any health complaints and with SDs above −1.99 were enrolled as the control group. Also, controls were from the same community as cases but without the outcome (impaired development and cognition).

The control and case groups of children were compared in terms of intestinal parasites, physical growth, and cognitive function. In this context, intestinal parasitic infection is the exposure, whereas development and cognition are the outcomes.

The questionnaire

A structured questionnaire with open- and closed-ended questions collected information from the parents of subjects regarding housing and sanitation. These included information on age, sex, community residence site, education and occupation of both parents, level of income, number in household and birth order of the child, housing conditions (ownership of the house as well as number of rooms and bathrooms), water supply, commonly used type of toilet, hand washing (no washing, washing only with water, or washing with soap), washing of the anal area with hand after

Table 1. Distribution of intestinal parasites according to case and control group of children

Parasitic infection	Case group of children (growth retardation and psychomotor development delay)		Control group of children		Total	
	n	%	n	%	n	%
G. intestinalis present + other intestinal parasites present	29	58.0	9	18.0	38	38.0
G. intestinalis present + other intestinal parasites present	13	26.0	7	14.0	20	20.0
No parasitic infection	8	16.0	34	68.0	42	42.0
Total	50	100.0	50	100.0	100	100.0
X^2=28.4; P=0.00						

defecation (yes/no), consumption of raw meat, child's playground (home, garden, or street), playing with soil, and multiple people sleeping in the same bed or sharing clothing.

Intestinal parasitic examination

Initially, an adhesive cellophane tape with a glass slide and a fecal specimen container were distributed to the parents. Three serial fecal specimens (0.5-1.5 g) in labeled plastic vials containing 10% formaldehyde for the preservation of helminth eggs, protozoan cysts, and trophozoites in the fecal specimens and adhesive cellophane tapes were collected and transported to the laboratory within 4 h of collection. The stool specimens were examined for the presence of parasites, helminth eggs, and larvae and protozoan cysts using direct wet mount, native-Lugol (saline and Lugol's iodine solution), modified formalin-ethyl acetate sedimentation, and acid-fast stained preparations. The cellophane tapes were examined for the presence of *Taenia saginata* and *Enterobius vermicularis.*

Assessment of psychomotor development

To assess the relationship between psychomotor development and intestinal parasites, we utilized the Ankara Child Development Screening Inventory (AGTE). This tool was developed by Savasir, Sezgin, and Erol as a culturally relevant device to yield an index of the developmental status of children. The AGTE is a measurement tool that evaluates four component scales (general development, social and self-help skills, fine motor and gross motor developments, and cognitive language) of children between the age of 1 month and 6 years. The AGTE has high correlation with the Denver Developmental Screening Inventory. The inventory consisted of 154 items answered by mothers as either "yes" or "no". If a child received a score of 20%-30% lower than the average score for his or her age in at least two subtests, he or she was classified as having poor psychomotor development (10, 11).

Statistical analysis

Study data were analyzed using Statistical Package for the Social Sciences (SPSS 11.5) software. The descriptive data was given as a means with standard deviations, frequency counts, and percentages.

Relationship among risk factors and intestinal parasites, psychomotor development, and physical growth were analyzed using chi-square tests (χ^2) and Student's t-test. Independent effects of social, demographic, and environmental factors were analyzed using logistic regression. The differences were considered to be statistically significant at $p<0.05$.

RESULTS

One hundred children from the same district were enrolled into this study, and all participants were examined for sociodemographic characteristics. Therefore, there was no significant sociodemographic difference between the case and control groups of children. Case group consisted of 20 boys (42.6%) and 30 girls (56.6%), whereas the control group consisted of 27 boys (57.4%) and 23 girls (43.4%). The mean age of children in the case group was 48.58±3.98 months and the mean age of children in the control group was 49.98±3.98 months.

Distribution of parasites among case and control groups of children

According to stool examinations, 58% of the children were infected with intestinal parasites. Of these children, 55.2% were infected with only one parasite, whereas 44.8% of them were infected with multiple parasites. The distribution of the parasites according to species was as follows: 42.53% of *Giardia intestinalis*, 27.58% of *E. vermicularis*, 18.39% of *A. lumbricoides*, 5.75% of *Hymenolepis nana*, 3.45% of *T. trichiura*, 1.15% of *Escherichia coli*, and 1.15% of *Blastocystis spp*. In the case group, 72.4% of the children with malnutrition were infected with one or more intestinal parasites, while 27.6% of the children in the control group were infected with one or more intestinal parasites.

Fifty-eight percent of the children with growth retardation and malnutrition were infected with *G. intestinalis* alone or with *G. intestinalis* and other intestinal parasites.

Table 1 indicates that children infected with *G. intestinalis* and other intestinal parasites had significant growth retardation and psychomotor development delay than children infected with other intestinal parasites and non-infected children. There was a significant relationship among *G. intestinalis* and other intestinal parasites and growth retardation/psychomotor development delay ($p<0.001$).

Relationship between child growth retardation/psychomotor development delay and intestinal parasitic infection

Table 2 presents the relationship between growth retardation and

intestinal parasitic infection. Children with parasitic infection had physical growth retardation at a rate that was 2.9 times higher (95% CI: 2.19-4.6) than non-infected children (p<0.001). Table 3 presents the relationship between psychomotor development delay and intestinal parasitic infection. When compared with children without parasitic infection, those with parasitic infection had general development delay that was 1.9 times higher (95% CI: 1.40-2.60), language-cognitive development delay that was 2.2 times higher (95% CI: 1.54-3.04), and fine motor development delay that was 2.9 times higher (95% CI: 1.70-4.90). These results show a significant relationship among parasitic infection of children and physical growth retardation, general development delay, language-cognitive development delay, and fine motor development delay (p<0.001). However, there was no statistically significant relationship between intestinal parasites and gross motor development or social and self-help skill developments (p>0.05).

The multiple logistic regression analysis (Table 4) reveals significant relationships among education level of both parents, poor economic situation, number of members in household (6 and above), not washing hands after toilet, wrong technique of washing hands, family history of parasitic infection, and parasitic infection in the children (p<0.05). No significant relationships were observed among household composition, paternal occupation, sharing of clothes, sleeping in the same bed, presence of toilet inside the house, and parasitic infection (p>0.05).

Children above the age of 37 months were infected with intestinal parasites at a rate that was 1.93 times higher (OR=1.93; 95% CI: 1.14-3.29) than that in children aged 36 months and below (p<0.05). Also, there was a significant relationship between playing with soil and parasitic infection (p<0.05). No significant relationship was identified between intestinal parasitic infection and child gender (p>0.05).

Table 2. Relationship between child growth and intestinal parasitic infection

	Growth (weight-for-age, height-for-age, and weght-for-height, respectively)	
	≤-2 SD	≥-1,99 SD
Parasitific infection	**% (n)**	**% (n)**
Yes	72.4 (42)	27.6 (16)
No	19.0 (8)	81.00 (42)
X^2 P OR (CI 95%)	27.75; 0.000; 2.90; 2.19-4.60	

Table 3. Relationship between psychomotor development delay and intestinal parasitic infection

	Delay in Psychomotor Development (AGTE Inventory)				
	Fine motor	Language-cognitive	Gross motor	Social skills/Self-Care	General development
Parasitic infection	**% (n)**	**% (n)**	**% (n)**	**% (n)**	**% (n)**
Yes	77.6 (45)	60.3 (35)	8.6 (5)	8.6 (5)	8.6 (5)
No	35.7 (15)	14.3 (6)	4.8 (6)	9.5 (4)	9.5 (4)
X^2 P	17.80; 0.00;	21.364; 0.00;	0.557; 0.455;	0.24; 0.876;	17.29; 0.00;
OR (CI 95%)	2.9; 1.7-4.9	2.2; 1.54-3.04			1.9; 1.4-2.6

Table 4. Factors associated with the risk parasitic infection of children (Logistic regression analysis)[a]

Characteristic	B	P	OR	%95 CI
Maternal education (illiterate)	1.105	0.012	3.019	1.279 - 7.130
Paternal education (illiterate)	1.600	0.002	4.954	1.819 - 13.492
Poor economic situation	1.080	0.010	2.945	1.292 - 6.717
Number of households (6 and above)	-1.053	0.014	0.349	0.150 - 0.811
Children aged 36 months and below	-1.057	0.036	1.93	1.14 - 3.29
Not weshing hands after toilet	-1.851	0.019	0.157	0.34 - 0.735
Wrong technique of washing hands	-1.151	0.007	0.157	0.137 - 0.731
Parasiticincetion history in family	0.958	0.034	2.607	1.076 - 6.316
Playing with soil	1.602	0.00	4.956	1.856 - 13.528
Paternal occupation	-0.856	0.135	0.425	0.140 - 1.290
Common use of clothes	0.580	0.216	1.786	0.713 - 4.476
Sleeping in the mase bed	0.486	0.239	1.625	0.724 - 3.645

B: This is the coefficient for the constant (also called the "intercept") in the null model; P: value used in testing the null hypothesis that the coefficient (parameter) is 0; OR: Crude odds ratios; CI: Confidence intervals

DISCUSSION

This survey supports and expands upon described relationships among intestinal parasites, growth retardation/psychomotor development, and risk factors.

The Southeastern Anatolia Project, a massive dam and waterways project, increases the amount of standing water in southeastern Turkey, thereby providing appropriate homes for the hosts of intestinal parasites (12). Şanlıurfa was chosen because of its location in this developing region.

Fifty-eight percent of the children were infected with intestinal parasites. Regarding the parasite prevalence in this study, the most common protozoan was *G. intestinalis* with a prevalence of 42.53%, and the most common helminths were *E. vermicularis*, *A. lumbricoides*, and *H. nana* with prevalence of 27.58%, 18.39%, and 3.45%, respectively. These results are consistent with the results of other studies (13-15). This may be because of higher transmission rates of parasitic infections in crowded families because of close contact and inadequate sanitary conditions in the families.

Several surveys have indicated that intestinal parasitic infections and malnutrition are endemic among communities of this province (16, 17). However, there was a lack of adequate data about intestinal parasitic infections and the psychomotor development of preschool children in Şanlıurfa. Only one study in Şanlıurfa has initially reported a significant relationship among language-cognitive and fine motor developments as well as childhood infections with only *G. intestinalis (*18). Our study is one of the exceptional studies that emphasizes the adverse impacts of intestinal parasites, including both *G. intestinalis* and intestinal helminths, on child growth retardation and psychomotor development delay. In this study, 72.4% of the children in case group were infected with one or more intestinal parasites.

Our data showed that children with parasitic infections had more general development, language-cognitive development delays, and fine motor development delays than children without any parasitic infection. Intestinal parasites were closely associated with physical growth retardation, general development delay, language-cognitive development delay, and fine motor development delay. However, there was no significant relationship between intestinal parasites and gross motor development or social and self-help skill developments.

The resulting delays in growth and psychomotor development of children exacerbated in case of malnutrition along with the presence of intestinal parasites. In particular, intestinal parasitic infections are a burden on malnutrition. According to our study, the presence of either malnutrition or intestinal parasites may put a child in a high-risk group for developmental delays and growth retardation. Also, our study emphasized the significant relationship between intestinal parasitic infection and undernutrition or stunted growth similar to that reported in other studies (1, 2, 13, 18-21); however, other studies have not reported the abovementioned observations (22-24) or had mixed results (25).

According to our study, most risk factors for growth retardation and psychomotor development delay found in children with intestinal parasitic infection appeared to be attributable to *G. intestinalis* infection combined with other intestinal parasitic infections rather than infection with other species of intestinal parasites without *G. intestinalis* infection.

In the present study, when the risk factors associated with intestinal parasitic infections were evaluated, it was seen that education level of both parents, poor economic situation, number of households (6 and above), not washing hands after toilet, wrong technique of washing hands, family history of parasitic infection, children aged above 37 months, and playing with soil were the most consistent factors for intestinal parasitic infection risk ($p<0.05$). The education level of the parents was significantly associated with intestinal parasitic infections. This was consistent with the results of other studies, as previously reported. Children whose parents had higher levels of education had lower prevalence of intestinal parasitic infection. Poor economic situation was found to be the second risk factor for intestinal parasites in this study, consistent with the results reported in other studies (13, 14, 25). We found that children in overcrowded families were more infected with intestinal parasites than those having five households and below, as reported by some authors (24-26). This might explain the transmission of parasitic infections from person to person, limited poor nutrition, and sanitary conditions in crowded families.

Children using correct hand washing technique significantly had a lower prevalence of parasitic infection than those using wrong technique of washing hands and those who did not wash hands. Some studies present similarity with our study's results (27, 28, 29).

In the current study, age was another significant risk factor for intestinal parasites. Children aged above 37 months were more infected with intestinal parasites than those aged below 36 months. This finding was consistent with the findings of another study (18). As opposed to another study (26), in our study, there was no significant difference between gender and intestinal parasites.

This study also suggests that playing with soil and inability to practice good hygiene by themselves are important causes of intestinal parasite infection. This can be explained in a way that children playing with soil on their hands could be contaminated with the eggs of soil-transmitted parasites. We could not determine any relationship among intestinal parasites and paternal occupation, sharing of clothes, and sleeping in the same bed.

Strengths and Limitations

Because of all these findings, our study provided convincing evidence of a crucial mechanism that indicates intestinal parasites can impair children's nutrition, growth, and psychomotor development by stealing the food of children. The major limitation of our study was its design as an epidemiologic case-control group study, but not as a screening study. For this reason, we cannot estimate the real prevalence of intestinal parasites in the study area. If we had been able to examine the stool as soon as possible, we might have found the trophozoite form and the ratio of parasites may have increased. Prospective cohort studies are needed to clarify this subject and the underlying mechanisms.

CONCLUSION

This study had important implications for improving the lives of children with regard to their psychomotor development. This study will be crucial to further support the hypothesis that parasitic infections lead to malnutrition, which is a factor that contributes to growth retardation and psychomotor development delay. As a result of our study, it might be considered that intestinal parasites are indeed associated with poor outcomes; therefore, public health interventions should embrace nationwide deworming in children.

Consequently, follow-up of children in primary care in terms of intestinal parasites, diagnosis, and treatment will have a positive effect on child health during the program of growth monitoring.

Ethics Committee Approval: Ethics committee approval was received from the ethics committee of the Faculty of Medicine at Harran University.

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