

Original papers

Epidemiological and clinical picture of parasitic infections in the group of children and adolescents from north-east region of Poland

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ABSTRACT. The epidemiological and clinical purview of parasite diseases is constantly evolving, mainly due to the changes in human behavior and our environment. The aim of this study was frequency analysis of certain parasite infections, risk factors and clinical symptoms in children and adolescents of north-eastern Poland. 120 children were tested due to the symptoms resembling parasite infection from December 2008 to May 2009. 90 patients (the tested group) aged from 5 months to 18 years were found to be infected with one or more than one of the following parasites: *Ascaris lumbricoides*, *Giardia lamblia*, *Toxocara* spp., *Strongyloides stercoralis* or *Enterobius vermicularis*. 30 children with no infections found were the control group. Parasites were found by means of microscope decantation stool tests, RIDA Quick Giardia stool test and ELISA blood test (Toxocara IgG). The patients' parents filled out the survey concerning the probability factors of infection and the ailments that were the cause of parasitical diagnosis. High percentage of either isolated or co-invasive parasite infections was ascertained in the tested group – 75%. The prevalence of ascariasis was 55.83%, toxocariasis – 16.67%, giardiasis – 12.5%, strongyloidiasis – 5.83% and of enterobiasis – 3.33%. The statistical significance of higher dirty hands–mouth contact frequency and more frequent presence of domestic animals in the tested group than in the control group was ascertained. A highly important correlation between the infection and the occurrence of symptoms from at least 3 various systems was ascertained. The presence of habits involving dirty hands – mouth contact and having domestic animals are significant risk factors of parasite infections. The presence of symptoms from at least 3 systems should compel to parasite infection diagnosis with proper differential diagnosis.

Key words: parasitic infection, *Ascaris*, *Toxocara*, *Giardia*, risk factors

Introduction

Epidemiological conditions, just like the clinical picture of parasite diseases are constantly changing, mainly due to the changes in human behavior and our environment. It is predicted that in future parasitic infections are not to disappear, but rather, to become different (tropical infections, opportunistic, connected with urbanization and with more frequent contact with wildlife) [1]. According to available data, the most popular parasitic infection is ascariasis, which afflicts, statistically, 800 million to 1,4 billion of worldwide human population. The prevalence of ascariasis is the highest in developing countries; it is found in 60% of Nigeria's population and in 68% of India's. Then again, the frequency of parasitic infections is the lowest in developed countries and for instance, in Japan it afflicts 0–5% of its citizens [2–4]. *Toxocara cati* and *Toxocara canis* infections are present in, depending on place of living, 2–80% of children, and enterobiasis in 4–28% [5] . What we also know from various sources is that strongyloidiasis affects 30 to 300 million people around the world.

Giardiasis' occurrence is quite varied and estimated at 2–5% of population in developed countries; this number is much higher in developing countries: 20–30% [6]. In Poland, the situation of parasitic infections is not fully known yet. The prevalence of ascariasis is estimated at 5–11.5%, depending on region [7–10]. The tests covering the population of north-eastern Poland were concerned with certain parasitic infections. Giardiasis was found in 1–9% of the group [1,11,12], and the presence of *Toxocara* antibodies – in 20.7% of them [13]. In the 1970s in south-eastern Poland 0.3% of population (mainly rural) was infected with *Strongyloides stercoralis*, chiefly by family infection [14,15].

The aim of this paper was analysis of frequency, risk factors and symptoms of certain parasite infections (ascariasis, giardiasis, toxocariasis, strongyloidiasis and enterobiasis) in children and adolescents in north-eastern Poland.

Material and methods

The tests covered 120 patients (aged 0–18) reporting symptoms characteristic to parasite infections, from December 2008 to May 2009. They were the patients of Dabrowa Bialostocka District Hospital Children's Ward (north-eastern Poland) and nearby children's outpatient clinic. In 90 of them an infection with one or two of the following parasites was found: *Ascaris lumbricoides*, *Giardia lamblia*, *Toxocara* spp., *Strongyloides stercoralis*, *Enterobius vermicularis*. 30 children that were not infected were the comparative (control) group.

The parents of the examined children filled out a survey. The questions were concerned with e.g. sex, child's environment, social and life conditions, hygienic habits and the ailments that were the cause of parasitological diagnosis. All the patients qualified for testing were thoroughly examined and measured anthropometrically, including their body mass and height. The survey's answers were the basis for results of this study. Medical University of Bialystok's Bioethic Committee gave their assent to conducting it. During it, the principles of Declaration of Helsinki were fully respected.

Diagnosing ascariasis and strongyloidiasis was based on positive results of microscope decantation stool tests (conducted 3 times). Data from written resources point to 30% sensitivity of a single stool test in identifying parasite eggs or larvae. Three subsequent tests have a total 50% sensitivity and seven of them reaches 100% [14,15]. Giardiasis was diagnosed on the basis of Giardia Lamblia protein qualitative immunochromatographic RIDA Quick Giardia (N1103) stool test. Sensitivity of this test is estimated at 80.0% and its specificity at ≥98% [16]. The data used in diagnosing toxocariasis were the positive results of serological ELISA blood test for identifying G class anti-*Toxocara* spp. excretory-secretory antibodies. This method is characterized by over 78% sensitivity and over 90% specificity [17]. Enterobiasis was diagnosed on the basis of medical history, as well as parent's report on the presence of pinworms in child's stool or anal region. Data from anthropometric measurements were compared with centile growth charts, thus marking each child's centile position. Cole's index was used for assessing patients' nutrition.

For statistical analysis, Stata/IC 11.0 application was used. Distribution normality of quantitative variables was tested by means of Shapiro-Wilk test. For testing the correlation between qualitative variables chi-square Pearson test was used, with Yates' correction used when it was necessary. Moreover, logistic regression function was used in order to find out if, basing on the number of affected biological systems, we can assign the patient to either tested (infected) or control group (not infected).

Results

The most common infection was ascariasis. *Ascaris lumbricoides* eggs in stool samples were found in 67 of 90 children (74.44%). Isolated infection was confirmed in 48 patients (53.33%), along with toxocariasis in 16 (17.78%), with giardiasis in 3 (3.33%). Second most common infection was the co-invasion of ascariasis and toxocariasis, which was found in 16 children (17.78%). Serological test results for *Toxocara* spp. infection were positive for 20 children (22.22%). Immunochromatographic stool test confirmed the presence of *Giardia lamblia* antigens in 15 of 90 children (16.67%). As a single infection, it was diagnosed in 10 children (11.11%), as a co-invasion with *Ascaris lumbricoides* in 3 children (3.33%), and with *Toxocara* spp. in 2 children (2,22%). *Strongyloides stercoralis* was diagnosed as a single one in 7 children (7.78%). *Enterobius vermicularis* was present in 4 children (4.44%) from the tested group (Table 1). It was also ascertained that most of the infections (66 instances) concerned children from 0–11 years old, and 24 instances – adolescents

Table 1. Frequency of parasite infections

Type of infection		Number of infected children	Percentage of infected children (N=90)	Percentage of tested children (N=120)
Single parasite infections	*Ascaris lumbricoides*	48	53.33	40.00
	Enterobius vermicularis	2	2.22	1.67
	Giardia lamblia	10	11.11	8.33
	Strongyloides stercoralis	7	7.78	5.83
Co-invasions	*Ascaris lumbricoides*, *Toxocara* spp.	16	17.78	13.33
	Ascaris lumbricoides, *Giardia lamblia*	3	3.33	2.50
	Toxocara spp., *Enterobius vermicularis*	2	2.22	1.67
	Toxocara spp., *Giardia lamblia*	2	2.22	1.67

(aged 12–18). In the adolescents examined not a single case of *Strongyloides stercoralis* was found (Table 2). The average age of infected children was 5.25 and 15.36 of adolescents. The median for all the infested was 7.72.

There were no statistically significant differences between the tested and control group according to the following factors: sex, environment (urban or rural), water source (waterworks or well), placement of water closet (indoors or outdoors), lack of hand washing with soap after using the toilet and before each meal, sleeping in one bed with siblings or parents, having a cat or a dog or fertilizing soil with animal manure (Table 3).

There was a statistically significant higher frequency (p=0.0002) of dirty hands–mouth contact in the tested group compared to the control group (respectively, 80% and 43.33%). Moreover, there was much higher frequency of domestic animals presence compared to control group (33.33% and 10%; p=0.009) (Table 3). Various parasitic infections were not the cause of malnutrition in the tested children; in 84.4% of cases, Cole index was about normal. In 10.0% of infected children over-nutrition was diagnosed, and minor malnutrition – in 5.56% (Table 4). Infections were accompanied with various organic and/or systemic symptoms. Statistically significant differences (p<0.001) were found between the tested and control group in frequency of the following symptoms: stomach ache (70% and 23.3%), loss of appetite (62.2% and 23.3%), sleep disturbances (45.56% and 3.33%), dark eye circles (37.78% and 0%), recurring respiratory airways ailments and irritation or nervous hyperactivity (35.56% and 3.33%), nausea (31.11% and 0%). Also, statistically significant differences (p<0.001) in frequency of systemic symptoms were found in both tested and control group in case of: digestive system (85.56% and 26.67%), general systemic symptoms (82.22% and

Table 2. Analysis of infected group and control group according to age

Type of parasite infection	Number of children			
	0–5 years old	6–11 years old	12–18 years old	0–18 years old
Ascaris lumbricoides	21	13	14	48
Toxocara spp., *Ascaris lumbricoides*	7	4	5	16
Giardia lamblia	2	5	3	10
Strongyloides stercoralis	5	2	0	7
Ascaris lumbricoides, *Giardia lamblia*	2	0	1	3
Enterobius vermicularis	0	2	0	2
Toxocara spp., *Giardia lamblia*	0	2	0	2
*Toxocara*spp., *Enterobius vermicularis*	0	1	1	2
Infected children in total	37	29	24	90
Control group	12	11	7	30

Table 3. Environmental-hygienic conditions in families of tested children

Tested factor		Tested group		Control group		p
		Number of children	Percentage [%]	Number of children	Percentage [%]	
sex	male	40	44.44	11	36.67	n.s. (non-significant)
	female	50	55.56	19	63.33	
environment	urban	46	51.11	18	60.00	n.s.
	rural	44	48.89	12	40.00	
water source	waterworks	79	87.78	29	96.67	n.s.
	well	11	12.22	1	3.33	
toilet	indoor	85	94.44	29	96.67	n.s.
	outdoor	5	5.56	1	3.33	
lack of regular hand washing	after using the toilet	29	32.22	10	33.33	n.s.
	before each meal	40	44.44	10	33.33	n.s.
sharing bed with siblings or parents		26	28.89	6	20.00	n.s.
dirty hands–mouth contact habit		72	80.00	13	43.33	<0.001
having cat or dog in the propriety		29	32.22	13	43.33	n.s.
having cat, dog or other animal in the household		30	33.33	3	10.00	0.009
fertilizing soil with animal manure		39	43.33	9	30.00	n.s.

43.33%), respiratory system (72.22% and 33.33%), cutaneous manifestations (65.56% and 3.33%) and psycho-emotional symptoms (58.89% and 10.0%) (Table 5). There was a highly significant correlation ($p<0.0001$) between infection and the presence of symptoms from at least 3 systems (Table 6).

Discussion

In the tested group comprising children and adolescents (120 people) there was a high infection percentage – 75%. The group for parasitic examination was not chosen accidentally; the patients were qualified to take part in those tests due to symptoms resembling parasite infection. The probability of parasite infection is always greater in the group of children suffering from various clinical symptoms than in the group with no symptoms at all. The presence of: recurring or chronic stomach ache, skin lesions, sleep disturbances or some respiratory system symptoms (asthmatic dyspnoea, catarrhal or conjuncitivitis symptoms) obliges us to carrying out comprehensive diagnostic actions, including comprehensive differential diagnosis. Unfortunately, there are not many publications on patognomic features of certain infections; probably, there are no such features at all. Urticaria, a symptom specific to allergy-induced diseases, is also found in case of ascariasis, giardiasis, toxocariasis and strongyloidiasis [18]. Stomach ache – the most common symptom of parasite infection in the mentioned research (70% of children), was as common as in patients with toxocariasis (77.8%) in Krzesiek et al.'s research

Table 4. Nutritional condition of infected children (N=90) according to Cole index

Cole's nutrition index	N	%	$\bar{x}$	sd	Me
severe malnutrition <75%	–	0	–	–	–
malnutrition (75%; 85%>	5	5.56	82.78	3.15	84
normal nutrition (85%; 115%>	76	84.44	99.02	8.14	98.55
overweight (115%; 120%>	2	2,22	118.60	1.27	118.6
obesity >120%	7	7.78	127.20	4.49	126

Table 5. Frequency of organic/systemic symptoms in group of infected children and control group

system	symptom	tested group N=90				control group N=30				p	
		N		%		N		%			
general systemic symptoms	loss of appetite	74	56	82.22	62.22	13	7	43.33	23.33	<0.001	<0.001
	headache		29		32.22		5		16.67		0.101
	fatigue		19		21.11		0		0.00		0.014
	fever only		19		21.11		1		3.33		0.023
	loss of body mass		16		17.78		0		0.00		0.029
	dizziness		13		14.44		2		6.67		n.s.
	high blood pressure		4		4.44		0		0.00		n.s.
digestive symptoms	stomach ache	77	63	85.56	70.00	8	7	26.67	23.33	<0.001	<0.001
	loose stool		35		38.89		3		10.00		0.003
	nausea		28		31.11		0		0.00		<0.001
	vomiting		20		22.22		0		0.00		0.004
	constipation		15		16.67		0		0.00		0.038
	anal itch		13		14.44		0		0.00		0.062
	severe abdominal pain requiring hospitalization		11		12.22		0		0.00		0.1
	appendectomy		2		2.22		0		0.00		n.s.
respiratory system	chronic catarrh	65	39	72.22	43.82	10	4	33.33	13.33	<0.001	0.003
	respiratory airways symptoms		32		35.56		1		3.33		<0.001
	chronic cough		29		32.22		3		10.00		0.017
	severe cough during sleep or after getting warm		26		28.89		4		13.33		0.088
	sore throat, no fever		24		26.67		0		0.00		0.001
	severe respiratory airways symptoms (bronchospasm or pneumonia)		12		13.33		0		0.00		0.079
skin symptoms	eye circles	59	34	65.56	37.78	1	0	3.33	0.00	<0.001	<0.001
	rash (no itching)		21		23.33		0		0.00		0.004
	skin itch		15		16.67		1		3.33		n.s.
	angular cheilitis		11		12.22		0		0.00		0.100
	perioral skin inflammation		8		8.89		0		0.00		n.s.
	urticaria		3		3.33		0		0.00		n.s.
	face and eyelid swelling		3		3.33		0		0.00		n.s.
Urinary tract	pollakiuria	14	8	15.56	8.89	3	0	10.00	0.00	n.s.	n.s.
	recurring urinary tract infections		5		5.56		3		10.00		n.s.
	bedwetting		4		4.44		0		0.00		n.s.
psycho-emotional symptoms	sleep disturbances (troubles with falling asleep, waking up, night fears)	53	41	58.89	45.56	3	1	10.00	3.33	<0.001	<0.001
	irritation or nervous hyperactivity		32		35.56		0		0.00		<0.001
	teeth grinding		22		24.44		2		6.67		0.035
Bone, joint and hematological symptoms	bone or joint ache	26	22	28.89	24.44	2	2	6.67	6.67	0.013	0.035
	anemia in medical history		2		2.22		0		0.00		n.s
	frequent epistaxis		2		2.22		0		0.00		n.s

Table 6. Polysystemic character of symptoms

Symptoms mentioned in Table 5	Number of systems	Infected group N=90			Control group N=30		
		N		%	N		%
Symptoms from at least 3 systems	7	2	75	83.33	0	0	0
	6	16			0		
	5	17			0		
	4	24			0		
	3	16			0		
Symptoms from up to 2 systems	2	11	15	16.67	11	30	100
	1	3			18		
	0	1			1		

[19]. In most of the infected patients concurrent symptoms from at least 3 systems were found (83.3% of patients). A smaller part of them had symptoms from 2 or 1 of the systems. Patients with severe abdominal pain (12.2%) and respiratory airways symptoms (13.3%) required hospitalization. The rest of patients had symptoms lasting for a couple of weeks or months, which made the parents consult a pediatrician. The majority of infections could be chronic, and the most frequent etiological factor was *Ascaris lumbricoides* (74.4%). There are many scientific sources telling that chronic ascariasis protects the infected organisms from the development of allergic process. There are some ongoing researches aiming at explaining mechanisms behind this phenomenon, due to tremendous increase in frequency of allergy-induced diseases in developed countries [20]. However, symptomatic cases of ascariasis and other infections require treatment because of clinical consequences such as: ailments' onerousness, vitamins and minerals (iron, calcium, magnesium) shortage, nutrient absorption disorders and immunity impairment, leading to some serious diseases [21]. Ascariasis treatment is also used to prevent the complications from this infection such as ileus, bile duct obstruction, bowel perforation, peritonitis, appendicitis or pancreatitis. Every year the number of people dying due to ascariasis complications reaches 10,000 worldwide [5].

The risk factors recognized as most significant in the tested group were: dirty hands – mouth contact habit (80%) and having cat or dog in the household (33.3%). Surely, fertilizing soil with animal manure in their parents' farms was harmful to children's health (43.3%) due to a possible spread of *Ascaris suum* eggs.

Ryngajłło in a group of 100 children infected with *Ascaris lumbricoides* observed a statistically significant correlation between being infected with that parasite and drinking water from well, draining waste to cesspool, eating unwashed vegetables and lack of hand washing after using the toilet and before meals [7]. The most common risk factor of parasite infection in our research was children's dirty hands–mouth contact habit along with increasing number of invasive parasite forms (eggs, cysts, larvae) present in their environment. The contamination with these forms is most prevalent in developing countries and in some other regions, where it is a common practice to fertilize farming soil with uncomposted animal manure – just like in Poland [22,23]. It is widely known that the following might be the source of pollution: sand, soil, dust, nasal discharge, fingernails, clothes, money, door knobs, furniture, classrooms, toilet seats, swimming pools, insects, dirty vegetables and fruit [5,21]. What we also know is the fact that *Ascaris* eggs are capable of surviving buried in the ground for a couple of months; given good climate conditions, like in Poland, they can retain their invasive potential for another 6–14 years [5,24,25]. Parasite forms die when exposed to: UV (intense, natural solar radiation), high temperatures (above 40ºC), dry conditions (with humidity below 4%), freezing (minus 12ºC for 3 months) [5,24]. Given this, Poland's climate conditions are not likely to destroy parasite eggs. The dispersive parasite forms are resistant to most anti-parasitic agents when dosed safely for mammals (as it is recommended) [24]. In recent years, it was found that *Ascaris suum* eggs might invade humans as well [5,7,26,27]. The genetic research conducted in Denmark proved genotypic compatibility of worms found in humans

with those in pigs. Also, there was a higher prevalence in people who consumed vegetables from pig manure-fertilized fields [27]. In Poland, the discharged eggs might be spread with animal manure, used as an organic fertilizer. They are resistant to unfavorable environmental conditions, which makes this sort of fertilization pose a danger of infection to environment or humans. What makes children's infection more possible a theory is the fact of symptoms recurrence intervals, which were shorter than 2 months. Clinical and scientific findings prove that in case of *Ascaris suum* human infection, time from swallowing the eggs to discharging them reaches 24–29 days (and is shorter than in ascariasis: 67–76 days). In such circumstances, this kind of infection has to be ruled out – given that the developmental cycle is the shortest in children up to 4 years old [5]. In our research, 43.3% of families of the tested children fertilized field and garden soil with animal manure (e.g. pig).

Each year, the number of people with toxocariasis is growing. The reasons for this are manifold, e.g.: growing number of animals in our environment, neglecting personal hygiene and parasite prevention practices. [19,28]. It is estimated that 36% of cities' dogs and cats and about 70% of young dogs in the country are infected with *Toxocara*. 60% of the owners deworm their animals, but not cleaning one's own dog feces is quite a popular practice in our country; density level of parasite eggs in cities is becoming alarming. *Toxocara* spp. eggs are found in 30–70% of tested samples coming from sandboxes, alleys, parks, urban or rural properties [24]. This parasite's habitat are sand or soil, preferably mixed with feces, insufficiently washed vegetables/fruit and fur [29], and its invasive eggs might survive when in soil up to 10 years [19]. It is toxocariasis that, along with ascariasis, giardiasis or enterobiasis was second most common parasite infection in the tested group of children (22.2%). Hemanowska-Szpakowicz's research found that in north-eastern Poland, 20.7% of tested people had *Toxocara* antibodies in serum [13]. The analysis of soil contamination conducted in several Polish cities showed that the most common parasite was *Toxocara* spp. [19]. In our study, 32.2% of families had cat or dog in their proprieties (as much as 43.3% in the control group).

Toxocariasis is one of the most common helminthzoonosis in the developed countries. The risk of infection is high both for rural and urban regions [25]. It is usually diagnosed accidentally, basing on laboratory tests conducted due to other reasons (eosinophilia, high IgE concentration in serum) conducted due to other reasons [25,30].

Both this and other infections might be either asymptomatic or cause a variety of organic or systemic symptoms (stomach ache, headache, limb pain, decreased appetite, rash, cough, fever, emotional hyperactivity). This sort of infection might be manifested generally (visceral larva migrans), which includes: hepatomegaly, splenomegaly, lymphadenopathy, fever, cough, intense stomach ache. Even the presence of *Toxocara* larvae in the eyeball does not have to give any symptoms, but eventually, may be the cause of impaired visual acuity and blindness [25]. Due to a high risk of eyeball invasion, anti-parasite therapy has to be employed every time when infection is diagnosed, even if there are no clinical symptoms [25,31]. In Poland, one of the newest parasite threats is *Baylisascaris procyonis*. In our country, raccoon population (local host of *Baylisascaris procyonis*) is already quite numerous. Due to the fact that raccoons willingly live in and come to human habitats, there are many raccoon latrines nearby proprieties, which present danger to our kind. Little children are exceptionally exposed to this because of their dirty hands–mouth contact habit and sometimes, geophagy. Moreover, the probability of dogs being infected and exposed to parasite invasion makes their feces a potential source of human infection. Compared to other nematodes' larvae, *Baylisascaris procyonis* migrate through tissue more aggressively and tend to reach central nervous system and eyeballs. There is no good serological diagnosis method nor effective treatment for people with baylisascariasis [32,33].

In order to prevent parasite infections as well as their recurrence we should aim at: eliminating the habit of dirty hands–mouth contact, harmful personal hygiene practices and lessening environmental pollution by de-worming domestic animals and pigs, as well as fertilize only with composted animal manure. In pediatric practice, the possibility of child's infection with polysystemic clinical symptoms has to be taken into account. It is worth remembering that helminths and protozoa together make 25% of all the etiological factors of infection-induced diseases (bacteria – 38%, fungi – 22%, viruses – 15%) [21].

Conclusions

1. In the examined region of north-eastern Poland a high percentage of single or co-invasive infections was ascertained (75%). The most common infection was ascariasis.
2. Presence of such habits as dirty hands–mouth contact (biting fingernails, putting hands, toys and other item into mouth) and having domestic animals are important risk factors of parasite infections.
3. In case of symptoms such as: abdominal pain, loss of appetite, sleep disturbances, irritation or nervous hyperactivity, recurring respiratory airways symptoms or nausea, parasite infection has to be taken into account. The presence of symptoms from at least 3 systems should compel to parasite infection diagnosis with proper differential diagnosis.

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