Prevalence and risk factors for giardiasis among primary school children in Damascus, Syria

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ABSTRACT

الأهداف: تقييم انتشار الإصابة بطفيلي الجيارديا اللمبليّة بين تلاميذ المدارس الابتدائية في مدينة دمشق وريفها و تحرّي عوامل الخطورة المحتملة للإصابة.

الطريقة: أجريت هذه الدراسة المقطعيّة العرضيّة على أطفال المدارس من ٢٣ مدرسة ابتدائيّة في دمشق خلال الفترة بين شهريّ آذار و حزيران لعام ٢٠٠٦. تم جمع البيانات من ١٤٦٩ طفلاً من كلا الجنسين ومن المناطق الحضريّة والريفيّة باستخدام الاستبيانات المهيكلة و القياسات البشريّة بالإضافة إلى التحاليل المخبريّة لعيّنات البراز. تمّ تحرّي الطفيلي باستخدام عيّنة وحيدة وفحصها بالطريقة الرطبة المباشرة تحت المجهر الضوئيّ.

النتائج: لقد أظهرت النتائج أنّ ٢٠٦ طفلاً من الـ ١٤٦٩ (١٤٪) كانوا مصابين بالجيارديّة اللمبليّة بينما وجد ١١٩ (٨٫١٪) طفلا مصابين بأنواع أخرى من الطفيليّات المعويّة. كما أظهرت النتائج عدم وجود ترابط بين الإصابة بالجيارديّة وبين أيّ من عمر الطفل أو جنسه أو الإقامة في المناطق الحضريّة أو الريفيّة أو توافر المياه المنقولة بالأنابيب أو وجود نظام شبكيّ للصرف الصحيّ. من جهة أخرى فقد وُجد أن المستوى التعليميّ للأمّ وللأب بالإضافة لعدد الأخوة في المنزل كانت عوامل تنبّؤ هامّة إحصائيّاً للأصابة بالجيارديا (قيم p كانت ٠٫٠٠٣ و ٠٫٠١٨ و ٠٫٠١٤ بالترتيب). أمّا بالنسبة للحالة التغذويّة للأطفال فقد بيّنت النتائج أنّ ٦٫٦٪ من الأطفال كانوا مصابين بالتقزّم و ١٫٨٪ بنقص الوزن و ٤٫٧٪ بالهزال لكن الإصابة بالجيارديّة لم تكن عامل تنبّؤ لهذه الحالات.

خاتمة: يمكن تصنيف منطقة دمشق كمنطقة ذات انتشار متوسط للإصابة بداء الجيارديّات وبناءً عليه يتوجب على المسؤولين المحليّين إعارة انتباه أكبر للوقاية من العدوى بهذا الطفيلي بالإضافة لتطوير التعليم و تحسين البيئة و الظروف الصحيّة.

Objectives: To evaluate the prevalence of giardiasis in primary school children in Damascus city and the countryside, and to investigate the possible risk factors for giardiasis infection.

Methods: A cross-sectional study was carried out on school children from 23 primary schools in Damascus, between March and June 2006. Data were collected from 1469 children of both genders from urban and rural regions using structured questionnaires, anthropometric measurements, and laboratory analysis of fecal samples. The parasites were detected using a single-stool sample by direct wet examination under light microscope.

Results: Two hundred and six (14%) of 1469 children were infected with *Giardia lamblia,* while 119 (8.1%) were found infected with other sorts of intestinal parasites. No correlation was found between giardiasis and age, gender, residence in urban or rural areas, availability of piped water or sewage system. In contrast, both mother's (p=0.003) and father's (p=0.018) levels of education, and the number of siblings in-home (p=0.014) were found significant predictors of giardiasis. As for children's nutritional status, 6.6% were found to have significant stunting, 1.8% had underweight, and 4.7% had wasting. Giardiasis, however, was not found a predictor of these conditions.

Conclusion: The Damascus region could be classified as medium-prevalence area for *Giardia* infections. Thus, the local administrators need to pay more attention to the prevention of parasitic infections along with improvement in education, environmental, and sanitary conditions.

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Giardia lamblia is a protozoan parasite, and has been recognized as the most common intestinal pathogen worldwide, with an estimated number of $2.8x^{10}$ infections per year in humans.[1] It is found in both the developing,[2] and developed countries.[3] In developed countries, *Giardia* has been implicated as a cause of diarrhea among children in day-care centers.[4] It has also been associated with diarrheal illness among campers,[5] swimmers,[6] and those travelling abroad, usually to less developed countries.[7] In developing countries, however, giardiasis is endemic and considered as a health problem. That is due to a high prevalence especially among children aged 4-12 years,[8-10] with little available information on epidemiological factors contributing to its transmission. *Giardia lamblia* spreads from person to person, and from animals to humans through fecal-oral transmission. It has an incubation period of 3-25 days (median 7-10 days), and has a 2-stage life cycle trophozoite, and cyst.[11] The mechanisms by which *Giardia lamblia* causes diarrhea, and intestinal malabsorption remains controversial. There is evidence, however, that *Giardia lamblia* can produce variable degrees of mucosal injury and, at the same time, influence conditions in the intestinal lumen, which could impair digestion and absorption.[12]

In Syria, a number of limited studies have been performed during the last decades on *Giardia,* and showed a prevalence of 22-24%.[13,14] Most of the results of these studies are contained in national documents or presented at local conferences, and are not generally available. This situation motivated a more extensive work. In this cross-sectional study, we surveyed the prevalence of *Giardia lamblia* by stool examination among children attending primary schools in Damascus, Syria. We also aimed to investigate possible risk factor for giardiasis, and to shed light on the possible relationship between *Giardia lamblia* carriage (symptomatic and/or asymptomatic), and weight and height indices in children.

Methods.

Study areas and study population. Damascus, the capital and largest city in Syria, is located at 33° 30' north parallels and 36° 19' east longitudes. The climate is very Mediterranean, however, there is a long dry season from May - October. Summers are hot and rainless (dry), with an average August temperature of approximately 30°C, winters are cold and rainy, and the average January temperature is approximately 4.4°C. The annual rainfall is approximately 255-510 mm.

Calculating sample size. The estimated population of pupils aged 6-12 years in Damascus is 299290.[15] The prevalence of *Giardia* found by previous studies is approximately 24%, with a maximum deviation of ±1.9%, and a confidence level of 90%, the estimated minimum sample size is 1361 pupils. No preset exclusion criterion was used, and all children in their first, second, third, or fourth levels were eligible for the study. Parents of children signed an informed consent form, and all children who agreed voluntarily through their parents were included in this study. Of 2316 children studied, only a total of 1469 (63.4%) delivered specimens for examination, and analyses was based on these children. The samples were collected from 23 primary school children of both genders. These children, aged 6-12 years, were representative of the general primary school population in terms of age, gender, socioeconomic status, and place of residence. A multistage stratified random sample was selected for the study. A school was randomly selected from each of Damascus' 23 regions (11 in the city, 12 in the countryside). In the second sampling stage, in each school 100 pupils were chosen randomly 25 from each of the 4 class levels involved: 1st grade, (374), 2nd grade (336), 3rd grade (364), and 4th grade (395). This study was performed between March and June 2006, and data were collected using a structured questionnaire, anthropometry, and laboratory analysis of fecal samples. This study was approved by the Research and Ethical Committee, Faculty of Medicine, University of Damascus, Syria

Stool examination. A single stool specimen was collected from students in a plastic container, and examined under light microscope using a saline-Lugol method to identify the presence of *Giardia lamblia* (cyst or trophozoite form).[16] When found negative, another smear was prepared and re-checked. The literature showed that this method is likely to detect almost 50-80% of cases of *Giardia lamblia*.[16-18] Later, results were given to parents via class teachers. It is worth mentioning here that detecting other types of parasites was not in the focus of this study. However, when an evidence of infection was found accidentally in the specimen, the case was reported.

Structured questionnaire. Children were given questionnaires, which enquired about their health status (diarrhea and gastrointestinal symptoms), previous infections by parasites, numbers in a household, education and occupation of parents, and source of drinking water and sewage system.

Anthropometry. All children underwent anthropometrics measurement by trained clinical investigators as follows: children were weighed using digital scales (0.1 kg scale), and height was measured using a supine measuring board (0.1 cm scale). Weight-for-age (WA) Z-score was used to denote underweight as an overall indicator for malnutrition. Height-for-age (HA) Z-score was used as an indicator for stunting (chronic malnutrition). Weight-for-height (WH) Z-score was used as an indicator for wasting (acute

malnutrition). We defined children as underweight if their WA Z-score was >2SD below the mean, stunted if their HA Z-Score was >2SD below the mean, and malnourished if their WH Z-score was >2SD below the mean.[19]

Statistical analysis of data was performed using the Statistical Package for Social Sciences version 13. Univariate and multivariate logistic regression were used to find out the effects of demographic and social factors on giardiasis infection. As for growth status indices, Z-scores for weight-for-age, height-for-age, and weight-for-height were derived using EpiNut Anthropometry (EpiInfo, CDC, Atlanta, GA, USA). This compared the subject's measurements to international National Centre for Health Statistics (NCHS) growth reference curves. The cut-off point used to identify malnourished children was less than -2 standard deviation units (SD) below the NCHS reference median. Tests were considered significant when the 2-sided *P*-value was <0.05.

Results. Out of the 1469 participants who responded to the study, 697 were boys and 762 girls, aged between 6-12 years, 819 live in rural areas whereas 650 in urban areas. Stool examination revealed the presence of *Giardia lamblia* in 206 (14%) children. In general, boys had a higher prevalence of giardiasis than girls. However, this difference was not statistically significant (χ^2=1.55, p=0.213). Similarly, children in rural areas tend to be more prone to infection than their counterparts living in urban areas, however, this difference did not reach a significant level ((χ^2=1.17, p=0.279) (**Figure 1**). On the other hand, infection with other parasites was also detected in 119 children (8.1%), with *Entamoeba coli* (5.6%) coming second, and *Blastocystis hominis* (2%) third in prevalence after *Giardia lamblia* (**Table 1**).

Univariate analysis identified both mother's (p<0.01) and father's levels (p<0.05) of education as significant predictors of giardiasis infection (**Table 2**). The number of in-home siblings has also been identified as a significant predictor of giardiasis (p<0.05). However, other factors including the age, gender, residence, source of drinking water, and type of sewage system were not found significant risk factors (**Table 2**). Predictors at p<0.2 in univariate analysis were entered into multivariate logistic regression model using stepwise (forward; likelihood ratio) method to eliminate possible confounding relationships among variables, and indicate the variables that showed statistical significance. Here, only mother's level of education was found a statistically significant independent variable (OR=1.97, 95% CI 1.29-3.01, p=0.002).

Among the 1469 subjects enrolled in this study there were 6.6% stunted, 1.8% underweight, and 4.7% wasted. Comparison between children with giardiasis and without any parasite, revealed no correlation between giardiasis and any of these 3 classifications of under-nourishment conditions (**Table 3**).

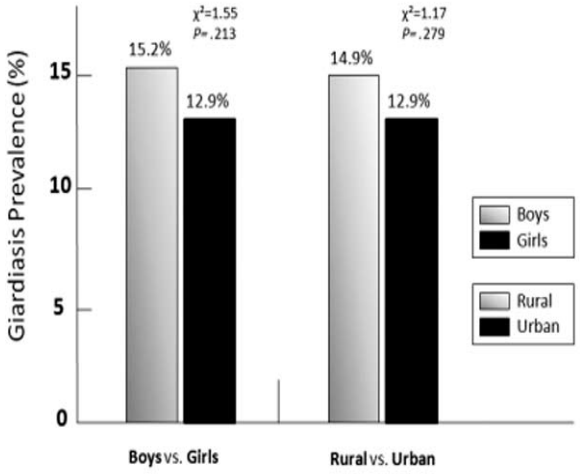

Figure 1 - Giardiasis prevalence among primary school children in Damascus, Syria, according to gender and place of residency.

Table 1 - Intestinal parasites identified in 1469 school children in Damascus, Syria.

Parasite	N (%)
Giardia lamblia	206 (14.0)
Other parasites	119* (8.1)
Entamoeba coli	82 (5.6)
Blastocystis hominis	29 (2.0)
Iodamoeba butschlii	16 (1.1)
Fungi	5 (0.3)
Endolimax nana	5 (0.3)
Ascaris lumbricoides	2 (0.1)
Enterobius vermicularis	2 (0.1)
Entamoeba histolytica	1 (0.1)
Hymenolepis nana	1 (0.1)
Chilomastix mesnilii	1 (0.1)
Entamoeba hartmanni	1 (0.1)

*Some samples contained more than one type of parasites.

Discussion. *Giardia lamblia*, also known as *Giardia intestinalis* or *Giardia duodenalis*, is considered one of the main health problems in the developing countries.[20,21] This study has revealed that 14% of the 6-12-year-old school children surveyed had *Giardia lamblia* detected by single stool examination. However, it should be noted that these results were obtained from the examination of a single stool specimen for

Table 2 - Univariate logistic regression analysis of potentially modifiable risk factors for giardiasis infection among 1469 school children, aged 6-12 in Damascus, Syria.

Variables*	Giardiasis (+)	Giardiasis (-)	OR*	*P*-value	CI 95%
	n (%)				
Gender			1.21	0.214	0.90-1.62
Boys	107 (15.2)	597 (84.8)			
Girls	99 (12.9)	666 (87.1)			
Residence			1.18	0.280	0.87-1.59
Rural	122 (14.9)	697 (85.1)			
Urban	84 (12.9)	566 (87.1)			
Drinking water			1.16	0.437	0.80-1.69
Not piped	41 (15.4)	226 (84.6)			
Piped water	153 (13.5)	978 (86.5)			
Sewage system			1.24	0.397	0.76-2.03
No network	21 (16.0)	110 (84.0)			
Network	162 (13.4)	1051 (86.6)			
Father's level of education			1.59	0.018	1.08-2.32
Low-medium	149 (15.2)	834 (84.8)			
High	37 (10.1)	328 (89.9)			
Mother's level of education			1.89	0.003	1.24-2.86
Low-medium	154 (15.2)	856 (84.8)			
High	29 (8.7)	304 (91.3)			
Age mean±SD	1.4 ± 8.6	1.4 ± 8.6	1.00	0.958	0.90-1.11
Siblings at home mean±SD	2.7 ± 4.2	2.3 ± 3.8	1.10	0.014	1.02-1.14

*Number of cases might not add up to 1469 for each variable due to variant response rate to different questions, OR - odds ration, CI - confidence interval

Table 3 - Association between giardiasis and child growth status, measured by weight and height indices. n (%)

Detected parasites	Height-for-age	Weight-for-age	Weight-for-height
		≤2SD	
No parasites	79 (6.9)	20 (1.7)	59 (5.2)
Giardia (+)	10 (4.9)	3 (1.5)	9 (4.4)
Other Parasites (+)	8 (6.7)	3 (2.5)	1 (0.8)
Total	**97 (6.6)**	**26 (1.8)**	**69 (4.7)**
P-value	0.28	0.77	0.63

χ^2 test was used to compare under scored weight and height indices (>2 SD), in children infected with *Giardia* against those who were not found infected with any parasites

each subject, which could lead to an underestimation of parasite prevalence.[17] Our study showed a higher prevalence of giardiasis than other studies in the region as it was in Saudi Arabia (10.9%),[22] Oman (10.5%),[21] and in Gaza Strip (8%).[24] However, it was less than the prevalence in other surrounding countries, such as 35% reported from Egypt,[25] 36% in Jordan,[21] and 16.5% in Turkey.[26] Previous stool surveys, in Syria itself, have indicated that approximately 22-24% of primary school children studied were infected with Giardiasis.[13,14] The recent improvement in domestic water supply with the introduction of a desalinized water treatment plant to Damascus region, combined with better sanitation and health education is likely to have a marked effect on prevalence of water-borne intestinal infections within the local population in the short run including *Giardia lamblia*.

While most of the previous studies reported no difference in the prevalence of giardiasis between genders,[27,28] several other studies found boys more prone to be infected than girls.[29,30] The present study, indeed, found no differences in the prevalence of giardiasis between genders (χ^2=1.55, p=0.213). Similarly, many studies found that the prevalence of *Giardia lamblia* rises during childhood, and only begins to decline during early adolescence.[10,30] presumably as protective immunity is acquired. In the current study, however, no significant age-related difference was found, and age was not found a predictor of giardiasis. This agrees with other studies, which reported no statistically significant difference of giardiasis in children of different age groups.[23,31,32]

Cysts of *Giardia* can survive for 3 months in water at 4°C. They are transmitted to a new host through contaminated water, or food, or by person-to-person, or animal-to-person contact. The inoculum required for infection in humans is between 10 and 100 cysts.[32] The number of people in the house was determined due to the higher possibility of contamination in crowded places. In our study, children living in houses occupied by more siblings were more prone to being infected with *Giardia lamblia* (p<0.05), with a 10% increase in the odds of giardiasis for each extra one sibling. Transmission of giardiasis, which appears to be endemic in the Damascus area is likely to occur by person-to-person transfer, especially among active children from the ages 6-12 years, who are most vulnerable to infection. Alternatively, an important factor which predisposes to high endemicity of water-borne infections like *Giardia* in specific areas within Damascus is the lack of urban systems of piped-water supply and sewage disposal. In our study, no significant correlation was found between the availability of piped water and the overall presence of giardiasis. Without further study and clarification, however, the precise route of endemic protozoan transmission in the Damascus area remains uncertain, as fecal-oral infections can not be ruled out depending on the information collected in this study.

Several authors have reported the lack of a significant association between giardiasis and stunting in young infants,[34] or older children.[35] In contrast to these findings, many other authors have reported significant reductions in the linear growth of *Giardia*-infected children.[36-40] A study in Brazil reported that children with symptomatic infections had significantly lowered weight-for-age and height-for-age.[9] Muniz-Junqueira and Queiroz,[41] in their study observed *Giardia*-infected children had decreased weight-for-age and weight-for-height Z-scores. A recent study of Ecuadorian children reported that *Giardia*-infected children had risk for stunted growth that was twice that of other children.[42] This study, however, found no significant relationship between giardiasis, and decline in linear growth of children. Clinical features of giardiasis may range from diarrhea to constipation, nausea, abdominal pain, and flatulence. However, many patients infected with *Giardia lamblia* do not present symptoms or damage in the small intestine. These asymptomatic individuals are important reservoirs for the spread of infection, and are less likely to seek treatment due to the absence of the clinical symptoms. Some studies provided evidence on the role of the asymptomatic carriers in the person-to-person transmission.[43] This evidence strongly supports the need to detect and treat the asymptomatic infections. In the current study, we tried to highlight the prevalence of giardiasis in children in Damascus. However, among the limitations of this study is that due to practical and resource constraints, we took only one sample of feces for each child. It is possible here that some patients have not been captured by the one-go test. Repetition of the specimen would have increased the sensitivity of the test. Another issue is that being a cross-sectional study, it was not able to clearly investigate the possible relationship between giardiasis and growth failure in children. Following up children prospectively would have strengthened our ability to detect the correlation between these 2 factors.

Despite previously mentioned limitations, we concluded that our study is by far, the largest attempt to gauge the prevalence of giardiasis in Syrian children. It offers crucial data that has important implications, and considered a crucial feedback for local administrators for their recently made efforts to improve environmental and sanitary conditions in the area. More studies should be conducted in this field, which use more accurate diagnosis methods (such as repetition of the specimen).

Moreover, there needs to be a longitudinal study which follows up children with giardiasis to directly observe the infection's implication on their growth.

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