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Original Article

The Prevalence of Urinary Schistosomiasis among School Children in Abougoudam and Chokoyan in Ouaddaï, Chad

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Abstract

Background: Schistosomiasis is the second most prevalent global parasitic endemic, following malaria. It is caused by trematodes of the *Schistosoma* genus. We aimed to evaluate the incidence of urinary schistosomiasis and the associated risk factors in educational institutions.

Methods: The investigation was conducted in two primary schools in Abougoudam and Chokoyan City, Chad from December 2021 to February 2022. Parasitological analyses were performed at the laboratory of Abeche Provincial Hospital and Chemistry and Microbiology Laboratory of National Higher Institute of Science and Techniques of Abeche (INSTA) in Chad. In the study 273 scholars, namely 136 males (49.82%) and 137 girls (50.18%), from two primary schools in two localities, were enrolled.

Results: The overall prevalence of *Schistosoma haematobium* was 42.86%. Boys had a prevalence of 44.85%, while females had a prevalence of 40.88% ($P>0.05$). The prevalence in the Chokoyan locality was 53.38%, while it was 32.86% in the Abougoudam locality ($P<0.05$). The prevalence of pupils in the [5-10] age group was 29.73%, while that of the [11-15] age group was 51.85% ($P<0.05$). 100% of the pupils who were afflicted were administered 40 mg/kg praziquentel.

Conclusion: *S. haematobium* is present in both localities; therefore, health education campaigns should be implemented to prevent the onset of this parasitosis and to facilitate the establishment of a national program to combat helminthiasis. *S. haematobium* bilharziasis continues to be a significant public health issue in Chad.

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Introduction

Water-dependent parasitic diseases, such as schistosomiasis or bilharzia, are prevalent worldwide, with a particular emphasis on sub-Saharan Africa (1). In 2017, the WHO estimated that this disease affected 250 million individuals in 52 countries worldwide and resulted in 800,000 fatalities annually (2). Schistosomiasis is a significant public health issue in endemic countries, with 42 of them located in Africa (3,4). It is the second most prevalent endemic disease in tropical and subtropical regions, following malaria (2). The disease is currently affecting nearly 800 million individuals worldwide (5).

Urinary schistosomiasis is caused by *S. haematobium*, a flatworm of the trematode class from the genus Schistosoma that lives in the urinary tract's venous circulatory system. The disease is propagated by snails that live in contaminated stagnant waters and act as intermediary hosts for the parasitic worm. These snails produce cercariae, free-swimming larvae capable of getting into people's skins, into the water. Once within the body, the cercariae move to the blood vessels surrounding the urogenital system and mature into adult worms. The female trematode produces eggs that reach the bladder, producing urinary tract symptoms and possibly leading to bladder wall tumors. The eggs are discharged into the water along with the urine and eventually enter the mollusk to complete the cycle (6,7). The disease is the cause of significant physical, social, and economic difficulties (7).

In Chad, national survey has not yet been conducted to evaluate the distribution of urogenital bilharziasis throughout the country, and the province of Ouaddaï is even less well-documented. In other regions of Chad, there have been a few rare studies conducted on this subject. For instance, the prevalence rates for urinary schistosomiasis were 26.4%, 24.9%, 39.2% and 23.24%, respectively, in N'djamena in the Sahelian zone (8), in Torrock and Rong population in the Sahelo-Sudanian zone (7), the population residing around the Ounianga lakes in the Sahara (9) and in Abeche commune in the Sahelian zone (10). Furthermore, Visclosky et al. (11) recently reported a haematuria rate of 55% in school-age children in the Salamat region of the Sudanian zone, which was caused by *S. haematobium* infection.

We aimed to ascertain the prevalence of urinary schistosomiasis in two localities (Abougoudam and Chokoyan) in the province of Ouaddaï that have not been previously documented as potential transmission sites for this disease. Additionally, the investigation identifies the primary risk factors that are associated to this transmission.

Materials and Methods

Ethical approval

The National Bioethics Committee of Chad granted ethical authorization for this protocol study, under the number N°004PT/PM/MESRI/SE/SG/CNBT/SG/2023. From the health Sub-division delegates of Ouaddaï and the National Education and Civic Promotion delegates of Ouaddaï, sampling survey authorizations were obtained. The Director of the Abeche Sub-Division Hospital authorized the parasitology procedures conducted in the laboratory. The purpose of the study was communicated to school pupils, instructors, and parents, and parental consent was obtained.

Study period and locations

The study was carried out in two different areas in the province of Ouaddaï, eastern Chad, from December 2021 to February 2022, in Abougoudam and Chokoyan in Ouaddaï Province (Fig. 1). It is bounded by the Wadi Fira region to the north, Sudan to the east, Dar Sila to the south, and Batha to the west, covering an area of 29,980 km^2 (12). The province of Ouaddaï faces a hot tropical Sahelian climate, with annual precipitation varying from 300 to 600 mm. Ouaddaï observes relatively moderate temperatures, with an average of 28 °C.

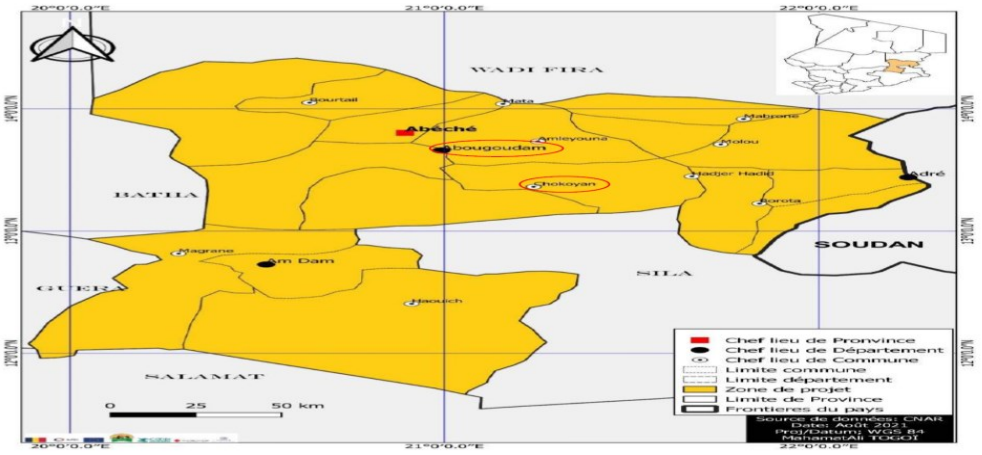

Fig. 1: Study area showing Abougoudam and Chokoyan in Ouaddaï province (CNAR, 2021)

Study population

The current study was a prospective cross-sectional investigation that assessed primary education scholars between the ages of five and fifteen. This age group was selected for several reasons: the highest intensities of specific parasitic infestations are typically recorded (13); children of this age were less hesitant to undergo mass examinations (14); they are easy to contact; they reflect the level of parasitic infection in the community (14); and they are particularly susceptible to infestation for hygienic, recreational, and behavioral reasons (15).

Inclusion criteria

The study included all boys and girls between the ages of 5 and 15 who were regularly enrolled in one of the selected schools, had been a resident of the study area for a minimum of 6 months, had not been dewormed in the three months prior to our arrival at their school, and had received written consent from their parent or guardian.

Exclusion criteria

The study excluded any child under the 5 years or over the 15 years who was not enrolled in one of the selected schools, or who was enrolled but had been dewormed less than three months prior to our arrival at the school, and whose parent or guardian had not provided written consent for enrolment.

Samples collection and analysis

In practice, each participant was provided with a 60 mL container that was sterile, hermetically sealed, and labeled in order to collect a fresh urine sample. After being collected, the samples were stored in an insulated cooler with ice packs for approximately 12 hours. They were subsequently sent to the laboratory at Abeche Provincial Hospital and the Chemistry and Microbiology laboratory of INSTA for parasitological analysis.

The urine was initially examined macroscopically to determine its color, and subsequently examined microscopically to detect *S. haematobium* ova as previously described (16). In actuality, a conical-bottomed tube was used to introduce a volume of 10 mL into each urine sample after homogenization. The tube was then agitated and centrifuged at 1000 rpm for 10 minutes. The supernatant was discarded, and the particle's fractions were measured between the coverslip and slide until the pellet was depleted. The x10 objective was used to observe, followed by the x40 objective (17). In accordance with WHO guidelines, the district nurse administered Praziquantel to pupils whose urine contained *S. haematobium* ova in the presence of their instructors (14).

Statistical analysis

SPSS version 20.0 (IBM Corp., Armonk, NY, USA), software was used to analyze the data. The Chi-square test was employed to compare the rates of infestation among genders, age categories, and living environments, as well as to identify risk factors associated with urinary schistosomiasis. A statistically significant value was defined as $P<0.05$.

Results

Characteristics of the study population

A total of 273 students participated in the study, with 137 girls (50.18%) and 136 boys (49.82%), with 133 from Abougoudam and 140 from Chokoyan.

The results of the analysis indicate that the proportion of boys who participated in this study was statistically significantly higher ($P<0.05$) than that of girls in Abougoudam. Conversely, the proportion of females in the survey was statistically significantly higher ($P<0.05$) than that of males in Chokoyan. Furthermore, the percentage of students in Chokoyan who participated in the current survey was statistically comparable to that of students in Abougoudam ($P>0.05$), with 48.72% and 51.28%, respectively (Table 1).

Table 1: Distribution of study subjects by gender and locality

Localities	Genres			
	N (%)	**Girls n (%)**	**Boys n (%)**	***P*-value**
Abougoudam	140 (51.28)	55 (40.15)	85 (62.50)	0.0004
Chokoyan	133 (50.72)	82 (59.85)	51 (37.50)	0.0005
Total	273 (100)	137 (100)	136 (100)	>0.05

N: total number, n: number

Parasitism as a function of socio-demographic variables

The prevalence of *S. haematobium* ova was recorded as 42.86%, with 117 out of 273 pupils eliminating them (Table 2). Gender analysis did not reveal any substantial disparities in prevalence. The prevalence of urinary bilharziasis varies between age groups and between localities, as illustrated in the table below. The smallest schoolchildren were less affected than their elders (29.73% vs. 51.85%), and individuals from Chokoyan were more impacted than those from Abougoudam (53.38% vs. 32.86%).

Table 2: *Schistosoma haematobium* egg excretion rates by genus, age group and locality

Parameter/ modalities	**Number of students examined**	**Number of students affected (%)**	***P*-value**
Genre			0.05
Male	136	61 (44.85)	
Female	137	56 (40.88)	
Age groups			0.0004
5 – 10 years	111	33 (29.73)[b]	
11 – 15 years	162	84 (51.85)[a]	
Locality			0.0006
Abougoudam	140	46 (32.86)[b]	
Chokoyan	133	71 (53.38)[a]	
Total	**273**	**117 (42.86)**	

For the same column, values carrying the same superscript letter are not significantly different at $P>0.05$

Schoolchildren practising faecal peril, i.e. 45.70%, were discovered to be carriers of *S. haematobium* ova. This prevalence was much higher than that of those who reported having latrines in their residences, i.e. 27.9% ($P<0.05$).

Of the pupils who drank borehole water, 53.7% excreted *S. haematobium* eggs in their urine; however, a significant proportion of the study participants (35.7%) who reported having well water in their residence were carriers of *S. haematobium* eggs ($P<0.05$).

A significant number of pupils (55.7%) who verified that they had bathed in marigots tested positive for parasites. Nevertheless, there were no instances of infestation among children who reported that they had never bathed at the marigot ($P<0.05$).

Pupils who reported washing their clothing and utensils near waterholes were diagnosed with an infection rate of 40.8% of *S. haematobium*. In comparison to the 48.6% of children who reported that they never laundered their garments around water sites, this percentage is relatively lower.

S. haematobium ova were carried by 43.0% of children who resided in close proximity to a watercourse, as opposed to 42.4% of those whose residences were located at a greater distance from a watercourse. These two percentages are statistically equivalent ($P>0.05$) (Table 3).

Table 3: Main risk factors associated with urinary schistosomiasis

Parameters	Pupils examined (%)	Pupils infected (%)	χ^2	*P*-value
Latrines at the home				
Yes	43 (15.75)	12 (27.9)	4.69	0.04
No	230 (84.25)	105 (45.7)		
Access to water				
Drilling	108 (39.56)	58 (53.7)	8.58	0.003
Well	165 (60.44)	59 (35.7)		
Swimming in the marigots				
Yes	210 (76.92)	117 (55.7)	61.43	0.0002
No	63 (23.08)			
Laundry, washing-up				
Yes	201 (73.63)	82 (40.8)	1.32	0.25
No	72 (26.37)	35 (48.6)		
Neighboring watercourses				
Yes	214 (78.39)	92 (43.0)	0.007	0.93
No	59 (21.61)	25 (42.4)		

For the same column, values carrying the same superscript letter are not significantly different at $P>0.05$

Discussion

The study's objectives were to evaluate the prevalence of urinary schistosomiasis in schoolchildren in two locations within the Ouaddaï province in the Sahelian zone of eastern Chad and to pinpoint the primary risk factors linked to the parasitosis's spread. The selection of study areas, Abougoudam and Chokoyan, was determined by a variety of factors, including the presence of a suitable target population, the likelihood of a parasite-risk context, and accessibility and logistics. It is obvious that Abougoudam and Chokoyan are

readily accessible sites, which facilitates the efficient organization of student follow-up, sampling, and visitation. Additionally, the presence of institutions with a sufficiently large and reachable population of the age group under investigation facilitates the collection of samples and the conduct of mass examinations. These locations may be suitable for parasite transmission due to their hygiene, behavioral, or environmental conditions, which justifies their inclusion in the investigation of infestations in susceptible populations. In Chad, very few studies have been conducted on the occurrence of schistosomiasis (7-10). No study has been conducted in our study areas.

The study included 273 students in total. 140 samples (51.28%) were obtained from the Abougoudam area, while 133 samples (48.72%) were obtained from the Chokoyan area. Boys made up 49.82% of the study's subjects, while female subjects made up 50.18%. As a result, the sex ratio was 1.01, which was marginally in favor of women. Bagayan et al. (18) found that 50.77% of the population were girls and 49.23% of the population were boys in Burkina Faso. The children in this study ranged in age from 5 to 15 years, and they were split into two age groups: 5–10 years and 11–15 years, with corresponding proportions of 111 (40.66%) and 162 (59.34%). Similar proportions have been reported in a number of studies (19-21).

S. haematobium infestations occurred in 117 out of the 273 participants sampled during this study, yielding an overall prevalence of 42.86%. Moser et al. (8) (39%) and Vislosky et al. (10) (55%) in the Salamat province and the people living around the Ounianga lakes in the Chadian Sahara, respectively. Compared to Chad and other places, this current percentage is higher than that reported among schoolchildren in the town of Abeche (23.24%) (10). The increased frequency reported in our study may be attributed to the population's hygienic circumstances in these towns, which were characterized by the lack of latrines and poor hygienic conditions which led in a high infestation rate.

In the Sahelian zone of Chad, Hamit et al. (8) reported a lower prevalence (26.24%) among schoolchildren in N'djamena. In the Sahelo-Sudanian zone of Chad, Lalaye et al. (7) observed a prevalence of 24.9% in the populations of Torrock and Rong. In the commune of Péhunco in northern Benin, Ibikounlé et al. (22) reported a prevalence of 29.40%. In south-west Cameroon, Green et al. (23) and Sumbele et al. (24) reported prevalences of 31.5% and 32.6%, respectively. The prevalence of *S. haematobium* was comparable between males (44.85%) and girls (40.88%) in our study. Additionally, certain authors have discovered no correlation between the gender of the host and urinary schistosomiasis (9, 25-26). On the other hand, other studies assert that there is a correlation between urinary schistosomiasis and humans (8,7,18,27,28). The absence of a disparity in the presence of *S. haematobium* between boys and girls in the current study may be attributed to the fact that boys' and girls' students in Ouaddaï province conduct in the same manner toward impermanent water when they are at school, which is separate from their family homes. The presence of a substantial estuary in close proximity to the school likely contributed to the predominant prevalence of *S. haematobium* among schoolchildren in the Chokoyan locality. This marigot was a genuine recreational area for the students, particularly during the hottest months of the year; as a result, it would exacerbate the risks of schistosomiasis transmission.

The results of our analysis also indicated that the prevalence of this parasitosis was substantially higher (P=0.0004) among pupils in the 11-15 years' group (51.85%) than in the 5-10 years' group (29.73%). The present result is in accordance with the results obtained by Amollo et al. (29) in southern Kenya and N'Gbesso et al. (30) in southern Côte d'Ivoire. However,

it is in contradiction to the findings of Bagayan et al. (18) in Burkina Faso, who demonstrated that urinary schistosomiasis affects children of all ages at the same level. Additionally, Sulieman et al. (31) found no significant difference in *S. haematobium* prevalence between children of two age groups in a village in Nile State, Sudan. Opara et al. (32) in the South of Nigeria and Faith et al. (28) in the municipality of Owena in Ondo State suggest that urinary schistosomiasis is more prevalent among the youngest pupils (aged between 5 and 10 years). In our situation, the study concurs with Poda et al. (33) that the low infestation rate among young children (5-10 years) can be attributed to the fact that they are under parental obligation and are unable to spend extended periods in water sources where there is a danger of infection or drowning.

The study also observed that the risk of contracting this disease was reduced by avoiding bathing (prevalence = 0.0%) and using latrines (prevalence = 27.9%) in marshes, as well as residing away from water collection points (prevalence = 6.12%). The same observation was made in Agnéby region of south-eastern Ivory Coast among school-age pupils. (34), and among pupils in Katsina, in Nigeria (35). Children are at a heightened risk of schistosomiasis infestation due to their close contact with water, such as when they bathe.

The absence of statistically significant correlations between the presence of urinary schistosomiasis and the proximity of watercourses, on the one hand, and the washing of clothes and dishes, on the other hand, is primarily attributable to the failure of school-age children to adhere to basic hygiene protocols (8).

Some limitations were identified in this study. First, the inclusion of pupils from other schools would represent an interesting alternative to the traditional model, which only uses one school per locality, thus broadening the representativeness of the data. Second, since the excretion of parasite ova is frequently intermittent, performing tests on a single urine sample is not sufficient; it would be necessary to repeat the analyses on three samples taken several days apart to improve diagnostic sensitivity. Finally, the failure of internal quality control during slide reading is a significant limitation that could influence the reliability of the results.

Conclusion

Urinary schistosomiasis occurs frequently in Abougoudam and Chokoyan. Its distribution is inconsistent between the two locations. The hygienic and environmental conditions that are conducive to the development of intermediate hosts and the dissemination of *S. haematobium* ova are significantly associated with the infestation of pupils. Public authorities are required to establish a national program to combat schistosomiasis in order to combat this disease. This program will be responsible for a variety of tasks, including the development of drinking water sites, the organization of ongoing screening surveys and treatment campaigns, and the promotion of public awareness.

Conflict of interest

The authors declare that they have no competing interests.

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