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Full Length Research Paper

Assessment of praziquantel efficacy against school age schistosomiasis in Kelo, Chad

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Abstract

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Background: Schistosomiasis is a major endemic parasitic disease in sub-Saharan Africa, particularly affecting school-age children. Praziquantel, administered in a single dose of 40 mg/kg, is the standard treatment recommended by the WHO. Samples were collected using a pre-established questionnaire. Of the 250 children examined before mass treatment, 200 students were recruited. The study had many limitations, mainly the post-treatment follow-up period, which was limited to three months, making it impossible to assess long-term reinfection dynamics. In addition, no measurement of parasite intensity (number of eggs/10 ml of urine) was performed, which would have allowed for an assessment of the effectiveness on parasite load, and the sample size was limited (200 students), which does not necessarily reflect the full diversity of the health district. **Methodology:** This study, conducted on children aged 6–14 years from five primary schools who received a dose of praziquantel in the Kélo health district (Chad), aimed to evaluate its therapeutic efficacy in a school setting. Children were recruited from May to July 2022. **Results:** A total of 200 students aged 6–14 years were included. Before treatment, the prevalence of Schistosoma haematobium was 28%. Three months after praziquantel administration, prevalence dropped to 3.5%, corresponding to a cure rate of 96.5%. The persistence of positive cases, observed in some schools, is likely linked to poor hygiene conditions and the risk of reinfection. **Conclusion:** These results confirm the high efficacy of praziquantel but highlight the need to combine treatment with complementary water, sanitation, and hygiene measures.

Keywords: Schistosomiasis-Praziquantel-Therapeutics-School-age-Kélo.

INTRODUCTION

The program to combat neglected tropical diseases (NTDs) in Chad not only treats schistosomiasis, but also develops an action plan against tropical diseases in health districts. It improves coverage of NTD treatment, including schistosomiasis, by providing access to treatment for all affected populations. Health agents have been trained to distribute drugs in villages and communities and to explain transmission, treatment, and case management. The NTD control program also includes an approach involving teachers, who distribute

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drugs in schools. Schistosomiasis is a parasitic disease caused by helminths of the genus Schistosoma, responsible for significant morbidity in tropical and subtropical regions (Zhang, 2019; Burden, 2019). Schistosomiasis affects 240 million people in the world, making it the second most common parasitic disease after malaria. According to the World Health Organization (WHO), 700 million people live in endemic areas and are therefore at risk of contracting the disease. Chemoprevention against schistosomiasis was needed in 50 countries, and 134.9 million school-age children and 118.9 million adults required treatment (WHO, 2013). World Health Organization. 2013. Assessing the efficacy of anthelminthic drugs against schistosomiasis and soil-transmitted helminthiases. Geneva: World Health Organization. It is among the most widespread neglected tropical diseases (NTDs), affecting over 200 million people worldwide, nearly 90% of whom live in sub-Saharan Africa. The World Health Organization (WHO, 2002) classifies schistosomiasis as a major public health problem due to its health, economic, and social impacts. In sub-Saharan Africa, school-age children are particularly vulnerable because of frequent contact with contaminated water, leading to high prevalence and morbidity in this age group (Mehadji, 2021). School-age children are at higher risk due to recreational or domestic activities in contaminated water. High prevalence in schools affects children's health (anemia, growth retardation, learning difficulties) and academic performance (Adenowo et al., 2015; Stecher et al., 20). Limited access to praziquantel and poor water, sanitation, and hygiene (WASH) conditions are key barriers to controlling schistosomiasis in endemic countries (Reinhard-Rupp et al., 2017; Montresor et al., 2022). Praziquantel, administered as a single dose, remains the reference treatment. It is recommended by the WHO, effective, low-cost, and well-tolerated (Bergquist, 2017; Timson et al., 2020; Nogueira et al., 2022). Variations in its therapeutic efficacy have been reported depending on parasite intensity, nutritional status of children, and risk of rapid reinfection (Tadele et al., 2023; Keiser et al., 2013). Regular evaluation of praziquantel's effects is essential to adapt control strategies. In Chad, schistosomiasis remains a major public health issue, particularly among school-age children. Despite efforts by the National Program for the Control of Neglected Tropical Diseases, the disease remains endemic in several health districts, including Kélo. Few studies have documented the actual efficacy of praziquantel in school settings in this district. The present study aims to evaluate the therapeutic effects of praziquantel on school-age schistosomiasis in Kélo. The findings will provide scientific data to strengthen control programs in Chad.

Research question:

prevalence and intensity of urinary schistosomiasis among school-aged children in endemic areas of Kélo, Chad?

Hypothesis:

Praziquantel administration among school-aged children in Kélo significantly reduces the prevalence and intensity of urinary schistosomiasis.

General objective

Evaluate the therapeutic effects of praziquantel on schistosomiasis in school settings in the Kélo health district, Chad.

Specific objectives

1.Determine schistosomiasis prevalence before and after treatment.
2.Evaluate parasitic clearance rates following praziquantel administration.
3.Identify factors associated with incomplete therapeutic response.

Methodology

The children were recruited voluntarily by the research team. Sociodemographic data were collected using a data collection form. Each child received two containers, one for urine samples and the other for stool samples. Parasitological examination was performed using the Kato-Katz method or urine filtration. Children who tested positive received a single dose of praziquantel at a dose of 40 mg/kg. After three (3) months, the team returned to evaluate post-treatment follow-up through parasitological and clinical monitoring**.** We can explain the unique detection of S. haematobium by the fact that children do not use latrines to urinate. Eggs present in the environment are easily carried away in stagnant water. The next time they swim in stagnant water or in the river, children are easy targets for the eggs.

Size calculation

To estimate the initial prevalence of schistosomiasis with an accuracy of ± 5% and a confidence level of 95%, the sample size must be calculated using the following formula: $n = Z^2 \times p\,(1 - p)/d^2$. The minimum sample size was determined using the following formula:

$$n = \frac{Z^2 \times p(1-p)}{d^2}$$

- Z=1.96, corresponds to a confidence level of 95%,
- p= represents the estimated previous local prevalence of schistosomiasis in Kelo Province,
- d=0.05 the precision

As we have no prevalence data for these schools, we randomly selected 200 children from the five schools, based on 40 students per class. We estimate that this sample is representative. Unfortunately, we do not have previous data on local prevalence in the schools studied. However, for logistical and feasibility reasons, we recruited 200 students (40 per school). We believe that this sample size is more than sufficient to analyze differences between schools. The results are well-presented, but consider adding: Confidence intervals for the prevalence and cure rates to provide a range of estimates. We calculated these using the following formula:

$$IC = p \pm 1.96 \times \sqrt{\frac{p(1-p)}{n}}$$

- p = observed proportion (96,5 %, 3,50%)
- n = sample size (total = 200);
- 1.96 = 95% confidence intervals

Study Type and Period:

Prospective descriptive observational study over three months (May–July 2022).

Study Setting:

Selected schools in Kélo city, Tandjilé province, Tandjilé West department.

Target Population:

Children aged 6–14 years who received mass drug administration (MDA) with praziquantel in 2022, residing in villages served by the five surveyed schools.

Sampling frame

The study population consisted of the official lists of students enrolled in the five schools selected for the year 2022. The sample was selected in two steps:

- **School selection:** five (5) schools were chosen based on solid reasons. According to local health data, the prevalence of schistosomiasis in Kélo was 22.4% in 2015;
- **Selection of children:** in each school, 40 children were selected at random using a simple draw from the list of names provided by the school administration. A replacement list was provided to replace any absences or declines to participate.

A pre-established questionnaire was used. of 250 children tested before treatment, 200 were recruited. Two diagnostic techniques were applied: Kato-Katz for stool examination and filtration for *S. haematobium* eggs in 10 ml of urine.

Patient Enrollment:

Children from the 2022 survey were included with verbal parental consent. Each child received two containers for urine and stool samples. Samples were preferably collected at 10 a.m. after physical activity to facilitate egg excretion. Positive children received a single oral dose of praziquantel 40 mg/kg. Praziquentel 600 mg tablets, Cesol™ 600, batch number M42286, Expiry date Jul 2028, dosage and administration: 40 mg/kg body weight and manufactured by Merck, S.A. de C.V., Mexico

Ethics:

Approval was obtained from the University of Toumai and the Kélo health district. Participation was voluntary and authorized by school directors.

Statistical Analysis:

Data management and analysis we used the simple one-t test and bidirectional ANOVA of version 10 of GraphPaD.

Results

Of the 200 recruited children, 62% (124/200) were boys and 38% (76/200) girls. Children aged 12–14 were the most represented (55%), followed by 9–11 years (32%) and 6–8 years (13%) (Figure 1). We have not registered any notable adverse effects; praziquantel is well tolerated.

Praziquantel Treatment:

Before treatment, 250 children were examined; 200 were enrolled (80% recruitment rate). Microscopically, 28% (56/200), were infected with *S. haematobium*, while most children were negative (72%, or 144/200). S. mensoni was not detected.

The table presents the proportion of children cured and reinfected three months after the administration of a single oral dose of praziquantel (40 mg/kg), along with their 95% confidence intervals (95% CI). Prevalence fell to 3.5% (7/200), representing a cure rate of 96.5% (193/200).

The differences between these schools were not statistically significant (ns, p = 0.990), suggesting that the variability observed may not be due to the response to treatment itself but rather to environmental or behavioral factors. The much lower prevalence observed in other schools suggests that praziquantel was highly effective in reducing the burden of infection **(Figure 3).**

School Hygiene Conditions:

Hygiene and sanitation were poor: Bayaka lacked both

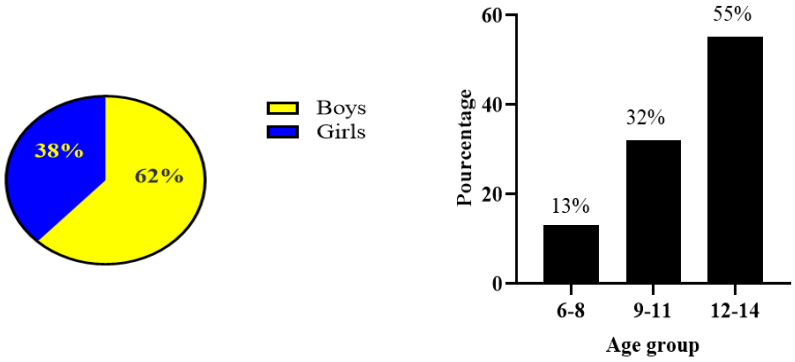

Figure 1: Distribution of children by sex and age group.

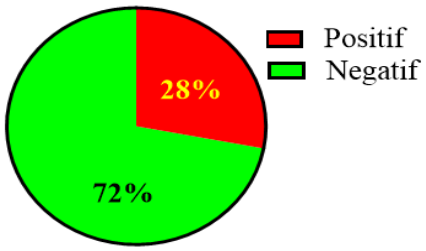

Figure 2: Distribution of parasite presence before treatment

Table I: Treatment response in children diagnosed.

Patients	Proportion	IC à 95 %
Cured	96,50% (193/200)	[93,95 %; 99,05 %]
Reinfected	3,50% (7/200)	[0,95 %; 6,05 %]

potable water and latrines, and Bagaye Dewé had latrines but no water source **(Figure 4).**

In this figure, we see that the differences observed between schools for the presence of latrines are not statistically significant (p = 0.1040). Given the sample sizes, it is not possible to state with certainty that the presence or absence of latrines directly and measurably influences the persistence of infection. Epidemiologically, even if the difference is not significant, the absence of latrines remains a recognized risk factor in the transmission of schistosomiasis.

Discussion

This study found an initial prevalence of urinary schistosomiasis of 28% among schoolchildren in the Kélo health district, with a parasitological clearance of 96.5% three months after praziquantel treatment. Children aged 12–14 years were the most affected (55% infected with *S. haematobium*), likely due to increased exposure through play in marshes and agricultural activities, as well as involvement in household chores. The difference in praziquantel efficacy between schools could be explained by the following reasons:

- In some cases, either the doses administered were insufficient due to errors in weight calculation, or the drug was not well absorbed.
- It has been reported that praziquantel works principally on adult parasites and is less effective on younger forms of the parasite.

Finally, immunity varies from one child to another. These

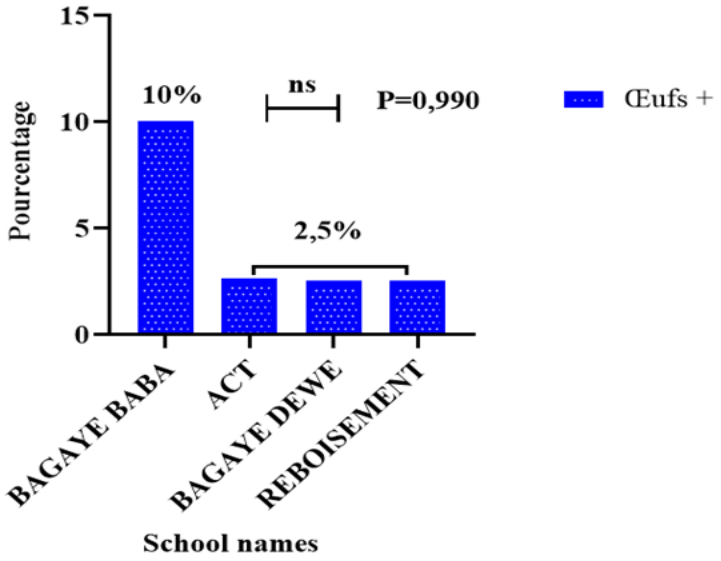

Figure 3: Distribution of parasites after treatment and by school

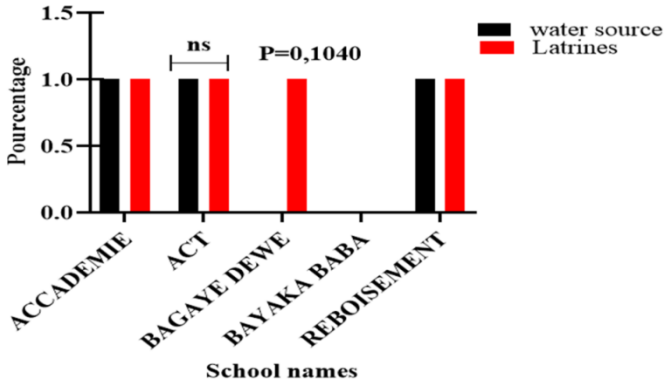

Figure 4: Hygiene and sanitation in the schools surveyed.

findings are consistent with reports from other African countries, although lower efficacy has been observed in moderate or heavy infections (Tafese et al., 2023). For example, Ojurongbe et al. (2014) in Nigeria reported parasitological efficacy above 80%, whereas Tchuem Tchuenté et al. (2013) in Cameroon found rates between 20% and 40%. High exposure to stagnant water, a well-documented risk factor, explains much of the variability (Fok et al., 2024; Charles et al., 2024). Praziquantel generally achieves significant reductions in infection intensity (Tadele et al., 2023; Adenowo et al., 2014; Stecher et al., 2017), consistent with our observations. Some studies have reported reduced efficacy in certain contexts (Botros, 2007; Wang, 2012; Xiao, 2018; Isaac, 2022).

The cure rate was 96.5%, with a 95% confidence interval ranging from 93.95% to 99.05%. The reinfection or persistent infection rate was 3.5%, with a 95% CI of 0.95% to 6.05%. These findings demonstrate a substantial reduction in schistosomiasis burden following mass drug administration. The persistence of a few positive cases may be explained by rapid reinfection, particularly in schools with inadequate water, sanitation, and hygiene conditions, or by incomplete parasite clearance in some individuals. Overall, this table confirms that praziquantel is highly effective for the

treatment of schistosomiasis among school-aged children in the Kelo health district. However, the occurrence of residual infections highlights the need to complement chemotherapy with integrated water, sanitation, and hygiene (WASH) interventions to achieve sustainable disease control.

In Chad, praziquantel has been used in mass drug administration for school-aged children since 2016. Post-treatment prevalence in this study dropped to 3.5%, representing an 88% reduction. Tafese et al. (2023) reported an 85.2% cure rate and a 93.3% egg reduction four weeks after a single 40 mg/kg dose, confirming the high efficacy of praziquantel, in line with WHO recommendations (>70% parasitological efficacy) WHO, 2020). Persistence ofinfection may result from immature *Schistosoma* stages, as praziquantel is ineffective against these stages (WHO, 2002). Despite ongoing transmission due to water retention sites and poor sanitation, reinfection is likely. Louis Fok et al. (2024) reported a 97% cure rate after standard treatment, particularly for light infections. Similarly, Tchuem Tchuenté et al. (2013) reported cure rates of 83.3% in Bessoum, 89.0% in Ouro Doukoudje, and 95.3% in Makenene, with no post-treatment mixed infections detected. In our study, a 3.5% post-treatment infection rate and 96.5% cure rate support WHO's strategy of monitoring infection reduction as a public health goal. These results confirm the effectiveness of mass praziquantel treatment in school settings. Contextual factors, including poor hygiene and lack of potable water, influence reinfection rates. Variability between schools (10% in Bagaye Baba vs. 0% in Académie) highlights the impact of environmental and sanitation conditions (Reinhard-Rupp, 2017; Montresor et al., 2019). Similar patterns have been observed in Cameroon and Tanzania, where post-treatment infection persistence correlates with sanitation (Stothard et al., 2013). Overall, these findings provide critical insights into the efficacy and challenges of controlling school-age schistosomiasis in Chad.

Conflict of Interest

The authors declare no conflict of interest. IMS and BC from the Ministry of Public Health and Prevention are solely responsible for the study results.

Conclusion

This school-based study in Kélo confirmed the therapeutic efficacy of praziquantel against urinary schistosomiasis. Prevalence dropped from 28% pre-treatment to 3.5% three months post-treatment, achieving a 96.5% cure rate. Persistent cases and school disparities underline the role of sanitation in transmission and reinfection. Mass treatment campaigns should be complemented with clean water access, latrines, community awareness, and control of transmission hotspots to reduce prevalence and aim for long-term elimination. The study showed that praziquantel was highly effective in the schools studied. However, 3.5% of treated children were reinfected. Further research is needed to investigate the mechanisms of resistance in these parasites.

Acknowledgments

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Limitations of the Study

The study had many limitations, principally the post-treatment follow-up period, which was limited to three months, making it impossible to assess long-term reinfection dynamics. In addition, there was no measurement of parasite intensity (number of eggs/10 mL of urine), which would have made it possible to evaluate the effectiveness on parasite burden, and the sample size was limited (200 students), which does not necessarily reflect the full diversity of the health district.

- The study was conducted in only five schools, chosen for their accessibility and presumed endemic status. Schools not included in the study, particularly those located in more rural areas, may have different characteristics;
- The techniques used have limited sensitivity, particularly when the parasite charge is low, and some students may be incorrectly reported as negative;
- As the study assessed children three months after praziquantel administration, it is difficult to distinguish between recent reinfection and persistent parasites due to incomplete therapeutic efficacy.
- Post-treatment follow-up limited to three months, which does not allow for an assessment of long-term reinfection dynamics;
- The small sample size (200 students), which does not necessarily reflect the full diversity of the health district.
- Lack of long-term parasitological follow-up: the cure rate was only assessed three months after treatment. This period does not provide sufficient time to evaluate the durability of the therapeutic response or the real rate of reinfection in the medium or long term.
- Uncontrolled environmental factors: the study did not include direct measurement of environmental parameters such as water quality, host mollusk density, and community sanitation

practices. These unmeasured variables may significantly influence transmission dynamics and schistosomiasis persistence.

Recommendations

- Strengthen communication to change behaviors.
- Provide latrines and clean drinking water.
- Avoid contact with contaminated water.

Perspectives

We plan to sequence reinfestation samples to examine the polymorphisms of the praziquantel resistance gene and conduct a study at many sites with a large number of samples.

Policy Implications

We make the following suggestions to the authorities in order to improve parasite control:

- Facilitate the supply and distribution system for praziquantel in endemic areas;
- Diversify the mass treatment strategy in the provinces of Chad.
- Make praziquantel available in health centers;
- Strengthen the capacity of health personnel to better treat cases.

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