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Prevalence of schistosomiasis in pre-school children in the Kasansa rural health zone in Kasai-Oriental province, Democratic Republic of the Congo

Prévalence de la schistosomiase chez les enfants d'âge préscolaire dans la Zone de santé rurale de Kasansa au Kasaï- Oriental, en République Démocratique Du Congo

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Résumé

Contexte et objectif. Le contrôle de la schistosomiase cible principalement les enfants d'âge scolaire et, dans une moindre mesure, les adultes à risque. Cependant, des études récentes ont rapporté des prévalences élevées chez les enfants d'âge préscolaire. La présente étude visait à évaluer la prévalence de la schistosomiase chez les enfants d'âge préscolaire dans la zone de santé de Kasansa et à identifier les facteurs de risque associés. *Méthodes.* Une étude transversale a été menée dans six AS de la ZS de Kasansa. Les enfants d'âge préscolaire ont été recrutés par échantillonnage à plusieurs degrés. La détection des schistosomes a été effectuée à l'aide des techniques de Kato-Katz et de filtration urinaire. Des analyses bivariées et multivariées ont été réalisées pour identifier les facteurs de risque associés à la schistosomiase.

Résultats. Au total, 368 enfants d'âge préscolaire ont été examinés. La prévalence de la schistosomiase était de 30,4 % (IC 95 % : 25,9 – 35,3), avec *Schistosoma mansoni* comme l'unique espèce détectée. La prévalence variait significativement selon les AS, allant de 0% à 53,5 %. Résider dans les AS de Kasansa (ORa = 16.5 ; p = 0,0001) ou de Nsangu (ORa = 9.2 ; p = 0,0001) était associé à un risque accru, tandis que se baigner avec de l'eau de puits semblait constituer un facteur protecteur (ORa = 0,3 ; p = 0,0077).

Conclusion. Cette étude a révélé une forte prévalence de la schistosomiase intestinale chez les enfants d'âge préscolaire dans la ZS de Kasansa.

Mots-clés : *Schistosoma mansoni*, *Schistosoma haematobium*, schistosomiase, Kasansa, âge préscolaire

Summary

Context and objective. Schistosomiasis control focuses primarily on infections among school-aged children and, to a lesser extent, on at risk-adults. However, recent studies in Africa have reported high prevalence among preschool children. The present study aimed to assess the prevalence of schistosomiasis among preschool children in the Kasansa health zone (HZ) and to identify associated risk factors. *Methods*. A cross-sectional study was carried out in six health areas (HA) of the Kasansa rural HZ. Preschool children were recruited through multistage sampling. Schistosome infection was assessed using the Kato-Katz and urine filtration techniques. Bivariate and multivariable analyses were used to identify risk factors associated to schistosomiasis. *Results.* A total of 368 preschool children were examined. The overall prevalence of Schistosomiasis was 30.4% (95% CI: 25.9 - 35.3), with only *Schistosoma mansoni* detected. Prevalence varied significantly across the studied HAs, ranging from 0% to 53.5%. Residing in the Kasansa (aOR =16.5; p= 0.0001) or Nsangu (AOR =9.2; p= 0.0001) HAs was associated with increased risk, whereas bathing with well water appears to be protective (aOR =0.3; 0.0077).

Conclusion. The study revealed a high prevalence of intestinal schistosomiasis among preschool children in the Kasansa HZ.

Keywords: *Schistosoma mansoni*, *Schistosoma haematobium*, schistosomiasis, Kasansa, preschool age
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Introduction

Schistosomiasis is a parasitic disease caused by six species of the genus *Schistosoma* infecting humans: *Schistosoma mansoni*, *S. haematobium*, *S. japonicum*, *S. mekongi*, *S. intercalatum*, and *S. guineensis* (1- 4). Despite control efforts, schistosomiasis remains a major global health issue in developing countries especially in South Saharan Africa. It ranks third among the most devastating tropical diseases, with severe health and socioeconomic impacts (3,5-7). It is prevalent in underserved communities lacking access to clean water and adequate sanitation, making it one of the most neglected tropical diseases (8-9).

The disease causes significant morbidity and mortality, along with adverse effects on young population health, including malnutrition, anemia, stunted growth, and cognitive impairments (5,9). Over 250 million people are affected by schistosomiasis worldwide, contributing to an estimated 70 million disability-adjusted life years (10-11). Global mortality estimates for schistosomiasis vary widely, from 24,072 to 200,000 deaths per year, according to the World Health Organization (WHO) (12).

Current control efforts focus primarily on mass treatment for school-age children and, to a lesser extent, for adults (13-15). However, reports of infections among infants and preschool children (ages 2 to 5) are rising in African countries such as Ghana, Kenya, and Tanzania, with prevalence rates ranging from 14% to 86% (16-18). Despite this, children under six are not yet included in the current schistosomiasis control policy (5). Neglecting this age group may perpetuate schistosomiasis transmission in the community, with a considerable clinical impact. Early childhood infection can potentially lead to severe long-term complications due to the inefficacy of delayed curative treatment (5). The Democratic Republic of the Congo (DRC) has long been recognized as highly endemic for schistosomiasis, with transmission reported in nearly every province since colonial times (19-21). *Schistosoma mansoni, S. haematobium and S. intercalatum* are the three *Schistosoma* species found in the country (19, 22). The distribution of these species varies by area with *S. mansoni* being the most widespread (19). The disease burden varies from province to province and even between different local foci within a province (19, 23). Schistosomiasis prevalence in the DRC ranges from 1% to 92%, based on studies primarily among school-aged children and adults (24-28).

Kasai-Oriental is one of the most schistosomiasis-endemic provinces, with the rural health zone (HZ) of Kasansa identified as a significant schistosomiasis hotspot (19, 23). Recent studies have reported prevalence rates of up to 95% among school-aged children in certain health areas (HA) (19, 23, 29-30). However, there is little epidemiological data on schistosomiasis among preschool-aged children in the DRC overall, and specifically in Kasai-Oriental, particularly in the Kasansa HZ. To fill this gap, the study aimed to assess the prevalence of schistosomiasis among preschool children in the Kasansa HZ and to identify associated risk factors.

Methods

Design, period and setting

We conducted a cross-sectional study on preschool children (aged 2 to 5 years) across six HAs within the rural HZ of Kasansa from May 25 to June 25, 2021. The HAs included Dinsanga, Kashila, Kasansa, Lac Lomba, Nsangu, and Nsenga-Nsenga. The Kasansa HZ is situated in the Tshilenge territory of Kasaï-Oriental province, in the central part of the DRC (Figure 1). This HZ was selected due to its long-standing endemicity of schistosomiasis dating back to the colonial era, the high prevalence of the disease among school-aged children (23), and the absence of data on preschool-aged children. This HZ is characterized by an extensive hydrographic network of rivers and lakes, including the Lubilanji, Monzo, Nsenga-Nsenga, Nsangu, Muya, Nsulu, Kajiba, Tshiabelaja, Kamilangala, Kabua, and Kalelu rivers, as well as the Lomba and Ndinga lakes (Figure 1).

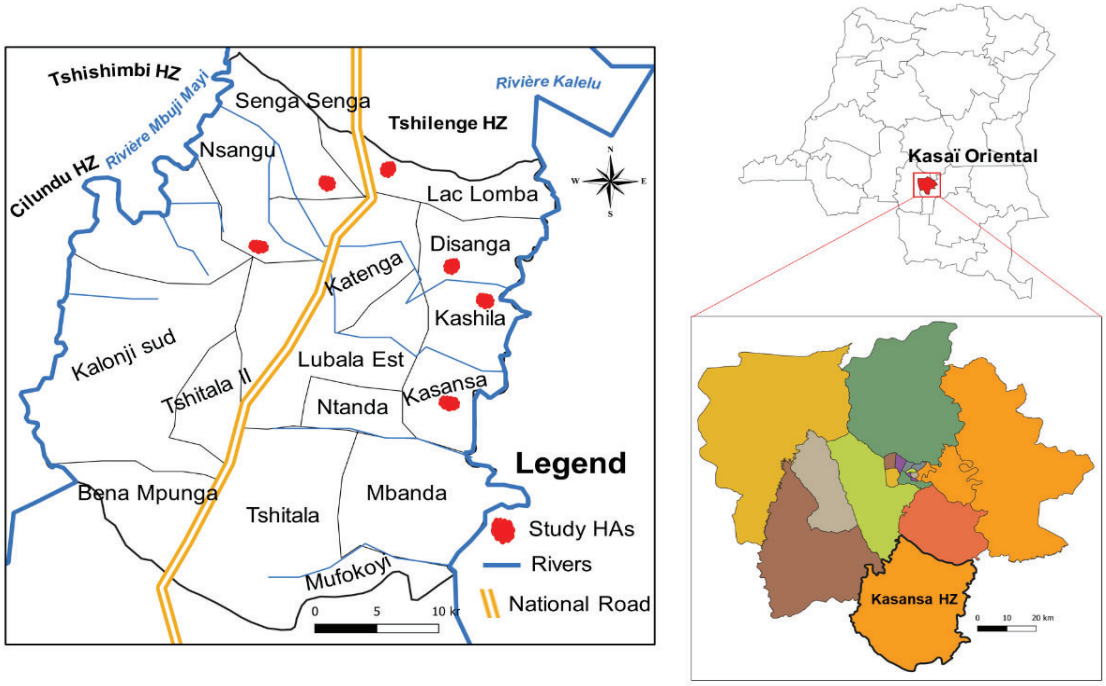

Figure 1. Study Sites. (HAs: Health Areas, HZ: Health Zone)

The inhabitants rely on these water sources for their daily activities, such as washing clothes and dishes, fishing, and personal hygiene.

Sampling Procedure

A four-stage sampling procedure was used, as follows:

- The first level consisted of a reasoned choice of study province,
- The second level consisted of a reasoned choice of HZ,
- Six HAs were randomly selected, and this constituted the third level: From the 19 HAs that make up the Kasansa HZ, we randomly selected the six mentioned above. Randomization was performed using Microsoft Excel by assigning each health area a random number with the =RAND () function. The list was then sorted in ascending order, and the first six health areas were selected.
- The fourth level was the recruitment of pre-school children. This was a non-random, exhaustive selection of children.

A minimum sample size of 246 children was calculated using the formula below:

- Z: Z-score, 1.96 for 95% confidence level;
- p = Schistosomiasis prevalence in the Kasansa HZ. We used the schistosomiasis prevalence found by Mupoyi et Linsuke in 2013 on school-aged children in the Kasansa HZ (p=0,83) (23);

- e = Margin of error (5%).

Assuming a non-response rate of 20%, the required sample size was 260 children.

Eligibility Criteria

- Inclusion criteria:

Children were eligible for the study if they met all the following conditions:

- Aged between 2 and 5 years;
- Residing in one of the selected HAs;
- Had never lived or travelled outside the Kasansa HZ;
- Provided signed informed consent from a parent or legal guardian;

- Non-inclusion criteria:

Children were excluded from the study under the following conditions:

- Refusal or inability of the parent or legal guardian to participate in the interview or to answer specific questions;
- Failure to provide both required samples in the specified quantities: stool (≥ 5 g) and urine (≥ 10 mL).

Variables and composite Scoring

The following variables were collected during the survey:

- Sociodemographic: Health area, age, sex, mother's occupation
- Clinical: History of blood in stool, history of blood in urine, abdominal distension, pruritus, hepatomegaly, liver pain, splenomegaly, diarrhea, abdominal pain, collateral circulation
- Risk factors: defecation in the river and water source used for bathing

Three composite scores were constructed to assess maternal knowledge, attitudes, and practices regarding schistosomiasis:

- Maternal Knowledge Score:

Derived from seven items. A score ≥ 4 was considered good knowledge. Items included :

- Awareness of the disease
- Knowledge of its symptoms
- Recognition of its local name
- Identification of schistosomiasis symptoms
- Whether the transmission is human-to-human or not
- Knowledge of transmission mode
- Awareness of prevention methods

- Maternal Attitude Score:

Based on two items. A score ≥ 1 was considered a good attitude. Items included :

- Seeking medical care if blood is observed in stool or urine

- Maternal Practice Score:

Based on five items. A score ≥ 3 was considered good practice. Items included :

- Regular contact with rivers or lakes
- Time spent in rivers or lakes
- Latrine availability at water points
- Defecation location
- Bathing location and water source

- *Data collection and laboratory analysis*
- In each HA, parents or legal guardians were invited to bring their children, aged 2 to 5 years, to the HA health center to participate in the study. The study was conducted in four stages: (1) interviews with the preschool children's parents or guardians following inclusion in the study; (2) physical examination of the preschool children; (3) collection of stool and urine samples. Two clean and labelled containers were provided to the parents for sample collection at home, which were then returned to the study team at the health center; and (4) preparation and examination of the samples.
- For each child, data on sociodemographic and clinical characteristics, as well as information on maternal knowledge, attitudes, practices, and risk behaviors related to schistosomiasis, were recorded on a data collection form. We focused on mothers because, in our study setting, preschool children are typically accompanied by their mothers during daily activities.
- Kato-Katz and urine filtration
- The samples provided by parents were recorded on a sample collection form and subsequently taken to the laboratory or analysis site. For each stool sample, two

Kato-Katz slides were prepared. The slides were examined by two independent microscopists under an Olympus binocular optical microscope at 400X magnification to detect and count *S. mansoni* eggs. According to WHO guidelines, *S. mansoni* infection was classified into light (1 – 99 eggs per gram of feces), moderate (100 – 399 eggs per gram of feces), or heavy infection (≥400 eggs per gram of feces) (23).

- For each urine specimen, the filtration technique was performed following a macroscopic observation to check for hematuria. This process involved passing 10 mL of urine through a Nytrel filter using a syringe before microscopy. The examination was done under an optical microscope 170 at 100X and 400X magnification to detect *S. haematobium* eggs.
- *Data Analysis*
- Analyses were performed using Epi info 7. For nominal variables, proportions and their 95% confidence intervals (CI) were calculated. For numerical variables, due to non-normal distributions, the median and interquartile ranges (IQR) were reported. Chi-square or Fisher's Exacts tests were used to assess associations between *Schistosoma* infection and categorical explanatory variables. Multivariate logistic regression was then performed to identify independent predictors of infection and to estimate the strength of association for each determinant, expressed as adjusted odds ratios (AORs). A significance threshold of $\alpha = 0.05$ was applied for all statistical tests.
- *Ethical consideration*
- This study received approval from the Ethics Committee of the School of Public Health, University of Kinshasa (Approval Reference: ESP/CE/96B/2021). All ethical considerations have been observed in accordance with the Declaration of Helsinki.
- **Results**
- *Sociodemographic and clinical characteristics*
- A total of 427 preschool children were initially enrolled in the study. Of these, 58 were excluded based on the eligibility criteria, leaving 368 participants included in the final analysis (Figure 2).

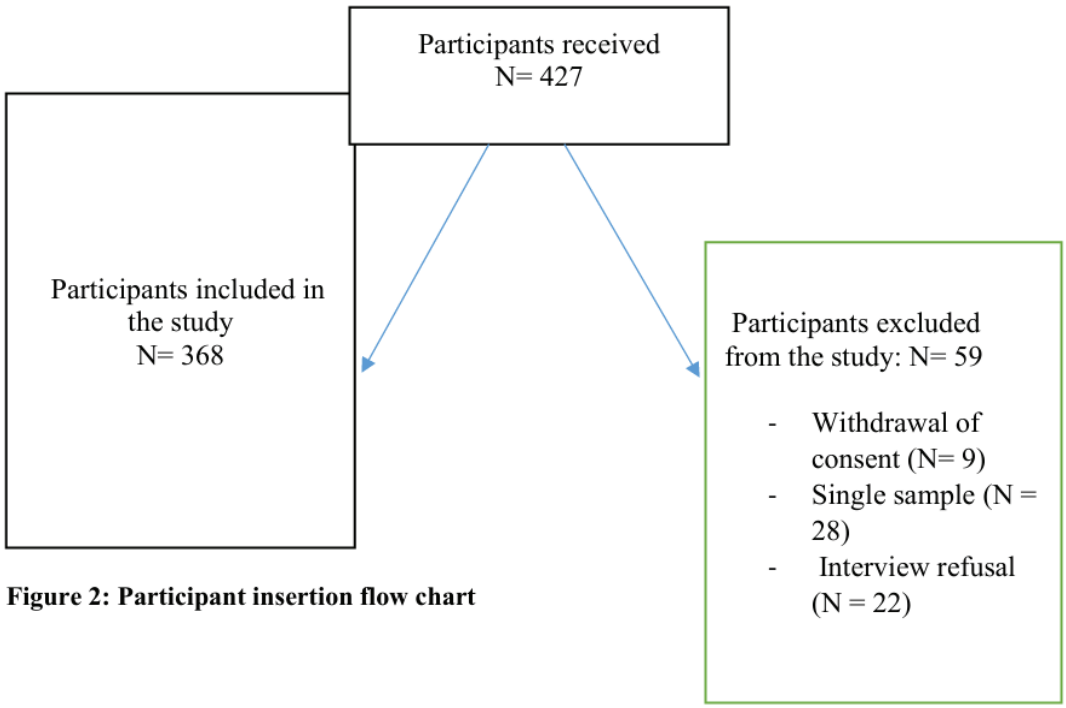

Figure 2: Participant insertion flow chart

The number of children provided by each HA varied from 53 (14.4%, 95% CI: 9.9 – 18.9%) in Dinsanga to 91 (24.7%, 95% CI: 20.1 – 29.3%) in Kasansa. The median age was 4 years (IQR: 3 years) with a minimum and maximum age at 2 and 5 years, respectively. Children aged 5 years were the most prevalent (33.9%, 95% CI: 29.0 – 38.8%). About 50.5% of the children were males and the sex ration M/F was 1.02. Most of the children had mother whose occupation involved contact with water (91.1%, 95% CI: 87.0 – 96.8%) (Table 1). The median value of the daily time spent in the water sources by child's mothers was 3 hours (IQR: 2 hours), with minimum and maximum values, respectively of 1 and 7 hours.

Children have presented varied clinical signs. The majority had a history of the presence of blood in the stools (68.4%, 95% CI: 63.5 – 73.0%) while only a few of them had a history of blood in urines (6.2%, 95% CI: 4.2 – 9.2%). About 14,6% (95% CI: 11.4 – 18.6%) had declared having pruritus, 31.8% (95% CI: 27.3 – 36.8%) having diarrhoea and 24.7% (95% CI: 20.6 – 29.3%) having abdominal pain. We observed abdominal distension and hepatomegaly, respectively in 23.3% (95% CI: 19.3 – 27.9%) and 15.2% (95% CI: 11.9 – 18.5%) of children (Table 1).

Table 1. Sociodemographic characteristics of children

Variables	**N**	**%**	**95% CI**
Heath Areas			
Dinsanga	53	14.4	9.9 – 18.9
Kasansa	91	24.7	20.1 – 29.3
Kashila	50	13.5	9.1 – 18.1
Lac Lomba	52	14.1	9.6 – 18.6
Nsangu	64	17.3	12.8 – 22.0

Nsenga-Nsenga	58	15.7	11.2 – 20.2
Age (years)			
2	69	18.7	14.0 – 23.4
3	90	24.5	19.9 – 29.1
4	84	22.8	18.2 – 27.4
5	125	33.9	29.0 – 38.8
Sex			
M	186	50.5	45.6 – 55.4
F	182	49.5	44.6 – 54.4
Mother occupation			
Occupations involving water	338	91.8	88.6 – 94.2
Others	30	8.1	5.7 – 11.4
Total	**368**	**100**	

n = Frequency, %=Percentage, CI: Confidence Interval

Risk behavior, Knowledge, attitude, and practice
Most of children mothers bathe in the river or lake (78.5%; 95% CI: 74.0% - 82.4%), although a small percentage occasionally defecate there (2.1%; 95% CI: 1.1% - 4.2%). The level of knowledge and attitudes about schistosomiasis among these mothers was generally good, with frequencies of 80.1% (95% CI: 75.5% – 83.9%) and 82.8% (95% CI: 75.5% – 83.9%), respectively. However, their practices were mostly poor, with an estimated frequency of 99.7% (95% CI: 78.7% – 86.4%) (Table 2).

Table 2. Risk behavior, Knowledge, attitude and practice

Variables	N	%	95% CI
Defecation in river/lake			
Yes	8	2.1	1.1 – 4.2
No	360	97.8	95.7 – 98.8
Bathing behavior			
river/Lake	289	78.5	74.0 – 82.4
Well water	52	14.1	1.9 – 18.0
Well water and river/Lake	27	7.3	5.0 – 10.4

Knowledge			
Good	290	80.1	75.5 – 83.9
Bad	72	19.9	15.7 – 23.9
Attitude			
Good	305	82.8	78.7 – 86.4
Bad	63	17.1	78.7 – 86.4
Practice			
Good	1	0.2	0.05 – 1.5
Bad	367	99.7	98.5 – 99.9
Total	**368**	**100**	

n = Frequency, %=Percentage, CI: Confidence Interval

Prevalence, parasite density and intensity of schistosomiasis disease

The Kato-Katz analyses were positive in 122 preschool children resulting in a schistosomiasis prevalence of 30.4% (95% CI: 25.9 – 35.3%). The highest prevalences were found in Kasansa (53.5% (95% CI: 43.9 – 63.1%)) HA while in Kashila HA, no child was infected (Table 3).

We found the presence of *S. mansoni* eggs among children in stool samples while no *S. haematobium* egg was detected in the urine. The median value of the number of eggs per gram of stools was 156 (IQR: 48), with minimum and maximum values at 24 and 3,108 respectively. About 42.8% (95% CI: 33.5 – 52.5%) of children had light *S. mansoni* infection against 32.1% (95% CI: 23.6 – 41.6%) and 25% (95% CI: 25.0 – 34.1%) who respectively had, a moderate and severe infection (Table 3).

Table 3. Prevalence and intensity of *Schistosoma mansoni* infection

Variables	n	Positive	%	IC95%
Overall prevalence of schistosomiasis				
	368	**112**	**30,4**	**25,9-35,3**
Health Areas				
Dinsanga	53	6	5.3	1.99-11,3
Kasansa	91	60	53.5	43.9-63.1
Kashila	50	0	0	0
Lac Lomba	52	5	4.4	1.47-10.11
Nsangu	64	33	29.4	21.2-38.8
Nsenga-Nsenga	58	8	7.1	3.1-13.5
Intensity				
Light		48	42.8	33.5 – 52.5
Moderate		36	32.1	23.6 – 41.6
Severe		28	25.0	25.0 – 34.1
Total		**112**	**100**	

n = Frequency, %=Percentage, CI: Confidence Interval

Risk factors

Most sociodemographic and clinical variables were not associated with *Schistosoma* infection except for HAs ($p < 0.0001$), diarrhea ($p < 0.001$) and abdominal pain ($p < 0.001$). The Presence of *Schistosoma* infection was significantly associated with children mother bathing behavior ($p < 0.001$), level of knowledge ($p < 0.001$), and practices ($p < 0.01$) (Table 3).

Compared to the Lac Lomba HA, the risk of *S. mansoni* infection was significantly higher in the Kasansa (AOR = 16.5; $p < 0.0001$) and Nsangu HAs (AOR = 9.2; $p < 0.0001$). This risk was significantly reduced among children whose mothers usually bathe using well water rather than river or lake water (AOR = 0.3; $p = 0.0077$). The level of knowledge, attitude, or practices did not show a significant impact on the risk of infection (Table 4).

Table 4. Risk factors associated to schistosomiasis

Covariates	Unadjusted OR	CI 95 %	p	aOR	CI 95 %	P
Health Area						
Lac Lomba	1			1		
Kasansa*	18.2	6.5 – 50.3	<0.0001*	16.5	5.7 – 47	<0.0001*
Dinsanga + Kashila	0.5	0.1 – 2.0	0.3903	0.5	0.1 – 1.9	0.3580
Nsangu*	10	3.5 – 28.4	<0.0001*	9.2	3.2 – 26.8	<0.0001*
Nsenga - Nsenga	1.5	0.4 – 4.9	0.5001	1.4	0.4 – 4.8	0.5102
Bathing behavior						
Rivers/Lakes	1			1		
Well water*	0.2	0.08 – 0.5	0.0019*	0.3	0.2 – 0.6	0.0077*
Well water and rivers/Lakes	1.9	0.8 – 4.2	0.1056	5.2	0.9 – 5.7	0.0903
Knowledge						
Bad	1			1		
Good	0.7	0.4 – 1.4	0.4442	0.7	0.4066 – 1.4837	

COR: Crude Odd Ratio; AOR: Adjusted Odd Ratio; p: p-value, *: Significant

Discussion

This study aimed to determine the prevalence of schistosomiasis among preschool children in the Kasansa HZ and to identify associated risk factors. The results revealed a high prevalence of *S. mansoni* infection at 30.4%, with no cases of *S. haematobium* detected. *S. mansoni* is the most prevalent species of *Schistosoma* in the DRC, particularly in the central region where Kasansa is located, whereas *S. haematobium* is rarely observed in this area (19, 29, 30). This prevalence aligns with findings among preschool-aged children in other Sub-Saharan African countries (14-86%), including Uganda, Kenya, Ghana, Mali, Niger, and Nigeria (20).

The prevalence of *S. mansoni* infection varied significantly across the HAs studied, ranging from no infection in Kashila HA to 53.5% in Kasansa HA. Children from Kasansa and Nsangu HAs were 16 and 9 times more likely to be infected with *S. mansoni,* respectively, compared to those from Dinsanga. This disparity may be attributed to ecological differences, such as proximity to water bodies (19). Similar trends have been observed in school-aged children in this HZ, with prevalence ranging from 55% to 94%, including a 74.5% prevalence in Kashila (23, 30). These results indicate a high risk of *S. mansoni* infection throughout the Kasansa HZ. Although we found lower prevalence rates in preschool children, the findings are still concerning, as 25% of infected children had a heavy infection load. These young children may face long-term health risks and serve as a

continual source of transmission since they are not included in control programs.

Among clinical signs, *Schistosoma* infection was associated with abdominal pain ($p < 0.001$) and diarrhea ($p < 0.001$), but not hepatomegaly. A study in northeastern DRC found an association between *S. mansoni* and both diarrhea and hepatomegaly, likely due to its inclusion of adult participants (28). In our younger population, infections may not have progressed long enough to affect the liver. The presence of blood in stools was not also associated with *S. mansoni* infection in our study, potentially due to other local causes or the relatively low sensitivity of the Kato-Katz technique. Previous studies have shown that relying solely on the Kato-Katz method can underestimate *S. mansoni* prevalence (28). Moreover, we collected only one stool sample per individual, which may have increased the likelihood of missed infections.

Children whose mothers bathe using well water were three times less likely to be infected with *S. mansoni* compared those whose mothers bathe in rivers or lakes. This is likely due to the consistency in bathing sources within households (23, 27, 29). *Schistosoma* requires freshwater bodies, such as rivers or lakes, to complete its life cycle, and the intensity of infection is closely linked to the duration and frequency of contact with these water sources (4, 19). However, in our study, maternal occupation, knowledge, and attitudes toward schistosomiasis did not significantly influence infection risk. This may be explained by the lack of access to safe water, which forces households to depend on natural water bodies regardless of awareness or education.

This study has limitations that future research should address. The non-random sampling of preschool children limits generalizability, and analyzing only one stool sample per individual reduces the sensitivity of the Kato-Katz technique. Additionally, using a more sensitive laboratory method, such as molecular techniques, would improve detection accuracy. However, this study represents the first report in the DRC to investigate schistosomiasis among preschool-aged children, an age group not currently included in the national control program.

Conclusion

This study revealed a high prevalence of intestinal schistosomiasis among preschool children in the Kasansa HZ. *S. mansoni* was the only *Schistosoma* species detected, with bathing in rivers or lakes emerging as the main risk factor for infection. Improving access to safe water could significantly reduce the burden of schistosomiasis in this setting. Control measures targeting the preschool children should be considered. This study provides crucial data to guide public health interventions and resource allocation for disease prevention in this vulnerable population.

Conflict of interest

None

Authors' contribution

CKM, HS, and DMN designed and implemented the study. CKM supervised data collection. EKL, and FV performed the statistical analysis. FV was responsible of the visualization. CKM, EKL, and FV wrote the original manuscript. All the authors edited and validated the manuscript.

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