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Is a mass drug administration deworming programme for school-aged children enough to reduce the prevalence of soil-transmitted helminths and *Schistosoma mansoni* in adults: a cross-sectional study from Togo

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Background: The world health organization (WHO) introduced the mass drug administration (MDA) strategy in order to reduce the prevalence of soil-transmitted helminths (STHs) and *Schistosoma mansoni* in endemic areas. However, this strategy is not implemented in adult population in Togo. Thus, the question arose if the present MDA strategy contributes to the reduction of transmission rates. The present study aimed to monitor the prevalence of STHs and *S. mansoni* among adult's, between 2017 and 2022, in the central region of Togo.

Methods: Two cross-sectional studies were conducted in six villages in the central region of Togo in 2017 and 2022. Stool samples were collected from adults over the age of 18 years. To assess STHs and *S. mansoni* infections, real-time multiplex qPCR and Kato-Katz techniques were performed. Data were analysed using SPSS software version 21 and GraphPad PRISM version 9.2.0. A p-value less than 0.05 was considered statistically significant.

Results: A total of 210 and 289 individuals were recruited in 2017 and 2022, respectively. We detected significant increase in the prevalence of STHs and *S. mansoni* from 7.61% to 24.56% ($p=0.0008$) and from 27.62% to 46.36% ($p=0.0014$) by Kato-Katz and RT-qPCR, respectively. The prevalence of

Ancylostoma duodenale infection was the highest with an increase from 7.14% to 23.53% by Kato-Katz and 9.09% to 40.0% by RT-qPCR.

Conclusion: The prevalence of STHs and *S. mansoni* increased in the adult population in the central region of Togo from 2017 to 2022, despite the implementation of MDA in school-aged children. Hence, there is an urgent need to include adult individuals and adapt the MDA programme in the central region of Togo.

KEYWORDS

soil-transmitted helminths, *S. mansoni*, adults, MDA programme, school-aged children

1 Introduction

Soil-transmitted helminths (STHs) and schistosomiasis are the most common parasitic worms in the world (1). These infections, disproportionately affect people and most of them in the underprivileged areas of Sub-Saharan Africa (2). In total, an estimated 1.5 billion people are infected with STHs (3) and about 250 million people are infected with schistosomiasis, 80% of whom live in Sub-Saharan Africa (4). STH infections are propagated by oral uptake of eggs that are excreted in the stool by people infected with STHs such as hookworm (*Ancylostoma duodenale* and *Necator americanus*), *Ascaris lumbricoides*, and *Trichuris trichiura*, whereas *Schistosoma mansoni* is transmitted through the penetration by the skin by cercariae which reside in fresh water (5, 6). STH infections can cause intestinal damage, loss of appetite, weakness, anaemia, and impaired physical and cognitive development (7); intestinal schistosomiasis can lead to abdominal pain, diarrhoea and blood in the stool causing severe public health problems in endemic regions (8). Children and pregnant women have been identified as the population at risk of STHs and schistosomiasis, with a high burden of disease for over 3.3 million and 1.8 million disability-adjusted life years (DALYs) respectively (9).

In order to control these infections, a global strategy programme based on preventive chemotherapy was introduced by the World Health Organisation (WHO) since 2006 (10). This programme consisted of mass drug administration (MDA) with praziquantel and albendazole for schistosomiasis and STH, respectively, mainly given to school-aged children (5 to 14 years old) (10, 11). Since then, several programmes in endemic countries, such as Togo, implemented periodic MDA according to WHO guidelines (12). Since 2010, this programme contributed to a decline in the prevalence of STHs from 31.5% to 11.6% and 23.5% to 5% for schistosomiasis in school-aged children between 2009 and 2015 (13). Similarly, in Ghana, a decrease in the prevalence of schistosomiasis from 23.8% to 3.6% and hookworm from 8.6% to 3.1% was observed (14) and also in other endemic countries such as Cameroon and Nigeria (15–17).

Despite the recent revision of WHO guidelines on the control of STHs and schistosomiasis, MDA is not effectively implemented in people over the age of 15 years (18) and therefore, the monitoring of STHs and schistosomiasis prevalence is less undertaken in this group. This could contribute to the failure of MDA programme, since this group is also exposed to infections. In the present study, we aim to monitor the prevalence of STHs and schistosomiasis between 2017 and 2022 in the Mô prefecture of the central region of Togo. Our findings contribute to improve WHO preventive chemotherapy programme and help countries health stakeholders to improve community policies to control and prevent STHs.

2 Methods

2.1 Study design and period

The present study based on two cross-sectional studies conducted in July 2017 and in August 2022. The frequencies of MDA were evaluated according to the national NTDs programme (Programme National de lutte contre les maladies tropicales négligées) guidelines. Their records from 2017 to 2021 were used.

2.2 Study area

This study was carried out in six villages of the Mô prefecture, namely Bato, Takadè, Kouida, Tchatchakou, Tchatoun-koura and Banda. The Mô prefecture is located in the central region of Togo close to the Ghanaian border (Figure 1). This area was chosen with reference to data provided by the National Programme for the Control of Neglected Tropical Diseases (NTDs) in Togo (Programme National de Lutte contre les Maladies Tropicales Négligées au Togo; PNLMTN) on areas of high prevalence of helminthiasis (20).

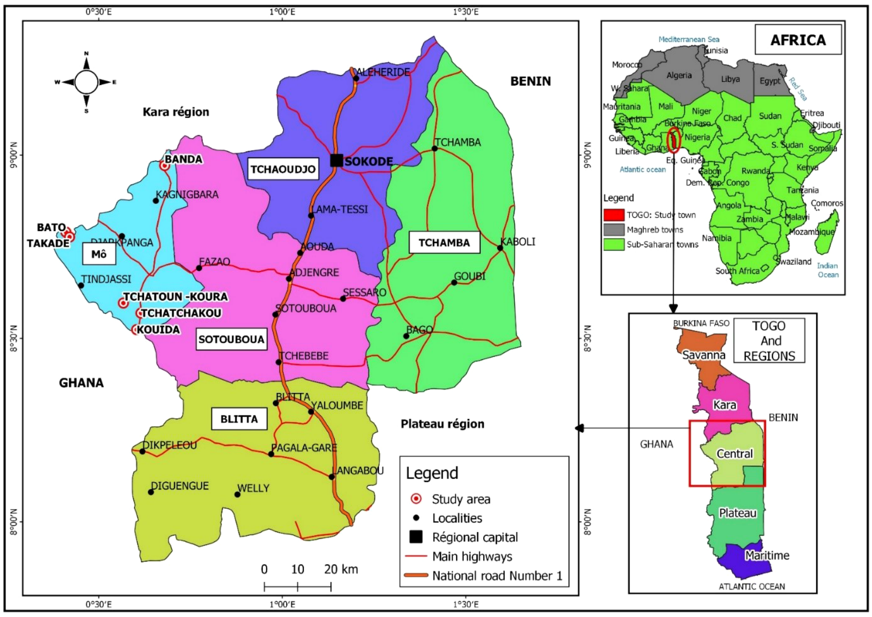

FIGURE 1
Map of Togo showing the Mô prefecture and the different study areas (created by our team during a previous study) (19).

2.3 Study population and sample size determination

The target population consists of male and female individuals over the age of 18 years, living in the study area for 10 years. The sample size was calculated according to the SCHWARTZ formula $n = Z^2 P(1-P)/d^2$ with Z, the accepted risk error at 1.96; d, the precision at 0.05; P, the prevalence of STHs estimated at 31.5% (12) and 11.6% (13) according to a previous study conducted in 2012 and 2018 in Togo respectively. Therefore, the estimated minimum sample size was 312 participants for the first study conducted in 2017 and 158 participants for that conducted in 2022.

2.4 Sample collection

The study was explained to the village communities during a meeting. Thereafter, stool containers (Quantum Biomedicals, Chennai, India) were distributed to participants to collect samples in the early morning. A semi-structured questionnaire was used to collect socio-demographic data. The questionnaire was validated in 2017 during a pilot study and was used for both studies. All information received from the participants was anonymised by assigning a code.

2.5 Parasitological diagnosis

The Kato-Katz (KK) technique was used to detect eggs of hookworm, *A. lumbricoides*, *S. mansoni*, *T. trichiura* and intestinal protozoan (21). The samples were processed in each locality on the same day at the sampling site or at the laboratory of the "Centre Hospitalier Préfectoral" (CHP) of Djarkpanga, where a team of qualified technicians evaluated the KK smears. The stool samples were then preserved in 1 mL of sterile eNAT medium (Copan, Brescia, Italy) and stored at -20°C for subsequent molecular analyses.

2.6 Molecular diagnosis of STHs and *Schistosoma mansoni*

2.6.1 DNA extraction

Previously stored stool samples were thawed and genomic DNA extracted using the Qiagen QIAmp Fast Stool Mini Kit (QIAGEN, Hilden, Germany) following the manufacturer's instructions. Briefly, approximately 180 mg of stool was weighed into a 2 mL tube (Eppendorf, Hamburg, Germany) and placed on ice. The stool samples were then heated to 70°C in a water bath for 10 minutes and stool particles were crushed by centrifugation for one minute at 14,000 RPM (MIKRO 200, Berverly, USA). Following, 15 µL of proteinase K and 200 µL of lysis buffer (AL buffer) were added to 200 µL of stool supernatant and the mixture was incubated at 70°C for 15 minutes. The resulting lysate was mixed with 200 µL of 95% ethanol (Alcoford, Lomé, Togo) and inverted on the column (QIAamp spin) for centrifugation at 14,000 RPM for one minute. To remove any other stool debris, columns were washed twice with 500 µL of buffer 1 (AW1 buffer) and buffer 2 (AW2 buffer) at 14,000 RPM for one minute and 3 minutes respectively. Finally, the DNA was eluted with 200 µL of elution buffer (ATE buffer) onto the QIAamp membrane in 1.5 ml tubes after 5 minutes of incubation. Once elution was completed, DNA quantification was performed from each extract using the RG-3000 Rotor-gene thermal cycler (Corbett Research, Sydney, Australia). For that purpose, a solution of DNA extract of known concentration was used as the standard, then four successive dilutions were made to plot the standard curve. Then, a total reaction volume of 20 µL of the DNA extracts were added into each reaction well and a 16 minutes run was performed on the RG-3000 Rotor-gene thermal cycler. The DNA concentration measurement analysis operates by relating the fluorescence (A.FAM) level to a concentration values. DNA samples were stored at -20°C for subsequent RT-qPCR.

2.6.2 Real-time quantitative polymerase chain reaction (RT-qPCR) assays

RT-qPCR was performed on a Rotor-Gene 3000 system (Corbett Research) in a total reaction volume of 20 µL for the detection of STHs. Multiplex RT-qPCR was performed to detect *A. duodenale, N. americanus, A. lumbricoides* and *S. mansoni* using the iQ Multiplex Powermix (Bio-Rad Laboratories, Hercules, CA, USA) and species-specific primers (22). The reaction mixture consisted of: 1) 2 µL template (DNA template/plasmid) at a concentration of 20 ng/µL; 2) 10 µL iQ Multiplex Powermix; 3) a subtotal volume of 1 µL (Forward primer + Reverse primer + Probe) for each species tested, i.e., a total volume of 4 µL, as we have 4 species; 4) 4 µL H_2O (Dnase Rnase free). The run consisted of an initial hold step of 95°C for 2 minutes, followed by 45 cycles of 95°C for 30 seconds and 53°C for 60 seconds. All species quenchers were acquired on last cycle of 53°C for 60 seconds.

All RT-qPCR runs included a positive control (plasmid) specific to each species of interest as well as a negative control consisting only of the master mix. All samples and controls were blinded and analysed in duplicate. Results were only considered positive when both duplicate samples were amplified with a cycle threshold below 40 (Ct <40) (23). Primers and probes used in the RT-qPCR are shown in Supplementary Data 1.

2.7 Sensitivity and specificity of RT-qPCR and Kato-Katz

The sensitivities and specificities of RT-qPCR and KK were calculated for STH species and *S. mansoni.* KK and PCR were used as a reference test (Gold standard). The 95% confidence intervals (95% CI), and percentage values were calculated using Microsoft Excel 2013. The formula used to calculate the sensitivity and specificity is summarised in Table 1 (24).

TABLE 1 Sensitivity and specificity calculation.

	Gold standard test	
	STHs Positive	STHs Negative
Positive test	TP	FP
Negative test	FN	TN
	Sensitivity =TP/(TP + FN)	Specificity =TN/(TN + FP)

FN, false negative; FP, false positive; TN, true negative; TP, true positive.

2.8 Statistical analysis

Statistical analysis was performed using SPSS software (IBM SPSS Statistics 21, Armonk, NY). Figures were generated using GraphPad PRISM version 9.2.0 software for Windows (GraphPad Software, San Diego California, USA). The Chi-square (χ^2) test or Fisher's exact test was used for percentage comparison. A p-value less than 0.05 was considered statistically significant.

2.9 Ethics approval and consent to participate

The study protocol was reviewed and approved by the ethical board of the Ministry of Health of Togo, "Comité de Bioéthique pour la Recherche en Santé" (CBRS), under the registration numbers 043/2016/MSPS/CAB/SG/DPLET/CBRS February 05th, 2016 and 029/2021/MSPS/CAB/SG/DPLET/CBRS June 25th, 2021 respectively in 2017 and 2022. All participants were informed about the study and provided written consent.

3 Results

3.1 Socio-demographic characteristics of the study population

A total of 210 subjects were recruited in the study area in 2017 and 289 subjects in 2022. The mean age of the participants was 37.15± 11.79 years and 42.01± 14.70 years in 2017 and 2022 respectively. The age ranges of 35-47 and 48-75 years were the most represented with 64 (30.5%) and 122 (42.2%) in 2017 and 2022 respectively. The mean lifetime in the study area was 24.43 years ± 13.66 in 2017 and 22.97 years ± 15.44 in 2022. Males were most represented with 121(57.6%) and 152(52.6%) in 2017 and 2022, respectively. The majority of the population were farmers with 147 (70.0%) and 240 (83.0%) in 2017 and 2022, respectively (Table 2).

3.2 Status of deworming in the study area

The data in Tables 3, 4 provide an overview about the MDA with albendazole and praziquantel treatment strategies in the study area from 2017 and 2021. The population for treatment, included only school-aged children 5 to 14 years of age.

The deworming programmes were carried out once a year with albendazole and the treatment coverage was > 97% from 2017 to 2021 (Table 3). However, for praziquantel, the treatment is given every two years in the same age group and the treatment coverage was 99.78% in 2018 and 97.97% in 2020. There was no treatment in 2017, 2019 and 2021 (Table 4). Adolescents and adults (15 years and older) were not included into the MDA programme.

TABLE 2 Socio-demographic characteristics of the study population.

Variables	2017 n (%)	2022 n (%)
Mean age (years)	37.15 ± 11.79	42.01 ± 14.70
Age range (years)		
[18-26]	50 (23.8)	58 (20.1)
[27-34]	40 (19.0)	42 (14.5)
[35-47]	64 (30.5)	67 (23.2)
[48-75]	56 (26.7)	122 (42.2)
Mean lifetime in the study area (years)	24.43 ± 13.66	22.97 ± 15.44
Lifetime in the study area (years)		
[1-15]	62 (29.5)	100 (34.6)
[16-25]	52 (24.8)	92 (31.8)
[26-34]	45 (21.4)	37 (12.8)
[35-75]	51 (24.3)	60 (20.8)
Sex		
Female	89 (42.4)	137 (47.4)
Male	121 (57.6)	152 (52.6)
Profession		
Trader	13 (6.2)	15 (5.2)
Student	1 (0.5)	6 (2.1)
Teacher	2 (1.0)	5 (1.7)
Housewife	47 (22.3)	23 (8.0)
Farmer	147 (70.0)	240 (83.0)

3.3 Sensitivity and specificity of RT-qPCR and Kato-Katz

In order to determine the performance of the RT-qPCR and KK approaches, sensitivities and specificities were calculated. For *A. duodenale*, the sensitivity of RT-qPCR related to KK was 100% in 2017 and 2022, while that of KK related to RT-qPCR was 45.45% and 57.63% in 2017 and 2022, respectively. The sensitivity of the KK and RT-qPCR tests was undetectable for *A. lumbricoides, N. americanus* and *S. mansoni*, due to the absence of double-positive subjects to both tests. However, in 2022 the sensitivity of RT-qPCR related to KK was 100% and 40% for KK related to RT-qPCR for *S. mansoni*. The specificity of KK related to RT-qPCR was elevated than RT-qPCR related KK for all species (Table 5). Absolute values obtained in the diagnostic assays are shown in Supplementary Data 2.

3.4 Increased STHs and *S. mansoni* prevalence from 2017 to 2022

From 2017 to 2022, the overall prevalence of STHs had significantly increased from 7.61% in 2017 to 24.56% in 2022 determined with the KK method (Figure 2A) and from 27.62% to 46.36% with the RT-qPCR method (Figure 2B). STHs were only detected in 5/6 villages by KK technique, whereas infected individuals were found in all of the villages using RT-qPCR. However, for all of the villages except Bato, we observed a general increase in the prevalence from 2017 to 2022. We found no cases of infection using the KK method in both 2017 and 2022 (Figure 2C) at Bato village, although RT-qPCR revealed 29.6% infection of helminths in 2017 and 28.6% in 2022 (Figure 2D). *A. duodenale*

TABLE 3 Mass drug administration with albendazole in the study area.

Year	Villages	Enrolled children for albendazol (5-14 years old)			Treated children with albendazol (5-14 years old)			Number of treatment per year	Period
		Male	Female	Total	Male	Female	Total		
2017	Bato	9	8	17	9	8	17	1	9-7 September 2017
	Takadè	72	72	144	72	72	144	1	
	Kouida	96	79	175	96	79	175	1	
	Tchatchakou	64	48	112	64	48	112	1	
	Tchatchounkoura	138	135	273	138	135	273	1	
	Banda	93	115	208	93	115	208	1	
	Total	**472**	**457**	**929**	**472**	**457**	**929**	-	
2018	Bato	10	11	21	10	11	21	1	13-25 April 2018
	Takadè	77	76	153	75	76	151	1	
	Kouida	66	80	146	66	80	146	1	

(Continued)

TABLE 3 Continued

Year	Villages	Enrolled children for albendazol (5-14 years old)			Treated children with albendazol (5-14 years old)			Number of treatment per year	Period
		Male	Female	Total	Male	Female	Total		
	Tchatchakou	61	66	127	61	66	127	1	
	Tchatchounkoura	157	134	291	157	134	291	1	
	Banda	75	80	155	75	80	155	1	
	Total	**446**	**447**	**893**	**444**	**447**	**891**		
2019	Bato	9	6	15	9	6	15	1	18 - 28 June 2019
	Takadè	85	78	163	84	78	162	1	
	Kouida	92	108	200	92	108	200	1	
	Tchatchakou	185	64	322	54	64	118	1	
	Tchatchounkoura	54	137	118	185	137	322	1	
	Banda	92	122	214	92	122	214	1	
	Total	**517**	**515**	**1032**	**516**	**515**	**1031**		
2020	Bato	9	6	15	9	6	15	1	8 - 19 September 2020
	Takadè	91	85	176	88	83	171	1	
	Kouida	102	98	200	102	98	200	1	
	Tchatchakou	64	55	119	64	55	119	1	
	Tchatchounkoura	106	86	192	102	86	180	1	
	Banda	71	66	137	71	66	137	1	
	Total	**443**	**396**	**839**	**436**	**394**	**822**		
2021	Bato	9	4	13	9	4	13	1	28 September to 9 October 2021
	Takadè	105	104	209	104	101	205	1	
	Kouida	100	59	159	100	59	159	1	
	Tchatchakou	77	60	137	77	60	137	1	
	Tchatchounkoura	85	99	184	85	99	184	1	
	Banda	38	55	93	38	55	93	1	
	Total	**414**	**381**	**795**	**413**	**378**	**791**		
2022*		–	–	–	-	-	–		

*MDA was performed two weeks after our sampling in the study area.

was the most prevalent helminth, with a significantly higher prevalence in 2022 than in 2017 analysed by KK (Figure 2E) and also by RT-qPCR (Figure 2F). With the KK technique we did not detect any infections with *N. americanus* and *A. lumbricoides* (Figure 2E), while RT-qPCR showed prevalence of 1.43% and 2.42% for *N. americanus* and 3.33% to 7.27% for *A. lumbricoides* (Figure 2F). *S. mansoni* prevalence increased from 0.48% to 1.38% by KK and from 2.38% to 3.46% by RT-qPCR although the difference was not statistically significant (Figures 2E, F).

3.5 Despite MDA in school-aged children there was increase of STHs and *S. mansoni* infections in adults

The treatment coverage in school-aged children was 100% and 99.5% in 2017 and 2021 respectively. However, the prevalences of STHs and *S. mansoni*, among adults increased between 2017 and 2022, from 7.61% to 27.62% by Kato-Katz and from 24.56% to 46.36% by RT-qPCR (Table 6). Overall, these data show that despite

TABLE 4 Mass drug administration with praziquantel in the study area.

Year	Villages	Enrolled children for praziquantel (5-14 years old)			Treated children with praziquantel (5-14 years old)			Number of treatment by year	Period
		Male	Female	Total	Male	Female	Total		
2017	Bato	9	8	17	0	0	0	1	9-7 September 2017
	Takadè	72	72	144	0	0	0	1	
	Kouida	96	79	175	0	0	0	1	
	Tchatchakou	64	48	112	0	0	0	1	
	Tchatchounkoura	138	135	273	0	0	0	1	
	Banda	93	115	208	0	0	0	1	
	Total	**472**	**457**	**929**	**0**	**0**	**0**		
2018	Bato	10	11	21	10	11	21	1	13 - 25 April 2018
	Takadè	77	76	153	75	76	151	1	
	Kouida	66	80	146	66	80	146	1	
	Tchatchakou	61	66	127	61	66	127	1	
	Tchatchounkoura	157	134	291	157	134	291	1	
	Banda	75	80	155	75	80	155	1	
	Total	**446**	**447**	**893**	**444**	**447**	**891**		
2019	Bato	9	6	15	0	0	0	1	18 - 28 June 2019
	Takadè	85	78	163	0	0	0	1	
	Kouida	92	108	200	0	0	0	1	
	Tchatchakou	185	137	322	0	0	0	1	
	Tchatchounkoura	54	64	118	0	0	0	1	
	Banda	92	122	214	0	0	0	1	
	Total	**517**	**515**	**1032**	**0**	**0**	**0**		
2020	Bato	9	6	15	9	6	15	1	8 - 19 September 2020
	Takadè	91	85	176	88	83	171	1	
	Kouida	102	98	200	102	98	200	1	
	Tchatchakou	64	55	119	64	55	119	1	
	Tchatchounkoura	106	86	192	102	86	180	1	
	Banda	71	66	137	71	66	137	1	
	Total	**443**	**396**	**839**	**436**	**394**	**822**		
2021	Bato	9	4	13	0	0	0	1	28 September to 9 October 2021
	Takadè	105	104	209	0	0	0	1	
	Kouida	100	59	159	0	0	0	1	
	Tchatchakou	77	60	137	0	0	0	1	
	Tchatchounkoura	85	99	184	0	0	0	1	
	Banda	38	55	93	0	0	0	1	
	Total	**414**	**381**	**795**	**0**	**0**	**0**		
2022*		-	-	–	–	–	-		

*MDA was performed two weeks after our sampling in the study area.

TABLE 5 Sensitivity and specificity of RT-qPCR and Kato-Katz for the different helminth species.

Species	Test	2017		2022	
		Sensitivity % (95% CI)	Specificity % (95% CI)	Sensitivity % (95% CI)	Specificity % (95% CI)
Ancylostoma duodenale	PCR related to KK	100	100	100	77.38 (71.86 - 82.89)
	KK related to PCR	45.45 (28.47-62.44)	90.77 (86.71 - 94.83)	57.63 (48.71-66.54)	100
Ascaris lumbricoides	PCR related to KK	N/A	67.67 (62.37 - 72.96)	N/A	77.38 (71.86 - 82.89)
	KK related to PCR	N/A	100	N/A	100
Necator americanus	PCR related to KK	N/A	69.00 (63.77 - 74.23)	N/A	97.58 (95.81 - 99.35)
	KK related to PCR	N/A	100	N/A	100
Schistosoma mansoni	PCR related to KK	N/A	98.09 (96.23 - 99.94)	100	97.89 (96.23 - 99.56)
	KK related to PCR	N/A	99.51 (98.57 - 100)	40.00 (9.64-70.36)	100

CI, Confidence Interval; N/A, Not applicable.

the large coverage of MDA, in school-aged children, prevalence of STHs and *S. mansoni* increased from 2017 to 2022.

4 Discussion

STHs and schistosomiasis remain public health problems despite efforts by the mass drug administration programmes to control these infections (25). The present study reported the prevalence of STHs among adults and revealed an overall increase in the prevalence of STHs and schistosomiasis from 2017 to 2022 in the six villages of the Mô prefecture in the central region of Togo. The MDA strategy in this area, which only includes children school-aged (5 to 14 years old) in the treatment of STHs and schistosomiasis (Table 4), may be a cause of increase in these infections in the adult population. It should be noted that the last deworming in the study area took place more than six months before the data collection in 2017 and 2022. However, due to the helminths endemic nature, even among people who receive treatment, reinfection may occur at any time of the year (26). For instance, a study on the effectiveness of MDA against STHs and schistosomiasis performed in 2018 in Togo, revealed a resurgence of hookworm infections in children who did not received albendazole in the previous 6 months (13). These parameters should be taken into account in future MDA strategies in the particular region but also in other endemic areas.

Among STH species assessed, *A. duodenale* was the most prevalent species in 2017 (7.14%) and 2022 (23.53%). Neither *N. americanus* nor *A. lumbricoides* cases were found. Similarly, during our previous study in 2020 in the central region of Togo we found that, among adult women (18 to 56 years old), hookworm was also the most prevalent parasitic infection with a prevalence of 95.34% (27). Moreover, according to a survey conducted in Togo in 2018, hookworm was the most frequent STH among school children in the central region of the country (15.2%), whereas *A. lumbricoides* and *Trichuris trichiura* were rare (28). As the prevalence of hookworm is as high in adults as in school-aged children, this could indicate the possibility of resistance of this species to drugs in this endemic area. Although most studies have focused on the prevalence of STH infections in school-aged children (29–32), it has been demonstrated that infections increase with age and peak in adults (33, 34). Thus our data is similar to that found in Tanzania where hookworm prevalence was highest (21.7%) followed by *S. mansoni* (12.4%) (35). STH infections can affect all age groups, and in view of the transmission cycle of the disease, we think that it is important to include adults in the MDA strategy to reach the elimination goals and protect vulnerable populations, such as children and pregnant women (5). The increase in prevalence observed in this study could continue if the control strategy is not reviewed, and this could slow down the WHO objective in the STHs and schistosomiasis elimination as a public health problem by 2030 (36). Interestingly, we did not detect *Strongyloides* infections, but the implemented Kato Katz method using a single stool sample is not suitable to accurately detect *Strongyloides* larvae. Thus, upcoming studies should use faecal culture methods and serological approaches to assess *Strongyloides* infections more in detail.

Our data showed that the prevalence of STHs and *S. mansoni* by KK microscopy was lower than that obtained by RT-qPCR method. The superiority of RT-qPCR to KK for diagnosing intestinal parasites has been described for 10 years now (37–39). This is also in accordance with findings from the area of Bato, since we observed an increase of prevalence from 0% to nearly 30% in 2017 and 2022. Similarly, Eindra et al. revealed that

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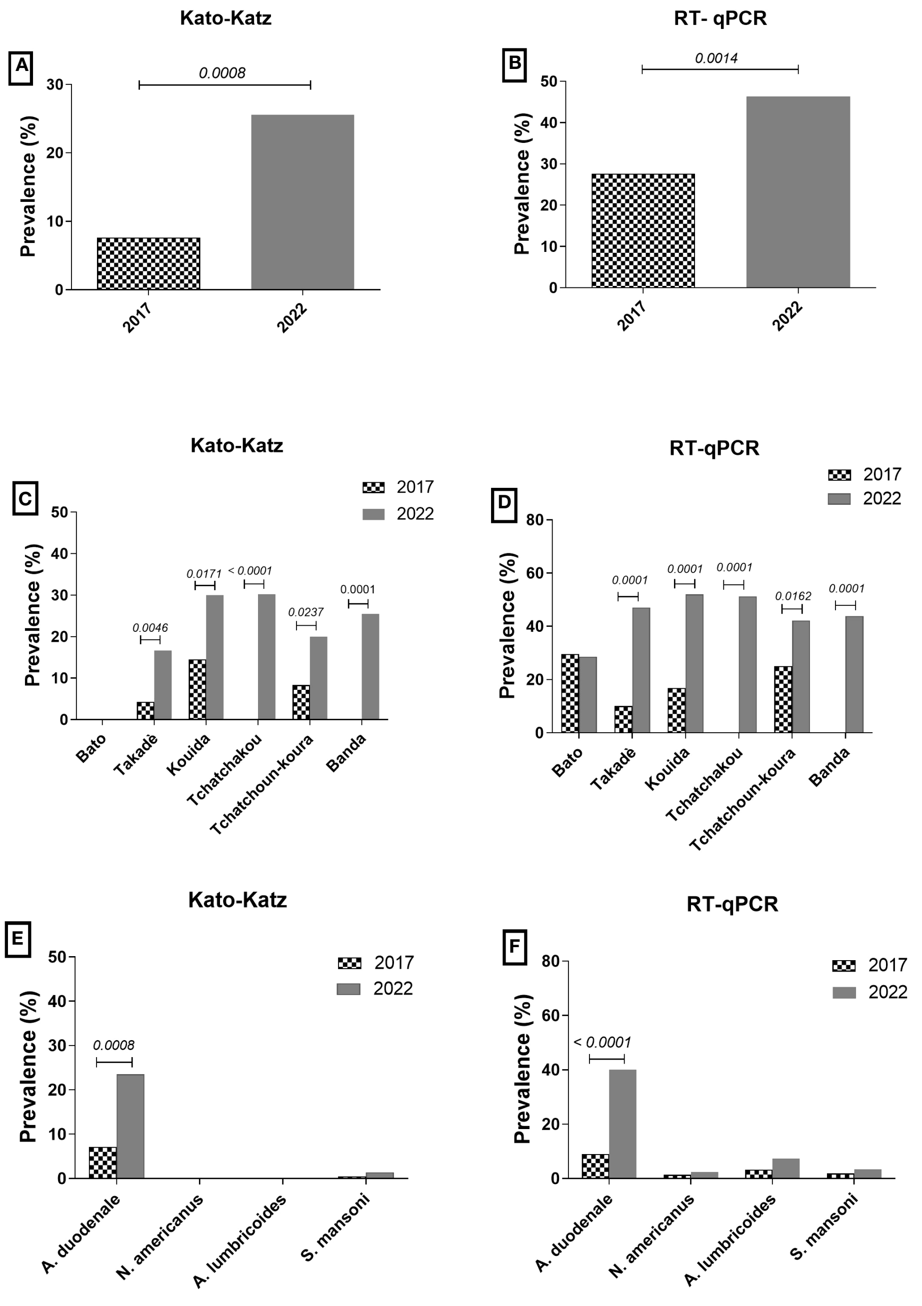

FIGURE 2
Prevalences of STHs and *S. mansoni*. Bars show the prevalence of infected people. **(A)** represents the total prevalence of STHs determined by KK and **(B)** by RT-qPCR in 2017 (n=210) and 2022 (n=289). **(C)** depicts the prevalence for individual villages using KK and **(D)** RT-qPCR. **(E)** shows the prevalence of the individual species studied by KK and **(F)** by RT-qPCR. For the comparison of percentages, a Fisher's exact test was performed, significant differences of *p<0.05* are indicated in the figures.

TABLE 6 Comparative table of MDA coverage in school-aged children and prevalence in adult.

Years	MDA coverage in school-aged children (%)	Prevalence among adults by Kato-Katz (%)	Prevalence among adults RT-qPCR (%)
2017	100	7.61	24.56
2021	99.5	27.62	46.36

KKnegative samples were positive using a RT-qPCR (40). Additionally, a study in the Philippines showed that RT-qPCR detected more STH infections than the KK method in school children (41). In addition, parasitological diagnosis such as microscopy is the most commonly method used in the surveillance of helminthiasis (42) since it is cost effective and does not require laboratory infrastructure. Nevertheless, it would be advantageous to include RT-qPCR diagnosis of helminths in epidemiological surveillance in Africa, especially in low-prevalence countries, whenever possible.

We noted that despite the large coverage of albendazole treatment, the prevalence of STHs increased between 2017 and 2022 in adults. This would be due to the exclusion of adults from the MDA programme. Our data are consistent with those found in Zambia where, the *S. mansoni* prevalence was elevated with 13.9% and 12.7% for both *A. lumbricoides* and hookworm, despite children in the same area were treated (43), which was also seen in Malawi (44). These treated children could be re-infected, due to the absence of parasite immunity, since they live in the same locality with infected adults, thus helping to maintain the transmission chain of the infection (45). However, this study has some limitations. As the study was cross-sectional, it was not possible to follow the included individuals over time to see whether they had been treated as children and inferable effect are not permitted due to the cross-sectional design of the study. However, given the mean age of the study population (37.15 ± 11.79 in 2017 and 42.01 ± 14.70 in 2022), most would not have had the chance to be included in the programme, since the deworming programme only began in Togo in 2010 (12).

In summary, we recommend that, as part of the implementation of the WHO roadmap for 2030, which targets that 90% fewer people require interventions against NTDs, 75% fewer NTD-related disability-adjusted life years and 100 countries achieving elimination of at least 1 NTD, more sensitive tests, such as PCR or circulating anodic antigen (CAA) recommended by the WHO should be used to confirm prevalence of less than 1% during epidemiological surveillance. Given that the prevalence of STHs has increased in the study area, it would be advisable to carry out an additional series of MDA, ideally also targeting adults. Moreover, surveys should be implemented each year to strengthen collaboration with handwashing (WASH) and sanitation partners, which have already proved their effectiveness in the fight against NTDs in Togo (28). In addition, a programme to provide an MDA coverage trend for each region should be established to guide intervention, which should be also connected to the Togo's National Programme for the Control of Neglected Tropical Diseases (PNLMTNT). Indeed, the burden of STHs and schistosomiasis varies considerably from one region to another due to differences in the nature of the, as well as environmental disease (particular schistosomiasis, which demands fresh water and snails for the transmission), social, cultural and economic conditions (46). Thus, regional programmes should implement for mapping, monitoring and controlling/eliminating zoonotic diseases and conduct operational research to inform policy on the factors affecting the transmission, morbidity and control of STHs and schistosomiasis. Finally, regular evaluations of the epidemiological impact of interventions through regular assessment of disease prevalence should be established.

5 Conclusion

This study showed that the prevalence of STHs (especially hookworm infection) and *Schistosoma mansoni*, was increased in 2022 compared to 2017 in adults, although MDA programmes are implemented in school-aged children. Collectively, this study suggests that MDA programmes in school-aged children do not reduce STHs and schistosomiasis prevalence in adults in Togo. Therefore, deworming and testing programmes need to be expanded to adults especially in highly endemic areas to reach the goal of elimination of helminth infections as a public health problem in Togo.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material. Further inquiries can be directed to the corresponding authors.

Ethics statement

The studies involving humans were approved by ethical board of the Ministry of Health of Togo, "Comité de Bioéthique pour la Recherche en Santé" (CBRS). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

HS: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. GK: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing – review & editing. KA: Validation, Visualization, Writing – review & editing. CN: Formal analysis, Methodology, Writing – review & editing. MA: Methodology, Writing – review & editing. ET: Methodology, Writing – review & editing. SK: Validation, Writing – review & editing. AY: Validation, Writing – review & editing. AH: Funding acquisition, Writing – review & editing. MK: Validation, Writing – review & editing. LL-H: Data curation, Funding acquisition, Supervision, Writing – review & editing. MR: Conceptualization, Project administration, Resources, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fitd.2024.1283532/full#supplementary-material

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