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Awareness towards urinary schistosomiasis and its relation with active infection among primary school pupils and students in North Kordofan state, Sudan 2022

Ghassan E. Mustafa Ahmed [a,*], Exeer Yahia M. Ahmed [a], Ayat Eltahir Ahmed [a], Lina Hemmeda [a], Anmar B. Birier [a], Tibyan Abdelgadir [b], Hadiea Mosaab Ahmed Elbashir Hassan [b], Esraa S.A. Alfadul [c], Musab Bakr [d], Ethar Awadelkareem Jaafer Sadig [c], Khotwa Charity Foundation [e]

[a] MBBS, Faculty of Medicine, University of Khartoum, Khartoum, Sudan.
[b] Faculty of Medicine, University of Khartoum, Khartoum, SudanFaculty of Medicine, University of Khartoum, Khartoum, Sudan
[c] Faculty of Medicine, University of Khartoum, Khartoum, Sudan
[d] Faculty of Medicine, University of Kordofan, Elobied, Sudan
[e] Humanitarian Aid Commission, Ministry of Social Development, Khartoum, Sudan

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ABSTRACT

Objectives: This study intends to evaluate the prevalence of active Schistosomiasis in school children, as well as their awareness, attitude, and behavior towards the illness in El-Rahad province.

Methods: This facility-based analytical cross-sectional study among 495 primary school children aged seven to 13 in five villages; Structured and pre-tested questionnaires were used to collect the data in face-to-face interviews, in addition, urine samples were collected from each pupil and then assessed microscopically for S. Haematobium eggs Presence. Data was analyzed using SPSS version 25.0.

Results: A total of 424 primary school students participated in the study. Almost all the students (96%) had poor knowledge about urinary schistosomiasis. In general, 100% of the students had poor practices. Attitude revealed that females have lower chance of having the infection than their male counterparts. About 27% (n = 115) of them had active urinary schistosomiasis infection at the time of the study.

Conclusion: The study revealed poor level of awareness and knowledge, positive attitude, and poor practices among primary school students. There was also high level of active infection among participants.

1. Introduction

Schistosomiasis is a water-borne parasitic disease caused by trematode worms of the genus Schistosoma also known as blood flukes. It is one of the neglected tropical diseases (NTD)and a major health concern, particularly in tropical and subtropical areas of the world.

* Corresponding author at: Faculty of Medicine, University of Khartoum, ElQasr Avenue, Khartoum 11111, Khartoum State, Sudan.
E-mail addresses: nimirghassan@gmail.com (G.E. Mustafa Ahmed), scientificsec@khotwacf.org (Khotwa Charity Foundation).

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There are five main species of schistosomes responsible for two forms of human schistosomiasis; intestinal, caused by *S. mansoni*, *S. japonicum*, S.guineensis, and related S. Intercalatum that manifest with abdominal pain, diarrhea, and blood in stool where the urogenital, caused by S. Haematobium manifest with hematuria. (Schistosomiasis [Internet], 2024)

According to estimates, at least 236.6 million persons required preventive therapy in about 78 countries worldwide in 2019, with Africa accounting for at least 90% of those seeking treatment for schistosomiasis (Schistosomiasis [Internet], 2024). Schistosomiasis is estimated to be 44.8% throughout eastern Africa. (Ngowi, 2020) *Schistosoma mansoni* and S. Haematobium are widespread throughout Africa (Epidemiology and risk factors [Internet], 2024). However, a 2017 nationwide study in Sudan estimates that the overall prevalence was 5.2% for S. haematobium and 0.06% for *S. mansoni*. (Cha et al., 2019), reflecting that both are the most common species in Sudan. More importantly, migration to urban regions and population movements are spreading the disease to new locations; hence, Increased population numbers and accompanying power and water needs frequently promote transmission. (Schistosomiasis [Internet], 2024) (Id et al., 2021a). In 2021 442,000 internal displacements were reported during the year, more than five times the figure for the previous year and the highest since 2014 as a result of inter-communal violence (Sudan [Internet], n.d.). This will contribute to the widespread of the disease.

Those species require intermediary snails before residing in a definitive host, commonly humans, in which the larvae penetrate the skin when coming in contact with the contaminated water while bathing, crossing, or swimming in dams and rivers, then the larvae develop into adult schistosomes. The eggs of those schistosomes are then passed out of the body in the feces or urine to continue the parasite's life cycle (Schistosomiasis [Internet], 2024) (Jokomo and Chimbari, 2017). Contacting contaminated water is necessary to spread the infection, and Sudan is a country with an extensive supply of water represented by the Nile and its two tributaries, the White Nile and the Blue Nile. Several irrigation projects have been established around those rivers. Still, they also foster the growth of the snails that serve as the disease's intermediate hosts and so raise the prevalence and intensity of the condition. (Amin, 2017) (Communication, 2016).

Furthermore, children are at higher risk due to poor hygiene, frequent reinfection, and increased contact with water. The disease affects those children's quality of life, development, and cognitive function and also inflicts a low rate of school attendance. (Ezeamama et al., 2018) (Terer et al., 2013) (Id et al., 2021b).

Children also show iron deficiency anemia, memory impairment, and poor growth rate. (Al-haidari et al., 2021)

Acute infection can cause liver, lung, and bladder disease depending on the type of species; however, chronic infection, as occurs in the endemic areas, may cause pulmonary hypertension, hepatosplenomegaly, and bladder cancer. Unfortunately, chronic infection may also cause fibrosis of the urinary tract, thus presenting with obstructive uropathy (hydroureter and hydronephrosis) (Colley et al.,

Table 1
shows Sociodemographic characteristics and prevalence of urinary schistosomiasis infection among primary school students in North Kordofan state, Sudan 2022.

Characteristic	Frequency/mean ± SD	Percent
Age	12.3 ± 1.884	
Maximum	18 years	
Minimum	8 years	
Gender (n = 423)		
Male	202	47.8
Female	221	52.2
Grade (n = 423)		
4th	101	23.9
5th	97	22.9
6th	103	24.3
7th	52	12.3
8th	70	16.5
Village (n = 423)		
Tendelti	94	22.2
Aradeba	95	22.5
Hagina	94	22.2
Majo	83	19.6
Broki	57	13.5
Main water source (n = 422).		
Wells	335	79.4
Canals	87	20.6
Infection status (n = 411)		
Positive	115	28
Negative	296	72

2014). Furthermore, urogenital schistosomiasis increases the susceptibility to the transmission of HIV. (Patel et al., 2020) These complications are not life-threatening but lead to major disabilities (Adenowo et al., 2015) that can be prevented early by hindering the spread of the infection.

Since no research has been done on the prevalence of schistosomiasis in Al-Rahad North Kordofan, to our knowledge, it is difficult to predict how well-informed the local population know about the infection and its complications and how to prevent it. This study intends to evaluate the prevalence of active Schistosoma infection in school children, the contaminated water sources, and the schooler's awareness, attitude, and behavior towards the illness. The findings of this study will provide us with a clear picture of the existing situation and help stakeholders make decisions about how to raise awareness about infection prevention and how to avoid its adverse implications.

Table 2
shows Knowledge About Urinary Schistosomiasis Infection, Source, Prevention, Symptoms and Complications Among Primary School Students in North Kordofan state, Sudan 2022. ($n = 296$).

Item	Answer	Frequency	Percent
Did you hear about schistosomiasis before?	yes	296	70.1
	no	126	29.9
What is the cause of schistosomiasis?	Worms (Parasite)	149	35.1
	Bacteria	26	6.1
	Virus	11	2.6
	I don't know	111	26.2
What do you think the way to catch the disease ($n = 127$)	Contacts with polluted water	213	50.2
	drinking polluted water	14	3.3
	others, exposure to sun light	16	3.8
	I don't know	39	9.2
	Salty water and food	8	1.9
	Carrying heavy things	1	0.2
	Contact with infected person's urine	2	0.5
	walking barefoot	2	0.5
	going to the river	1	0.2
	Eating without washing hands	1	0.2
Urine is regarded as a source of infection ($n = 299$)	Yes	191	63.9
	No	91	30.4
	I don't know	17	5.7
Is schistosomiasis a serious disease	Yes	249	83.3
	No	47	15.7
	I don't know	3	1
Can schistosomiasis can be prevented ($n = 163$)	Yes	267	89.6
	no	24	2.3
	I don't know	7	8.1
How?			
	avoid swimming in fresh water	141	47.0
	Avoid paddling in fresh water	54	18.0
	Avoid washing in fresh water	14	4.7
	Purify the water and keep it clean	28	9.4
	Avoid drinking polluted water	25	8.4
	Avoid the exposure to sunlight	15	5
	Avoid contact with infected people	288	96.6
	Praziquantel	84	28.5
What is the treatment of schistosomiasis ($n = 129$)	I don't know	211	71.5
What are the symptoms of schistosomiasis?			
	Passing blood in your urine	130	43.5
	Itching in your skin	9	3.1
	Pain during urination	54	18.3
	Urinary frequency	19	6.4
	Loin pain	46	15.6
	Malaise	27	9.2
	Fever	12	2.8
	Headache	11	3.7
	Others	7	2.4
	I don't know the symptoms	84	71
What are the complications of the schistosomiasis			
	Anemia	5	1.7
	Vaginal discharge	0	0
	Bladder cancer	14	4.8
	Renal failure	22	5.2
	Infections	250	84
	Death	268	90.2
	Others	117	39.9
	I don't know	159	54.3

2. Methodology

This facility-based analytical cross-sectional study evaluated primary school students' knowledge, attitudes, and practices about urinary schistosomiasis and linked them to the presence or absence of a current active infection, as determined by urine ova microscopic detection in the studied area. This study was carried out in North Kordofan State, El-Rahad locality. El-Rahd is situated 545 km to the west of Khartoum, between longitudes 30,18, and 31,21, and latitudes 12,45, and 13,42 in the southern section of North Kordofan state. The absence of rivers in the region is a well-known fact. The inhabitants of this region depend on the freshwater lake (Al turaa), a man-made reservoir that collects rainwater. The study was carried out as part of a medical mission – conducted by Khotwa Charity Foundation - to (Id et al., 2021a) villages in North Kordofan State. Each village had a medical day with free access to a range of medical services (clinics, labs, and pharmacies), as well as health education programs that helped with population recruitment. The data for this study were collected from five primary schools located in five villages at El-Rahad locality accompanying the medical day setting. The study population was all primary school children at Tendelti, Broki, Aradeba, Hegina, and Majo, who were aging8–18 years and studying from grade four to grade eight in the primary schools of the villages mentioned above. The total number of pupils in each school and the sex distribution are provided in Table 1. Schoolchildren aged between seven and 13 who assented to participate and whose guardians signed informed written consent were eligible to participate. These are the age groups carrying the highest burden of schistosomiasis in endemic areas, as stated by the World Health Organization (WHO) (https://www.who.int/publications/i/item/9789241548267). Our exclusion criteria included severely ill children during data collection to the degree that it interfered with their participation. Stratified sampling technique was used. The sample size was calculated using the formula of known population size: $n = N/1 + N^*(e)2$, n = sample size, N = population size (26273), e = the acceptable margin of errors (0.05). (See Table 2.)

$n = 26273/1 + 26273^*(0.05)2 = 394$, to ensure the full coverage of the determined sample size, taking into account that some participants may not consent to join the study, a total of 425 children were included. Data were collected through two methods:

Face-to-face interviews: Data were obtained using an author-designed structured questionnaire with four main sections: socio-demographic information, knowledge of the causal agent, transmission routes and control strategies; attitude and beliefs towards the disease; swimming and other practices. The questionnaire was developed after a thorough literature review of studies with similar objectives. To avoid reliability concerns in data collecting, the questionnaire had been translated into Arabic. The study authors then,

Table 3
shows Attitude and Practice of Primary School Students in North Kordofan State, Sudan 2022 ($n = 269$).

Item	Answer	Frequency	Percent
Attitude n = 296			
What will you do is you had blood with urination, increased urinary frequency, loin pain, fever, malaise.)?	Visit a health care facility	252	85.1
	Use traditional medicine	11	3.7
	I will buy medicine from a drug store without visiting the doctor	10	3.4
	I will not do anything	17	5.7
	Others	6	2
Why would you choose this option?	To get the treatment	178	63.1
	I have not told my parents yet	1	0.3
	Failure of past experience	1	0.3
	More efficient	62	21.9
	To avoid complications	11	3.9
	Safer	8	2.8
	Past experience	3	1
	Cheaper	1	0.3
	I don't know	15	5.3
	Others	2	0.7
If you were diagnosed with urinary schistosomiasis and prescribed a medication, would you take it?	Yes	284	84.4
	No	46	15.6
Do you think the drug used in treatment of schistosomiasis efficient	Yes	219	74.0
	No	77	26.0
Why isn't it efficient?	No past experience	50	66.7
	did not improve the symptoms	11	14.7
	Expensive	1	1.3
	Non-compliance	2	2.7
	Recurrence of symptoms	2	2.7
	I don't know	8	10.7
Practice $n = 241$			
Swimming/bathing in open water	Yes, I did	181	75.1
	No, I did not	60	24.9
Indiscriminate urination (in water sources; "Turaa = canals")	Yes, I did	20	8.3
	No, I did not	221	91.7
Fetching water from ponds/streams	Yes, I did	150	89
	No, I did not	92	38
Washing clothes or utensil in open water source	Yes, I did	162	66.9
	No, I did not	80	33.1

with the help of language experts, retranslated the questionnaire into English. After receiving several training sessions from the study authors, a group of medical students did the data collection interviews. Kobo-collect, a mobile data collection app, was used to enter the collected data.

2.1. Laboratory examination

Freshly passed urine specimens were collected using a clean plastic container from each pupil before the interview. Then the medical mission's lab team received the gathered samples and used direct microscopy to check for the presence of Schistosoma haematobium eggs.

Data were initially entered and cleaned using Microsoft excel, then analyzed using Statistical Package for Social Sciences (SPSS) version 25.0, categorical data presented in form of frequencies (n) and percentages (%). For analytical statistics, we used chi square test was to describe the relationship between the demographic characteristics, knowledge about schistosomiasis and practice with the presence of schistosomiasis infection. and Binary logistic regression were used to identify predictors affecting prevalence of schistosomiasis among participants. *P* value of <0 0.05 was considered significant.

3. Results

A total of 424 primary school students, from five villages; participated in the study. Their mean age was 12.3 years with standard deviation of 1.9 years and a range from 8 to 18 years. 52.1% of them were females. The majority were sixth, fourth and fifth graders (n = 103, 24.3%) (n = 97, 22.9%) and (n = 101, 23.8%) respectively. Among all the students; 29.7% (126) have not heard about

Table 4
Shows Distribution differences of schistosomiasis infection status among primary school children in North Kordofan state, Sudan 2022.

Characteristic	Microscopic examination result		P-Value[1]
	Positive	Negative	
	Frequency (%)	Frequency (%)	
Gender			
Male	60 (14)	140 (34.1)	0.295
Female	54 (13.8)	156 (38%)	
Grade (n = 204)			
4th	33 (8.0)	64 (15.6)	0.024
5th	23 (5.6)	70 (17.0)	
6th	36 (8.8)	63 (15.3)	
7th	8 (1.9)	44 (10.7)	
8th	15 (3.6)	55 (13.4)	
Village			
Tendelti	67 (16.3)	17 (4.1)	0.0000
Aradeba	16 (3.9)	78 (19)	
Hagina	2 (0.5)	92 (22.4)	
Majo	10 (2.4)	73 (17.8)	
Broki	20 (4.9)	36 (8.8)	
Main water source			
Wells	62 (15.1)	271 (65)	0.000
Canals	53 (12.9)	24 (5.8)	
Have you ever heard about schistosomiasis?			
Yes	77 (18.7)	212 (51.6)	0.522
No	38(9.2)	83 (20.2)	
Knowledge about schistosomiasis			
Good	0	0	0.197
Fair	6 (3.3)	8 (4.3)	
Poor	41 (22.3)	129 (70.1)	
Practice			
One practice	14 (6)	56 (23.8)	0.019
Two practices	26 (11.1)	49 (20.9)	
Three practices	34 (14.5)	51 (21.7)	
Four practices	0 (0)	5 (2.1)	

[1] Chi-squared test.

schistosomiasis before. About 27% ($n = 115$) of them had active urinary schistosomiasis infection at the time of the study. (Table 1).

Almost all the students (96%) had poor knowledge about urinary schistosomiasis, causative agent, transmission, presentation, complications and prevention.

Regarding attitude, majority of the students had a positive attitude towards seeking professional medical care and taking the medications, given that 85% of them said they would visit a healthcare facility if they feel the symptoms of schistosomiasis. 63.8% reported that they chose their answer in order to get the treatment, and 21% said that the option they have chosen is more efficient than other options. About 83% reported that they would take the treatment, yet only 74.4% think the treatment is efficient. The reasons behind their choices were that they don't have a past experience with the treatment in the case of 66.7% of the students, and a 14.7% have a past experience but without improvement. (Table 3). In general, 94% of students was found to have positive attitude regarding seeking medical help and receiving treatment of schistosomiasis.

A 100% of the students perform at least one of the poor practices that leads to spreading or contracting the infection with schistosomiasis. The most frequent practice was fetching water from ponds/streams (89%), followed by swimming or bathing, washing clothes or utensils in water sources (75.1%, 66.9% respectively), and the least frequent was indiscriminate urination in water sources (8.3%) (Table 3). In general, 100% of the students had poor practices.

4. Factors affecting the prevalence of urinary schistosomiasis between primary school students

The prevalence of urinary schistosomiasis was significantly higher among students of fourth (34.4%), sixth (36.4%) and fifth grade (24.7%, *p*-value 0.024). Prevalence was also higher among students whose main source of water for their houses is canals with a percentage of 68.8%, p-value <0.001. Also, in accordance to village of residency; a significantly high percentage (80%) of the positive students were from Tendelti with a *p*-value of <0.001. (Table 4).

Multivariate analysis of association of prevalence of schistosomiasis infection with; gender, educational level, village, knowledge and attitude revealed that females have lower chance of having the infection than their male counterparts, *p*-value 0.01 (OR;0.173, CI:0.046–0.658). The village of residence has a significant association with schistosomiasis infection, hence residence in the villages other than Tendelti puts the student at less risk of having the infection, p-value 0.002, the least affected village was Hagina p-value <0.001 (OR:0.004, CI:0.00–0.068). (Table 5).

Also, the students who revealed that they are not going to do anything when noticing schistosomiasis symptoms showed a 26 times higher chance of having the infection than other students who said that they will go to the doctor or even buy the medications without a prescription, p-value 0.023, (OR:26.493, CI: 1.52–443.55), and assessing knowledge effect on prevalence of schistosomiasis showed no significant association, p-value 0.0567. students with negative attitude towards seeking help and taking treatment have 1.71 higher chance of being infected, yet it was statistically not significant, p-value 0.788 (Table 5).

5. Discussion

This study investigated the awareness of primary school children from 5 villages in AL-Rahad, North Kordofan state towards urinary schistosomiasis and the relation between this awareness and the state of infection whether active or not. The study included

Table 5
shows Prevalence of urinary schistosomiasis and associated factors in primary school students of North Kordofan state, Sudan 2022.

Variables		OR *(95% CI**)	P value***
Gender	Males	1	0.010
	Females	0.173(0.046–0.658)	
Grade	4th	1	0.207
	5th	0.646 (0.094–4.4)	0.656
	6th	1.577 (0.262–9.482)	0.619
	7th	0.36 (0.028–4.759)	0.44
	8th	0.243 (0.029–2.009)	0.189
Village	Tendelti	1	0.002
	Aradeba	0.070 (0.008–0.623)	0.017
	Hagina	0.004 (0.00–0.068)	0.000
	Majo	0.011(0.001–0.138)	0.000
	Broki	0.163 (0.030–0.87)	0.34
Main water source	Wells	1	0.516
	Canals	1.760	
Attitude when noticing symptoms of urinary schistosomiasis	Visit a health care facility	1	0.48
	Use traditional medicine	2.62 (0.163–42.2	0.49
	buy medicine without visiting the doctor	1.392 (0.038–51.044)	0.87
	Will not do anything	26.493 (1.52–443.55)	0.023
Knowledge	Fair knowledge	1	0.567
	Poor knowledge	0.54 (0.066–4.449)	
Attitude	Positive attitude	1	0.788
	Negative attitude	1.711 (0.370–3.710)	

424 primary school students with their ages ranging between 8 and 18 years old, and school level between 4th and 8th grade.

Almost all participating students (96%) had poor awareness and lack of information about urinary schistosomiasis, its cause, mode of transmission, and symptoms. This finding is compatible with results reported by a similar study in Botswana which discovered low level of awareness towards schistosomiasis and its cause (72%) and (75%) did not know hematuria is a symptom of the disease (Gabaake et al., 2022). This similarity could also be attributed to low educational levels and socioeconomic status shared between the two countries. 70.3% of the participants have heard of schistosomiasis before, which is less compared with the study from Swaziland that reported most of the participants (97.3%) had heard about schistosomiasis R2SWAZ. The mean score of awareness was found to be 11.2 ± 2.5, which is similar to the study in Swaziland which reported a score of 11 ± 1.45. (Maseko et al., 2018)

Regarding students' attitude, the majority showed positive attitude towards dealing with schistosomiasis and seeking medical care in case of infection. 83% stated they would take medications, but only 74% thought the treatment was efficient, which was justified by the fact that 66.7% of them had not tried the medications before, and 14.7% reported that the medications they took were inefficient. The Swaziland study also reported a positive attitude towards taking medications and 81.5% of the participants agreed that it is important to take anti-schistosomiasis tablets (Maseko et al., 2018). These findings were slightly higher than those reported by a study in South Africa which found that 70% of the students were willing to receive praziquantel as a treatment. (Kjetland, 2012)

All students practiced at least one of the poor practices leading to high risk of getting infected with urinary schistosomiasis. The most frequent practice was fetching water from ponds/streams for domestic purposes (89%), followed by swimming or bathing, washing clothes or utensils in water sources. These practices were also reported by the Swaziland study as the most practiced among school children in the region (Maseko et al., 2018). The same practices – but to a lesser degree- were reported by a study conducted in South Africa. (Kjetland, 2012)

About 27% of the students had active urinary schistosomiasis infection at the time of the study. Multivariate analysis showed a significant association between risk of infection and being a male, as a well as an association with area of residency, with participants from Tendelti reporting higher levels of infection (79.8%), which can be justified with the fact that their only source of water was the exposed canals, unlike other participating villages which had wells and pumps as major sources of water. A previous Sudanese study reported the prevalence of urinary schistosomiasis among school children to be 16%, but with a higher significance among males. (Dahab and El-bingawi, 2012)

This study was the first to target this issue in North Kordofan state, which gave an insight to the high levels of infection as well as poor awareness that requires further focus and consideration from the ministry of health and the stakeholders via implementing educational programs and medical field trips to the area. The study also revealed the socio-economic status of certain villages which require quick interference from the authorities to provide safe and secure sources of water.

There was no enough evidence or previous studies tackling the research problem in the region. Also, the reasons behind the poor awareness and the rate of active infection were not scientifically investigated whether they were social, cultural, or economical. Another limitation that could be noticed by the reader, is the discrepancies in sample size between variables and tables in the results section, which are attributed to missing data i.e. data were incomplete, due to reasons such as pupils wouldn't cooperate, and some pupils may abandon the interview before the all questions are addressed. All these limitations require further studies on the problem in the area which would draw recommendations to the acting authorities in the state.

6. Conclusion

The study revealed poor level of awareness and knowledge, positive attitude, and poor practices among primary school students. There was also high level of active infection which was significantly associated with being a female and resident of particular villages such as Tendelti. Further studies on the reasons behind the poor awareness and the rate of active infection as well as the impact at the social, cultural, or economical levels should be conducted.

Ethics approval and consent to participate

Ethical clearance for the study was obtained from the State Ministry of Health, North Kordofan state Ethics Committee. The school principals and parents granted permission and approval to research before the study was conducted. Information about the study was sent to parents or guardians, and written informed consent was requested from them. All learners provided assent.

Consent for publication

No personal data were collected from the participants.

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All authors revised the manuscript and approved it for publication.

CRediT authorship contribution statement

Ghassan E. Mustafa Ahmed: Conceptualization, Project administration, Supervision, Writing – original draft, Writing – review &

editing. **Exeer Yahia M. Ahmed:** Conceptualization, Data curation, Formal analysis, Project administration. **Ayat Eltahir Ahmed:** Methodology, Writing – original draft, Writing – review & editing. **Lina Hemmeda:** Conceptualization, Writing – original draft, Writing – review & editing. **Anmar B. Birier:** Conceptualization, Formal analysis, Writing – review & editing. **Tibyan Abdelgadir:** Writing – original draft, Writing – review & editing. **Hadiea Mosaab Ahmed Elbashir Hassan:** Writing – original draft, Writing – review & editing. **Esraa S.A. Alfadul:** Writing – original draft, Writing – review & editing. **Musab Bakr:** Writing – review & editing. **Ethar Awadelkareem Jaafer Sadig:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no competing interests.

Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request. The data are not publicly available due to issues of privacy.

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