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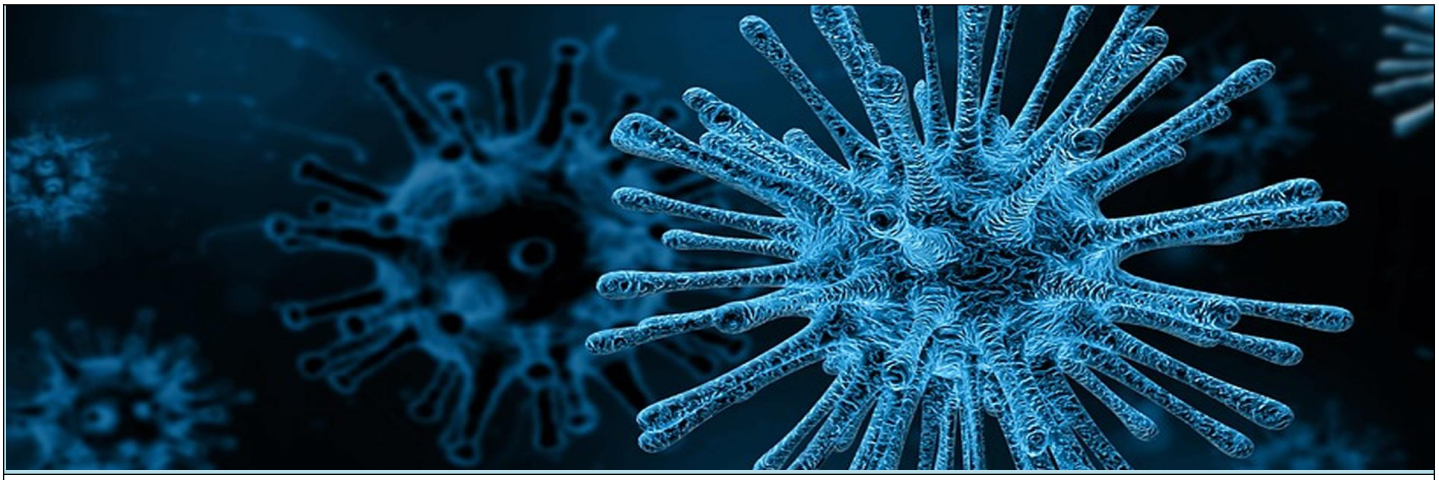

Survey of *Schistosoma haematobium* among Basic School Children in Urban and Rural Communities in Khartoum North, Khartoum State, Sudan.

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NAME OF THE AUTHOR

***Nadia A Elsammani[1], Abdelghaffar Ali Adam[2], Adam Abdalla Mater[3],**

[1]PhD Student, Alzaiem Alazhari University, Sudan.
[2]Professor of Community Medicine, Shendi University,Sudan.
[3]Associate Professor, Alzaiem Alazhari University, Sudan.

ABSTRACT

A cross-sectional study was conducted to determine the prevalence of *S. haematobium* among school children in selected basic schools in a rural and an urban area in Khartoum North, Khartoum State, Sudan. A structured questionnaire was administered to 600 children to collect information used to determine the factors associated with Schistosomiasis. Urine specimens (600 samples) were examined using the standard sedimentation technique to determine the prevalence of *S.haematobium*. Overall, prevalence of *S.haematobium* in both communities was of 15.7% a rural area had a higher prevalence 16.0% compared to an urban community 15.3%.The prevalence rates were significant in both communities, with gender in both communities, males *was* recorded higher infection rate than females, 90(23.5%) and 4(1.8%), respectively, while age group 13-15 year age group recorded the highest prevalence18(22.2%) and 21(17.1%) in the urban area and the rural area, respectively. When compared to other age groups, these differences were significantly different ($p < 0.05$) in both communities. It was concluded that Schistosomiasis remains a serious public health concern in Sudan. Therefore, application appropriate integrated control program will significantly reduce the disease transmission.

KEYWORDS : *Schistosoma haematobium,* Prevalence, Rural, Urban.

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** Corresponding author*

I. INTRODUCTION

Schistosomiasis is one of the seventeen neglected tropical diseases (NTDs) [1] .The disease was formerly known as bilharziasis or snail fever [2], caused by blood flukes of the genus *Schistosoma* (*s*) [3]. Schistosomiasis was estimated to be the third leading cause of Disability Adjusted Life Years among NTDs worldwide [4] and runs up only to malaria as an important parasitic disease [5] in Sub-Saharan Africa accounting for 200 million deaths annually [6],[7],[8]. This parasitic infection affects either gastrointestinal or urinary tracts depending on the causative agent [6]. Five species infect humans, namely: *S. haematobium, S. mansoni, S. japonicum, S. mekongi,* and *S. intercalatum* [9]. There are responsible for two forms of human schistosomiasis; intestinal, caused by *S. mansoni*, *S. japonicum* and *S. intercalatum*, and urogenital, caused by *S. haematobium* [10]. Two species common in Africa of main concern to humans are; *S. haematobium* transmitted by *Bulinus* snails and *S. mansoni* transmitted by *Biomphalaria* snails [11],[12]. *S. haematobium* is endemic in 53 countries in the Middle East and most of the African continent [13]. An estimated two hundred million people are to be infected worldwide with *S. haematobium*, 70% of which live in the sub- Saharan African [14]. The occurrence of the disease mostly affects poor and rural communities, is particularly linked to agricultural and fishing populations. Across Sub-Saharan Africa, women, children and those working in contact with natural water bodies, are also at greater risk [15], [16].

In Sudan, both *S. haematobium* and *S. mansoni* are endemic; *Schistosoma haematobium* has been predominant in the west and the north of Sudan. Urinary schistosomiasis has been widespread and constitutes a critical health problem, particularly in children [17]. Meanwhile, the infection rate of *S. haematobium* among school children as high as 73.5%,was reported in Al-Lamab Bahar Abiad Area, Khartoum State [18] , also the infection of *S. haematobium* was reported the different part of the country; White Nile State [19],[20], Gezira area Central Sudan, Southern Kordofan State, South Darfur and River Nile State [21],[22],[23],[24]. To achieve appropriate and cost effective control measures of urinary schistosomiasis in Sudan, it is important to provide useful epidemiological data and disease distribution among the high risk population in the different parts of the community [25]. This study comparatively examined the prevalence of *S. haematobium* and risk factors among basic school children in two contrasting communities in Khartoum North, Sudan.

II. MATERIALS AND METHODS

2.1. Study design

A cross-sectional study was conducted to determine the prevalence of *S. haematobium* and risk factor in selected basic schools in a rural and an urban community in Khartoum North, Khartoum State, Sudan.

2.2. Study area

This study was conducted in government basic school, Bahri Shmaal (urban area) and Bahri Rural Area, both of Khartoum North, Khartoum State, Sudan from June to August 2018 (Figures 2.1). Khartoum North (Khartoum Bahri) is a city in Khartoum State, lying to the north of Khartoum state, the capital of the Republic of Sudan. Khartoum North is located on the east bank of the River Nile and the north bank of the Blue Nile, and near the confluence of the Blue Nile with the White, bridges connect it with both Khartoum to its south and Omdurman to its west. And it covers an area between latitudes 15° 38' 33" N and longitudes 32° 33' 13".

2.3. Study Population

The study population comprised children who were six to fifteen years old. Twenty basic schools were selected for the study; ten schools selected for rural area, and the other ten schools were selected for the urban area. The sample size was 600 school children, collected randomly from pupils in classes 1-8.

2.4.Data collection

2.4.1.Socio-demography and related factors

Structured questionnaire was used to collect socio-demographic data included age, sex, and associated risk factor data for *S.haematobium*.

2.4.2.Urine sample collection

Each pupil was given clean labeled plastic containers, urine collection was done between 10 am and 2pm .The urine collected was immediately taken to the laboratory for analysis.

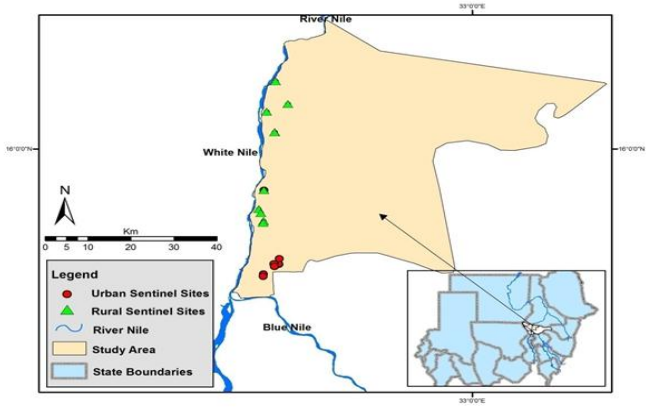

Figure (2:1) Map of the Study areas.

2.5. Laboratory Analyses

Urine sample was analyzed for *Schistosoma haematobium* eggs using the standard sedimentation technique [26]. Each sample was centrifuged at 1500rpm for 5 minutes and the prepared slides were examined microscopically using x10 and x40 objective lens.

2.6. Data analysis

The data were entered and analyzed using SPSS version 22. Data summary was made using descriptive statistics. Statistical significance was considered at 95% CI and P-value less than 0.05.

III. RESULTS

3.1 Community (urban and rural area) related prevalence of *S.haematobium*

Of the 600 children screened for *S.haematobium* infection, 94(15.7%) were positive for *S. haematobium* eggs (Table 1). The prevalence rates of *S.haematobium* in the rural area 48(16.0%) were higher than in the urban area 46(15.3%). There was no significant difference in the infection between the urban and the rural communities (p-value >0.05) (Tables 1).

3.2 Prevalence of *S. haematobium* infection by gender

A total of 600 school children were examined, comprising 63.8% males and 36.2% females. The distribution of infection, according to gender revealed that male, 90(23.5%) pupils were more infected than females, 4(1.8%) (Table 1). In both the urban area and the rural area male participants were more infected than the females. There was a significant difference in prevalence of infection between the gender ($\chi 2=49.166$, p = 0.000).

3.3 Age related prevalence of *S.haematobium*

In relation to age, the 13-15 year age group recorded the highest prevalence 18(22.2%) and 21(17.1%) in the urban area and rural area, respectively, while the lowest was in the 6 -9 year age group in both communities (Table 2). There was a significant difference in the rate of infection in relation to the age of the pupils (p < 0.05).

3.4 Sources of water related prevalence of *S.haematobium*

Based on the responses to the questionnaire, the available sources of water supply included pipe, well and canal, pupils who use the canal as their source of water recorded the highest prevalence (27.3%), followed by those who use the well as their source of water, in the urban area there was no significant difference in the rate of infection in relation to the water source of the pupils While statistically significant indicates that the source of water is associated with the prevalence of *S. haematobium* was reported in the rural area p<.05 (Table 3).

3.5 Prevalence of *S.haematobium* in relation to Water contact habit

Table 4 highlights the prevalence of the disease in relation to water contact activities of pupils in the study area. It was observed that children water contact by taking animals for drinking in the canal or rivers had the highest prevalence 2(25.0%), followed by the children who were involved in the bathing and swimming with prevalence 68(23.1%). However, chi square analysis showed variables were significant difference in the prevalence rate of infection with water contact activities of the children (X^2 =26.834, p = 0. 000).

3.6 Prevalence of *S.haematobium* in relation to education and occupation of the parents

Based on parents' occupation and level of education, the highest prevalence was recorded in students whose parents are farmer's 42(19.0%) , followed by those whose parents were self-employed 43(15.6%), Chi square analysis showed no significant difference between the prevalence rate of infection and the occupation of the parents (X^2 =5.735, p = 0. 057) (Table 5). However, pupils whose parents had basic or inter medial education had the highest prevalence 58(21.5%), the least prevalence was recorded in pupils whose parents are university educate. In the urban area there was a significant difference in the rate of infection in relation to parents' education, but in the rural area there was no significant difference (Table 5).

Table 1. Prevalence of *S. haematobium* in relation to gender in the study areas

Gender	Bahary Shmaal(Urban)		Bahary Rural Area(Rural)		Total	
	No. examined	No. Infected (%)	No. examined	No. Infected (%)	No. examined	No. Infected (%)
Male	150	43 (26.7%)	233	47 (20.27%)	383	90 (23.5%)
Female	150	3 (2.0%)	67	1 (1.5%)	217	4 (1.8%)
Total	300	46 (15.3%)	300	48 (16.0%)	600	94 (15.7%)
significant	X^2 =41.082, p = 0.000		X^2 =13.509, p = 0.000		1.$\chi 2$=0.52, p = 0.822 2. $\chi 2$=49.166, p = 0.000	

1. Significant (infection between the urban and rural).
2. Significant (infection between genders).

Table 2. Prevalence of *S. haematobium* in relation to age group in the study areas

Age group	No. examined	No. Infected (%)	Chi-Square (X^2)	p value
Bahary Shmaal(Urban)				
6 -9 years	104	7(6.7%)	9.649	0.008
10- 12 years	115	21(18.3%)		
13-15 years	81	18(22.2%)		
Total	300	46(15.3%)		
Bahary Rural Area(Rural)				
6 -9 years	97	7(7.2%)	10.495	0.005
10- 12 years	123	21(17.1%)		
13-15 years	80	20(25.0%)		
Total	300	48(16.0%)		
Grand Total	600	94(15.7%)	19.900	0.000

Table 3. Prevalence of *Schistosoma haematobium* in relation to source of drinking water in the study areas

Gender	Bahary Shmaal(Urban)		Bahary Rural Area(Rural)		Total	
	No. examined	No. Infected (%)	No. examined	No. Infected (%)	No. examined	No. Infected (%)
Pipe	286	45 (15.7%)	286	43 (15.0%)	572	88 (15.3%)
Well	7	1 (14.3%)	10	2 (20.0%)	17	3 (17.6%)
Canal	7	0 (0.0%)	4	3 (75.0%)	11	3 (27.3%)
Total	300	46 (15.3%)	300	48 (16.0%)	600	94 (15.7%)
significant	X^2 =1.309, p = 0. 520		X^2 =10.677, p = 0. 005		X^2 =1.206, p = 0. 547	

Table 4. Prevalence of *Schistosoma haematobium* in relation to water contact habit

Water contact habit	Bahary Shmaal(Urban)		Bahary Rural Area(Rural)		Total	
	No. examined	No. Infected (%)	No. examined	No. Infected (%)	No. examined	No. Infected (%)
Bathing and swimming	148	32 (22.1%)	147	36 (24.3%)	295	68 (23.1%)
Bringing water	15	1 (6.7%)	20	4 (20.0%)	35	5 (14.3%)
Animals drinking	2	2 (100%)	6	0 (0.0%)	8	2 (25.0%)
Other	0	0 (0.0%)	1	0 (0.0%)	1	0 (0.0%)
No contact	135	11 (8.2%)	126	8 (6.3%)	261	19 (7.3%)
Total	300	46 (15.3%)	300	48 (16.0%)	600	94 (15.7%)
significant	X^2 =21.788, p = 0. 000		X^2 =18.186, p = 0. 001		X^2 =26.834, p = 0. 000	

Table 5: Prevalence of urinary schistosomiasis in relation to the level of education and occupation of the parents of the children in the study areas

Parameters	Bahary Shmaal(Urban)		Bahary Rural Area(Rural)		Total	
	No. examined	No. Infected (%)	No. examined	No. Infected (%)	No. examined	No. Infected (%)
Level of education						
No formal education	87	11 (12.6%)	44	5 (11.4%)	131	16 (12.2%)
Basic or inter-media education	133	29 (21.8%)	137	29 (21.2%)	270	58 (21.5%)
Secondary education	53	3 (5.7%)	95	12 (12.6%)	148	15 (10.1%)
University	27	3 (11.1%)	24	2 (8.3%)	51	5 (9.8%)
Total	300	46 (15.3%)	300	48 (16.0%)	600	94 (15.7%)
significant	X^2 =8.966, p = 0. 030		X^2 = X^2 =5.278, p = 0. 153		X^2 = X^2 =12.846, p = 0. 005	
Occupation						
Farmer	77	14 (18.2 %)	144	28 (19.4 %)	221	42(19.0 %)
Employee	49	4 (8.2%)	55	5 (9.1%)	104	9 (8.7%)
Self-employed	174	28 (16.1 %)	101	15 (14.9 %)	275	43 (15.6%)
Total	300	46 (15.3 %)	300	48 (16.0 %)	600	94 (15.7%)
significant	X^2 =2.499, p = 0. 287		X^2 =3.324, p = 0. 190		X^2 =5.735, p = 0. 057	

IV. DISCUSSION

Schistosomiasis as a tropical disease remains a major health concern in Sudan. This study revealed that *S.haematobium* is moderate endemic in both communities (rural and urban); the prevalence of 16.0% recorded in the rural area was found to be higher than 15.3% in the urban area. This prevalence was lower compared to studies carried out in the Asalaya Locality, White Nile State (24.54%), White Nile River (45%) and Al-Takamul area, Khartoum State (22%) [24],[27],[28] Sudan. However, it was higher compared to studies conducted in El-tawella rural area of White Nile State (13.2%) and Um-Asher area, Khartoum (12.9 %)[19],[29] The difference in rate infection of *S.haematobium* in the part of the country can be explained by the ecological factor such as the seasonality in transmission and types of water contact among the study group [30],[31]. In both communities, prevalence appeared to be highly associated with the age and the gender of the children. Male's pupils were

more infected at the rate of 23.5% than females who had 1.8%. Similar results were obtained in previous studies also reported prevalence rate of Schistosomiasis among the males rather than the females [20],[29],[24],[27],[32]. Male were more infected with *S. haematobium* compared to the female, this could be due to activities that indulge males in one position include, frequent bathing in rivers than girls who are restricted by various cultural norms and this could result in the lower infection rates due to reduced contact with infected water. Water contact activities like swimming, taking animals for drinking in the canal and bathing are reported putting children at higher risk of infection in the area. In addition, from the interviews conducted it was observed that farmers' children (parents' occupation) suffer a high rate of prevalence of infection. This can be explained by those children frequently going to work on their guardians' farms, with frequent contact with water, which can lead to a high rate of vulnerability to infection when the canals around the farms are infested with the infective stages of the parasite. However, the traders' children were found to acquire the highest intensity of infection and this is probably due to their extensive exposure to infested water bodies. This result is probably due to the level of exposure to infested water bodies rather than to economic reasons. .Farmers' children suffer a high rate of prevalence of infection, this can be explained by those children frequently going to work on their guardians' farms, with frequent contact with water, which can lead to a high rate of vulnerability to infection when the canals around the farms are infested with the infective stages of the parasite contact with bodies of water and workings in irrigated agricultural fields are significantly associated with the risk of infection with the disease [33], [34].

V. CONCLUSION

The present study findings prevalence of *S. haematobium* was higher in the rural area than in the urban area. Infection is more prevalent among males compared to that in females in both communities, also with age and water contact activity in the rural area than in the urban area. Significant difference in the rate of infection in relation to the gender, water contact age and of the pupils was recorded ($p < 0.05$). According to our study finding suggested the implementation an integrated control program including health education program.

VI. REFERENCES

[1] **Njenga SM, Mutungi FM, Wamae CN, Mwanje MT, Njiru K K ,Bockarie M J**. Once a year school-based deworming with praziquantel and albendazole combination may not be adequate for control of urogenital schistosomiasis and hookworm infection in Matuga District , Kwale County , Kenya. *Parasites & Vectors*. 2014;7(1), 1–9.

[2] **Mutapi F**. Changing Policy and Practice in the Control of Pediatric Schistosomiasis. *Pediatrics*. 2015;135(3), 536–544.

[3] **Gryseels B, Polman K, Clerinx J, Kestens L.** Human Schistosomiasis. *Lancet*. 2006; 368(9541):1106–1118.

[4] **Herricks JR, Hotez PJ,Wanga V, Coffeng LE, Haagsma JA, Basáñez MG**, The global burden of disease study 2013: what does it mean for the NTDs? *PLoS Negl Trop Dis*. 2017 ; 11: e0005424. doi: 10.1371/journal.pntd.0005424.

[5] **Atalabi TE, Lawal U, Ipinlaye SJ**. Prevalence and intensity of genito-urinary schistosomiasis and associated risk factors among junior high school students in two local government areas around Zobe Dam in Katsina State, Nigeria. *Parasites & Vectors*. 2016 ;1–12. https://doi.org/10.1186/s13071-016-1672-5.

[6] **Gray DJ, Ross AG, Li YS, McManus DP**. Diagnosis and management of schistosomiasis. *BMJ* .2011;342:d2651. doi: 10.1136/bmj.d2651.

[7] **Adenowo AF, Oyinloye BE, Ogunyinka BI, Kappo AP**. Impact of human schistosomiasis in sub-Saharan Africa. *Braz J Infect Dis*. 2015; 19:196–205. doi: 10.1016/j.bjid.2014.11.004

[8] **Steinmann P, Keiser J, Bos R, Tanner M, Utzinger J**. Schistosomiasis and water resources development: systematic review, meta-analysis, and estimates of people at risk. *Lancet Infect Dis*. 2006; 6:411–25 doi: 10.1016/S1473-3099(06)70521-7.

[9] **Olveda DU, Li Y, Olveda RM, Lam A K, Chau TN, Harn DA, Williams GM, Gray DJ, Ross AG**. Bilharzia: Pathology, Diagnosis, Management and Control. *Trop Med Surg*. 2013;1(4).

[10] **Colley DG, Bustinduy A, Secor WE, King CH**. Human schistosomiasis. *Lancet*. 2014; (ISSN 0140-6736). https://doi.org/10.1016/S0140-6736(13)61949-2.

[11] **Ross G. Vickers D. Androve J. Secor E.** Geographical Distribution of *Schistosomiasis* and soil transmitted Helminthes in Western Kenya: implications for anthelminthic mass treatment. *American Journal Tropical Medical Hygiene* 2007;69, 318 -323.

[12] **Sang HS, Muchiri G, Ombok M, Odiere RM, Mwinzi P.** *Schistosoma haematobium* hot spots in South Nyanza, Western Kenya; Prevalence distribution and co – endemicity with *Schistosoma mansoni* and soil transmitted helminthes. *American Journal Tropical Medical Hygiene*. 2014; 4,100 – 112.

[13] **Chitsulo L, Engels D, Montresor A, Saveold L.** The global status of schistosomiasis and its control. *Acta Tropica*. 2000;77: 41-51

[14] **Jukes MCH, Nokes CA, Alcock KJ.** Heavy schistosomiasis associated with poor short-term memory and slower reaction times in Tanzanian school children. *Trop Med Mt Health*. 2002; 7(2):104 -117.

[15] **Navas ALA, Hamm NA, Magalhães RJS, Stein A**. Mapping soil transmitted Helminths and Schistosomiasis under uncertainty: a systematic review and critical appraisal of evidence. *PLoS Negl Trop Dis*. 2016;10:e0005208. doi: 10.1371.

[16] **Manyangadze T, Chimbari MJ, Gebreslasie M, Mukaratirwa S.** Risk factors and micro-geographical heterogeneity of *Schistosoma haematobium* in Ndumo area, uMkhanyakude district, KwaZulu-Natal, South Africa. *Acta Trop*. 2016;159:176–184.

[17] **Ahmed AM, Abbas H, Mansour AF, Gasim G, Adam I**. *Schistosoma haematobium* infections among schoolchildren in central Sudan one year after treatment with praziquantel. Parasit Vectors. 2012; 2012; 5(108):1- 7.

[18] .**Osman R M, Eisa NS, Nasr AA, Omer OA, Siddig EE, Nouh S M.** Prevalence of *Schistosoma haematobium* among School Children in Al-Lamab Bahar Abiad Area, Khartoum State, Sudan.2017: A Cross Sectional Study *EC Microbiology*. 2018; 14 (8): 454-459.

[19] **Atijani A AG, Mohielain A, Elbashir A, Abdelrahman S. Nour B.** Prevalence of *Schistosoma Haematobium* among pupils_ El-tawella village Kosti-White Nile State- Sudan (2012**).** *Advance Research Journal of Multi-Disciplinary Discoveries***.** 2017; I (18).

[20] **Elsiddig H A, Khider E, Nour S M, Abdelrafi M, Makhaw, Mogadam BE. Mogadam B.** Prevalence of urinary schistosomiasis among schoolchildren in White Nile State, Sudan. *African Educational Research Journal*. 2019; 7(1):29-32.

[21] **Eltayeb NM, Mukhtar MM, Mohamed AB**. Epidemiology of schistosomiasis in Gezira area Central Sudan and analysis of cytokine profiles. *Asian Pac J Trop Med*.2013;6(2):119–25.

[22] **Abou-Zeid AH, Tigani ARashid, O.** Schistosomiasis infection among primary school students in a war zone, Southern Kordofan State, Sudan. *BMC Public Health series* . 2013; **(**13**):** 643.

[23] **Deribe K, Eldaw A, Hadziabduli S , Kailie E, Omer MD, Mohammed AE**. High prevalence of urinary schistosomiasis in two communities in South Darfur: implication for interventions. *Parasit Vectors*. 20114; (1):14.

[24] **Mohammed WM, Garbi MI, Satti AB, Khdary NH**. Prevalence of *Schistosoma Haematobium* Infection in Alsyal village, River Nile State, Sudan Biomed J Sci & Tech Res. 2019;22(1) :DOI: 10.26717/BJSTR.2019.22.003685 .

[25] **Utizinger J, N'Goran EK, R Caffrey C, Keiser J**. From innovation to Application: Socio-ecological context, diagnostics, drugs and integrated control of Schistosomiasis. *ActaTropica*. 2011;(120). 121-137.

[26] **Cheesbrough M**. "District laboratory practice in tropical countries". Cambridge University press (2006).

[27] **Ismail H, Hong ST, Babiker A, Hassan R, Sulaiman M, Jeong HG, Kong W, Lee S, Cho H, Nam H, Oh C, Lee Y**. Prevalence, risk factors, and clinical manifestations of schistosomiasis among school children in the White Nile River basin, Sudan. *Parasit Vectors*.2014;7(1):478.

[28] **Al-Basheer BS, Aljafri AS**. Urinary shistosomiasis among primary school children at Al-Takamul area, eastern Khartoum State, Sudan: An example for urban schistosomiasis. *Annals of Trop Med and Public Health*. 2017;10(2):353-56.

[29] **Hamza AE, Elfadel E, Nahied E, Dahab R**. Prevalence of Schistosomiasis and the Associated Risk Factors among School Children in Um-Asher area, Khartoum, Sudan. *International Journal of Advances in Science Engineering and* Technology. 2018; 6: 2321 –8991.

[30] **Clements ACA, Firth S, Dembele R, Garba A, Toure S, Sacko M, Landouré A, Bosqué-Oliva E, Barnett AG, Brooker S, Fenwick A**. Use of bayesian geostatistical prediction to estimate local variations in *Schistosoma haematobium* infection in western Africa. *Bull World Health Organ*. 2009;87:921–927.

[31] **.Ivoke N, Ivoke ON, Nwani CD, Ekeh FN, Asogwa CN, Atama CI, Eyo JE**. Prevalence and transmission dynamics of *Schistosoma haematobium* infection in a rural community of southwestern Ebonyi State, Nigeria. *Trop Biomed*. 2014;31(1):77–88.

[32] **Shashie G, agersew A, Sisay G, Zeleke M. Berhanu E**. Prevalence of urinary schistosomiasis and associated risk factors among Abobo Primary School children in Gambella regional State, Southwestern Ethiopia: a cross sectional study. Journal of parasites and vectors. 2015; (8): 822-825.

[33] **Enk MJ, Lima AC, Barros HS, Massara CL, Massara P.Z, Schal PZ**. Factors related to transmission and infection with *Schistosoma mansoni* in a village in the South Eastern Brazil. *Mem Inst Oswaldo Cruz*. 2010; 105(4): 570–577.

[34] **Alembrhan A, Tadesse D, Zewdneh T.** Infection prevalence of Schistosoma mansoni and asso-ciated risk factors among schoolchildren in suburbs of Mekelle city, Tigray, Northern Ethiopia. MEJS. 2013; 5:174–188.

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