Prevalence, intensity of infection and risk factors of urinary schistosomiasis in pre-school and school aged children in Guma Local Government Area, Nigeria

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ARTICLE INFO

Article history:
Received 20 October 2013
Received in revised form 10 November 2013
Accepted 15 December 2013
Available online 20 January 2014

Objective: To determine the prevalence and intensity of infection and the risk factors associated with urinary schistosomiasis in pre-school and school aged children in Guma Local Government Area of Benue State, Nigeria. Methods: Urine filtration technique using polycarbonate membrane filters was employed to process urine specimens and to determine presence of Schistosoma haematobium eggs in urine. Questionnaires were also administered to children to collect information on socio-demographic data and water-contact activities. Results: An overall prevalence of 55.0% (165/300) was recorded out of the 300 urine samples examined. Prevalence of infection varied between 36.0%-64.0% with a significant difference ($\chi^2 = 11.59, P = 0.041$) between the different communities visited. Males were more infected (60.6%, 103/170) than females (47.7%, 62/130) with a significant difference ($\chi^2 = 4.95, P = 0.026$). The age–related prevalence showed higher prevalence (70.5%, 36/52) in the 11–15 year old children than that in the 1–5 year old ones (44.9%, 53/118). A significant difference was observed in the prevalence between the age groups ($\chi^2 = 10.56, P = 0.014$). The prevalence of light intensity of infection (1–49 eggs/10 mL of urine) (86.6%) was significantly higher than that of heavy intensity of infection ($\geq 50$ eggs/10 mL of urine) (13.3%) in the area ($\chi^2 = 16.48, P = 0.000$). Water contact activities of the children revealed that children that were involved in irrigation and those that went swimming in water bodies were observed to be at higher risk of becoming infected with urinary schistosomiasis in the area with odd ratios (risk factors) of 2.756 (1.334–5.693) and 2.366 (1.131–4.948) respectively at $P<0.05$ level. Conclusions: The study revealed the hyperendemicity of urinary schistosomiasis in the pre-school and school aged children in Guma Local Government Area. It is therefore recommended that praziquantel should be administered to children in the area and systematic epidemiological studies should be undertaken in the whole Local Government Area and the State at large to discover new foci of infection.

1. Introduction

Urinary schistosomiasis is a parasitic disease caused by the larval forms of blood flukes (schistosomes) acquired from infested freshwater snails of the Bulinus species. The disease can lead to chronic ill health condition and is considered as a major public health concern mostly in rural dwellers of tropical and sub–tropical regions of the world.

Currently, about 436 million people are at risk of infection and 112 million are infected with urinary schistosomes in sub-Saharan Africa[1]. This number underestimates the total burden, because several endemic foci are yet to be discovered. Nigeria is one of the highly endemic countries with an estimated 101.3 million at risk of infection and 29 million of the people being infected[2].

In Benue State, Nigeria, urinary schistosomiasis is considered to be a serious public health problem and no reasonable effort has been made by the stakeholders to control the disease particularly in rural communities that are deprived from health infrastructures and potable drinking water. However, the lack of this latter commodity forces rural dwellers to completely rely on ponds, streams and rivers for their daily chore activities. Previous and recent studies reported prevalence varying from 42.8%–46.6% in Benue State[3–6].

Guma Local Government Area (LGA) neighbors Makurdi...
LGA, the capital city of Benue State, Nigeria. Based on current records from its local hospitals, clinics and health centers, the area is reported to be endemic for urinary schistosomiasis. Reports obtained from the interviews of the population and several health officials revealed that neither epidemiological survey nor control intervention was undertaken in the area. This study was therefore undertaken to determine the prevalence and intensity of infection and the risk factors associated with the disease in pre-school and school aged children known as the vulnerable groups. This can be used as baseline data to later expand the study and plan strategies for control program in accordance to the World Health Organization (WHO) recommendations.

2. Materials and methods

2.1. Study area

The study was conducted in Guma LGA located at latitude 7° 30’–8° 03’ E and longitude 8° 04’–9° 02’ N. The area is bounded to the south by Tarka, Makurdi and Buruku LGAs, to the east by Logo LGA and to the north and west by Nasarawa State. Six communities, namely, Daudu, Mgham, Ukpam, Unenge, Ukohol and Ortese, were visited. These communities were located at about 18 km for the shortest and 35 km for the farthest distance from the north of Makurdi LGA, the capital city of Benue State. Health facilities are found to be dilapidated with grossly inadequate trained staff in the area. The area is drained by streams, ponds and rivers and has a monthly temperature varying between 27.0–28.0 °C and may go up to a maximum of 30.1–38.1 °C during the hottest period. The area receives 900–1 000 mm of rainfall annually with two distinct seasons. The dry season starts in late October and usually ends by April, while the rainy season lasts from mid–April to early October. The rainy season is the period of intensive agricultural activities when the indigenous people mainly Tivs are engaged in fishing and farming of crops like yams, guinea corn, maize, rice, sesame and cassava which are the principal food and cash crops.

2.2. Study population

Prior to the commencement of the investigation, ethical approval was obtained from the Ministry of Health, Makurdi. Thereafter, visits were made to the various communities, and consultations/discussions were held with officers in charge of health centers who assisted in mobilizing pre-school and school aged children the following day. Parents of these children were also mobilized and educated about the importance of the study. Informed consents of both parents and enrolled children were obtained.

2.3. Sampling technique

The study was cross-sectional in nature. Three hundred urine samples (50 from each community) from pre-school and school aged children were collected during 3 weeks in the month of September 2012. Participants were selected randomly and we did not use sample size calculation based on the baseline nature of the study. Information on the age, sex and water contact activities of children was collected using structured questionnaires. About 20 mL of urine was collected in 20 mL capacity universal bottles by children themselves who were carefully instructed. Mothers of children ≤5 years were directed to collect urine of their children and they were also interviewed on the water contact activities of these children. All collections were done between 10:00 am and 2:00 pm within the premises of each community health center. The specimens were preserved in a cooler and then transported within 30 minutes to the laboratory for analysis.

2.4. Laboratory investigations and classification of infection intensity

The standard parasitological method, the filtration technique using a 10 mL syringe, swinney filter holder (13 mm diameter) and polycarbonate membrane filters (12.0 μm porosity and 13 mm diameter), was employed to recover Schistosoma haematobium (S. haematobium) eggs in the laboratory[7,8]. The ×10 and ×40 objectives were used to systematically examine the filters for eggs of S. haematobium. The number of eggs was then counted and reported as eggs per 10 mL of urine: 0 egg/10 mL of urine was reported as negative, 1–49 eggs/10 mL of urine was reported as negative, 1–49 eggs/10 mL of urine as light intensity of infection and ≥50 eggs/10 mL of urine as heavy intensity of infection[8].

2.5. Statistical analysis

Data were double entered in Microsoft Excel and Predictive Analysis Software version 18.0 to perform data analysis. The Pearson chi-square ($\chi^2$) was used to compare differences in prevalence between sex and age groups, while the student $t$-test was used to compare the difference between light and heavy intensities of infection. Association between water contact activities and prevalence of infection was determined using univariate analysis. A $P$ value <0.05 was considered to be significant.

3. Results

3.1. Prevalence of urinary schistosomiasis in pre-school and school aged children in Guma LGA of Benue State, Nigeria

Table 1 describes the age, sex and communities related
prevalence among the pre-school and school aged children in Guma LGA of Benue State, Nigeria. An overall prevalence of 55.0% (165/300) was recorded out of the 300 urine samples collected from the children. Prevalence of infection varied between 36.0%–64.0% in the different communities visited, with Uikpam community having the lowest prevalence (36.0%, 18/50) and Ukohol and Ortese communities having the highest (64.0%, 32/50). A significant difference was observed in the prevalence of urinary schistosomiasis between the different communities (χ² =11.59, P=0.041). Sex related prevalence showed that the males recorded higher prevalence (60.6%, 103/170) than the females (47.7%, 62/130) with a significant difference (χ² =4.95, P=0.026). Age related prevalence varied between 44.9%–70.5%, with the age group 1–5 years having the lowest prevalence (44.9%, 53/118) and the age group 11–15 years having the highest (70.5%, 36/52). A significant difference was observed in the prevalence of urinary schistosomiasis between the age groups (χ² =10.56, P=0.014).

Table 1
Age, sex and communities related prevalence of urinary schistosomiasis among pre-school and school aged children in Guma LGA, Benue State, Nigeria.

| Category       | Number examined | Number infected (Prevalence, %) | χ²  | P-value |
|----------------|-----------------|---------------------------------|-----|---------|
| Overall        | 300             | 165(55.0)                       |     |         |
| By community   |                 |                                 | 11.59 | 0.041   |
| Daudu          | 50              | 25(50.0)                        |     |         |
| Mgbam          | 50              | 18(36.0)                        |     |         |
| Uikpam         | 50              | 32(64.0)                        |     |         |
| Unenge         | 50              | 18(36.0)                        |     |         |
| Ukohol         | 50              | 32(64.0)                        |     |         |
| Ortese         | 50              | 30(60.0)                        |     |         |
| By sex         |                 |                                 | 4.95  | 0.026   |
| Male           | 170             | 103(60.6)                       |     |         |
| Female         | 130             | 62(47.7)                        |     |         |
| By age (years) |                 |                                 | 10.56 | 0.014   |
| 1–5            | 118             | 53(44.9)                        |     |         |
| 6–10           | 131             | 76(58.0)                        |     |         |
| 11–15          | 51              | 36(70.5)                        |     |         |

Table 2 describes the intensity of urinary schistosomiasis among the infected pre-school and school aged children of Guma LGA, Benue State, Nigeria. Light intensity of infection (86.7%) was observed to be higher than heavy intensity of infection (13.3%) with a significant difference (t=16.48, P=0.000). In relation to sex, no significant variations were observed in eggs excretion between the males and females in both light (85.4% vs 88.7%) and heavy (14.6% vs 11.3%) intensities of infection (χ² = 5.29, P=0.071). In relation to age, light intensity of infection varied between 72.2%–92.1% with the age group 11–15 years having the lowest rate (72.1%) and the age group 6–10 years having the highest (92.1%). Heavy intensity of infection varied between 7.9%–27.8% with the age group 6–11 years having the lowest rate (7.9%) and the age group 11–15 years having the highest rate (27.8%). However, a significant variation was observed in S. haematobium eggs excretion in both light and heavy intensities of infection between the age groups of the infected children (χ² = 21.15, P=0.002).

Table 2
Intensity of urinary schistosomiasis among infected pre-school and school aged children in Guma LGA of Benue State, Nigeria.

| Category       | Number infected (Prevalence, %) | t-test | χ²  | P-value |
|----------------|---------------------------------|--------|-----|---------|
| Overall        | 143(86.7)                       | 16.48  |      | 0.000   |
| By sex         |                                 |        | 5.29 | 0.071** |
| Male           | 88(85.4)                        | 15(14.6)|     |         |
| Female         | 55(88.7)                        | 7(11.3) |     |         |
| By age (years) |                                 |        | 21.15| 0.002   |
| 1–5            | 47(88.7)                        | 6(11.3) |     |         |
| 6–10           | 70(92.1)                        | 6(7.9)  |     |         |
| 11–15          | 26(72.2)                        | 10(27.8)|    |         |

Light intensity of infection, 1–49 eggs/10 mL of urine; Heavy intensity of infection, ≥50 eggs/10 mL of urine. **Not significant.
4. Discussion

4.1. Prevalence of urinary schistosomiasis in Guma LGA of Benue State, Nigeria

The burden of urinary schistosomiasis in the area (55.0%) falls within the WHO classification as hyperendemic[8]. This hyperendemicity was observed in four of the villages surveyed (Daudu, Uikpam, Ukohol and Ortese). These villages were observed to have ponds and streams where children and women spend most of their time playing, bathing, swimming, washing and fetching water for domestic purposes. The lack of potable water and dilapidated health infrastructures in the area might have also contributed greatly to this hyperendemicity. The prevalence reported in this study corroborates the findings of other studies which reported high prevalence of urinary schistosomiasis in rural areas of Nigeria: 75.6% in Ogbesi-Ekiti, Ekiti State[9], 72.0% in Dutsinma, Katsina State[10], 83.3% in Odau community in the Niger-Delta[11] and 65.0% in a rural community of Edo State[12]. High prevalence of urinary schistosomiasis has also been reported in Sudan (51.4%)[13] and Mali (61.7%)[14] which are developing as well as sub-Saharan countries like Nigeria. The prevalence in this study contrasts to those reported in earlier studies in other LGAs of Benue State: 42.6% in Ogbadibo LGA[4], 44.6% and 42.6% in Buruku and Katsina LGAs respectively[5,6] and 46.2% in 10 villages of four LGAs (Katsina–Ala, Gboko, Kwande and Logo)[3]. Lower prevalence (42.2%) than that in the present study has also been reported in a rice farming community in Biase LGA of Cross River State, Nigeria[15].

Males were reported to be more infected than females; this could be due to the higher tendencies of water contact activities among males through swimming, playing and laundry besides the primary domestic activity of fetching water which exposes both sexes to infection. Kanwai et al. reported similar findings with males more infected than females in Igabi LGA of Kaduna State, Nigeria[16]. This study disagrees with studies conducted in rural areas of South–west and South–south, Nigeria and Kwazulu–Natal, South Africa which reported females to be more infected than males[17–19].

The age related prevalence showed that children aged 6–10 years and 11–15 years had the highest prevalence. This trend has been reported in several previous studies which explained that factors like swimming, washing, fishing and playing in infested water bodies contribute to the high prevalence of urinary schistosomiasis in children aged 7–16 years[20,21]. These various activities have also been reported among children examined in this study.

Children <5 years were considerably infected (44.9%) with urinary schistosomiasis in the area. These children were observed to be taken along with their mothers to ponds for their bath. The children were also observed to be kept by the pond edges by their mothers in basins filled with water fetched from the ponds to make these ones not interfere with their activities. These children could also get infected through the learning process of swimming when they follow their older ones to water bodies. This age group seems to be always neglected in most epidemiological studies while they can be potential source of transmission in areas where successful control programs have been implemented. It was until recently that the WHO has considered this age group as a high risk group in areas endemic for schistosomiasis and validated a report on their inclusion during control program[1]. Studies conducted in Nigeria and other sub-Saharan countries like Ghana, Mali, Niger, Uganda, Sudan, and Zimbabwe reported prevalence in pre–school children ranging from 18.0%–63.0%[22–26].

### Table 3

Risk factors for urinary schistosomiasis among pre–school and school aged children in Guma LGA of Benue State, Nigeria.

| Risk factors                     | Number examined | Number infected (Prevalence, %) | Odd ratio | Confidence interval | $\chi^2$ | P–value |
|---------------------------------|-----------------|---------------------------------|-----------|---------------------|---------|---------|
| Closeness to water bodies       |                 |                                 |           |                     |         |         |
| Yes                             | 273             | 152 (55.7)                      | 0.75      | 0.29–1.91           | 0.36    | 0.55**  |
| No                              | 27              | 13 (48.1)                       |           |                     |         |         |
| Irrigation                      |                 |                                 |           |                     |         |         |
| Yes                             | 248             | 149 (60.1)                      | 2.75      | 1.78–6.43           | 7.85    | 0.00    |
| No                              | 52              | 16 (30.8)                       |           |                     |         |         |
| Laundry                         |                 |                                 |           |                     |         |         |
| Yes                             | 183             | 111 (60.7)                      | 1.22      | 0.70–2.12           | 0.48    | 0.48**  |
| No                              | 117             | 54 (46.2)                       |           |                     |         |         |
| Playing                         |                 |                                 |           |                     |         |         |
| Yes                             | 268             | 153 (57.1)                      | 0.56      | 0.22–1.92           | 0.59    | 0.44**  |
| No                              | 32              | 12 (37.5)                       |           |                     |         |         |
| Swimming                        |                 |                                 |           |                     |         |         |
| Yes                             | 232             | 141 (60.8)                      | 2.36      | 1.31–5.69           | 5.40    | 0.02    |
| No                              | 68              | 24 (35.3)                       |           |                     |         |         |

**Not significant.
4.2. Intensity of S. haematobium eggs in infected pre-school and school aged children in Guma LGA of Benue State, Nigeria

The findings of this study show that a greater proportion (86.7%) of the children was found with light intensity of infection and just a small proportion having heavy intensity of infection. This could be simply explained by the differences in water contact activities among the children. However, this difference could be explained by some genetic factors which play important roles in the susceptibility to disease[27,28]. The high rate of light intensity of infection can also reflect high transmission rate in the area. Reports of studies from various parts of Nigeria also reported people with urinary schistosomiasis having light intensity of infection was more than those having heavy intensity of infection[10,19,20,29,30]. The rate of heavy intensity of infection observed (27.5%) has to be considered as a strong public health concern, because this could reflect the worm burden and if not stemmed on time will have an increasing effect on egg excretion that will directly affect the physical conditions and cognitive fitness of the children.

Males and females did not show any significant difference in the excretion of S. haematobium eggs. The slight difference in light intensity of infection between males and females could be explained by the differences in the social and occupational roles taken up by the females who could often follow their mothers to water bodies for fetching or other daily chore activities like washing. The slightly higher rate of light intensity in females than in males corroborates reports of a study on gender–related differences in the impact of tropical diseases on women[31]. Similar results were also reported in southeast and southwest Nigeria and these explained that women are more exposed to water when they assume typical men roles[32-34].

Intensity of S. haematobium eggs by age showed lower rate of heavy intensity of infection in the age groups of 1–5 and 6–10 years. This could be explained by the reduced worm burden in these children which has led to less excretion of eggs. The higher rate of heavy intensity of infection in the older children is not surprising, because in areas endemic for urinary schistosomiasis this age group always carry the heavy burden of the disease mostly because of their increased water contact activities and possibly the high fecundity rate of the parasite. Adolescents with heavy intensity of infection have also been reported in endemic areas of southeast and northern Nigeria[26,35].

4.3. Risk factors for urinary schistosomiasis among pre-school and school aged children in Guma LGA of Benue State, Nigeria

Water contact activities like swimming and laundry are reported to put children at higher risk of infection in the area. This could be due to the complete lack of political will of the stakeholders to finalize some of the pipe–borne water projects seen in some of the communities. The lack of that commodity obliges inhabitants to completely rely on streams and ponds, therefore exposing them to infection. However, these children could also become infected when they follow their parents to irrigate rice farms in swampy areas. Moreover, the high illiteracy and negligence levels of the parents, mostly farmers, observed in the area, can lead to the non–education of preventive measures to their children, therefore influencing transmission pattern.

The prevalence of urinary schistosomiasis among the pre–school and school aged children in Guma LGA was found to be hyperendemic. Light intensity of infection was reported to be more predominant in the area than heavy intensity of infection. Water contact activities like swimming and irrigation were considered as risk factors that could put children at higher risk of infection with urinary schistosomiasis in the area.

Based on the above results, the followings are therefore recommended: (i) Treatment program using praziquantel and systematic epidemiological studies should be undertaken in the whole LGA and the State at large. (ii) Pre–school children should be regarded as high risk group in the area and they should be taken into consideration during treatment program. (iii) There should be provision of safe water supply and development of recreational water bodies in the area so as to avoid contact with existing infested water bodies. (iv) There is the need to identify and embark on the control of snail vectors in the area and the State. (v) There is a need of public awareness and education regarding urinary schistosomiasis in the area and the State. (vi) Campaign for urinary schistosomiasis should be included among other public health interventions such as malaria, HIV/AIDS and tuberculosis. (vii) Geographical information system should be used in future studies to show the exact location of the affected areas, which will help in focalizing control program in the endemic areas.

Conflict of interest statement

The authors declare that they have no competing interests.

Acknowledgments

We would like to express our gratitude to all the children that participated in the study and without whom the study would not have been feasible. The parents of the children, heads of the various communities surveyed and officers in charge of the health centers consulted during data collection are gratefully acknowledged. Our sincerest thanks also go to our field assistants, namely, Caleb, Ene, Precious, Terfa, Esther and Queen, for their help during field data collection.
References

[1] WHO. Schistosomiasis: population requiring preventive chemotherapy and number of people treated in 2010. *Wkly Epidemiol Rec* 2012; 87: 37–44.

[2] Hotez PJ, Kamath A. Neglected tropical diseases in sub-Saharan Africa: review of their prevalence, distribution and disease burden. *PLoS Negl Trop Dis* 2009; 3: e412.

[3] Okwuosa VN, Banke ROK. A study of the urinary schistosomiasis from some schools in four local government areas of Benue State. *Nig J Pure Appl Sci* 2008; 1(1): 1–4.

[4] Mbata T, Orji M, Oguoma VM. The prevalence of urinary schistosomiasis in Ogbadibo Local Government Area of Benue State, Nigeria. *Internet J Infect Dis* 2008; 7(1): 101–105.

[5] Houmsou R, Kela S, Suleiman M, Ogidi J. Endemicity and intensity of vesical schistosomiasis: epidemiological profile of two Local Government Areas of Benue State, Nigeria. *Internet J Health* 2009; 9(2). DOI: 10.5580/21b.

[6] Houmsou RS, Amuta EU, Sar TT. Profile of an epidemiological study of urinary schistosomiasis in two local government areas of Benue state, Nigeria. *Int J Med Biomed Res* 2012; 1(1): 39–48.

[7] Cheesbrough M. *District laboratory practice in tropical countries*. Part 1. London: Cambridge Press; 1998. p. 454.

[8] WHO Expert Committee. Prevention and control of schistosomiasis and soil–transmitted helminthiasis. *World Health Organ Tech Rep Ser* 2002; 912: i–vi, 1–57, back cover.

[9] Olugbade CA, Olojede AB, Olaifa OA, Olumuyiwa OW. Schistosomiasis in Ogbese–Ekiti, re–infection after successful treatment with praziquantel. *Global J Med Res* 2012; 12(3): 1–6.

[10] Shinkafi BY, Adamu T, Abdullahi K, Mangas B, Bala Y. Schistosomiasis in communities around Zobe dam, Dutsinma, Katsina State, Nigeria. *Nig J Parasitol* 2012; 33(1): e38

[11] Agi PI, Okafor EJ. The epidemiology of *Schistosoma haematobium* in a rural community in the Niger–Delta area of Nigeria. *J Appl Sci Environ Manage* 2005; 9(3): 37–43.

[12] Nnoruchi OPG, Eghumwenya O, Ukandu NCD, NWoko NQ. Urinary schistosomiasis in a rural community in Edo State, Nigeria: eosinophiluria as a diagnostic marker. *Afr J Biotech* 2005; 4(2): 183–186.

[13] Abedaziz MA, Hana A, Fahli AM, Gasim IG, Ishag A. *Schistosoma haematobium* infections among school children in central Sudan one year after treatment with praziquantel. *Parasit Vectors* 2012; 5: e108.

[14] Landouré A, Démbérelé R, Goita S, Kané M, Tuinmsa M, Sacko M, et al. Significantly reduced intensity of infection but persistent prevalence of schistosomiasis in a highly endemic region in Mali after repeated treatment. *PLoS Negl Trop Dis* 2012; 6(7): e1774.

[15] Etim SE, Okon OE, Oku EE, Ukpong GI, Ohionma ME, Utteh CE. Urinary schistosomiasis in a rice–farming community in Biase Area of Cross River State. *Nig Parasitol* 2012; 33(2): 197–201.

[16] Kanwai S, Ndam IS, Kogi E, Gyem ZG, Hena JS. Urinary schistosomiasis infection in Dumbun Dutse, Igabi Local Government Area, Kaduna State, Nigeria. *Sci World J* 2011; 6(3): 1–3.

[17] Etim SE. Water–contact activities and schistosomiasis among women. *Nig Parasitol* 1995; 16: 135.

[18] Mogoss–Thomasen DE, Kvalsvig JD, Gundersen SG, Taylor M, Kjetland EF. Schistosomiasis and water–related practices in school girls in rural Kwazulu–Natal, South Africa. *South Afr J Epidemiol Infect* 2010; 25(4): 30–33.

[19] Sam–Wobo SO, Idowu JM, Adeleke AM. Urinary schistosomiasis among children and teenagers near Oyan dam Abeokuta, Nigeria. *J Rural Tropol Public Health* 2011; 10: 57–60.

[20] Agi PI, Awi–waudu GDB. The status of *Schistosoma haematobium* infection in Anyu community in the Nigére–Delta, Nigeria. *J Appl Sci Environ Manage* 2008; 12(2): 21–24.

[21] Ughomoiko US, Ofozie IE, Okoye IC, Heukelbach, J. Factors associated with urinary schistosomiasis in two peri–urban communities in South–western, Nigeria. *Ann Trop Med Parasitol* 2010; 104(5): 409–419.

[22] Kabateriene NB, Brooker S, Koukounari A, Fleming F, Tukablewa EM, Kabzibwe F. Implementation strategies for schistosomiasis control in Uganda and research needs under the programme. Report of the Scientific Working Group on Schistosomiasis. TDR/ SWG/07. 2005. p. 114.

[23] Ekpo UF, Laja–Daila A, Ohawole AS, Sam–Wobo SO, Mafiana CF. Urinary schistosomiasis among pre–school children in a rural community near Abeokuta, Nigeria. *Parasit Vectors* 2010; 3: 58.

[24] Odogwu SE, Ramamurthy NK, Kabatereine NB, Kazibwe F, Tukahewa F, Webster JP, et al. Schistosoma mansoni in infants (aged <3 years) along the Ugandan shoreline of Lake Victoria. *Ann Trop Med Parasitol* 2006; 100(4): 315–326.

[25] Bosompem KM, Bentum IA, Otchere J, Anyan WK, Brown CA, Osada Y, et al. Infant schistosomiasis in Ghana: a survey in an irrigation community. *Trop Med Int Health* 2004; 9(8): 917–922.

[26] Dabo A, Badawi HM, Barry B, Doumbo OK. Urinary schistosomiasis among pre–school–aged children in Sahelian rural communities in Mali. *Parasit Vectors* 2011; 4: e21.

[27] Kouriba B, Traoré HA, Dabo A, Sangaré L, Guindo H, Keita AS, et al. Urinary disease in 2 Dogon populations with different exposure to *Schistosoma haematobium* infection: progression of bladder and kidney diseases in children and adults. *J Infect Dis* 2005; 192: 2152–2159.

[28] Abel L, Demenais F, Prata A, Souza AE, Dessein A. Evidence for the segregation of a major gene in human susceptibility/resistance to infection by *Schistosoma mansoni*. *Am J Hum Genet*; 48(5): 959–970.

[29] Sulyman MA, Fagbenro–Beyioku AF, Mafo MA, Oyiho WA, Ajayi MB, Akande PO. Prevalence of urinary schistosomiasis in school children in four states of Nigeria. *Nig J Parasitol* 2009; 30(2): 110–114.

[30] Ejimia IAA, Odaibo AB. Urinary schistosomiasis in the Niger–Benue basin of Kogi State Nigeria. *Int J Trop Med* 2010; 5(3): 73–80.

[31] Vlaseff C, Bouilla E. Gender–related differences in the impact of tropical diseases on women. What do we know? *J Biosocial Sci* 1994; 26(1): 149–157.

[32] Okon OE, Udontum MF, Oku EE, Nta AJ, Etim SE, Abraham JT. Prevalence of urinary schistosomiasis in Abini community, Biase Local Government Area, Cross–River State, Nigeria. *Nig J Parasitol* 2007; 28(1): 28–31.

[33] Adeoye GO, Akabogu QAS. Occurrence of urinary schistosomiasis among residents of Ado–Odo/Ota area of Ogun State, Nigeria. *Nig J Parasitol* 1996; 17: 30–32.

[34] Nnoruka VN. Epidemiological studies of urinary schistosomiasis in Imo State: rapid assessment. *Nig J Parasitol* 2004; 21: 21–32.

[35] Anosike JC, Ogouwuike UT, Nwoke BEE, Assa JE, Ikpeama CA, Nwosu DC, et al. Studies on vesical schistosomiasis among rural Ezza farmers in the southeastern border of Ebonyi State, Nigeria. *Ann Agric Environ Med* 2006; 13: 13–19.