micro-haematuria with RDT strips were indications of urogenital schistosomiasis among pupils under study.

Table 1: Diagnosis of urogenital schistosomiasis with PCTE before praziquantel therapy

		Pupils Examined		Pupils Positive	
		No.	%	No	%
Gender	Male	212	53.0	49	23.11
	Female	188	47.0	42	22.34
	Total	400	100	91	22.75
	χ^2=0.538, *df*=1, *p*>0.05				
Age-group (years)	<10	105	26.3	22	20.95
	11-20	295	73.7	69	23.38
	Total	400	100	91	22.75
	χ^2= 24.274, *df*=2, *p*<0.05				
Location	School "A"	200	50.0	53	26.50
	School "B"	200	50.0	38	19.00
	Total	400	100	91	22.75
	χ^2=2.472, *df* =1, *p*>0.05				

Table 2 revealed that PCR test gave the highest prevalence (25.75%) before MDA with praziquantel but had the least prevalence after MDA. Other tests results with PCTE, microhaematuria, proteinuria and Leucocyturia before and after MDA with praziquantel are also shown in Table 2. Gel electrophoresis results showing that *S. haematobium* were amplified at 121 bed pairs, and similarly at 121 base pairs are shown in Plates 2 and 3 respectively.

Table 2: Diagnosis of urogenital schistosomiasis before and after praziquantel treatment

Diagnostic parameters	Infection before MDA		Infection after MDA	
	No.	%	No.	%
Molecular analysis with PCR	103	25.75	14	3.50
Urinalysis with PCTE filters	91	22.75	29	7.25
Urinalysis with RDT strips:				
Microhaematuria	96	24.00	52	13.00
Proteinuria	82	20.50	44	11.00
Leucocyturia	62	15.50	40	10.00
		χ^2=27.743, *df*=4, *p*<0.05		

Urine samples examined (n=400)

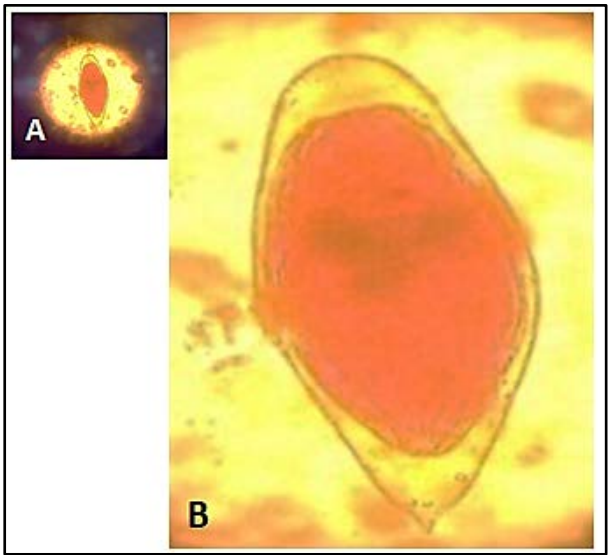

Plate 1: Ovoid egg of *Schistosoma haematobium* as seen under a compound microscope [A]; and zoomed to show characteristic terminal spine [B]

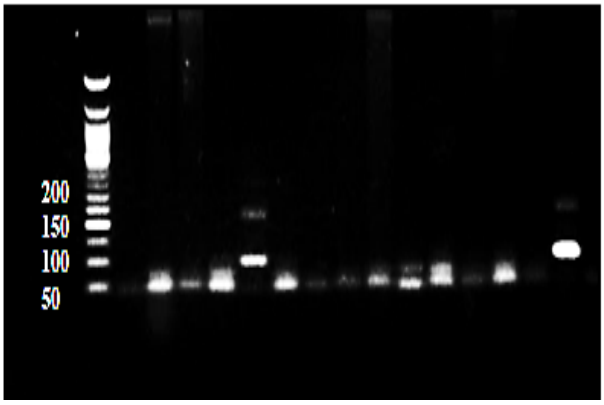

Plate 2: Gel electrophoresis result of *S. haematobium* amplified at 121 bed pairs.

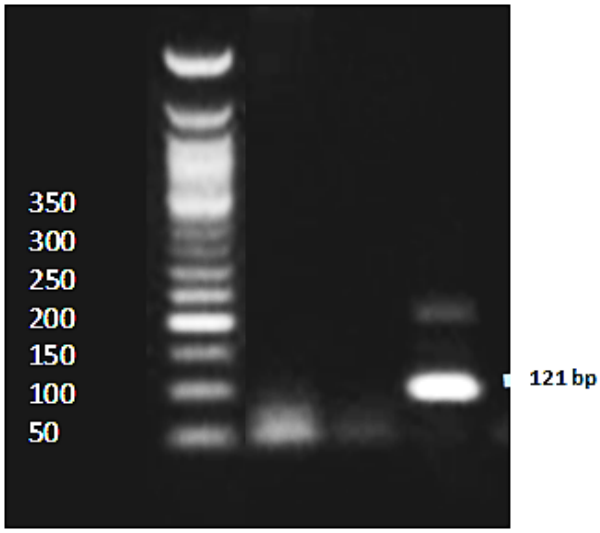

Plate 3: Gel electrophoresis showing *S. haematobium* amplified at 121 base pairs

Schistosoma haematobium prevalence in the present study was higher in males than in females in this study, it has been reported that differences in gender related prevalence in a study could be as a result of water contact activities of resident of the area. Hajissa *et al*. (2018) reported no significant difference in schistosomiasis prevalence between males and females in Sudan but Gyuse *et al*. (2010) reported higher prevalence in females than males in Osun State, Nigeria due to higher water contact activities by females than males. Moira *et al*. (2010) reported higher *S. haematobium* prevalence in males than in females reporting also that, even after drug treatment, males had significantly higher reinfection rates than their female counterparts due to their higher degree of exposure to infected water.

Schistosoma haematobium prevalence was significantly higher in school children aged between 10 and 20 years of age. This differences in age- prevalence could be due to the fact that children aged 10 - 20 years tend to be more adventurous and as a result visit water bodies with their peers, to swim and to fish (Chikwendu *et al*., 2019, Okwelogu *et al*., 2012), also fishing is a common water contact activity in the section of River Benue at Makurdi, thereby making them more vulnerable to *S. haematobium* infection.

Schistosoma haematobium infection in participants was diagnosed by the detection of eggs in urine using PCTE filters. Egg output in children is known to be high in children less than ten years, and to peak at ages 10-20 years and thereafter decline in young adults of 20 years and above (Pereira *et al*., 2010). For this reason, children aged 10-20 years are the main target of mass chemotherapy with praziquantel for the control of urinary schistosomiasis (Pereira *et al*., 2010). It is also important to note that if schistosomiasis is not treated in children even though egg output may become significantly reduced or stop completely as they grow older, secondary morbidities due to *S. haematobium* may linger leading to complications like female genital schistosomiasis in females (Masong *et al*., 2021) and

infertility in males, kidney and bladder cancers; morbidities which at an older age, may not be reversed by simple praziquantel treatment (Ossai *et al*., 2014). Our findings were in agreement with Moira *et al*. (2010) who opined that children are more susceptible to schistosomiasis than adults. In a case of experimental exposure to cercariae, adults were found to be less susceptible leading to the suggestion that adults have acquired a form of resistance to *S. haematobium* infection due to childhood exposure. Shehata *et al*. (2018) also reported significantly higher *S. haematobium* prevalence and infection intensities in children in Zambia.

The presence of parasite eggs in urine as determined using PCTE filters dropped significantly after treatment with praziquantel, as did the prevalence as determined by PCR. The presence of blood in urine (microhaematuria) also reduced significantly following praziquantel MDA. Leucocyturia also reduced after MDA; however the reduction was not significant. The significant drop in *S. haematobium* prevalence is an indication that the drug praziquantel is highly effective against urinary schistosomiasis.

The significant reduction in microhaematuria is proof that praziquantel is effective in reducing blood loss due to schistosomiasis. Microhaematuria and proteinuria are important morbidity due to urinary schistosomiasis and occurs as a result of the sharp terminal spines of *S. haematobium* eggs puncturing the urinary bladder of those infected (Knopp *et al*., 2018). The loss of blood and proteins is the reason for protein deficiency anaemia and malnourishment associated with the disease; in some cases blood loss is so severe it appears as visible blood in urine in form of macro-haematuria (Houmsou *et al*., 2008). Following praziquantel treatment a significant reversal of blood loss in urine occurred (see Table 2) showing that praziquantel may not only be effective against the *Schistosoma* worms but could also reduce morbidity due to infection with the worms. Since the reduction in proteinuria was not significant, it follows that certain chronic morbidities may not be reversible even with treatment, so chronic infections with *S. haematobium* should be avoided at all cost. Other preventive measures like health education, water sanitation and hygiene, avoiding waters with infected intermediate snail hosts should be implemented, and not relying solely on a yearly MDA with praziquantel. In the present study we also observed that leucocyturia did not reduce significantly eight (8) weeks after treatment with praziquantel. According to Ochodo *et al*. (2016) and Rodrigue Roman *et al*. (2016), the presence of white blood cells in urine is indicative of infection. Ossai *et al*. (2014) opined that secondary bacterial infections can occur as a result of schistosomiasis, which could cause the body to release leucocytes to fight the infection. Praziquantel drug treatment alone may be unable to reverse secondary bacterial infections resulting from schistosomiasis infections. With this in mind, routine treatment should be done faithfully in endemic communities to avoid morbidities which may not be easily reversed.

After praziquantel treatment, we noticed that egg positive samples detected by PCTE filters were significantly higher in number than positive samples as detected by PCR. This could mean that although subjects continued to pass out eggs in urine, the eggs were actually non-viable, and so were not detected by PCR; thus showing PCR as a superior method capable of distinguishing true infection from false positives. Adewale *et al*. (2018) observed a significant drop in intensity (egg count) and in urinary schistosomiasis prevalence in school aged children 6 months after praziquantel treatment with a single dose of praziquantel in Lagos, Nigeria. However, our results were at variance with Shehata *et al*. (2018) who reported only a slight (non-significant) decrease in schistosomiasis prevalence following praziquantel treatment in Zambia, which was followed by a significant increase in prevalence and intensity the following year. Such a result demonstrates the need for integrated control measures in the control of schistosomiasis as opposed to relying strictly on chemotherapy for the control of the disease particularly in areas with high infection and reinfection rates. Shehata *et al*. (2018) opined that as long as reinfection following treatment is not checked, praziquantel treatment would be a futile annual routine.

Conclusion

This study has demonstrated that different diagnostic methods may yield different *S. haematobium* prevalence and as such, it may be necessary to combine more than one method to increase the accuracy of diagnosis and for proper understanding and interpretation of prevalence. The PCR method has proved to be of high sensitivity and specificity. Since Praziquantel is able to significantly reduce egg count and morbidities like microhaematuria, annual MDA with praziquantel should continue to be used for control of schistosomiasis in endemic areas of the country but infections should be avoided when and where ever possible.

REFERENCES

Adewale, B., Mafe, M.A., Sulyman, M.A., Idowu, E.T., Ajayi, M.B., Akande, D.O., Mckerrow, J.H. and Balogun, E.O. (2018). Impact of single dose praziquantel treatment on *Schistosoma haematobium* infection among school children n endemic Nigerian community. *Korean Journal of Parasitology*, 56(6):577-581.

Cheesbrough, M. (2010). District Laboratory Practice in Tropical Countries. Part2. Cambridge University Press, London.56pp.

Chikwendu, J.I., T.S. Atsuwe, and V.U. Obisike. (2019). Prevalence and Distribution of Urogenital Schistsomiasis and Trichomoniasis in Oju LGA, Benue State, Nigeria. *South Asian Journal of Parasitology,* 2(4):1-5.

Colley, D.G., Bustinduy, A.L., Secor, W.E. and King, C.H. (2014). Human Schistosomiasis. *Lancet*, 383(9936): 2253-2264.

Dawaki, S., Al-Mekhlafi, H.M., Ithoi, I., Ibrahim, J., Abdulsalam, A.M., Ahmed, A., Sady, H., Atroosh, W.M., Al-Areeqi, M.A., Elyana, F.N., Nasr, N.A. and Surin, J. (2016). Prevalence and risk factors of schistosomiasis among Hausa communities in Kano State, Nigeria. *Revista do Instituto de Medicina Tropical de Sao Paulo*, 58:54-62.

Gyuse, K.I., Ofoezie, I.E., Ogunniyi, T.A. (2010). The effect of urinary schistosomiasis on the health of children in selected rural communities of Osun State, Nigeria. *Journal of Tropical Medicine and Parasitology,* 33:7-16.

Hajissa, K., Muhajir, A.E., Eshag, H.A., Alfadel, A., Nahied, E., Dahab, R., Ali, S.M., Mohammed, M., Gaafar, M. and Mohamed, Z. (2018). Prevalence of schistosomiasis and associated risk factors among school children in Um-Asher Area, Khartoum, Sudan. *BMC Research Notes*, 11:779-788.

Houmsou, R.S., Kela, S.L. and Suleiman, M.M. (2011). Performance of microhaematuria and proteinuria as measured by urine reagent strips in estimating intensity and prevalence of *Schistosoma haematobium* infection in Nigeria. *Asian pacific Journal of Tropical Medicine*, 4: 997-1000.

Houmsou, R., Kela, S., Suleiman, M. and Ogidi, J. (2008). Urine colour as a rapid assessment indicator in evaluating the prevalence of *Schistosoma haematobium* infection in two endemic areas of Benue State-Nigeria. *The Internet Journal of Tropical Medicine* 6:1

Houmsou, R.S., Agere, H., Wama, B.E., Bingbeng, J.B., Amuta, E.U. and Kela, S.L. (2016). Urinary schistosomiasis among children in Murbai and Surbai Communities of Ardo-Kola Local Government Area, Taraba State, Nigeria. *Journal of Tropical Medicine*, Article ID 9831265.

Huyse, T., Van den Broeck, F., Hellemans, F., Volckaert, F., and Polman, K. (2013). Hybridization between the two major African schistosome species of humans. *International Journal for Parasitology*, 43:52-76.

Ibironke, O.A., Phillips, A.E., Garba, A., Lamine, S.M. and Shiff, C. (2011). Diagnosis of Schistosoma haematobium by detection of specific DNA fragments from filtered urine samples. *American Journal of Tropical Medicine and Hygiene*, 84(6):998-1001

Iwueze, M.O., Anakenyi, A.M., Ezeagwuna, D.A and Ikpeze, O.O. (2018). Urinary schistosomiasis diagnosed among children of Omogho in Nigeria. *The Diagnostics*, 2(1):34-39. https://www.thebiomedicaldiagnostics.org

Kane, R.A. and Rollinson, D. (1994). Repetitive sequences in the ribosomal DNA internal inscribed spacer of *Schistosoma haematobium*, *Schistosoma intercalatum* and *Schistosoma mattheei*. *Molecular and Biochemical Parasitology*, 63:153-156.

Khurana, U., Majumdar, K., Kapoor, N., Joshi, D., Goel, G., Sharma, T. and Biswas, D. (2018). Spectrum of parasitic infections in centrifuged urine sediments from a newly developed tertiary care center in central. *India. Journal of Parasitic Diseases*, 42(4):608-615.

King, C.H. (2009). Towards the elimination of schistosomiasis. *The New England Journal of Medicine*, 360:106-109.

King, C.H. and Bertsch, D. (2013). Meta-analysis of urine heme dipstick diagnosis of Schistosoma haematobium infection, including low-prevalence and previously treated populations. *Neglected Tropical Diseases*, 7(9):e2431.

Knopp, S., Ame, S. M., Hattendorf, J., Ali, S. M., Khamis, I. S., Bakar, F., Khamis, M. A., Person, B., Kabole, F., Rollinson, D. (2018). Urogenital schistosomiasis elimination in Zanzibar: accuracy of urine filtration and haematuria reagent strips for diagnosing light intensity *Schistosoma haematobium* infections. *Parasites and Vectors*, 11:552

Krauth, S.J., Greter, H., Stete, K., Coulibaly, J.T., Traore, S.I., Ngandolo, B.R., Achi, L.Y., Zinsstag, J., N'Goran, E.K. and Utzinger, J. (2015). All that is blood is not schistosomiasis: experiences with reagent strip testing for urogenital schistosomiasis with special consideration to very-low prevalence settings. *Parasites and Vectors*, 8:584-955.

Masong, M.C., Wepnje, G.B., Mariene, N.T., Gamba, V., Mengue, M., Kouokam, E., Stothard, J.R. and Ekobo, A.L. (2021). Female genital schistosomiasis (FGS) in Cameroon: A formative epidemiological and socioeconomic investigation in eleven rural fishing communities. *PLOS Global Public Health* 1(10): e0000007 https://doi.org/10.1371/journal.pgph.0000007

Moira, P.A., Anthony, J.C. Fulford, A.J., Kabatereine, N.B., Ouma, J.H., Booth, M. and Dunne, D.W. (2010). Analysis of complex patterns of human exposure and immunity to *Schistosoma mansoni*: The influence of age, sex, ethnicity and IgE. *PLoS Neglected Tropical Diseases*, 4(9):e820.

Ochodo, E.A., Gopalakrishna, G., Spek, B., Reitsma, J.B., van Lieshout, L., Polman, K., Lamberton, P., Bossuyt, P.M. and Leeflang, M.M (2015). Circulating antigen test and urine reagent strips for diagnosis of active schistosomiasis in endemic areas. *Cochrane Database Systematic Review*, 3:CDC009579.

Okwelogu, I.S., Ikpeze, O.O., Ezeagwuna, D.A., Aribodor, D.N., Nwanya, A.V., Egbuche, C.M., Okolo, K.V and Ozumba, N.A (2012). Urinary Schistosomiasis among School Children in Okija, Anambra State, South-Eastern Nigeria. *Scholarly Journal of Biological Science*, 1(1):1-6. Available online http://www.scholarly-journals.com/SJBS

One-Step dipstick, 10 parameters manufactured by Dongbang Acuprime, DFI Co. Ltd.

Ossai, O.P., Dankoli, R., Nwodo, C., Tukur, D., Nsubuga, P., Ogbuabor, D., Ekwueme, O., Abonyi, G., Ezeanolue, E., Nguku1, P., Nwagbo, D., Idris, S. and Eze, G. (2014). Bacteriuria and urinary schistosomiasis in primary school children in rural communities in Enugu State, Nigeria. *Pan African Medical Journal*, 15:1-5.

Pereira, A.P., Favre, T.C., Galvao, A.F., Beck, L., Barbosa, C.S. and Pieri, O.S. (2010). The prevalence of schistosomiasis in school-aged children as an appropriate indicator of its prevalence in the community. *Memorias do Instituto Oswaldo Cruz*, 105(4):563-570.

Rao, J.N and Scott, A.J. (1992). A simple method for the analysis of clustered binary data, *Biometrics*, 48(2):577-585. PMID: https://www.pubmed.ncbi.nim.nih.gov

Rodrigue Roman, D., Jeannette, T., Lucia, T., Lucie, O., Adamou, M., Sandra, N., Monique, N. and Roger, M. S. (2016). Prevalence of leucocyturia among *Schistosoma haematobium* infected school children in Cameroon. *International Journal of Tropical Disease and Health*, 14(1):1-7.

Shehata, M.A., Chama, M.F. and Funjika, E. (2018). Prevalence and intensity of *Schistosoma haematobium* infection among schoolchildren in central Zambia before and after mass treatment with a single dose of praziquantel. *Tropical Parasitology*, 8(1):12-17.

Tamarozzi, F., Ursini, T., Hoekstra, P. T., Silver, R., Costa, C., Gobbi, F., Monteiro, G., Motta, L., van Dam, G. J., Corstjens, P. L., van Lieshout, L. and Buonfrate, D. (2021). Evaluation of microscopy, serology, circulating anodic antigen (CCA), and eosinophil counts for the follow-up of migrants with chronic for the follow-up of migrants with chronic schistosomiasis: a prospective cohort study. *Parasites and Vectors* 14:149 https://doi.org/10.1186/s13071-021-04655-z

Weerakoon, K.G., Gobert, G.N., Cai, P. and McManus, D.P. (2015). Advances in the diagnosis of human schistosomiasis. *Clinical Microbiology Reviews*, 28(4):1-29.

WHO (2019). Prevention and control of schistosomiasis and soil-transmitted helminthiasis. Geneva, World Health Organization: Geneva, Switzerland
http://www.apps.who.int/iris/bitsrem/10665/42588/html

Zwang, J. and Olliaro, P. (2017). Efficacy and safety of praziquantel 40 mg/kg in pre-school aged and school-aged children: a meta-analysis. *Parasites and Vectors* 10 (1):47 doi:10.1186/s13071-016-1958-7