Prevalence and factors associated with persistent transmission of Schistosoma haematobium among primary school children after five rounds of mass drug administration using praziquantel: A cross sectional study in Mkuranga district, Tanzania

Veronica Richard Kajembe¹, Dinah B Gasarasi¹, Donath S Tarimo¹, Mayala Lushina¹ and Boniphace Sylvester²

Abstract
Despite a human schistosomiasis control programme through praziquantel mass drug administration (MDA) between 2011 and 2015, there was still persistent transmission among primary schoolchildren (PSC) in Mkuranga district, Tanzania. Our cross-sectional study was conducted among 396 PSC who provided urine for diagnosis of Schistosoma haematobium infection. Observations were conducted to determine PSC water contact activities. Logistic regression was used to test association between dependent and independent variables. We found MDA uptake among PSC as 72.5%, and the prevalence of Schistosoma haematobium infection 5.8%. The risk of infection increased among PSC engaged in fetching water and adjusted odds ratio (AOR) for swimming, bathing, fishing, crossing ponds and paddy fields were 0.123, 0.166, 0.232, 0.202 and 0.093 respectively. Thus we conclude that multiple water contact activities and low participation in MDA is responsible for persistent Schistosoma transmission.

Keywords
Prevalence, association, Schistosoma haematobium, water contact activities, mass drug administration, Mkuranga district

Introduction
Globally, over 200 million people are infected with urinary schistosomiasis, and 85% of these cases are found in Sub-Saharan Africa where children aged 5-19 years are at a higher risk of infection. In Tanzania, all administrative regions have some level of schistosomiasis infection, ranging from 12.7% to 87.6%, with higher prevalence along the coast of the Indian Ocean and shores of Lake Victoria.¹

The Global schistosomiasis control programme encourages the endemic communities to adopt mass drug administration (MDA) using praziquantel (PZQ) as a control strategy for urinary schistosomiasis based on existing levels of prevalence. Through the Ministry of Health in Tanzania the campaign for mass drug administration (MDA) using praziquantel was adopted and launched in July 2005 in various phases. Phase I of MDA implementation was conducted in 2005 and 2007 in eleven regions, while Phase II was conducted in 2008 in six regions which are highly endemic for S. haematobium. Communities were selected for MDA on the basis of

¹Department of Parasitology and Medical Entomology, Muhimbili University of Health and Allied Sciences, Dar es salaam, Tanzania
²Department of Biochemistry and Molecular Biology, Hubert Kairuki Memorial University, Dar es salaam, Tanzania

Corresponding author:
Boniphace Sylvester, Department of Biochemistry and Molecular Biology, Hubert Kairuki Memorial University, P.O. Box 65300 Dar es salaam, Tanzania.
Email: migroboniphace@gmail.com
existing prevalence levels of Schistosomiasis. In schools or in areas with prevalence of <10% praziquantel is made available in local health facilities, in areas with prevalence of 10–50% praziquantel MDA is given to all school age children plus other high-risk groups in the community.1

The Pwani region in coastal Tanzania was involved in the praziquantel MDA campaigns during Phase II implementation in 2011, which covered six districts including Mkuranga district.2

Before MDA in Mkuranga district, the prevalence of frank haematuria among school children was 9.7%, equivalent to an average of 10% egg positivity prevalence by microscopic sample analysis for S. haematobium. However, according to the World Health Organization, if a MDA had been conducted for five consecutive years in an area, the Schistosoma prevalence was expected to decline.

Methods

Our study was conducted in Mkuranga district located near water bodies. Mkuranga lies between latitude 6° 35’ and 7° 30’ S and between longitudes 38° 45’ and 39° 30’ E, and has several rivers, ponds, marshy swamps and irrigated rice fields which provide a suitable environment for Bulinus snail as an intermediate host for S. haematobium. Lack of hygienic urine disposal and certain play habits predispose schoolchildren to infections.3,4

A quantitative cross-sectional study was conducted. Primary school pupils of standard II-VII who attended school on the day of data collection were included in the study. Pupils from standard I were excluded because they did not participate in earlier rounds of MDA, since they had not yet joined primary school. School children with a history of being clinically ill and who had used anti-parasitic drugs were also excluded. Study area were observed to determine their actual water contact activities that might expose them to Schistosoma haematobium infection.

Questionnaires were checked for correct use of codes and completeness. Data were coded, validated and analyzed using SPSS version 22.0. Descriptive statistical analysis

| Variable Category | Examined (N) | Positive (%) |
|-------------------|-------------|--------------|
| Age group         |             |              |
| <11               | 218         | 15(6.9)      |
| 12–13             | 120         | 8(6.7)       |
| ≥14               | 58          | 0(0.0)       |
| Gender            |             |              |
| Female            | 203         | 11(5.4)      |
| Male              | 193         | 12(6.2)      |
| Class level       |             |              |
| Standard II–III   | 131         | 10(7.6)      |
| Standard IV–V     | 137         | 7(5.1)       |
| Standard VI–VI    | 128         | 6(4.7)       |

| Water contact activity | N (%) |
|------------------------|-------|
| Fetching water in a pond | 142(35.9) |
| Washing clothes in a pond | 135(34.1) |
| Swimming in a pond | 238(60.1) |
| Bathing in a pond | 137(34.6) |
| Vegetable gardening | 146(36.9) |
| Fishing | 134(33.8) |
| Crossing a river/stream on way to school | 107(27.0) |
| Cross a pond on way to school | 105(26.5) |
| Cross swamp area on way to school | 93(23.5) |
| Cross temporary water pools | 133(33.6) |
| Cross paddy field on way to school | 114(28.8) |
| Watering animals | 78(19.7) |
| Washing legs on way to school | 146(36.9) |
was performed to summarize socio-demographic data, infection status, drug uptake and types of water contact activities. Pearson’s chi-square statistical tests were used to compare proportions between groups. Logistic regression analyses were performed to determine association between infection status as an outcome and other independent variables. Crude odds ratios (COR) were estimated by bivariate logistic regression analysis to determine factors to be included in the final model. Thereafter, adjusted odds ratios (AOR) were computed using multivariable logistic regression analysis by taking all variables with significant association in a bivariate analysis. The statistical significance level of P < 0.05 and 95% confidence interval (CI) were used in all analysis.

**Ethical consideration**

Ethical clearance was obtained from MUHAS Ethical Review Board (ERB). Permission to conduct the study was obtained from the Mkuranga district administrative authorities and the District Education Officer. The consent to interview the pupils was obtained from the head teacher of the respective school on behalf of their parents or guardians.

**Results**

A total of 396 primary school children from standard II-VII with a mean age of 11 years, range between 6 to 16 years

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**Figure 1.** A map of Tanzania showing the study area (Mkuranga district in Pwani region).

**Figure 2.** Water contact activities observed at Kipara and Kilimahewa pond.
participated in the study. More than half 55.1% (218) of pupils were aged ≤11 years, females were 51.3% (203) and more than a quarter 29.3% (116) studied at Kilimahewa primary school (Table 1). The overall prevalence of *S. haematobium* infection in Mkuranga district was 5.8% and there was no variation of the prevalence across socio-demographic groups (Table 1).

Out of 396 pupils, more than half 60.1% (238) admitted swimming in the water bodies compared to other water contact activities (Table 2). Some 11.6% (46/396) pupils were observed to contact water bodies during their usual social activities, the majority being observed swimming, bathing, washing clothes and washing legs in a pond (Figure 1 & 2).

Almost three quarters, 72.5% (287) of the children had participated in MDA campaigns at some point, with 40.7% in only one round, 36.6% in two rounds, 17.8% in three rounds and 4.9% in more than four rounds. (Figure 3).

In both bivariate and multivariate analysis, water contact activities were significantly associated with *S. haematobium* infection (P < 0.2; P < 0.05 respectively). (Table 3).

**Discussion**

Our study indicates that urinary schistosomiasis is still a public health problem among school pupils with a significant prevalence of 5.8%. Transmission has been demonstrated to be influenced by high-risk water contact activities. Such lifestyle and activities be unavoidable. Reduction of contact with potentially infected water may be achieved through piped water systems, and water treatment by killing the cercaria or extermination of the snail species vectors using molluscides which are more selective to *Bulinus* species and less harmful to the aquatic ecosystem. We also note that pupil participation in MDA campaigns was below the WHO goal.

We recommend that MDA campaigns need to be accompanied by minimizing contact with infected water.

**Acknowledgements**

The authors would like to thank the technical Staff of Central Pathology Laboratory at Muhimbili Nation Hospital and Muhimbili University of Health and Allied Sciences for technical support to accomplish this work. We are grateful to Mkuranga District council for permission to carry out this study. Special thanks go to research assistants, head teachers and health teachers of the respective schools for their cooperation during the study, which made it a success. Appreciation is extended to the research participants of Class II-VII pupils from respective schools, without them this study would not have been possible. Very special thanks are extended to Mr & Mrs. Richard Kajembe for funding this study.

**Authors’ contributions**

V. R. Kajembe: Participated in concept development, data collection, performed the experiments, analyzed the data and writing of the manuscript. D. Gasarasi, guided concept development, research process and critically reviewed the manuscript. D. Tarimo and B. Sylvester carried out critical review of the manuscript and provided data analysis guidance. M. Lushina participated in the performed experiments, analyzed the data and writing of the manuscript. All authors read and approved the final manuscript.

**Competing interests**

The authors declare that they have no competing interests.
Table 3. Factors associated with S. haematobium infection: Logistic Regression Analysis.

| Bivariate Variable          | COR(95%CI)   | P-Value | Multivariate AOR(95%CI) | P-value |
|-----------------------------|--------------|---------|-------------------------|---------|
| Age group                   |              |         |                         |         |
| ≤11                         | Ref          |         |                         |         |
| 12–13                       | 0.97(0.40–2.35) | 0.940   | 0.53(0.23–1.22)          | 0.134   |
| ≥14                         | 0.00(0.00–0.00) | 0.997   |                         |         |
| Gender                      |              |         |                         |         |
| Female                      | 0.86(0.37–2.01) | 0.734   | 0.95(0.33–2.75)          | 0.931   |
| Male                        | Ref          |         |                         |         |
| MDA uptake                  |              |         |                         |         |
| Yes                         | Ref          |         |                         |         |
| No                          | 0.72(0.26–1.99) | 0.524   | 0.50(0.14–1.75)          | 0.276   |
| Fetching water              |              |         |                         |         |
| Yes                         | 3.27(1.35–7.91) | 0.009   | 0.39(0.11–0.99)          | 0.048   |
| No                          | Ref          |         |                         |         |
| Washing clothes             |              |         |                         |         |
| Yes                         | 3.94(1.63–9.58) | 0.002   | 0.80(0.27–2.34)          | 0.679   |
| No                          | Ref          |         |                         |         |
| Swimming                    |              |         |                         |         |
| Yes                         | 4.74(1.38–16.23) | 0.013   | 0.12(0.03–0.57)          | 0.007   |
| No                          | Ref          |         |                         |         |
| Bathing                     |              |         |                         |         |
| Yes                         | 4.76(1.91–11.88) | 0.001   | 0.17(0.05–0.53)          | 0.002   |
| No                          | Ref          |         |                         |         |
| Fishing                     |              |         |                         |         |
| Yes                         | 4.00(1.65–9.70) | 0.002   | 0.23(0.074–0.73)         | 0.012   |
| No                          | Ref          |         |                         |         |
| Gardening                   |              |         |                         |         |
| Yes                         | 2.84(1.20–6.74) | 0.018   | 0.75(0.255–2.18)         | 0.593   |
| No                          | Ref          |         |                         |         |
| Cross river/stream          |              |         |                         |         |
| Yes                         | 2.98(1.27–6.97) | 0.012   | 0.38(0.13–1.10)          | 0.075   |
| No                          | Ref          |         |                         |         |
| Cross a pond                |              |         |                         |         |
| Yes                         | 3.59(1.53–8.41) | 0.003   | 0.20(0.07–0.59)          | 0.003   |
| No                          | Ref          |         |                         |         |
| Cross paddy field           |              |         |                         |         |
| Yes                         | 4.20(1.76–5.76) | 0.001   | 0.09(0.03–0.31)          | 0.000   |
| No                          | Ref          |         |                         |         |

Key: χ² = Pearson Chi-square test; COR: Crude odds ratio AOR: Adjusted odds ratio P < 0.05.

Declaration of conflicting interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iD
Boniphace Sylvester https://orcid.org/0000-0001-8577-9452

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