International Journal of TROPICAL DISEASE & Health
22(1): 1-15, 2017; Article no.IJTDH.30784
ISSN: 2278–1005, NLM ID: 101632866

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Schistosomiasis Occurrence and Risk Factors Influencing Transmission in Different Surface Irrigation Schemes in Morogoro and Kilimanjaro Regions, Tanzania

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Author's contribution

Author FSS designed the study, collected data, performed the statistical analysis and wrote the first and final draft of the manuscript.

Article Information

DOI: 10.9734/IJTDH/2017/30784
Editor(s):
(1) Lim Boon Huat, Deputy Dean of Research, Postgraduate Studies and Networking School of Health Sciences, Health Campus, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia.
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Reviewers:
(1) Calvin Bisong Ebai, University of Buea, Cameroon.
(2) B. Awosolu Oluwaseun, Federal University of Technology, Akure, Nigeria.
Complete Peer review History: http://www.sciencedomain.org/review-history/18046

Original Research Article

Received 30th November 2016
Accepted 6th February 2017
Published 4th March 2017

ABSTRACT

Aims: To assess schistosomiasis occurence and identify risk factors influencing its transmission in different surface irrigation schemes in Morogoro and Kilimanjaro Regions of Tanzania.
Study Design: Cross-sectional research design was used and Schistosomiasis recorded cases for ten years (January 2002 to December 2011) were collected from health facilities located nearby the irrigation schemes.
Place and Duration of Study: Mkindo, Chabi and Mwega (Morogoro Region) and Kikafu Chini, Lower Moshi and Njoro (Kilimanjaro Region) between October and December, 2011.
Methodology: Out of 378 respondents selected; 240 in the questionnaire survey, 96 in the Focus Group Discussions and 42 in the Key informant interviews. In each scheme 40 farmers practicing irrigation rice farming were interviewed. Binary logistic regression was used to test association

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between schistosomiasis infection and a number of predictors such as: age, sex, education, wearing gumboots during irrigation activities, washing clothes and household utensils and cleaning farming tools in canals. Data on activities involving water contacts, water management practices and people's behaviour were collected through questionnaires and observations. Moreover, tables and figure were used to describe the data.

Results: There was no significant statistical association between predictors and disease occurrence in both Regions (P>0.05). The findings further show that lack of toilets in the schemes and excessive vegetation growth in irrigation and drainage canals have lead to prominence of schistosomiasis infection. Education in both Morogoro and Kilimanjaro schemes highly contribute to occurrence of the disease (Walds 2.057 and 1.164 respectively).

Conclusion: Although the level of schistosomiasis occurance is slightly reducing in the study areas the government of Tanzania through the Ministry of Health and Social Welfare should have a plan of schistosomiasis control to communities engaged in irrigation farming and those who live close to irrigation schemes. This should be done through providing praziquantel tablets to communities at least once in a year.

Keywords: Schistosomiasis occurrence; risk factors; irrigation schemes; Kilimanjaro and Morogoro Regions.

1. INTRODUCTION

More than 80% of the population in Tanzania is engaged in agricultural activities that contribute about 45% of Gross Domestic Product (GDP) and about 30% of export earnings [1]. Agriculture also provides employment to about 75% of the total labour force [1]. However, rainfall is unreliable for crop production in many of the areas in Tanzania. Therefore, irrigation is considered the only alternative against drought and erratic rainfall, as well as a strategy to boost production. In Tanzania, about 48% of households use water from rivers for irrigation. According to the National Irrigation Master Plan (NIMP) based on the study by Sosovele et al. [2], out of 43 million hectares of arable land, 29.4 million hectares are suitable for irrigation development. Consequently, there are about 52 modern irrigation schemes (35,900 ha), 982 traditional irrigation schemes (122,600 ha), 113 improved traditional irrigation schemes (25,500 ha) and 42 schemes under water harvesting (197,000 ha), making a total of 381,000 hectares currently under irrigation [2].

Generally, irrigation has the potential to increase agricultural production and consequently improve the economic and social well-being of the rural population. However, irrigation farming necessitates an individual to be in constant contact with water and this has been reported to be among the predisposing factors to water-borne diseases such as schistosomiasis and protozoal diseases [3]. According to Tanji and Kielen [4], most irrigation systems in Africa, create specific conditions that may favour the establishment of schistosome intermediate hosts and the subsequent transmission of schistosomiasis [4]. Several studies have shown that irrigation and other water resource development projects have increased transmission of schistosomiasis and other water-related diseases [5-11].

In Tanzania, two major schistosome species are prevalent, mansoni and haematobium causing intestinal and urogenital schistosomiasis, respectively [12]. Since late 1970s to early 1980s activities such as the construction of hydroelectric dams and development of irrigation schemes to meet demand for food and water supply altered the transmission pattern of schistosomiasis in the country. Both dams for hydroelectric and irrigation schemes are the risk areas for schistosomiasis transmission as they create favourable environmental conditions for snail intermediate hosts [13,14,15]. Until 2012, Urogenital and intestinal schistosomiasis remained the major public health problems in Tanzania [3]. Further, the entire population of approximately 44 million people in Tanzania is at risk of getting schistosomiasis, and the prevalence of the disease appears to increase with the increase in population size. For example, schistosomiasis rose from 19% in 1977 to 51.5% in 2012 [3].

Despite the success of schistosomiasis control programmes in a few countries such as China and Morocco, the disease has remained one of the most serious public health problems, particularly in areas with irrigated agriculture [16]. Adults in communities engaging in fishing and

irrigation farming, are more exposed to cercariae-infested water than the youth, due to their occupations such as paddy cultivation in swamps or fishing in lakes [17,18,19]. In Philippines and China respectively it was observed that, age difference in prevalence and infection intensity is influenced by school based control approaches, in which the control intervention is only centered on school children, and the adult population is not included [20,21].

In Tanzania, schistosomiasis and soil-transmitted helminths (STHs) are found countrywide with prevalence ranging between 12.7% and 87.6% for schistosomiasis and up to 100% for STHs [22]. However, many efforts have been made by the Government of Tanzania on minimizing schistosomiasis risks to children. This has been done through providing praziquantel drugs to school children, the group considered to be at a higher risk. Regardless of the above efforts but still in some irrigation areas, the disease is considered a problem. Studies on assessment of schistosomiasis prevalence through hospital/ dispensary data, water contact activities during irrigation and risk factors that influence schistosomiasis transmission in irrigation areas are inadequate. Previous studies have addressed children behaviour related to water contact such as swimming and playing in water [23]. This study therefore intended to assess occurrence of schistosomiasis in the chosen irrigation schemes through health facilities/dispensary data and by identifying risk factors associated with transmission in different surface irrigation schemes in the two regions of Tanzania.

2. MATERIALS AND METHODS

2.1 Study Areas

Six surface irrigation schemes were included in the study. These were Mwega, Mkindo and Chabi located in Morogoro and Lower Moshi, Kikafu Chini and Njoro located in Kilimanjaro. The schemes differed in terms of their designs and construction of infrastructure [24]. Farmers from the five schemes that is, three from Morogoro (Mkindo, chabi and mwega) and two from Kilimanjaro (Lower Moshi and Kikafu Chini) used water from rivers as a source of irrigation while farmers in Njoro use water from natural springs originating from Njoro forests.

Kikafu Chini irrigation scheme is located in Hai district at 03º14'S and 37º15'E; lower Moshi irrigation scheme is located in Moshi rural District, 03 00'ºS and 37.5º00'E while Njoro scheme is located in Moshi town at 3°21'00"S and 37°19'59.88"E. Mkindo scheme is located in Mvomero district between 8 - 10º S and 28 – 37º E [25] while Mwega and Chabi schemes are located in Kilosa district, 06º42'S and 37º02'E (www.agriculture.go.tz/Organization structure/ARD/eastern zone.html).

A detailed description of the schemes, climate, topography and information about administrative boundaries of the schemes, the two regions and five districts where the schemes were located could be found in Salehe and Hassan [26] and Salehe et al. [24].

2.2 Study Designs and Sampling Procedures

Both cross sectional and longitudinal study designs were used for gathering information. Data were collected between August to October 2012 using quantitative methods through questionnaires and a combination of qualitative methods including observations, key informant interviews and Focus Group Discussions (FGDs). A total of 378 participants were involved. A total of 336 participants were chosen randomly in all six schemes from lists of farmers practicing irrigation rice farming, provided by the village government offices and 42 participants were randomly chosen from local pharmacies and dispensaries in the study areas. Out of 378 participants, 240 in all six schemes were included in the questionnaire survey, 40 participants from each scheme. 96 participants in all the schemes were included in 12 FGDS, two FGDs with 16 participants from each scheme, i.e. 8 men in the first group and 8 women in the second group. Men and women groups were formed in order to let women feel free to express themselves, because according to the African culture women are sometimes shy to speak in front of men. Also interviews were conducted with 42 key informants in all the schemes. About 7 key informants in each scheme were interviewed, 4 health personnel from dispensaries and 3 workers of the local pharmacies. Information on activities involving water contact pattern, water management practices, people's habits and behaviours were directly observed in the six irrigation schemes three in Morogoro and three in Kilimanjaro

Regions, during October 2011 to October 2012. Moreover schistosomiasis prevalence retrospective data from January 2002 to December 2011 were collected from Mkindo, Malolo and Carmel dispensaries in Morogoro Region and from Pasua, Dr. Nderingo and Mabogini dispensaries in Kilimanjaro Region to compare schistosomiasis prevalence between years in schemes within and between the two Regions.

2.3 Data Analysis

Descriptive statistics were presented in tables and graphs to give information on water management practices and diseases, and the mean number of infected people per year in the study areas. Data from the FGDs and key informant interviews were interpreted and summarized into themes based on what was reported by participants. A binary logistic regression model was used to test whether there was any association between schistosomiasis infection and a number of predictors such as: age, sex, education, wearing gumboots during irrigation activities, washing clothes and household utensils in irrigation canals and cleaning farming tools in the irrigation canals. The mentioned data above are activities involving water contact patterns.

2.4 Research Permit

Research permit was given by the Vice Chancellor, Sokoine University of Agriculture (SUA), the Regional Administrative Officers of Morogoro and Kilimanjaro Regions and the District Administrative Officers of Mvomero, Kilosa, Hai and Moshi District.

3. RESULTS AND DISCUSSION

3.1 Health Status in the Studied Areas

3.1.1 Diseases, place for treatment and source of domestic water supply

More than 50% of participants interviewed through the questionnaire survey in all the schemes (Morogoro and Kilimanjaro), mentioned schistosomiasis as the most severe public health problem in their areas followed by malaria (Table 1). All the participants (100%) in Kilimanjaro schemes, more than three quarters of the participants in Mkindo scheme and more than half of the participants in Chabi and Mwega schemes go to hospitals/dispensaries for treatment. All interviewed respondents (100%) in Mkindo, more than half of participants in Lower Moshi (60%) and more than three quarters (86%) in Njoro scheme mentioned that they obtained domestic water from the taps. In addition, 128% of participants in Mwega and Kikafu chini schemes used pumped wells as the source of water for domestic use. Rivers were used as a source of domestic water supply by all farmers in Chabi and by more than a quarter (30%) in Mwega schemes.

Study results, further showed that malaria and schistosomiasis were the major diseases affecting the majority of the respondents in all the six schemes. The results also indicated that participants in Kilimanjaro schemes were aware of the importance of attending hospitals in case of illness may be because dispensaries and hospitals were within the scheme areas. In the Lower Moshi scheme not everyone could have access to clean water because there was a schedule of distributing clean water for domestic use and only those who had high income could have access to clean water as opposed to those with low income who were not ready/could not afford to buy water for home consumption. The only alternative for people with low income was to use water from the irrigation canals for all household activities.

3.2 Risk Factors

3.2.1 Toileting during field working hours

Regarding places for relieving during working hours, majority (75%) of participants during questionnaire survey declared that they relieved around the scheme area while minority (25%) go back home (Table 2). Some of the participants especially in women's FGDs insisted that they just kneel down in the same place where they are working and relieved for the case of urinating and some said that they just made a small hole enough to drop the stool. Participants also insisted by saying that ''it is not possible for someone to go back home in case one wants to relieve during working hours, every one of us relieve in the scheme area.'' Moreover, during FGDs farmers were asked if toilets were to be built in the scheme areas would they make use of them. Participants especially in male Focus Group Discussions in Lower Moshi, Chabi, Mwega and Kikafu Chini schemes said they would make use of the toilets, while in the female Focus Group Discussions in Chabi,

Mwega and Kikafu Chini said that it would not help because people's behaviour are different, some farmers would still not make use of the toilets.

The results showed that lack of toilets and people's behaviour influence schistosomiasis transmission in the studied areas. The results also implied that farmers had to be sensitized continuously on the importance of using toilets and how schistosomiasis could be controlled if toilets were be built and utilized effectively. The findings were in line with those of Chimbari, (2012) in Zimbabwe [27] who reported that, construction of toilets in a way that every farmer in the field gets closer to it helped in minimizing schistosomiasis transmission.

3.2.2 Schedule for canal maintenance (cleaning)

Table 2 indicates that more than 75% of the participants in Mkindo, Mwega and Kikafu Chini schemes clean irrigation canals once in a month, while more than half of the participants in Chabi do clean canals twice in a month. Similarly, half of the participants in Lower Moshi and more than quarter of the participants in Njoro schemes declared to have been removing vegetation in canals once in two months. When farmer were asked during Focus Group Discussions whether they understood why was it important for them to remove vegetation in canals and drain excess water in the field, their response were in two categories. First majority of them gave two reasons, which were: (i) they remove vegetation in order to allow easy flow of water from canals to their paddy plots and, (ii) they remove excess water to let their crops dry during harvesting. The second view, which comprised the minority (from Mkindo and Lower Moshi schemes), related the removal of vegetation in canals for control of diseases.

Results implied that participants in the two schemes, Morogoro improved traditional scheme (Mkindo) and Kilimanjaro modern scheme (Lower Moshi), were aware of the reason of removing vegetation probably because they received training from Mkindo Farmers Center and Kilimanjaro Agriculture Training Centre respectively.

Table 1. Diseases, place for treatment and season experiencing schistosomiasis infections (n=240)

Variables		Schemes					
		Morogoro			Kilimanjaro		
		Mkindo %	Chabi %	Mwega %	Kikafu %	Lower moshi %	Njoro %
Waterborne diseases commonly found in the study areas	Diarrhea	0.0	2.0	2.0	0.0	0.0	0.0
	Schistosomiasis	54.0	84.0	84.0	54.0	84.0	62.0
	Malaria	30.0	6.0	14.0	28.0	12.0	26.0
	Typhoid	12.0	8.0	0.0	18.0	4.0	12.0
	I don't know	0.0	0.0	0.0	0.0	0.0	0.0
	Others	4.0	0.0	0.0	0.0	0.0	0.0
Access to medical facilities	Hospital	87.5	55.0	67.5	100.0	100.0	100.0
	Hospital and local pharmacy	12.5	12.5	22.5	0.0	0.0	0.0
	Hospital and traditional healers	0.0	32.5	7.5	0.0	0.0	0.0
	Local pharmacy	0.0	0.0	2.5	0.0	0.0	0.0
Seasons for schistosomiasis infections	Long rains	52.0	48.0	32.0	34.0	48.0	48.0
	Short rains	6.0	0	0	0	0	0
	Dry season	12.0	14.0	16.0	12.0	24.0	4.0
	Intermediate dry season	8.0	14.0	20.0	8.0	2.0	0.0
	All seasons	8.0	22.0	24.0	10.0	26.0	4.0
	I don't know	14.0	2.0	8.0	36.0	0.0	44.0

Table 2. Risk factors influencing schistosomiasis transmission

Variables		Schemes					
		Morogoro			Kilimanjaro		
		Mkindo %	Chabi %	Mwega %	Kikafu %	Lower moshi %	Njoro %
A place for relieving during field work hours	Go back home	16.0	18.0	10.0	18.0	20.0	34.0
	Around the scheme area	84.0	82.0	90.0	82.0	80.0	66.0
	I don't know	14.0	2.0	8.0	36.0	0	44.0
Schedules for canal cleaning	Once a month	82.5	46.2	100.0	77.5	32.5	72.5
	Twice a month	15.0	53.8	0.0	22.5	17.5	27.5
	Once in two months	2.5	0.0	0.0	0.0	50.0	82.5
	Irrigation canal	0.0	28.0	20.0	0.0	34.0	0.0
Sources of domestic water supply	Tap	100.0	0.0	0.0	10.0	60.0	86.0
	Pumped well	0.0	0.0	50.0	78.0	6.0	0.0
	Rivers	0.0	100.0	30.0	12.0	0.0	0.0
	Springs	0.0	0.0	0.0	0.0	0.0	14.0

3.2.3 Risk factors and likelihood of having schistosomiasis infection: Comparison for schemes in the two regions

Direct logistic regression was performed to assess the impact of a number of factors on the likelihood of respondents in all schemes studied to report that they had schistosomiasis infection or not. The model contained six independent variables (sex, age, education, cleaning farming tools in canals, wash clothes and household utensils in canals and wore gumboots during irrigation farming activities). It was observed that, there was no significant statistical association between predictors and disease occurrence in both Regions.

3.2.4 Binary logistic regression outputs and the odds of being infected schistosomiasis

Case processing summary was one of the important outputs of binary logistic regression model. In the tables it shows that 100% were included in the analysis in each Region representing the whole sample of 120 of respondents interviewed in each region. There were no missing cases in both Regions.

The Omnibus test is another output of binary logistic regression model. It tests for the capability of all predictors (independent variables) in the model jointly to predict the response (dependent) variable. From the output results as seen in Table 3a it shows that there were no significant differences in all the data entered into the model in the two Regions.

Moreover, the model summary, which is presented in Table 3b showing Cox & Snell R square and Nagelkerke R square, was chosen as an important output of the binary logistic regression model. The Cox-Snell R2 and Nagelkerke R2 are attempts to provide a logistic analogy to R2 in OLS regression; hence are called pseudo R2. Nagelkerke R2 is a modification of Cox-Snell R2 to assure that Cox-Snell R2 varies from zero to one, as does R2 in OLS regression. If Cox-Snell R2 is not modified, its maximum value is usually less than 1, making it difficult to interpret.

Nagelkerke R2 is normally higher than Cox-Snell R2 and is the most-reported of the pseudo R2 estimates. Therefore, based on the results in Table 3c which show that Nagelkerke R2 was 0.100 and 0.038 in Morogoro and Kilimanjaro Regions respectively, it means that the independent variables entered in the model explained 10 and 3.8% of variance in the dependent variable for schemes in Morogoro and Kilimanjaro respectively.

Hosmer and Lemeshow Test is another output of logistic regression model which tests the goodness-of-fit of a logistic regression model. In this study, the value of the Hosmer and Lemeshow chi-square obtained was 7.193 for schemes in Morogoro and 3.783 for schemes in Kilimanjaro Region, and it was not significant (p= 0.576 and p=0.876) for schemes in Morogoro and Kilimanjaro respectively, as observed in Table 3c. Normally, where the Hosmer and Lemeshow chi-square value is greater than 0.05, it represents the goodness of fit of the model. Therefore it implies that the model's estimate

which was used in this study which contained six explanatory variables in each region fitted the data at an acceptable level.

Wald statistics is another useful output. Wald coefficients associated with individual independent variables help us realize the relative importance of each independent variable. A bigger Wald statistic implies that the independent variable associated with it has high contribution to the occurrence of the dependent variable. In this case Education in both Morogoro and Kilimanjaro schemes highly contribute to occurrence of the dependent variable since they have bigger Walds (2.057 and 1.164 respectively).

In a B coefficient, a negative sign shows that, that particular variable decreases the logit of the dependent variable (i.e. it decreases the probability of that event (in this case schistosomiasis infection) will be realized, and vice versa. For example in Table 3d: age, sex and the activity of washing clothes and household utensils in canals in Morogoro schemes; and sex, education and the activity of cleaning farming tools in irrigation canals in Kilimanjaro schemes reduced the chances of farmers to be infected by schistosomiasis since their B values are associated with negative signs. In other words, the other variables increase chances of farmers to be infected since they have positive signs. Therefore in Morogoro schemes education, the activity of bathing in irrigation canals and the behaviour of not wearing gumboots during field works in paddy plots had impact on schistosomiasis infection.

3.2.5 Risk factors identified during observations

In Mwega scheme, people of different age groups were observed taking bath in the canals. Since the scheme area is close to residential areas, all activities that involve water are done in the irrigation canals (see Plates 1 and 2). It was observed that some people especially those that reside near to the canals (4 to 15 m away) were seen in the morning hanging towels on their shoulders, holding tooth brushes and soap in their hands going to the canal for bathing. The same activity of washing and bathing directly in the canals was observed in the evening where groups of men on one side of the main canal and other groups of women on the other side of the main canal taking a bath half naked (for women) and naked (for men). In addition, to the above observations, improper cropping pattern were observed in the plots. One plot was found with paddy while the next plot had maize, beans or onions. This observation implies that there is improper water management practice carried out in this plots since all the crops mentioned above have different water demands and therefore there will be standing pools of water since paddy crop needs more water in its initial stage of growth compared to maize, beans and onion crops which needs little water for its growth.

Table 3a. Omnibus test of model coefficients

Schemes in Morogoro Region

		Chi-square	Df	p-value
Step 1	Step	9.055	6	0.171
	Block	9.055	6	0.171
	Model	9.055	6	0.171

Schemes in Kilimanjaro Region

		Chi-square	Df	p-value
Step 1	Step	3.407	6	0.756
	Block	3.407	6	0.756
	Model	3.407	6	0.756

Table 3b. Model summary

Schemes in Morogoro region

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	147.534	0.073	0.100

Schemes in Kilimanjaro region

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	160.238	0.028	0.038

Table 3c. Hosmer and Lemeshow test

Schemes in Morogoro region

Step	Chi-square	Df	p-value
1	7.193	8	0.576

Schemes in Kilimanjaro region

Step	Chi-square	Df	p-value
1	3.783	8	0.876

Table 3d. Likelihood of reporting schistosomiasis infection by region

Variables	B	S.E.	Wald	Df	P-value	Exp (B)	95.0% C.I for odds ratio	
							Lower	Upper
Morogoro schemes								
Age	0.024	0.016	2.245	1	0.134	0.976	0.945	1.008
Sex	-0.582	0.398	2.139	1	0.144	0.559	0.252	1.219
Education	1.278	0.891	2.057	1	0.152	3.591	0.626	20.606
Wash clothes house-hold utensils in canals	-0.32	0.416	0.600	1	0.438	0.725	0.321	1.637
Bath in canals	0.277	0.401	0.477	1	0.490	1.320	0.601	2.899
Wear gumboots during irrigation activities	0.515	0.721	0.511	1	0.475	1.673	0.408	6.869
Constant	1.441	0.976	2.179	1	0.140	4.226		
Kilimanjaro schemes								
Age	0.009	0.017	0.274	1	0.601	1.009	0.976	1.043
Sex	-0.305	0.405	0.564	1	0.452	0.737	0.333	1.632
Education	-1.268	1.175	1.164	1	0.281	0.281	0.028	2.817
Wash clothes and house-hold utensils in canals	0.308	0.406	0.574	1	0.449	1.360	0.614	3.016
Cleaning farming tools in irrigation canals	-0.338	0.419	0.650	1	0.420	0.714	0.314	1.621
Wear gumboots during irrigation activities	0.137	0.414	0.110	1	0.740	1.147	0.509	2.584
Constant	-0.523	0.920	0.322	1	0.570	0.593		

P is significant at 0.05 level (two tailed test), Df= Degrees of freedom

Plate 1. A child swimming in the canal

Plate 2. A Woman washing close to the main canal

Even though farmers in Mkindo had access to clean water from taps, still a number of people infected with schistosomiasis from the dispensary data were high compared to other schemes. The researcher was therefore interested to know why the number of infected people in Mkindo was so high for the ten years in which data were collected compared to other scheme areas, and therefore Mkindo as a case to be investigated. Risk factors that were observed in Mkindo irrigation scheme were as follows: (i) standing pools of water almost for the whole scheme area; (ii) the main irrigation canal and the main drainage canal were full of water and vegetation. This encourage growth of snails since they feed on vegetation (iii) the drainage canal is also used as irrigation canal, (iv) the division boxes (structures) were also chocked with vegetation and snails were found sticking on the vegetation cover for feeding; (v) the drainage canals were not serving the purpose of removing excess water from the plots since the plots were found with standing water even during harvesting period (see Plates 3 and 4).

Observation from the scheme in Chabi showed that: (i) the village did not have a domestic water supply system, therefore water for domestic purposes was collected from the canals and Chabi river, (ii) there was a very big swamp

called ''tete'' in respondents local language. The swamp stores water used for irrigation purposes and it was chocked with aquatic weeds.

Plate 3. Rice plots filled with water during harvesting period

Plate 4. Canals chocked with vegetation

Observations from Lower Moshi scheme were as follows: (i) people were found washing, swimming especially children and collect water for domestic use in canals; (ii) some farmers were found drinking water from the canals during field working hours; (iii) some were washing their limbs and farming tools in the canals after farm work.

The following were considered as the main causes and risk factors of schistosomiasis transmission during observations in Kikafu Chini scheme: (i) some of the earth canals are constructed near residential houses, (ii) the canals used to irrigate bananas, vegetables and coffee and people do wash clothes and bath in the canals; (iii) pit latrines constructed close to irrigation canals at the middle stream; (iv) children do bath close to these canals and the downstream dwellers do fetch water for domestic use.

The same risks were observed in Njoro scheme where; people were found fetching water for washing and bathing from the irrigation canals. In addition children were swimming, and farmers were found washing their limbs and farming tools after field work in the canals.

These results suggest that activities involving water contact such as washing household utensils, bathing, swimming, collecting water for household use and washing of limbs and farming tools in irrigation canals may have contributed to exposing farming communities to schistosomiasis infections and transmission in the study areas. These results concur with the findings of others .who reported that provision of hygienic communal washing place including a safe rural water supply, laundry basins and cattle troughs in the design of an irrigation system reduces the risk of schistosomiasis transmission at the water collection point [28,29,30]. The results further show that lack of toilets in the studied schemes and excessive vegetation growth in irrigation and drainage canals have also lead to prominence of schistosomiasis infection. These results are supported by the study done in Benue Upper-Valley by Tsafack [31] and the study done in Gezira irrigation scheme by Hilali et al. [32]. Very few farmers particularly men in the four schemes (Mkindo, Kikavu Chini, Lower Moshi and Njoro) were observed wearing rubber/gum boots while working in the water. This also indicates that farmers are exposed to schistosomiasis infections during working hours of the day.

None of the independent variables tested made a significant statistical contribution to the model when testing association between independent variables and reporting schistosomiasis infection. However, wald statistics showed that education had significant contribution to occurrence of schistosomiasis infection in the two regions. Other variables which contributed positively to schistosomiasis infections were bathing in irrigation canals, behaviour of not wearing gumboots during field works in paddy plots and washing clothes and household utensils and farming tools in canals.

3.3 Schistosomiasis Occurrence

3.3.1 Information on schistosomiasis at community level

During interviews with key informants (Health personnel and local pharmacists) from Mabogini and Carmel dispensaries, it was revealed that

the number of people visiting dispensaries and pharmacies for schistosomiasis clinical test and treatment has been declining compared to the past years (from year 2009 to 2011). However, key informants in Mkindo still believe that the number of people infected by schistosomiasis per year is still high. Also schistosomiasis recorded data from dispensaries in the studied areas (Mabogini, Carmel mission, Malolo and Pasua dispensaries) reveals the same (Fig. 1).

Further discussions with the key informants in all the schemes show that people of all ages are equally affected by schistosomiasis. In addition, when the key informants were asked why children are equally affected like adult farmers while they spent most of their time in schools, the key informants in the five schemes with exception of those in Mkindo scheme answered that children do play and swim in irrigation canals after school hours. On the contrary informants in Mkindo pointed out that children play in the standing pools of water during the rainy season and some accompany their parents to work in the rice fields during weekends and holidays. These activities can expose children to risks of being infected by schistosome worms.

Regarding the question on whether schistosomiasis infected people seek treatment in the early stages or late stages of the disease the key informants pointed out that some do visit the dispensaries for clinical tests and get treatment from the dispensary whenever they themselves or their children saw symptoms related to schistosomiasis. However, others just visit the local pharmacy complaining that they have signs of schistosomiasis without prescription from the doctor. The local pharmacists in Mkindo village insisted that most of those visiting the pharmacy without doctor's prescription were male adults who shy off visiting dispensaries for clinical tests because they relate signs of blood in urine with other sexually transmitted diseases (STDs).

Responding on why schistosomiasis is still a health problem in the study areas the key informants in Mwega, Chabi, Kikafu Chini and Lower Moshi claimed that the majority of people in these areas depend on water from the irrigation canals for their domestic uses (drinking, cooking, washing, bathing and for animals). Informants in Mwega scheme further argued that worse enough some people do clean cooking pots and wash clothes in canals and some bath in the canals and faeces have been seen several times floating in canals indicating that some people use the canals as toilets. Key informants in Kikafu Chini and Mwega added that parents leave their children to play in the canals.Maintained with stated, informants in Kikafu Chini maintained that the canals are not regularly cleaned and some households drain dirty water from toilets into the canals.

3.3.2 Schistosomiasis occurrence in the study area

Study results further show that February, May, June and December constituted the months with the highest number of people infected by schistosomiasis in scheme areas in Morogoro Region while January through May also maintained higher level of infection in scheme areas in Kilimanjaro Region (Fig. 1). The pattern for Kilimanjaro was irregular in the period from June to December. It was also evident that in all months across ten years (2002-2011) schistosomiasis recorded cases were higher in Morogoro health centers compared to Kilimanjaro, meaning that schistosomiasis reported cases were higher in the Morogoro schemes while the cases were least in Kilimanjaro schemes.

According to the secondary data for a ten year period (2002-2011), there were a total of 4272 schistosomiasis patients who received treatment from health facilities in/near Mkindo, Malolo and Chabi schemes in Morogoro while 1778 patients were diagnosed to have schistosomiasis infections in the Mabogini, Pasua and Dr.Kisanga's health facilities in Kilimanjaro (Table 4). Comparatively, Mkindo health center (in Morogoro) had the highest number of recorded schistosomiasis cases followed by Mabogini health center (in Kilimanjaro) while Pasua health center (also in Kilimajaro) had the least cases of the disease (Table 4). In addition, there were more recorded patients in year 2007 in all six health facilities compared to other years.

Only data for 2010 and 2011 were accessed in Kikafu Chini from Dr. Kisanga's dispensary, simply because there were no records of patients visiting the dispensary. Therefore, the researcher adviced the Doctor to start keeping records for schistosomiasis cases from the year 2010 to 2011. In addition, FGDs were conducted with some farmers to get information on schistosomiasis prevalence. From the FGDs, it was revealed that apart from Dr Kisanga's dispensary people used to get treatment from Dr Mbonea's dispensary which is located 5 kms away from Kikafu Chini village.

Table 4. Number of people infected by schistosomiasis per year in the six health facilities in Morogoro and Kilimanjaro regions

Region	Health facilities in the scheme areas	Total number of schistosomiasis cases in different years										
		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Morogoro	Mkindo	189	0	0	440	730	635	0	800	298	276	3368
	Malolo	0	0	0	0	42	50	31	29	0	0	152
	Carmel	0	98	0	68	0	347	78	123	34	4	752
	Total	189	98	0	508	772	1032	109	952	332	280	4272
Kilimanjaro	Mabogini	268	0	242	274	0	179	141	67	64	49	1284
	Pasua	112	84	33	8	25	79	23	48	29	8	449
	Dr. Kisanga	0	0	0	0	0	0	0	0	29	16	45
	Total	380	84	275	282	25	258	164	115	122	73	1778

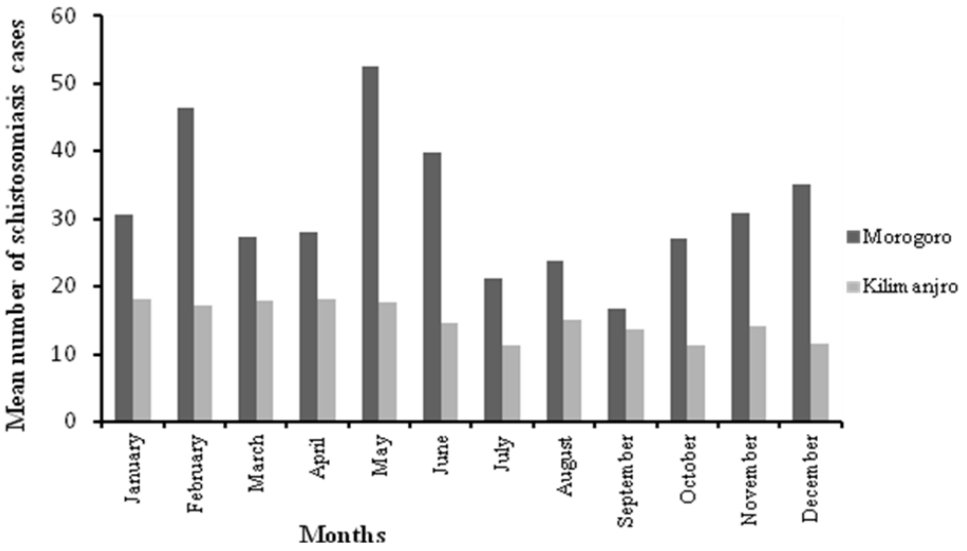

Fig. 1. Mean monthly schistosomiasis occurence recorded cases from different health centres in Morogoro and Kilimmanjaro across ten - year period from 2002 to 2011

The result implies that, the number of infected people by schistosomiasis in Malolo, Carmel, Pasua and Mabogini dispensaries decreased from the year 2010 to 2011 probably due to health education people receive from health personnel from the above mentioned health facilities. In addition, the reason as to why people living in Mkindo village had high number of schistosomiasis cases in all the ten years data collected may be contributed by poor drainage system and vegetation growth in the conveyance systems which encouraged snails breeding. According to Salehe et al. [33], poor knowledge of schistosomiasis is another reason which causes increase in schistosomiasis transmission in Mkindo scheme as only 45% of respondents in the scheme had better knowledge on schistosomiasis predisposing factors. From this result, it indicates that majority of farmers in Mkindo scheme are not aware of the risk factors influencing schistosomiasis transmission. Moreover, the presence of a swamp chocked with vegetation in Morogoro traditional scheme (Chabi) may have contributed to schistosomiasis transmission as snails breed and feed on weeds.

4. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusions

From the above results the researcher concludes that, occurrence of schistosomiasis decreased

from year 2008 in Mabogini, Carmel, and Malolo dispensaries while the number of cases was still high in Mkindo dispensary. Schistosomiasis mass treatment programmes which were provided to primary school children since year 2004 might have helped in minimizing the number of cases.

Major risk factors observed were people's behaviour of swimming, bathing and washing of clothes and farming tools in irrigation canals. Other risks observed were: Limited availability of toilets which enhanced schistosomiasis transmission; poor maintenance of irrigation and drainage canals to remove vegetation and snails were found attached to vegetation covers in the canals in all studied schemes.

4.2 Recommendations

From the above findings the researcher recommends that the Government through the Ministry of Health and Social Welfare and the National Institute for Medical Research should provide praziquantel tablets to irrigation farming communities at least once in every year. This should be done through mass treatment programmes. The more farmers receive treatment in irrigated areas, the lesser transmission of the disease and the fewer the snails will be infested by the parasites.

The researcher also recommends that irrigation department through the local government at District level should: i) keep on creating awareness to farmers about schistosomiasis, its effects, transmission and the way people can protect themselves from infections. ii)provide education to farmers on the necessity of cleaning canals to remove vegetation cover and proper draining of excess water in the fields and canals; iii) sensitize farmers to raise funds for construction of simple affordable toilets and educate them on the importance of using toilets.

The researcher further recommends that the Ministry of Agriculture, Livestock and Fisheries Development through the department of irrigation and technical services should do the following:

(i) Integrate irrigation and health related issues during farmers training.
(ii) Include budget for construction of toilets and clean water for domestic use during planning and designing of irrigation projects.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the author.

ETHICAL CLEARANCE

Ethical clearance was obtained from the Medical Research Coordinating Committee of the Tanzania National Institute for Medical Research (NIMR) (attached in Appendix 1). Consent was obtained from each of the participating individuals after explaining the purpose and importance of the study prior to commencement of interviews. Participation in the study was on voluntary basis. All the information collected from the participants was kept under the custody of the researcher as confidential and the study participants were anonymized.

ACKNOWLEDGEMENTS

Funds for this work were provided by the Tanzania Government through the Tanzania Commission for Science and Technology (COSTECH), Dar Es Salaam -Tanzania.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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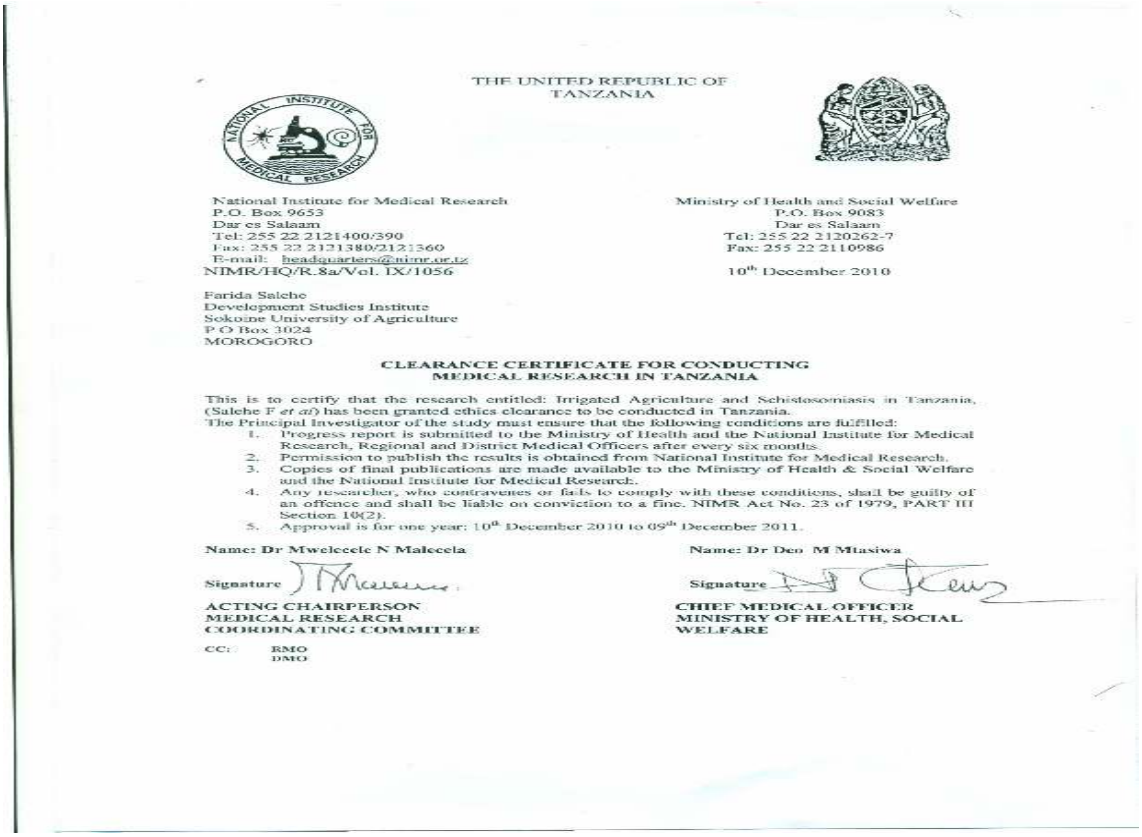
APPENDIX 1

Ethical Clearance



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CLEARANCE CERTIFICATE FOR CONDUCTING MEDICAL RESEARCH IN TANZANIA

This is to certify that the research entitled: Irrigated Agriculture and Schistosomiasis in Tanzania, (Salehe F *et al*) has been granted ethics clearance to be conducted in Tanzania.
The Principal Investigator of the study must ensure that the following conditions are fulfilled:

1. Progress report is submitted to the Ministry of Health and the National Institute for Medical Research, Regional and District Medical Officers after every six months.
2. Permission to publish the results is obtained from National Institute for Medical Research.
3. Copies of final publications are made available to the Ministry of Health & Social Welfare and the National Institute for Medical Research.
4. Any researcher, who contravenes or fails to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine. NIMR Act No. 23 of 1979, PART III Section 10(2).
5. Approval is for one year: 10th December 2010 to 09th December 2011.

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