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ORIGINAL ARTICLE

Improved Perceptions and Practices Related to Schistosomiasis and Intestinal Worm Infections Following PHAST Intervention on Kome Island, North-Western Tanzania

Joseph R. Mwanga[1], Godfrey M. Kaatano[1], Julius E. Siza[1], Su Young Chang[2], Yunsuk Ko[2], Cyril M. Kullaya[2], Jackson Nsabo[2], Keeseon S. Eom[3,*], Tai-Soon Yong[4], Jong-Yil Chai[5], Duk-Young Min[6], Han-Jong Rim[7], John M. Changalucha[1]

[1]National Institute for Medical Research, P.O. Box 1462, Mwanza, Tanzania; [2]Good Neighbors International, Tanzania Western Chapter, P.O. Box 367, Mwanza, Tanzania; [3]Department of Parasitology, Medical Research Institute and Parasite Resource Bank, Chungbuk National University School of Medicine, Cheongju 28644, Korea; [4]Department of Environmental Medical Biology, Institute of Tropical Medicine and Arthropods of Medical Importance Resource Bank, Yonsei University College of Medicine, Seoul 03722, Korea; [5]Department of Parasitology and Tropical Medicine, Seoul National University College of Medicine, Seoul 03080, Korea; [6]Department of Immunology and Microbiology, Eulji University School of Medicine, Daejeon 34824, Korea; [7]Department of Parasitology, College of Medicine, Korea University, Seoul 02841, Korea

Abstract: Schistosomiasis and intestinal worm infections are widespread diseases of public health importance in Tanzania. A study on perceptions and practices related to schistosomiasis and intestinal worm infections was undertaken among a community population of Kome Island in Sengerema District, north-western Tanzania, where intestinal schistosomiasis and intestinal worm infections are endemic. Schistosomiasis and intestinal worm-related perceptions and practices were assessed before and 3 years after implementation of a participatory hygiene and sanitation transformation (PHAST) intervention as a control measure. Data were obtained from baseline and post-intervention knowledge, attitudes, and practices (KAP) questionnaire surveys conducted twice in 2009 and 2012 among 82 individuals aged ≥15 years. We found significant increases in respondents' knowledge of the cause, transmission, symptoms, health consequences, and prevention of schistosomiasis and intestinal worm infections after PHAST intervention. The increase in respondents' knowledge on almost all aspects of the said infections was translated into actions to control schistosomiasis and intestinal worm infections. This has not been achieved by chance, but due to well-designed and locally-adapted PHAST intervention. We conclude that despite criticisms, PHAST approach is still useful in empowering communities to control water, sanitation, and hygiene related infectious diseases such as schistosomiasis and intestinal worm infections.

Key words: *Schistosoma mansoni*, perception, behavior, schistosomiasis, intestinal worm, control, participatory hygiene and sanitation transformation (PHAST), Tanzania

INTRODUCTION

Human helminthiases are of considerable public health importance in sub-Saharan Africa (SSA), Asia, and Latin America [1-7]. Helminths are a broad range of organisms that include intestinal parasitic worms. They are the most common infections worldwide when transmitted by soil, and affect the poorest and most deprived communities. Among the human helminthiases, schistosomiasis and soil-transmitted helminth (STH) infections are the world's most serious neglected tropical diseases (NTDs). Of the world's 207 million estimated cases of schistosomiasis, more than 90% occur in SSA, and Tanzania is the second country for having the highest burden of schistosomiasis in SSA, the first being Nigeria [7]. More than 1.5 billion people or 24% of the world's population are infected with one or more helminth species, with the greatest numbers occurring in SSA, the Americas, and China and East Asia [6]. It is estimated that 198 million people are infected with hookworms, whereas 173 million and 162 million people are infected with *Ascaris* and *Trichuris*, respectively [8,9]. In Tanzania, both intestinal and urinary schistosomiases as well as STH infections are endemic particularly in school age children, ad-

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* Corresponding author (keeseon.eom@gmail.com)

olescents, and in fishing communities living along the shores of Lake Victoria [10].

Consequences of chronic infection include suffering, stigmatization, subtle and gross morbidity, and premature death. These infections are associated with low work productivity, poor cognitive performance, and slow socioeconomic development, thereby contributing to accentuate poverty and inequality [6,11].

Despite their insidious effects at the individual and societal levels, schistosomiasis and STH infections and their associated disease sequelae have not received as much research and investment attention as other acute or life-threatening conditions, a fact that has placed them in the category of NTDs. However, since 2004 there has been an increased recognition of the importance of NTDs as impediments to development [12]. The collective morbidity that these diseases cause is considerable and comparable to that caused by malaria, HIV/AIDS, or tuberculosis [11], and they are responsible for excess mortality [13,14].

In recognition of the burden helminth infections impose on human populations, particularly the poor, major intervention programmes have been launched to control them. The Disease Reference Group on Helminth infections (DRG4) established by the special Programme for Research and Training in Tropical Diseases (TDR) in 2009 was given mandate to review helminthiases research and identify research priorities and gaps [15]. However, schistosomiasis and STH infections are widely recognized as diseases that are socially determined, and hence, an understanding of social and behavioral factors linked to their transmission and control should play a vital role in designing policies and strategies for prevention and control [16-18].

A study on perceptions and practices related to schistosomiasis and intestinal worm infections was conducted among the people in 1 community population of Kome Island, Sengerema District, in North-western Tanzania before and 3 years after implementation of a participatory hygiene and sanitation transformation (PHAST) intervention to control schistosomiasis and STH. The study was undertaken under the auspices of a 5-year programme (2008-2013) entitled 'Neglected tropical diseases control on Kome Island and the Lake Victoria basin, Tanzania' funded by Korea International Cooperation Agency (KOICA) through Good Neighbors International (GNI) of the Republic of Korea. The broad objective of this sub-study was to evaluate the impact of PHAST intervention on people's perceptions and practices related to schistosomiasis and intestinal worms infections. Specifically, the study aimed at evaluating people's knowledge, attitudes, and practices (KAP) towards schistosomiasis and intestinal worm infections at the beginning of the project and 3 years after implementation of locally adapted control interventions.

MATERIALS AND METHODS

Study area and population

The study was carried out on Kome Island, one of the islands situated in the south-eastern part of Lake Victoria in Sengerema District in north-western Tanzania between November 2009 and December 2012. The Island lies between 32˚24′ and 32˚34′ east, and 2˚14′ and 2˚25′ south covering a total area of about 290 km^2. Kome is the fourth largest Island on Lake Victoria after Ukerewe, Ukara, and Maisome Islands.

The Island is predominantly inhabited by Wazinza ethnic group (a Bantu-speaking people who are the natives of Uzinza. Most of the inhabitants earn their living from peasantry, cultivating mainly cassava, sweet potatoes, maize, and paddy, and livestock keeping mainly cattle, goats, sheep, and poultry, and a few of them undertake fishing. Crop production and livestock keeping are undertaken within the framework of individual households.

Kome Island is divided into 2 administrative wards, namely Nyakasasa and Lugata each with 4 villages. Nyakasasa, Isenyi, Buhama, and Nyamiswi villages belong to Nyakasasa ward, and Lugata, Nyakabanga, Bugolo, and Kabaganga villages belong to Lugata ward. According to the 2002 Population and Housing Census, the island had 5,189 permanent households, apart from fishermen's settlements; a population of 38,062 with an average population growth rate of 2.9%. The average household size was estimated at 6.6 people [19]. The most recent Population and Housing Census of 2012 put the Island's population at 47,534 people of which 24,480 are males and 23,054 are females. The average household size is 5.8 [20].

The island is served by 1 health center and 2 dispensaries with chronic shortages of personnel, equipment, and drugs. Lake Victoria is the main source of water for drinking, washing, and other domestic chores. Other sources are natural wells and streams. All occupational, domestic, as well as recreational activities of the people on Kome Island have obvious bearing on acquisition and transmission of schistosomiasis, STH, and other parasitic diseases. However, since 2008 there has been combined control of schistosomiasis and intestinal worm infections on Kome Island by GNI in collaboration with National Institute of Medical Research (NIMR), Mwanza Center, through the following research and intervention activities:

(i) Mass treatment on schistosomiasis and intestinal worm infections with praziquantel and albendazole, respectively;
(ii) Provision of pumped wells in each sub-village;
(iii) Community health education on schistosomiasis and intestinal worm infections through PHAST strategy.

Study design and sampling

The study design was quasi-experimental based on a pre-/post-intervention comparison (before/after study) and process evaluation, which involved studying 1 community population in which PHAST intervention to control schistosomiasis and STH infections was carried out. The study population was observed before, during, and 3 years after the intervention, to test, explore, and explain the differences taking place as a result of the intervention.

At the core of this study is a health education intervention. The intervention which was introduced to control schistosomes and intestinal worms among the people on Kome Island is known as PHAST, widely regarded as an innovative approach to promote hygiene, sanitation, and community management of water and sanitation facilities. It originated from efforts to control cholera and other diarrheal diseases [21]. The approach attempts to go beyond the teaching of hygiene and sanitation concepts to developing capacity of participants to identify opportunities and overcome obstacles to change generally. PHAST is an approach to health education/promotion that focuses on community participation and capacity development rather than spreading health messages alone but also inducing improved hygiene behavior change. The methodological experience of the PHAST intervention in the control of schistosomiasis in Tanzania has been described elsewhere [18,22].

Study participants were randomly selected from adults aged between 15 years and above for quantitative questionnaire surveys. The same individuals (n=82) were interviewed twice during baseline in November 2009 and post-intervention survey in December 2012.

Methods for data collection

Researcher-administered (face-to-face) KAP questionnaires were used to collect information from the study respondents during baseline and after 3 years of follow-up. Six trained research assistants (3 males and 3 females) with education ranging from secondary to basic university degree were involved in conducting same-sex interviews. The questionnaire contained both closed and open-ended questions on background information, knowledge, and awareness about the cause, mode of transmission, symptoms, health consequences, and preventive practices with regard to schistosomiasis and intestinal worm infections.

Data management and analysis

Both pre- and post-intervention questionnaire survey data were edited in the field for omissions and/or inconsistencies and entered in the computer by 2 independent data entry clerks using Census and Survey Processing System (CSPro) version 3.3 (US Census Bureau, 2007) computer software for cleaning and validation. Data was then analyzed using STATA version 10.0 computer software (Stata Corp., College Station, Texas, USA). Separate analysis was done per survey rounds (baseline and follow-up) for relevant variables followed by combined analysis of the retained cohort (n=82); in which the proportions between the baseline and follow-up surveys were compared to determine the significance of the difference between them. Frequency tables and cross tabulations were generated. Pearson's χ^2-test was used for statistical analysis.

Ethical considerations

The Tanzanian Medical Research Coordinating Committee provided ethical approval for this study. Study aims and objectives, procedures, potential risks, and benefits were explained to participants through an information sheet read/provided to them. Adequate informed consent was sought through signature or thumb print on the consent forms. Participants were informed of their rights to refuse to participate and withdraw from the study at any time when they wish to do so during the study with no consequences. Confidentiality and anonymity was assured and ensured to the information gathered from the study participants. Codes were used instead of names on all study forms and field notes.

RESULTS

Social and demographic characteristics of respondents

Table 1 summarizes social and demographic characteristics of the study participants. A total of 82 respondents were retained during the follow-up KAP survey. Of the retained co-

Table 1. Socio-demographic characteristics of study participants

Variable	Age groups (year)	Sex (n, %)		Total (n, %)
		Male (n=54)	Female (n=28)	82
Age	15-24	1 (1.9)	2 (7.1)	3 (3.7)
	25-34	6 (11.1)	12 (42.8)	18 (22.0)
	35-44	12 (22.2)	8 (28.6)	20 (24.4)
	45-54	16 (29.6)	4 (14.3)	20 (24.4)
	55+	19 (35.2)	2 (7.1)	21 (25.6)
Education	No formal education	19 (35.2)	11 (39.3)	30 (36.6)
	Primary (VII)	30 (55.6)	16 (57.1)	46 (56.1)
	Secondary (O-level)	5 (9.3)	1 (3.7)	6 (7.3)
Ethnic group	Wazinza	29 (53.7)	17 (60.7)	46 (56.1)
	Wasukuma	7 (13.0)	4 (14.3)	11 (13.4)
	Wajita	3 (5.6)	2 (7.1)	5 (6.1)
	Wakerewe	8 (14.8)	2 (7.1)	10 (12.2)
	Other	7 (13.0)	3 (10.7)	10 (12.2)
Religion	Christian	50 (92.6)	28 (100.0)	78 (95.1)
	Muslim	2 (3.7)	0 (0.0)	2 (2.4)
	Traditional	2 (3.7)	0 (0.0)	2 (2.4)

Table 2. Respondents' knowledge of how can one get infected with schistosomiasis

Possible causes	Baseline		Follow-up		*P*-value
	N	n (%)	N	n (%)	
Contact with infected water	82	35 (42.7)	82	69 (84.2)	<0.001
Contact with dirty water	82	12 (14.6)	82	29 (35.4)	<0.002
Bad weather/wind	82	1 (1.2)	82	9 (11.0)	
Witchcraft	82	0 (0.0)	82	0 (0.0)	
Sexual contact	82	2 (2.4)	82	0 (0.0)	
Over exposure in the sun	82	0 (0.0)	82	1 (1.2)	
Other	82	8 (9.8)	82	10 (12.2)	

hort, two-thirds of respondents (n=54; 65.9%) were males and one-third of respondents (n=28; 34.1%) were females. A vast majority of respondents (n=79; 96.0%) were aged ≥25 years. Slightly more than a half of respondents (n=46; 56.1%) had primary education. However, a good proportion of respondents (n=30; 36.6%) had never been to school. Furthermore, the vast majority of respondents (n=78; 95.1%) were Christians. Slightly more than a half of respondents (n=46; 56.1%) belonged to Wazinza ethnic group.

Knowledge on the cause of schistosomiasis

Respondents were asked how one can get infected with schistosomiasis. A vast majority of respondents (n=69; 84.2%) mentioned contact with infected water as the possible cause of schistosomiasis during follow-up survey compared to fewer (n=35; 42.7%) who said so during baseline survey. The difference was highly significant at $P<0.0001$. Contact with dirty water was also mentioned to be the cause of schistosomiasis by a good number of respondents (n=29; 35.4%) after the intervention compared to a few (n=12; 14.6%) before intervention. The difference was also significant at $P<0.002$. There were no significant differences for those who mentioned sexual contact or witchcraft, bad weather/wind, and over exposure in the sun (i.e., lay epidemiology) to be the cause of schistosomiasis (Table 2).

Knowledge on symptoms of intestinal schistosomiasis

Respondents were also asked what the symptoms of intestinal schistosomiasis are. Table 3 summarizes the findings. Generally speaking, respondents were more knowledgeable of the symptoms such as abdominal pains, diarrhea, blood in stool, dysentery, vomiting blood, and swollen abdomen after the intervention than before. The differences were highly significant at $P<0.0001$.

Knowledge on health consequences of intestinal schistosomiasis

Respondents were also asked about the health consequences

Table 3. Respondents' knowledge of the symptoms of schistosomiasis

Symptoms	Baseline		Follow-up		*P*-value
	N	n (%)	N	n (%)	
Abdominal pains	82	26 (31.7)	82	60 (73.2)	<0.0001
Diarrhea	82	19 (23.2)	82	52 (63.4)	<0.0001
Blood in stool	82	6 (7.3)	82	34 (41.5)	<0.0001
Dysentery	82	7 (8.5)	82	30 (36.6)	<0.0001
Vomiting blood	82	3 (3.7)	82	27 (32.9)	<0.0001
Swollen abdomen	82	25 (30.5)	82	51 (60.2)	<0.0001

Table 4. Respondents' knowledge of the health consequences of schistosomiasis

Consequences	Baseline		Follow-up		*P*-value
	N	n (%)	N	n (%)	
Ascites	82	26 (31.7)	82	66 (80.5)	<0.0001
Severe liver damage	82	5 (6.1)	82	45 (54.9)	<0.0001
Hematemesis	82	17 (20.7)	82	41 (50.0)	<0.0001
Poor cognitive performance	82	0 (8.5)	82	18 (22.0)	<0.0001
Stunted growth	82	1 (1.2)	82	17 (20.7)	<0.0001
Body weakness/fatigue	82	16 (19.5)	82	40 (48.8)	<0.0001
Anemia	82	5 (6.1)	82	27 (32.9)	<0.0001
Death	82	47 (57.3)	82	62 (75.6)	0.01
Other	82	12 (14.6)	82	17 (20.7)	

Table 5. Respondents' preventive measures against schistosomiasis

Measures	Baseline		Follow-up		*P*-value
	N	n (%)	N	n (%)	
Avoid contact with infected water	82	10 (12.2)	82	67 (81.7)	<0.0001
Avoid contact with dirty water	82	5 (6.1)	82	62 (75.6)	<0.0001
Contact/use safe water sources	82	3 (3.7)	82	26 (31.7)	<0.0001
Taking bath at home	82	9 (11.0)	82	43 (52.4)	<0.0001

of intestinal schistosomiasis if it is not treated in time. The key findings are presented in Table 4. Knowledge of respondents with regard to health consequences of intestinal schistosomiasis were found to have increased significantly during the follow-up compared to the baseline survey. Many respondents mentioned ascites (swollen abdomen), severe liver damage (liver cirrhosis), hematemesis (vomiting blood), poor cognitive performance, stunted growth, body weakness/fatigue, and anemia during post-intervention survey than baseline. The differences were highly significant at $P<0.0001$.

Preventive measures against intestinal schistosomiasis

Respondents were also asked what measures they take to prevent themselves from getting infected with schistosomiasis. We found a significant increase in knowledge of the respondents with respect to preventive measures undertaken between baseline and post-intervention surveys such as avoiding contact with infected water (e.g. water with snails), avoiding contact with dirty water, contact/use safe water sources (e.g. water from pumped well), and taking bath at home. This increase in knowledge was highly statistically significant at $P<0.001$ (Table 5).

Knowledge on the cause of intestinal worm infections

Respondents were asked how one can get infected with intestinal worms. There was significant increase in respondents' knowledge on the cause of intestinal worm infections (Table 6). Many respondents knew how one can get infected with intestinal worms after the intervention than before. Possible cause mentioned were eating food without thoroughly washing hands, walking and visiting latrine barefooted, not thoroughly washing hands after visiting latrine, eating fruits and raw foodstuff (e.g., a piece of raw cassava or mango) without

Table 6. Respondents' knowledge of how can one get infected with intestinal worms

Possible causes	Baseline		Follow-up		*P*-value
	N	n (%)	N	n (%)	
Eating food without washing hands	82	15 (18.3)	82	49 (59.6)	< 0.0001
Visiting latrine barefooted	82	4 (4.9)	82	59 (72.0)	< 0.0001
Walking barefooted	82	13 (15.9)	82	45 (54.9)	< 0.0001
Eating fruits and other raw foodstuff without washing	82	11 (13.4)	82	42 (51.2)	< 0.0001
Not washing hands after visiting a latrine	82	5 (6.1)	82	38 (46.3)	< 0.0001
Eating food leftovers without warming	82	10 (12.2)	82	11 (13.4)	0.82
Other	82	13 (15.9)	82	11 (13.4)	

Table 7. Respondents' knowledge of the symptoms of intestinal worms

Symptoms	Baseline		Follow-up		*P*-value
	N	n (%)	N	n (%)	
Abdominal pains	82	28 (34.2)	82	53 (64.6)	< 0.0001
Diarrhoea	82	13 (15.9)	82	48 (58.5)	< 0.0001
Loss of appetite	82	4 (4.9)	82	37 (45.1)	< 0.0001
Nausea	82	15 (18.3)	82	30 (36.6)	0.0005
Anaemia	82	3 (3.7)	82	27 (32.9)	0.009
Swollen legs & face	82	42 (51.2)	82	60 (73.2)	0.004
Stunting	82	2 (2.4)	82	18 (22.0)	< 0.0001
Body weakness	82	22 (26.8)	82	44 (53.7)	0.0005

Table 8. Respondents' knowledge of the health consequences of intestinal worms

Consequences	Baseline		Follow-up		*P*-value
	N	n (%)	N	n (%)	
Ascites	82	16 (19.5)	82	68 (82.3)	< 0.0001
Obstruction of bowel	82	0 (0.0)	82	36 (43.9)	< 0.0001
Stunted growth	82	1 (1.2)	82	22 (26.8)	< 0.0001
Body weakness/fatique	82	19 (23.2)	82	49 (59.8)	< 0.0001
Poor cognitive performance	82	1 (1.2)	82	15 (18.3)	0.0002

washing. The difference in the increase of knowledge was significant at $P < 0.001$.

Knowledge on symptoms of intestinal worm infections

Respondents were also asked what the symptoms of intestinal worms are. Table 7 summarizes the findings. Generally speaking, respondents were more knowledgeable of the symptoms such as abdominal pain, diarrhea, loss of appetite, nausea, anemia, swollen legs and face, stunting, vomiting blood, and swollen abdomen after the intervention than before. The differences were highly significant at $P < 0.0001$.

Knowledge on health consequences of intestinal worm infections

Respondents were also asked about the health consequences of intestinal worms if not treated in time. The key findings are presented in Table 8. Knowledge of respondents with regard to health consequences of intestinal worm infections were found to have increased significantly during the follow-up compared to the baseline survey. Many respondents mentioned ascites (swollen abdomen), obstruction of bowel, stunted growth, body weakness/fatigue, and poor cognitive performance during post-intervention survey than baseline. The differences were highly significant at $P < 0.0001$ and $P = 0.0002$.

Preventive measures against intestinal worms

Respondents were also asked what measures they take to prevent themselves from getting infected with intestinal worms. We found a significant increase in knowledge of the respondents with respect to preventive measures undertaken

Table 9. Respondents' preventive measures against intestinal worms

Possible causes	Baseline		Follow-up		*P*-value
	N	n (%)	N	n (%)	
Washing hands with soap before eating	82	6 (7.3)	82	66 (80.5)	< 0.0001
Wearing shoes all time/when visiting latrine	82	8 (9.8)	82	45 (54.9)	< 0.0001
Washing hands with soap after visiting latrine	82	7 (8.5)	82	60 (73.2)	< 0.0001
Washing fruits/vegetables and other raw foodstuff before eating	82	3 (3.7)	82	26 (31.7)	< 0.0001
Washing hands with soap after washing baby's bottom	82	5 (6.1)	82	38 (46.3)	< 0.0001

between baseline and post-intervention surveys such as washing hands thoroughly before eating, wearing shoes all the time/when visiting latrine, washing hands thoroughly after visiting latrine, washing fruits/vegetables and other raw foodstuff before eating, and washing hands thoroughly after washing baby's bottom. This increase was highly statistically significant at $P < 0.001$ (Table 9).

DISCUSSION

This study examined changes in perceptions and practices related to schistosomiasis and intestinal worm infections in a community population following implementation of a 3-year community health education intervention using PHAST strategy. Quasi-experiments are most often used in evaluating social programmes [23]. We acknowledge the limitations of our before/after design without control groups, but the decision to exclude control communities was not done deliberately but was purely based on the fact that a strong ethnographic element was incorporated in studying the PHAST intervention and to include control communities would have created considerable demand on investigators. Furthermore, by convention, in experimental designs, controls have to be far from experimental communities which would have created additional burden in terms of distance to cover between almost 2 different projects.

In brief, we concur with concerns raised elsewhere questioning the relevance of experimental studies using control groups, let alone randomized control trials, in understanding the processes and impacts of health education/promotion initiatives however well they may be conducted [24].

The retained cohort (n = 82) comprised of a good number of male respondents (two-thirds). This might have biased some findings of this study. However, characteristics of those whom we lost during follow-up and those who were retained were comparable.

Findings of this study point out towards respondents' increased knowledge of the cause, modes of transmission, symptoms, health consequences, and preventive measures with regard to schistosomiasis after PHAST intervention. These observations suggest that PHAST intervention had a positive impact on community's KAP with regard to schistosome infections. This increase in knowledge after health education intervention is in agreement with other studies in Tanzania [17,25,26]. Similarly, there was significant increase in respondents' knowledge of the cause, transmission, symptoms, health consequences, and prevention of intestinal worms after PHAST intervention.

KAP surveys are some of the most widely used contributions of the social sciences to public health [16,27-29]. However, we acknowledge the limitations of KAP surveys in providing snapshots of the distribution of normative or desired knowledge, but not necessarily attitudes and practice of individuals. All the same, the questionnaire-based surveys in this study provided insights into distribution of normative KAP regarding schistosome and intestinal worm transmission and control in a community population in Tanzania which was useful as a source of baseline data for post-intervention evaluation. Respondents' increase in knowledge in almost all aspects of schistosomiasis and intestinal worm infections was translated into actions to control the said infections. However, this has not been achieved by chance, but due to well-designed and locally adapted PHAST intervention.

We conclude that there has been significant improvement in KAP of the study community with respect to schistosomiasis and intestinal worm infections which is primarily attributable to PHAST intervention and possibly other control interventions such as mass drug administration and provision of pumped wells which were taking place simultaneously on Kome Island as attempts to achieve combined control of the said infections.

There seems to be a relatively successful transfer of biomedical knowledge on schistosomiasis and intestinal worm infections through PHAST intervention, and this knowledge was still evident both theoretically as well as practically in the sense that it was translated into preventive actions by the study population in their local practices related to schistosomiasis and intestinal worm infections 3 years after the intervention.

The involvement of local communities in the design and implementation of schistosome and intestinal worm control programmes is increasingly becoming recognized as crucial if cost-effective and long-term success is to be realized. Despite criticisms [30], PHAST approach is still useful in empowering communities to control water, hygiene, and sanitation-related infectious diseases such as schistosomiasis and intestinal worm infections. Once people's knowledge and perceptions of the disease and its consequences are recognized, health education needs to be tailored to enhance more understanding of the nature of the disease and the human role in its transmission.

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CONFLICT OF INTEREST

We have no conflict of interest related to this work.

REFERENCES

1. Utzinger J. A research and development agenda for the control and elimination of human helminthiases. PLoS Negl Trop Dis 2012; 6: e1646.
2. Lustigman S, Prichard RK, Gazzinelli A, Grant WN, Boatin BA, McCarthy JS, Basáñez MG. A research agenda for helminth diseases of humans: the problem of helminthiases. PLoS Negl Trop Dis 2012; 6: e1582.
3. Gazzinelli A, Correa-Oliveira R, Yang GJ, Boatin BA, Kloos H. A research agenda for helminth diseases of humans: social ecology, environmental determinants, and health systems. PLoS Negl Trop Dis 2012; 6: e1603.
4. Boatin BA, Basáñez MG, Prichard RK, Awadzi K, Barakat RM, García HH, Gazzinelli A, Grant WN, McCarthy JS, N'Goran EK, Osei-Atweneboana MY, Sripa B, Yang GJ, Lustigman S. A research agenda for helminth diseases of humans: towards control and elimination. PLoS Negl Trop Dis 2012; 6: e1547.
5. 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.
6. Hotez PJ, Brindley PJ, Bethony JM, King CH, Pearce EJ, Jacobson J. Helminth infections: the great neglected tropical diseases. J Clin Invest 2008; 118: 1311-1321.
7. Steinmann P, Kaiser J, Bos R, Tanner M, Utzinger J. Schistosomiasis and water resources development: systematic review, meta-analysis, and estimates of people at risk. Lancet Infect Dis 2006; 6: 411-425.
8. Brooker S, Clements AC, Bundy DA. Global epidemiology, ecology and control of soil-transmitted helminth infections. Adv Parasitol 2006; 62: 221-261.
9. Brooker S, Clements AC, Hotez PJ, Hay SI, Tatem AJ, Bundy DA, Snow RW. The co-distribution of *Plasmodium falciparum* and hookworm among African schoolchildren. Malar J 2006; 5: 99.
10. Mazigo HD, Nuwaha F, Kinung'hi S, Morona D, Pinot de Moira A, Wilson S, Heukelbach J, Dunne DW. Epidemiology and control of human schistosomiasis in Tanzania. Parasit Vectors 2012; 5: 274.
11. Hotez PJ, Molyneux DH, Fenwick A, Kumaresan J, Sachs SE, Sachs JD, Savioli L. Control of neglected tropical diseases. N Engl J Med 2007; 35: 1018-1027.
12. Molyneux DH, Malecela MN. Neglected tropical diseases and the millennium development goals: why the "other diseases" matter: reality versus rhetoric. Parasit Vectors 2011; 4: 234.
13. Little MP, Breitling LP, Basáñez MG, Alley ES, Boatin BA. Association between microfilarial load and excess mortality in human onchocerciasis: an epidemiological study. Lancet 2004; 363: 1514-1521.
14. Utzinger J, Keiser J. Schistosomiasis and soil-transmitted helminthiasis: common drugs for treatment and control. Expert Opin Pharmacother 2004; 5: 263-285.
15. Prichard RK, Basáñez, MG, Boatin BA, McCarthy JS, Garcia HH, Yang GJ, Sripa B, Lustigman S. A research agenda for helminth diseases of humans: intervention for control and elimination. PLoS Negl Trop Dis 2012; 6: e1549.
16. Bruun B, Aagaard-Hansen J. The social context of schistosomiasis and its control. An introduction and annotated bibliography. Geneva, Switzerland. UNICEF/UNDP/World Bank/WHO Special Programme for Research & Training in Tropical Diseases (TDR). 2008, pp. 1-213.
17. Aagaard-Hansen J, Mwanga JR, Bruun B. Social science perspectives on schistosomiasis control in Africa: past trends and future directions. Parasitology 2009; 136: 1747-1758.
18. Mwanga JR, Lwambo NJS. Pre-and post-intervention perceptions and water contact behaviour related to schistosomiasis in north-western Tanzania. Acta Trop 2013; 128: 391-398.

19. National Bureau of Statistics. The 2002 population and housing census, Mwanza regional profile. Dar es Salaam, Tanzania. President's Office, Planning Commission. 2003.
20. National Bureau of Statistics & Ministry of Finance, Dar es Salaam & Office of Chief Government Statistician, Dar es Salaam, Tanzania. President's Office, Finance, Economy and Development Planning, Zanzibar. The 2013 Population and Housing Census. 2013.
21. Wood S, Sawyer R, Simpson-Hebêrt M. PHAST step-by-step guide: a participatory approach for the control of diarrhoeal diseases. Geneva, Switzerland. World Health Organization (WHO/EOS/98.3). 1998, pp. 1-137.
22. Mwanga JR, Lwambo NSJ, Rumisha SF, Vounatsou P, Utzinger J. Dynamics of people's socio-economic status in the face of schistosomiasis control intervention in Ukerewe district, Tanzania. Acta Trop 2013; 128: 399-406.
23. Bernard, HR. Research methods in anthropology, qualitative and quantitative approaches. 2nd ed. London and New Delhi. Altamira Press, Walnut Creek. 1995, pp. 1-585.
24. Tones K, Tilford S. Effectiveness in Health Promotion, Efficiency and Equity. 3rd ed. London, UK. Nelson Thorne. 2001, pp. 2-524.
25. Lansdown R, Ledward A, Hall A, Issae W, Yona E, Matulu J, Mweta M, Kihamia C, Nyandindi U, Bundy D. Schistosomiasis, helminth infection and health education in Tanzania: achieving behaviour change in primary schools. Health Educ Res 2002; 17: 425-433.
26. Mwanga, JR. Community-integrated and action-oriented health education intervention on schistosomiasis and other illnesses among children of primary school-going age in Magu district, Tanzania. Ph.D. thesis. Mwanza/Copenhagen/Charlottenlund, National Institute for Medical Research/Danish University of Education/Danish Bilharziasis Laboratory. 2004.
27. Mwanga JR, Magnussen P, Mugashe CL, Gabone RM, Aagaard-Hansen J. Schistosomiasis-related perceptions, attitudes and treatment-seeking practices in Magu district, Tanzania: public health implications. J Biosoc Sci 2004; 36: 63-81.
28. Mwanga JR, Mugashe CL, Gabone RM. Schistosomiasis and intestinal helminth infections in Sengerema district, Tanzania: sociological and epidemiological approaches. Tanzania Health Res Bull 2005; 7: 49-54.
29. Mwanga JR. Perceptions and practices on schistosomiasis among communities in Ukerewe district, Tanzania. Tanzania Health Res Bull 2005; 7: 55-61.
30. Malebo HM, Massaga JJ, Mshana JM, Kesheni PS, Lugimbana-Malebo L, Nyoni J, Dillip A, Kisinza WN, Nyigo VA, Imeda C, Msambazi M, Swai M, Lyimo A, Rwakibalila G, Kahesa A, Bibby S. Evaluation of Performance of the Participatory Hygiene and Sanitation Transformation strategy (PHAST) in Tanzania: focusing on effectiveness and sustainability of water, sanitation and hygiene activities in four districts of mainland Tanzania. Unpublished Report. 2008, pp. 1-62.