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Full Length Research Paper

Human water contact activities and urinary schistosomiasis around Erinle and Eko-ende dams

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There is much evidence that people's behavior affects agents, hosts, and the environment, and that behaviour can also either increase or decrease the risk of a disease. Studying behaviour may advance medical knowledge and increase the effectiveness of health protection and medical care. The objective of this work was to gain greater insight into the pattern of water contact in relation to schistosomiasis among residents of five communities around Erinle and Eko-Ende dams by identifying the water contact activities that are more likely to produce infection and examine the socioeconomic factors associating water contact activities. Semi quantitative observations on human water contact patterns were made at each of water contact site in February (dry season), May (early rainy season), August (rainy season) and November (early dry season) for three years. Each observation lasted for a period of six hours. Records taken for every individual observation included sex, age, type of contact, length of exposure and degree of body exposure. Each cohort subject was asked to fill in a water contact activity diary every day during the transmission period. The frequency, duration and relative index of exposure of the observed contact activities in the five study communities varied according to individual community. Eko-Ajala had the least characteristics with 130, 826 and 385.1 contacts, duration and relative index of exposure respectively. However, there was no statistical difference (P<0.05) in the variables between the five communities. The main purpose of contact to the dams is for economic reasons with total contact of 565 closely followed by recreational with a value of 532 and personal reason had the least contact of 48. We concluded that an increase in economic water contact was associated with poor socioeconomic conditions. Our results suggest that in the subjects we studied, there was a socioeconomic determination for water contact. Our data emphasize the importance of a broad and integrated approach in studying water contact activities and in implementing behavioral interventions for schistosomiasis treatment, prevention and control in the study area and similar settings in Nigeria.

Keywords: Economic factors, urinary schistosomiasis, Erinle, Eko-Ende dam

INTRODUCTION

In Nigeria, *Schistosoma haematobium* is wide spread mainly in riverine areas and communities around impoundment of river (dams). This parasitic infection is a significant public health problem with about 10million individuals at the risk of infection in the 36 state of federation and federal capital territory (Ofoezie, 2002) Human infection with schistosomes depends on the fulfilment of a simple set of basic transmission

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requirements (Helmut *et al.,* 1998). These comprise introduction of viable schistosome eggs into freshwater habitats harbouring snail intermediate hosts and human exposure to such habitats harbouring infective cercariae. The first leads to environmental contamination which is linked to the second because it occurs when people are engaged in various types of water contact activities. Spatial, epidemiological and ecological information is important for the control of schistosomiasis because all three components of the life cycle (humans, the parasite and snail intermediate hosts), must converge in space and time at suitable water bodies for transmission to occur (Helmut *et al.,* 1998). There is much evidence that people's behavior affects agents, hosts, and the environment, and that behaviour can also either increase or decrease the risk of schistosomiasis (Heggenhougen and Shore, 1986, Woolhouse, 1996). Thus, intensity of infection is influenced considerably by the frequency, duration and intensity of human contact with infective water.

In water contact studies in the Nile Delta, the risk of schistosomiasis infection was found to be related to the surface area of the body exposed to canal water. Moreover, the length of exposure time proved to be positively related to schistosomiasis infection (Kloos and Lemma 1980 and Khairy and Farag, 1995). Together, these factors seem to have a role in determining the infection risk connected with different water contact activities. Kloos and Lemma (1980) actually constructed an exposure index based on the product of frequency, duration and intensity of water contact (proportion of body surface exposed) which is used to predict infection. (Kloos, 1995, Khairy and Farag, 1995) Very scanty information is available on how *S. haematobium* eggs reach natural water bodies because this is very difficult to study. Jordan and Webbe (1993) suggested direct urination into water by infected persons as the most likely route.

Modifying attitudes and behaviour may require social, economic, and political interventions. An additional important issue related to behavioural interventions is the extent to which methods of persuasion can be used while still respecting individual freedom of decision and choice (Baric, 1972). The impact that health education has on people's attitudes and behaviour may vary. Watts *et al*. (1998) point out that water contact activities are processes taking place in a social, spatial, and temporal context, rather than a series of discrete activities performed by individuals. In communities around Erinle and Eko-Ende dams, water contact behaviour may depend not only on the individual's own choice but also on constraints or opportunities generated by socioeconomic situations. It is against this background that this study is designed to investigate the water concact activities that were most likely result to transmission of infection and determine the socioeconomic reasons for the particular water contact activities in the studied communities in order to establish human behaviours related to schistosomiasis transmission in the study areas.

MATERIALS AND METHODS

The study area

The study area lies between Latitude $7^0$44' and $7^0$57' N and Longitude $4^0$26' and $4^0$41 East of the Greenwich Meridian. The Erinle Dam (Owalla Dam), is an extension of the old Ede Dam on Erinle River and Eko-Ende Dam on Otin River (Adediji and Ajibade 2008). Erinle Dam and Eko-Ende Dam are situated in Olorunda and Irepodun local government areas of Osun state, Nigeria, respectively. Erinle Dam is 12 km northward along the Erinle River and its Otin River tributary with maximum width of 3.5 km. The reservoir covers about 14.0 km^2 at the normal water level, and about 15 km^2 at maximum water level (Oyo State Water Corporation Report, 1982). The gross capacity and safe annual yield of the impounding reservoir on Erinle River was estimated at 94 and 92.5 Million Cubic Metre (MCM), respectively (Oyo State Water Corporation Report, 1982).

The Eko-Ende Dam was impounded on the Otin River in 1973, the reservoir had storage capacity of 5.5 MCM and the associated head works were designed to provide potable water supply to Oba, Eko-Ende, Eko-Ajala, Ikirun, Iragbiji and Okuku. The regional relief of the study area is rugged with elevations ranging from 35 m to over 400 m above sea level (Osun state Water Corporation Report, 1994). The area constitutes a part of the Basement complex of Southwestern Nigeria and characteristically underlay by crystalline igneous and metamorphic rocks. These rocks constitute the prominent outcrops and inselbergs that define the topographic highlands in the area (Osun State Water Corporation Report, 1994). Although the rocks are essentially of migmatite-gneiss complex, they are largely monolithologic (Adediji and Ajibade, 2008). The study area is in tropical rainforest climate (Adediji and Ajibade, 2008). The mean annual rainfall is about 1400 mm with the wet season covering March to October with its beginning and end marked by torrential rains and thunderstorms. Temperatures are generally high and almost uniform throughout the year (Iloeje, 1978).

Ethical clearance

Ethical clearance and approval was obtained from Osun state Ministry of Health and Ethical Committee of Ladoke Akintola University of Technology Teaching Hospital, Osogbo, Osun State. Informed consent was also sought and obtained from the communities and subjects used for the study.

Activity/ies	Coefficient of exposure
Swimming	0.90
Using boat	0.10
Washing fishnets	0.35
Sorting fish	0.35
Processing farm produce	0.35
Washing limbs	0.10
Fetching water	0.18
Washing utensils	0.15
Bathing	0.20
Washing clothes	0.15

The relative index of exposure (RIE) for each individual activity is calculated as RIE = $\propto$ x nobs x mdur

Mobilization and advocacy visits

The head of each community was informed and mobilized for the study with the help of the personel of Osun state Ministry of Health and the local government. After getting the permission from the heads, the residents of the communities were mobilized.

Human water contact studies

Semi quantitative observations on human water contact patterns were made at each of water contact site in February (dry season), May (early rainy season), August (rainy season) and November (early dry season) for three years. Each observation lasted for a period of six hours; 7.00am to 1.00pm in February and August and 1.00pm to 7.00pm in May and November as described by Ofoezie, *et al.*, 1991. Records taken for every individual observation included sex, age, type of contact, length of exposure and degree of body exposure. The various types of contact activities were categorized on the basis of the general purpose of contact. Thus, domestic contact activities comprise fetching water, processing of farm produce, washing clothes, utensils; personal contact comprises washing exposed limbs, recreational contact comprises bathing and swimming, while economic contacts comprise washing fish nets, sorting fish and using boats. On the basis of degree of body exposure and mean duration of contact, fetching water, using boat, washing utensils, washing exposed limbs and sorting fish which all involve exposure of only parts of the lower (foot and leg) and / or the upper (hand and forearm) limbs for a short period of time were further grouped together as partial contact activities. Limited contact activities comprise washing clothes and fish nets and processing farm produce which may involve exposure of most parts of the lower and or the upper limbs for a longer period. Bathing and swimming generally involving total exposure for a very long time are categorized as complete contact. (Ofoezie 1996)

Based on schemes separately proposed by Chandiwana (1987) and Wilkins (1987, 2002), the following activity coefficients were used to calculate the relative index of exposure (RIE):

Where $\propto$ is the activity coefficient, nobs the number of contacts and mdur the mean duration of contact (in minutes). For each of the categorized contact types, e.g. partial, limited and complete, the RIE is called as $\widehat{\propto}$ x tnobs x mdur. Where $\widehat{\propto}$ is mean activity coefficient, tnobs = the total number of observations for all component activities and mdur =the mean duration of the contact activities.

Each cohort subject was asked to fill in a water contact activity diary every day during the transmission period. A cross-interview with the subjects and their relatives using a questionnaire (Yu *et al.*, 2001) were organized to further validate the water contact activity record. The water exposure for all subjects, were calculated by the formula that have been used previously and the mean exposure were expressed as square metre/ minutes/day (Li *et al.*, 1999).

RESULTS

Water contact activities around Erinle and Eko-Ende dams

The frequency, duration and relative index of exposure of the observed contact activities in the five study communities are presented in Table 1. Out of a total of 1519 contacts with a total duration of 15688 minutes, and 6927.5 total relative index of exposure, Ilie had 495 contacts, 6820 minutes duration and 3257.7 relative index of exposure closely followed by Oke-ore with 449, 4888, 1625.3 contacts, duration and index of exposure respectively. Eko-Ajala had the the least characteristics with 130, 826 and 385.1 contacts, duration and relative index of exposure respectively. However, there was no statistical difference ($P<0.05$) in the variables between the five communities.

Table 1. Water contact characteristics observed in five communities around Erinle and Eko-Ende Dams

Community	Total contacts	Total Duration (minutes)	Relative index of exposure
Ilie	495	6820	3257.7
Eko-Ende	244	1797	3257.7
Oke-Ore	449	4888	1625.3
Oba	201	1357	876.4
Eko-Ajala	130	826	385.1
Total	1519	15688	6927.5

Total contacts X^2= 295,5, df= 45, p< 0.05; Total duration X^2= 14.7, p < 0.05; RIE X^2= 18.1, p <0.05.

Table 2. Water contact characteristics observed in the study sites according to the Dams

Dams	Total contacts	Total duration (minutes)	Relative index of exposure
Erinle	1145	13065	5318.4
Eko-Ende	374	2623	1609.1
Total	1519	15688	6927.5

The pooled data revealed that Erinle dam had higher water contact activities than Eko-Ende. Erinle dam recorded 1145, 1306.5 and 5318.4 total contacts, durations and relative index of exposure respectively while Eko-Ende had 374, 2623 and 1609.1 water contact, total duration and relative index of exposure respectively (Table 2).

Types of water contact activities

Studies on the degree of exposures by the people revealed that 661, 305 and 553 were partial, limited and complete contact exposures for 4009 (25.6%). 6025 (38.4%) and 5654 (36.0%) minutes, respectively. However, partial exposure had highest number of contacts while limited exposure had highest duration in the group. Complete exposure had the overall relative index of exposure of 3874.4 accounting for 55.9% of total value in the group of observation.

The total durations of observed personal, domestic, recreational and economic water contacts were 289, 5428, 5487 and 4482 minutes, respectively. The main purpose of contact to the dams is for economic reasons with total contact of 565 closely followed by recreational with a value of 532 and personal reason had the least contact of 48. The total index of exposure of 0.5%, 17.9%, 56.8% and 24.8% was obtained for personal, domestic, recreational and economic respectively (Table 3). Swimming was the most prominent water contact activity, accounting for 48.2% of the total index. The index was also relatively high for washing clothes, sorting fish, washing fishnets and bathing with 911.1(13.2%),872 (12.6%), 690.0 (9.9%), and 591.8 (8.5%) in descending order.

Water contact patterns by age and sex

The age-related pattern of water contact behavior at the five communities around Erinle and Eko-Ende Dams is shown in Table 4. The people within age group of 10-39 years had the highest water contact while age groups of 10-14 and 30-39 had the highest activities. Due to high contact of long duration, a very pronounced peak in the relative index of exposure was recorded in the 10-14 years age group, where there was a high level of recreational water contact (300)

Although both males and females of most age groups participated in all types of water contact activities, some activities exhibited a clear sex-related pattern. Female fetched water, bathed, and washed utensils, clothes and fishnets more often than males, while males swam, used boats and sorted fish more often than females. Though, males had a higher frequency of water contact than females, the total duration of water contact was significantly higher in females (P<0.05) (9412 minutes) than male duration of water contact (6276 minutes) (Table 5). The relative index of exposure of females also significantly higher than the males (p< 0.05, (Table 6)

Daily variations in patterns of water contact

The daily variation (07.00 to 19.00 hours), in number and relative index of exposure is shown in Table 6. The

Table 3. The relative importance of different types of water contact activities in five communities around Erinle and Eko-Ende Dams

Primary Activity	Total contacts	Duration (minutes)			Relative index of exposure
		Minimum	Maximum	Total	
Fetching water	185	2	22	651	235.6
Washing utensils	118	4	30	322	35.0
Washing limbs	61	1	9	318	29.0
Washing clothes	220	2	180	4175	911.1
Bathing	279	2	25	1572	591.8
Swimming	211	3	180	3894	3341.7
Paddling boat	153	1	50	713	87.5
Sorting fish	169	2	44	2210	872.0
Washing fish nets	93	2	30	1491	690.0
Processing farm produce	30	10	33	342	133.8
Total	1519			15688	6927.5
Purpose of contact					
Personal	48	1	10	189	24.1
Domestic	374	2	172	5428	1451.2
Recreational	532	1	197	5587	3910.9
Economic	565	2	62	4482	1540.3
Total	1519			15688	6927.5
Degree of exposure					
Partial	661	2	46	4063	921.9
Limited	305	2	186	6037	2131.2
Complete	553	2	198	5588	3874.4
Total	1519			15688	6927.5

$p = 0.000$ ($P<0.05$)

Table 5. Age and sex related patterns of human water contact at five communities around Erinle and Eko-Ende Dams (February 2008-November 2011)

Total duration (minutes)									
Age group	**Male**	**Female**	**Total**	**Male**	***Female***	**Total**	**Male**	**Female**	**Total**
5-9	71	74	145	472	678	1150	564.1	584.1	1148.2
10-14	158	142	300	1881	3038	4919	990.7	1598.6	2589.3
15-19	118	124	242	810	1140	1950	425.0	475.0	900.0
20-29	163	122	285	1003	1486	2489	398.2	388.2	786.4
30-39	168	129	299	1068	1718	2786	409.1	431	840.1
40-49	64	70	134	535	942	1477	164.3	187.2	351.5
50-59	32	29	61	415	240	655	118.4	115.1	233.5
60+	7	9	16	30	49	79	4.9	10.4	15.3

$X^2 = 30.6$, $p = 0.000$; $df = 8$,

peaks were recorded during mid-morning (09.00-10.00 hours), late morning (11.00 – 12.00 hours), mid-afternoon (14.00-15.00 hours), and the evening (17.00-18.00 hours). These peaks, however, were not community specific, primarily taking place at all water contact sites in the communities. The 14.00-15.00 hours peak built up shortly after schools closed for the day when children arrived to swim, play and, in many instances, to fetch water. However, the contribution by each peak period differed markedly, as 21.1%, 14.1%, 12.2% and 14.9% of

Table 6. Daily variation in the pattern of human water contact and in relative index of exposure

Times of day	Total contacts	Total duration (minutes)	Relative index of exposure
07-08	3	5	0.6
08-09	46	413	117.0
09-10	320	3678	1335.6
10-11	140	1161	363.7
11-12	214	2189	1076.6
12-13	18	147	49.3
13-14	97	1511	881.0
14-15	185	3441	1891.7
15-16	105	1070	503.1
16-17	96	817	331.7
17-18	226	924	257.4
18-19	69	332	119.8
Total	1519	15688	6927.5

Total contacts X^2= 99.0, df = 1518, $p < 0.05$; Total duration X^2= 190.0, $p < 0.05$;
RIE X^2= 284.1, $p < 0.05$.

the total number of contacts, 23.4%, 13.9%, 21.9% and 6.0% of the total duration of contact, and 19.3%, 15.5%, 27.3% and 3.7% of the total index of exposure were accounted for by the 09.00-10.00, 11.00-12.00, 14.00-15.00 and 17.00-18.00 hours peaks, respectively (Table 6). Thus, while the highest overall frequency and duration of contacts occurred during the mid-morning peak, the highest overall relative index of exposure occurred during the mid-afternoon peak with 3441 (21.9%).

Seasonal variations in patterns of water contact.

A well defined seasonal pattern of water contact was also found. Thus, frequency and duration of contacts and the relative index of exposure increased gradually from the rainy season (July-September) through the early dry season (October-December) to peak in the hot dry season (January-March). Water contact was generally more intensive during 2009 than during 2010. In addition, different categories of water contact activities exhibited different seasonal patterns. Thus, while peaks in both recreational and domestic water contacts occurred during the dry season in both 2009 and 2010, economic activities had the highest frequency during the early rainy season.

DISCUSSION

There was high contact with the dams by residents of the study communities due to different activities. The contact was known to be seasonal most importantly during the dry season and the beginning of rainy season. It was observed that economic water contact was the most important type of water contact significantly associated with schistosomiasis in the communities. This is closely followed by leisure activities, domestic water contact and other conducts associated with fishing in the all the communities. A similar observation was made by Oladejo and Ofoezie in (2006) in Oba-Ile. There is also intensive relative index of exposure in Erinle Dam compare to Eko-Ende Dam which is positively correlated with higher degree of infection in communities adjoining Erinle. Other researchers Firmo *et al.,* (1996) found similar results with a cross-sectional study in a suburban area of Belo Horizonte, a large industrial city in Brazil. However, this is not the most common pattern that other studies have found in small villages and rural areas (Tiglao and Camacho, 1983). The frequency of contact was related to the risk of the infection, but distance between the individual's home and the water contact site did not seem to play an important role. This can be easily explained by the large volume of water 94 Million Cubic Metre (MCM) and 5.5 MCM that offer opportunities for water contact from the two Dams (Erinle and Eko-Ende Dam respectively). Other studies have reached differing conclusions concerning frequency and distance (Fulford *et al.,* 1996; Akogun and Akogun, 1996; Kloos *et al.,* 1997). A well defined seasonal pattern of water contact was also found. Thus, frequency and duration of contacts and the relative index of exposure increased gradually from the rainy season (July-September) through the early dry season (October-December) to peak in the hot dry season (January-March).

Water contact was generally more intensive during 2009 than during 2010. In addition, different categories of water contact activities exhibited different seasonal patterns. Thus, while peaks in both recreational and

domestic water contacts occurred during the dry season in both 2009 and 2010, economic activities had the highest frequency during the early rainy season. All these observations were in agreement with other workers (Ofoezie, 1996; Oladejo and Ofoezie, 2006). Though, the prevalence of the infection has not been known to be seasonal, the transmission is suspected to be intense during the dry season and the beginning of rainy season since the water contact has been known to be correlated to the schistosomiasis transmission.

In conclusion, our observations from this study showed high water contact of the residents with the dams and this predisposes them to continuous infection with schistosomiasis. The results provide useful information, for the planning of local interventions however it should be supplemented by broader research. The residents around the two dams should be enlightened on the mode of transmission of urinary schistosomiasis and public health implications of poor sanitary behaviour.

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