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ASSESSMENT OF MALARIA AND SCHISTOSOMIASIS PREVALENCE AT THE KOGA IRRIGATION SCHEME IN MECHA WOREDA OF WEST GOJJAM ZONE, AMHARA NATIONAL REGIONAL STATE, ETHIOPIA

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ABSTRACT

The transmission of malaria and schistosomiasis is increased following agricultural irrigation development. However, assessing the prevalence of these diseases before the construction of irrigation project is limited. Therefore, the main aim of this study was to assess malaria and schistosomiasis prevalence at Koga irrigation scheme in Mecha woreda of West Gojjam Zone, Amhara region, Ethiopia. A community-based cross-sectional survey was conducted from March 20 to April 21, 2009 in four villages along the Koga irrigation scheme. Blood films and stool specimens were collected from 318 randomly selected study participants and examined for infection of malaria and intestinal parasites, respectively. Data were analyzed using SPSS version 16.0 computer software. Of the total stool specimens examined 90 (28.3%) were positive for intestinal parasites. Of the parasites, 60 (18%) were hookworm, 27 (8.5%) were Ascaris lumbricoides and 3 (0.9%) were Enterobius vermicularis. Schistoma mansoni is not identified in the stool of respondents. Of the total people for whom blood smear examination was done, any kind of malaria parasites were not observed. Regarding environmental sanitation of the study households, 270 (84.9%) had no latrine and only 48 (15.1%) had latrine. Most of the households utilized traditional wells as a water source (61%). Malaria and Schistosoma mansoni have not yet established prior to the initiation of the irrigation development. Hence, attention is needed to maintain this trend about malaria and schistosomiasis at the future Koga irrigation project sites.

KEYWORDS: Koga Irrigation Scheme, Malaria, Schistosoma Mansoni, Prevalence

INTRODUCTION

Malaria is one of the most common and serious tropical diseases, causes at least one million deaths every year and the majority of which occur in the most resource-poor countries (1). More than 40% of the world's population is at risk of acquiring malaria, and the proportion increases each year because of the deteriorating health systems, growing drug and insecticide resistance,
climatic changes, natural disasters and armed conflicts (1, 2). Since 20th century, schistosomiasis has doubled in prevalence, largely because of the enormous expansion of irrigation schemes in hot climates (3).

The transmission of malaria and schistosomiasis is increased following agricultural irrigation development (4). Irrigation promises one solution to alleviate hunger and encourages economic growth but it can alter the distribution of disease vectors, particularly the water snails and mosquitoes that transmit schistosomiasis and malaria, respectively. The infection of these diseases observed following major irrigation and dam projects around the world. Scheme of irrigation or the system employed for water resource development results a profound ecological changes. This again can aggravate the existing disease pattern with their vectors and expected to introduce the new ones (3,4). In Ethiopia, the development of irrigation system in Fincha Valley is a vivid example of how such activities prone to exacerbate schistosomiasis, malaria problems (5). Human malaria is a disease of wide distribution caused by the genus Plasmodium, and the hosts are female Anopheles mosquitoes. There are four species of Plasmodium that infect human; Plasmodium falciparum, Plasmodium vivax Plasmodium malariae and Plasmodium ovale.

Schistosomiasis is the most important parasitic infections in the tropics (5). Human has been infected due to Schistosoma mansoni, Schistosoma heamatobium and the hosts of schistosome are snails and human infection occurs when a person wading, washing, swimming and fishing in schistosome infected water bodies (4, 5).

More than 80% of the malaria case is estimated to occur in sub-Saharan Africa (1). More than 75% of the land mass of the country (Ethiopia) is potentially malarious and two-thirds of the population are at risk of infection (2). Despite efforts to control malaria, it continues to be one of the most important causes of morbidity and mortality. Above 6 million annual cases of malaria are occurring in Ethiopia. Social and economic crises of the disease are also sobering, with large number of people kept from work due to illness, resulting in low productive output (6).

Schistosomiasis is an old as well as a new emerging disease. Most of the people affected by Schistosoma mansoni in Ethiopia are rural farming villages at intermediate altitudes depending on rain fed agriculture that are located nearby many perennial streams (6). For example, 60% of the schoolchildren were infected with Schistosoma mansoni in Denbia plain nearby Lake Tana (7).

Schistosomiasis is caused by flat worms whose free-swimming larval form penetrate the skin and enter the blood stream when a person is wading, bathing or washing clothes and swimming. Following irrigation, the number of mosquitoes and snails usually increase, which leads to a rise in the prevalence of malaria and schistosomisis (8). A marked association was observed between
water contact activities and the distribution of Schistosoma mansoni infections in many parts of Ethiopia because of water resource development (9). However, the baseline data to support this association is not adequate. Major gaps in information on the prevalence of malaria and Schistosoma mansoni remain scarce before the construction and implementation of irrigation scheme. The main aim of this study was to assess malaria and schistosomiasis prevalence at the Koga irrigation scheme in Mecha woreda of West Gojjam zone, Amhara National Regional State.

Investigation of the prevalence of water related diseases on the particular emphasis of malaria and schistosomiasis is essential for the control of the existing or prevention of the anticipated future diseases and their vectors, at the initial stage of the agricultural water resource development. The study is believed to be useful in view of the area being potential for trade, agricultural development and it can serve as baseline data for further investigation and prepare for intervention prior to the completion of the project.

**Methods and materials**

**Study area and setting:** The study was conducted from March 20-April 21, 2009 in the Koga irrigation project areas, West Gojjam zone. The project main site is at the Bojed grassing land and it is located 510 Km. away from Addis Ababa. This project was planned to alleviate the food shortage of the country. The construction was started in 2005 and it is expected to be completed in 2009. The altitude of the area is about 1600 meters above sea level and its climatic condition is “Woynadega” with moderate temperature and rainfall. Currently, intensive construction of irrigation dam, canals offices and residential houses are under way.

**Study design and population:** A community based cross-sectional study was conducted on all population of the four villages, who are involved and close boundary to the Koga project site. Study population, a person in each household fulfilling the inclusion criteria. Sample sizes were estimated by using a single proportion formula by considering 30% proportion malarial infection, 5% margin of error and 95% CI (10). With 10% used for compensation of non-response the total sample size was 318. Systematic random Sampling technique was used to select household. Households were distributed to the four villages proportionate to the number of households. These villages were selected purposely very close/ boundary to the Koga project site. The households were distributed to all villages in the following manner. Among households of each village (Bojed about 120 households n=69 Dengele about 80 households n=46 Kirkagna about 200 households n=116 and Rim-Kuskam about 150 households n=87). After selecting the first house by bottle spinning method next house has
been taken to the direction of the bottleneck throughout study until the assigned sample size of each village was accomplished. Respondent who were voluntary, not seriously ill, who were not under medication and age less than 20 years old were included in the study.

**Data collection techniques and measurement:** structured questionnaire and checklist were used for data collection. Pre-test was conducted on five percent of the sample to ensure reliability and consistency of the study tools and necessary modifications were made before actual data collection. The data collectors were laboratory college students in Bahir Dar Alkan Health College. Data were collected by 6 trained laboratory technicians. Two-trained technician handled about 106 households over 10 days. Along with one laboratory technician and the principal investigator supervised overall the data collection process. During specimens examination in the laboratory 2, laboratory technologists were participated in Merawi health center.

**Parasitological examination,** in each village, using bottle spinning sampling method and one individual who was under 20 years in a household was examined for parasitological examination that was selected by lottery method from family members in less than 20 years of age. Stool specimens, after getting verbal consent from study participants, fresh stool specimens were collected on pieces of plastic sheets and about one gram each was transferred into screw-capped vials pre-filled 10% formalin and was put into vaccine carrier with icebox to keep alive the parasites. In the laboratory, the specimens were examined by direct microscope and the formal-ether concentration techniques. Blood film, after getting verbal consent from study participants, blood samples were taken from all sampled population by finger prick and thin and thick smears were prepared. The slide films were labeled and examined under higher magnification (100X) for parasite identification. For conformation, duplicate smears were fixed with 70% ethyl alcohol and re-examined by other professionals after staining with Giemsa for consistency. Household interview, using structured questionnaires each household was asked; in this case the respondents were age above 10 years old in the sample population for only the variable of knowledge and for the variable of regular work, were interviewed age above 5 years old. Larvae of Anopheles mosquito and snail population were assessed by observation at the banks of the Koga River and streams, within average distance of 2 Km to each village. One vector-biology technician and principal investigator did this activity.

**Ethical consideration:** study protocol was approved research ethical committee of Department of Community Health, Faculty of Medicine, Addis Ababa University. The
purpose of the study was explained for the concerned bodies’ and respondents. Written and verbal informed consent was obtained from study participants. Any activity of conducting this study assumed not to harm the study population in moral, cultural and religious wise. On the spot, positive individual for any parasite has got full treatment through cooperation with Merawi health center and the principal investigator.

**Statistical analysis and interpretation:** Data were entered using Epi info to minimize data entry error and exported to SPSS version 16.0 for analysis. Then, recoded, cleaned, edited, and analyzed using SPSS version 16.0 for analysis. The descriptive statistics were used to describe the results of analysis in this study.

**Results**

**Socio-demographic characteristics of participants**

Three hundred eighteen households were visited among these all of the households were participated. Of 318 study subjects that were involved in this study, 151 (47.5%) were males and 167(52.5%) were females. Of the study subjects, 123 (38.7%) belongs to age group of 10-14 years, 112 (35.2%) were belongs to age group of 5-9 years, 69 (21.7 %) belongs to age group of 15-19 years and the remaining 14 (4.4%) belongs to age group of 0-4 years. In this study, 180 (56.6 %) of the respondents were with literate and 138 (43.4%) were with illiterate (Table1).

**Household interview**

Of 318 study subjects, except for the variable of regular work and awareness level about Schistosoma mansini all the 318 respondents were interviewed for the rest household interview variables. Of the respondents, 316 (99.4%) were not from other localities, only two respondents were from other localities. In addition, 100.0% of the respondents did not go anywhere for the last two weeks. With regarding to regular work activities of the respondents, 304 of the study subjects above 5 years were interviewed, among these 217 (71.4%) were herdsman and the rest 87 (28.6%) were plantation workers. Concerning distance from the respondents’ home to the Koga river, 227 (71.4%) of the respondents were living less than 2 kilo meters, 90 (28.3%) lived within 2-3 kilo meters and the rest 0.3% far away from 3 kilo meters. Two hundred thirty five of respondents whose age greater than 10 years interviewed for awareness about Schistosoma mansoni, of these 233 (99%) of the respondents did not have awareness about Schistosoma mansoni for its causative agent, mode of transmission and preventive measures. In this study knowledge about malaria was not interviewed (Table 1)
Table 1: Socio-demographic characteristics of the respondents, Koga project site, West Gojjam Zone, March 2009.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>151</td>
<td>47.5</td>
</tr>
<tr>
<td>Female</td>
<td>167</td>
<td>52.5</td>
</tr>
<tr>
<td><strong>Age group in years</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-4</td>
<td>14</td>
<td>4.4</td>
</tr>
<tr>
<td>5-9</td>
<td>112</td>
<td>35.2</td>
</tr>
<tr>
<td>10-14</td>
<td>123</td>
<td>38.7</td>
</tr>
<tr>
<td>15-19</td>
<td>69</td>
<td>21.7</td>
</tr>
<tr>
<td><strong>Educational status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literate</td>
<td>180</td>
<td>56.6</td>
</tr>
<tr>
<td>Illiterate</td>
<td>138</td>
<td>43.4</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eregna</td>
<td>217</td>
<td>71.6</td>
</tr>
<tr>
<td>Atikiltegna</td>
<td>87</td>
<td>28.4</td>
</tr>
<tr>
<td><strong>Indigenous to the area</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>316</td>
<td>99.4</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Movement in the last 2 weeks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
<td>00.0</td>
</tr>
<tr>
<td>No</td>
<td>318</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Residential distance to the river</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 2 km</td>
<td>227</td>
<td>71.4</td>
</tr>
<tr>
<td>Between 2 and 3 km</td>
<td>90</td>
<td>28.3</td>
</tr>
<tr>
<td>&gt; 3 km</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Have awareness of S. mansoni</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>No</td>
<td>233</td>
<td>99.0</td>
</tr>
</tbody>
</table>

**Parasitological examination**

The 318 respondents were participated in the stool and blood film examination. The respondents for household interview and parasitological examination were in the same sampled population.

**Stool specimen examination**

Of 318 stool specimens examined 90 (28.3 %) were positive for intestinal helminthes. Of the parasites, 60 (18.9 %) were hookworm, 27 (8.5%) were Ascaris lunbricoide and three (0.9%) were Enterobius vermicularis. Schistosoma mansoni was not found in the stool of the respondents. With regards to distance from the Koga River 62(19.5%) of the respondents resided within less than 2 kilometers, 26(8.2%) of the subjects resided within 2-3 kilometers, and the remaining one respondent was above 3 kilometers. Concerning villages, 31(9.7%) of the intestinal parasite cases were in Kirkagnia, 25(7.9%) in Rim Kuskam, 20 (6.3%) in Dengele and the remaining 14 (4.4%) in Bojed (Table 2).
Table 2. Prevalence of intestinal parasites among the respondents, Koga irrigation site, West Gojjam Zone, March 2009.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Age group</th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-4</td>
<td>5-9</td>
<td>10-14</td>
<td>15-19</td>
<td></td>
</tr>
<tr>
<td>Total examined</td>
<td>14</td>
<td>112</td>
<td>123</td>
<td>69</td>
<td>318</td>
</tr>
<tr>
<td>Positive for helminthes</td>
<td>5</td>
<td>31</td>
<td>33</td>
<td>21</td>
<td>90</td>
</tr>
<tr>
<td>Percent positive</td>
<td>1.6</td>
<td>9.7</td>
<td>10.4</td>
<td>6.6</td>
<td>28.3</td>
</tr>
</tbody>
</table>

**Intestinal parasites**

- **Hookworm**
  - A. lumbricoides: 2(0.6%) 10(3.1%) 7(2.2%) 7(2.2%) 27(8.5%)
  - E. vermicularis: 0 1(0.3%) 2(0.6%) 0 3(0.9%)

**Sex**

- Male: 2(0.6%) 19(5.9%) 16(5%) 11(3.5%) 48(15.1%)
- Female: 3(0.9%) 12(3.8%) 17(5.3%) 9(2.8%) 42(13.2%)

**Distance to the river**

- < 2 km: 4(1.3%) 26(8.2%) 21(6.6%) 11(3.5%) 62(19.5%)
- 2-3 km: 0 5(1.6%) 11(3.5%) 9(2.8%) 26(8.2%)
- > 3 km: 0 0 1(0.3%) 1(0.3%) 2(0.6%)

**Villages**

- Kirkagna: 0 10(3.4%) 12(3.8%) 9(2.8%) 31(9.7%)
- Rim Kuskam: 0 8(2.5%) 10(3.4%) 7(2.2%) 25(7.9%)
- Bojed: 1(0.3%) 9(2.8%) 7(2.2%) 3(0.9%) 20(6.3%)
- Dengel: 4(1.3%) 4(1.3%) 4(1.3%) 2(0.6%) 14(4.4%)

**Blood film examination**

Of the 318 people for which blood smear examination was done, but all respondents have been negative for any kind of malaria parasites (Table 3).

Table 3: Malaria prevalence among the study subjects, Koga irrigation site, West Gojjam Zone, March 2009.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Age group</th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-4</td>
<td>5-9</td>
<td>10-14</td>
<td>15-19</td>
<td></td>
</tr>
<tr>
<td>Total examined</td>
<td>14</td>
<td>112</td>
<td>123</td>
<td>69</td>
<td>318</td>
</tr>
<tr>
<td>Positive for malaria</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Percent positive</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Species:**

- P. vivax: 0 0 0 0 0
- P. falciparum: 0 0 0 0 0
Environmental conditions of the study area

The Koga River is a fast flowing river near the project site. By observation, the banks of the river were clear from vegetation and the mud content of the river was less. In this study, snail and Anopheles mosquito were assessed using observation checklists, snail hosts and Anopheles mosquito larvae were not found. Regarding environmental sanitation of the study subjects, 270 (84.9%) had no latrine and only 48 (15.1%) had latrine unfortunately; as evidenced by observation people did not utilize the available latrine (Fig 1).

![Pie chart showing latrine availability](image)

84.9% of the respondents did not have latrine
15.1% of the respondents had latrine

Fig. 1. Latrine availability of the study households, Koga irrigation site, West Gojjam Zone, March 2009.

Concerning water supply condition of the respondents, 194 (61.%) utilized traditional well as water source, 63 (19.8%) used hand pump water, 60 (18.9 %) used River water and the remaining only 0.3 % utilized spring water for their daily water consumption (Fig 2).
Discussion

The absence of snail population and zero prevalence of Schistosoma mansoni indicate that schistosomiasis has not yet established in the future Koga irrigation site. Absence of snail population along the Koga River may be related to the high velocity and mud content of the river as well as absence of dense vegetation. However, as some researches documented water resource development for irrigation may be expected to create conducive places for breeding of snail hosts (4, 7, 11). River canal as well as its mud content could be taken as the main contributing factor (4). Hence, with irrigation related environmental modification and creation of slow moving water, humidity, presence of micro vegetation and increased population movement to the newly developed area, Schistosoma mansoni may become a major parasitic disease.

People expected to coming from the neighboring localities like Bahir Dar Zuria Woreda and Gorgora around Lake Tana, which already have the highest prevalence of Schistosoma mansoni 29 % (8). When the findings of this study were compared to the study conducted in localities like Genale River, Fincha valley and Gorgora near Lake Tana far less result were obtained. The reason might be the fast flow and the slop of the river for the far less result of Schistosoma mansoni and absence of infected snail host in this study area (4, 5, 8).

The presence of other intestinal parasites the most important one hookworm which result anaemic and children growth retardation, related to this environmental sanitation of the study area was almost poor because only 15 % of the respondents had latrine and could not utilize
appropriately that was the reason hookworm and Ascaris lumbricoide were observed predominantly in the Koga irrigation site.

The findings indicate that the respondents have been found with intestinal helminthes such as hookworm, Ascaris lumbricoides and Enterobius vermicularis. This implies the population of the study area had low level of awareness about personal hygiene and environmental sanitation. To stress, faeces were observed in their own surroundings. When the irrigation development increased, the movement of the people and density of population are expected to increase. Relevant health education, sanitation facilities and health services should be addressed to the Koga irrigation site communities. With regard to intestinal parasites, the study finding was related to Genale River Project Site Study, in this study the prevalence of intestinal parasites were not in agreement; the hookworm and Ascaris lumbricoide were in agreement in the former Delo Awraga of south Ethiopia(12). The reason might be the awareness level, and the personal and environmental sanitation of the population.

About malaria, both of the vectors of malaria in Ethiopia – Anopheles arabiensis and Anopheles pharoensis, and the parasites –Plasmodium vivax and falciparum were present (6). There were no Anopheles mosquito larvae, and malaria parasites. Literature review shows that malaria is the number one public health problem and accounts the major causes of illness and hospitalization (13, 14). The high influx of non immune people into agricultural developed area for social and economic reasons will contribute for future malaria epidemic in the Koga irrigation site.

The irrigation canal and drainage slopes need to be made following scientific principles to prevent the breeding of mosquitoes in the future Koga irrigation scheme. This issue should be viewed from the increasing occurrence of population movement, environmental modification and drug resistant to malaria parasites in Ethiopia (1, 15, 16). The study result of malaria was compared with Genale River project study; the result was far less in prevalence (4). The reason might be the season of the study time and altitude of the area. There was a need to compare with different studies but similar studies like baseline data before the initiation of irrigation development were very limited in our situation of Ethiopia (11). Most of them were done after completion of the dam projects. In this case, it is clearly difficult to reach conclusion that irrigation development increases the prevalence of malaria and schistosomiasis.

The findings of this study showed that most of the study households (71%) living with in less than 2 km our finding indicates that for the future when irrigation activities intensified
these nearby to the water lodgment area population could be exposed to malaria epidemic. This finding was in line with finding of other similar study in which malaria risk is very high closer to dam and reservoir projects. For example, in Tigray region, the magnitude of the problem of malaria was increased by 7 fold, as it was determined by cases control study of malaria incidence among children near dam (9, 17).

Large hectares of lowland mass have been observed that can hold huge amount of water bodies. Children are expected to swim; play and fishing practice will be started. Another large-scale dam (Jema River) is planned in Mecha woreda; this plan will need to be carefully reviewed in the light of our findings so that, when possible, future dams will be sited as far away as possible from villages or if not possible the displace villagers have a right to get appropriate place to live. Because of the burden of malaria and other water associated diseases in the future when the irrigation activities intensified. Hence water associated disease interventions are going to be mandatory.

Domestic occupational and recreational water contact activities put the majority of Ethiopian population in endemic areas at risk of acquiring infection in the absence of safe domestic water supply(7). The study findings indicate that most of the subjects utilized traditional well as water source. This implies people can be saved from infection with cercaria. This study was compared with the study made from Jiga Town; the study result was less especially, in piped water supply (19.8 % versus to 79.2 %). The reason may be Jiga is a town that priority was given by concerned bodies. The schistosome eggs are excreted in faeces or urine and often end up in surface water especially shallow, slow-moving water, ditches, and irrigation channels where they infect water snails (5, 12, 18).

Most of our study households had no latrine this indicates pollution of surface water and environmental contamination are inevitable that needs providing sanitary facilities for the disposal of excreta and requires provision of safe water at their home, thereby eliminating the risk of exposure to infected water bodies coupled with health education. The study result was compared with the study conducted in Tigray region the study result was different, the implication may be poor awareness about latrine usage and prevention measures of parasitic infection (11).

In Conclusion malaria and Schistosoma mansoni have not yet established prior to the initiation of the irrigation development. This implies that water insect related diseases were insignificant before the development the irrigation scheme. Latrine availability, appropriate utilization of the available latrine and knowledge of the respondents about Schistosoma
mansoni were very low. Most of the respondents utilized water from their own surrounding area as traditional well water source that shows most of the people can be saved from Schistosoma mansoni. Protected spring and piped water sources were very inadequate in the Koga irrigation site. Most of the study households were living very close to the Koga dam. Based on the findings, the following recommendations were forwarded to the concerned bodies:

- The residents around Koga irrigation site should receive relevant health education about Schistosoma mansoni and other intestinal parasites.
- As some studies confirmed that latrine availability and appropriate utilization of it is very essential to prevent the transmission of schistosomiasis and other intestinal parasites, the concerned bodies should work hard to change the behavior of the people emphasizing the importance of personal environmental sanitation.
- Although malaria and Schistosoma mansoni were not a prevalent in this study, institutional arrangement should be strengthened to maintain this trend by establishing environmental health units with government agencies responsible for irrigation and community health care.
- Water utilization at home should be encouraged especially for those villages which are very close to the irrigation dam for this concern community participation is vital to prepare their own hand pump well and give advice to avoid irrigation water contact for searching dirking water.
- The nearby health organization in cooperation with the Koga irrigation project agency should take control measures on intestinal parasites such as hookworm, ascaris and others by periodic de-worming of children using broad spectrum antihelminthic such as albindazole and mebindazole.

References


