A review of environmental determinants of schistosomiasis prevalence in Africa.

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DEDICATION

I wish to dedicate this dissertation to my loving children namely Elina, Fredrick, Quinn, Jonathan, Samuel and Temwani.

DECLARATION

I, **Charles Titus Kaira** do hereby declare that this dissertation is entirely from my own work and has never been presented elsewhere for other awards such as this Master of Science of Epidemiology that I am pursuing.

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CERTIFICATE OF APPROVAL

The Board of Examiners has approved the dissertation of **Charles Titus Kaira** in partial fulfillment of the requirements for the award of degree of Masters of Science in Epidemiology at the University of Zambia.

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I **Charles Titus Kaira** hereby certify that this dissertation is the product of my own work and, in submitting it for the Degree of Master of Science in Epidemiology, attest that it has not been submitted to another University in part or whole for the award of any program.

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Having supervised and read this dissertation, I am satisfied that this is the original work of the author under whose name it is being presented. I confirm that the work has been completed satisfactorily and has been presented to the Board of Examiners

Name of Supervisor: **Dr. Gershom Chongwe**

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ABSTRACT

Background: In Africa, different studies have been conducted on schistosomiasis, one of the most devastating parasitic diseases in tropical countries. However, environmental determinants have not fully been explored as important means of additional strategies for prevention and control of the disease. Therefore, the aim of this study was to review environmental determinants that are associated with schistosomiasis prevalence in Africa.

Methods: A systematic review was conducted by searching Pubmed, Embase and Google scholar for articles published between 2000 and April 2014. A total of 492 articles were retrieved. The inclusion and exclusion criteria was directed by the suitability of the title, the year and the continent the study was conducted, duplication and related outcome. Twenty four cross sectional studies met the inclusion criteria. Evaluation of each article's findings was conducted based on the study design, selection of participants, measurement of exposures and outcomes. A data capturing spreadsheet was created in Excel and used for data abstraction. Study details were then transferred to Review Manager 5 Meta analytical package for further processing.

Results: The results obtained indicated that **o**f the 6634 infected participants in twenty four studies conducted in ten countries, males were at 59% and females were at 41% showing that males were more likely to be infected by schistosomiasis than females. Schistosomiasis prevalence was also found to be more among participants living closer to rivers/streams and ponds emphasizing the fact that water bodies were the leading environmental determinant to schistosomiasis prevalence. Although Anto et al. (2013) and Sammy (2013) found strong associations between schistosomiasis prevalence and wet farming and fishing, when read together with other studies, this environmental determinant was insignificant showing that it has a low contribution to the prevalence. Unsafe water and sanitation alone had no direct association with schistosomiasis prevalence.

Conclusion and Recommendations: Findings of this study suggest that living close to water bodies is associated with schistosomiasis prevalence while wet farming and fishing has a low part to play. This study suggests that use of rivers and streams increases exposure to schistosomisis. Urgent interventions that focus on behavior and attitude change and provision of safe water as well as good sanitation to reduce usage of rivers/streams are therefore needed.

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ABBREVIATIONS/ACRONYMS

MSC	Master of Science
NGO	Non-Governmental Organization
PubMed	Publisher Medline
PZQ	Plazequantel
REvMan5	Review Manager 5
SHN	School Health and Nutrition
USA	United States of America
WHO	World Health Organization

GLOSSARY OF TERMS

Proximity	Distance of not more than 1 Kilometer
Close to water bodies:	About 5 or less kilometers to rivers, lakes and ponds

CHAPTER 1: INTRODUCTION

1.0 Introduction

This dissertation aimed at reviewing environmental determinants of schistosomiasis Prevalence in Africa. These environmental determinants included physical and social environments that directly associated with the disease. The importance of these determinants in the transmission of schistosomiasis had long been recognized. However, the mechanisms by which they influenced epidemiological interaction with public health interventions had rarely been well considered. A review of these determinants was done to assist to confirm their validity and provide conclusive and consistent statistical evidence for the purposes of prevention and control.

1.1 Background

Schistosomiasis, also known as bilharzia is one of most devastating parasitic diseases in tropical countries. Zakhary (1997) described it as a parasitic infection caused by blood flukes namely *Schistosoma haematobium* that affects the urinary system and genitals, while *S. mansoni* and *S. japonicum* that are found in the intestines. The disease is transmitted to humans by vectors known as snails that are found in water. This is when they come into contact with contaminated freshwater through activities such as swimming, bathing, washing laundry, fetching water including wet farming and fishing. Children are most affected; they come into contact with the disease causing organisms through their daily chores of collecting water or as they swim and play. Simoonga et al. (2009) stated that other important determinants to the transmission of this disease were several species of aquatic snails belonging to two genera*; Bulinus* that transmits *S. haematobium* and *Biomphalaria* that transmits *S. mansoni* that act as intermediate hosts for the development of the parasite to an infective free-swimming larval stage called cercariae. Humans acquire infection through cercarial skin penetration during water contact.

Typical sources of infection include natural streams, ponds and lakes, man-made reservoirs and irrigation schemes. Exposure to infection is mainly from lack of safe alternative water sources for agricultural, domestic, and recreational activities (King 2013).

The geographical distribution of the agent schistosoma is wide. *S. mansoni*, which is responsible for causing hepatic and intestinal schistosomiasis is found in Africa, the Arabian Peninsula and South

America. In the case of *S. haematobium*, which is responsible for urinary form of the disease, it is found in Africa and the Arabian Peninsula. *S. japonicum*, the organism causing intestinal schistosomiasis, is found in parts of China and Indonesia (Steinmann et al., 2008).

1.2 Problem statement

Schistosomiasis is one of most devastating parasitic diseases in tropical countries. The disease mostly affects children and young women (Chipeta, 2014).Its clinical manifestations includes haematuria, anemia, and cystitis which when left untreated, leads to carcinoma of the bladder and intestines. If individuals live for years without knowing that they are infected with schistosomiasis, the liver and spleen may progressively grow larger, and the abdominal blood vessels may have hypertension. Occasionally, if eggs are found in the spinal cord or brain, it may result in spinal cord inflammation, paralysis or seizures. Children who have been repeatedly infected may suffer from malnutrition, anemia and learning disabilities. They may have distended bellies (Zakhary, 1997).

Many Studies are conducted to determine schistosomiasis prevalence. However Environmental determinants are not being explored as other important means of mapping out additional strategies for prevention and control of the disease. For the studies that did explore some of the determinants, results show inconsistent association with the schistosomiasis prevalence. It is for this reason that a systematic review of these studies was therefore necessary to provide consistent evidence for policy adjustment.

Environmental determinants include; poor sanitation, unsafe sources of water supply, proximity to stream and other pools of water, wet farming and fishing. Improving these determinants is beneficial to the community in many ways. For instance providing safe water supply and good sanitary facilities reduces continuous access to schistosomiasis infested rivers, streams and other pools of water by the community especially women and children and therefore reduce new infections and prolong life (Hany et al., 2013, Shur et al., 2011).

1.3 Justification

Though a lot of studies have been done in the area of environmental determinants, a synthesis of the evidence is needed to support or disprove some assertions. Among studies that did explore some determinants, results showed inconsistent associations with the prevalence of the disease. It is for this reason that a systematic review of these studies is necessity.

A systematic review of environmental determinants of schistosomiasis prevalence is critical in that it provides conclusive and consistent statistical evidence to answering the problem of defining major determinants that are highly associated with the prevalence. Furthermore, the study provides addition information to the general scientific approaches related to the prevention and control of the disease thereby contributing to improvement of the community health status and enhanced development.

The purpose of this study therefore is to provide a comprehensive analysis of the determinants that are likely to affect the prevalence of this diseases and recommend options for mitigating it.

1.4 Objectives

1.4.1 General Objective

The aim of this study was to review environmental determinants that are associated with schistosomiasis prevalence from published studies carried out in Africa between 2000 and 2014.

1.4.2 Specific objectives

1) To evaluate the association of proximity (distance) from ponds, lakes, and streams/rivers to schistosomiasis prevalence in Africa.
2) To associate wet farming and fishing with schistosomiasis prevalence in Africa.
3) To assess poor water and sanitation regarding schistosomiasis prevalence in Africa.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

Various studies show that the prevalence of schistosomiasis is very high especially in Sub Saharan Africa. For instant Bruun et al. (2008) confirms by stating that schistosomiasis is highly prevalent particularly in Sub Saharan Africa while it is also persistent in some areas of China, Japan, South America. Similarly Ologuide et al. (2012) describes urinary schistosomiasis infection as one of the major public health problem facing developing countries with school age children being at greater risk. Biu et al. (2009), found that *S. haematobium* infection was much more in school aged children between 13 and 15 years and especially boys in Konduga area of Northern Nigeria. Oniya et al. (2012) also found schistosomiasis prevalence to be 18% among sampled school aged children in Ondo State. In addition Ndlovu (2006) as well found that *S. haematobium* was highest in young women (60%) below 20 years of age in Zimbabwe. While Mazigo et al. (2012) also revealed that there was high prevalence and intensity of *S. mansoni* and *haematobium* among school children of 15 years of age and over in Lake Victoria shores named Unguja and Pemba areas of Tanzania.

In Zambia, historical studies conducted revealed that both *S. haematobium* and *mansoni* have been endemic for a long time.For instant, Mun'gomba et al. (1993) sited a very high schistosomiasis prevalence around Lake Kariba, in Siavonga with *S. mansoni* reaching as high as 56% while *S. haematobium* was at 17%. Kalungwana (2010), through a prevalence survey conducted in November 2007 by Zambia Bilharzia Control Program, confirmed schistosomiasis prevalence of about 30% in Ng'ombe Township of Lusaka. Rutagwera et al. (2012) also found an overall schistosomiasis prevalence rate of 11.5% in Zambezi District. To sum it all, Chipeta (2014) acknowledged the fact that the prevalence and morbidity of schistosomiasis was real and very high among children.

2.1 Schistosomiasis Prevalence

Watts (2005) states that the environmental influence on the prevalence of schistosomiasis was well recognized in Africa. It is also known that 85% of infections are found mostly among poor people who live in remote areas, without access to health services, safe water, and good sanitation. In addition, Bruun et al. (2008) says that schistosomiasis transmission is enabled by the interrelated effects of broader environmental, climatic, biological, political, demographic, economic, social and cultural trends. While Watts (2005) mentions that the relevant environmental and social characteristics are lack of access to resources, especially health services, safe water, sanitation, and education.

Hany et al. (2013) in the study conducted in Yemen revealed that high prevalence of schistosomiasis was recorded in areas where environmental determinants such as good personal hygiene, good sanitary practices, provision of clean and safe drinking water and proper sanitation were lacking. Furthermore Kapito-Tembo et al. (2009) in his study conducted in Malawi also revealed significant associations between prevalence and environmental and socio-economic determinants. For example, using a multivariate analysis, he found that there was significantly an association between *S. hematobium* infections with children's knowledge of open water source in the area and distance of less than 1km from school to the nearest open water source.

Sady et al. (2013) showed that higher prevalence of schistosomiasis was highly associated with children who lived in houses without toilets plus those who use unsafe sources for drinking water, and those who lived in houses where water used for household purposes was fetched from unsafe sources e.g. stream, rain, well, water collection tank, and trough. The prevalence was also high in children of uneducated fathers and those from families with low household monthly income. Oniya et al. (2012) found high prevalence of schistosomiasis among school children in schools that were situated close to the village river. Zakhary (1997) also in his study conducted in Ghana found a link in the increased prevalence of schistosomiasis to an increase in fish activities after the creation of the Volta Delta. The prevalence was very high in villages situated closer to the lakeshore. Shur et al. (2011) in the study on schistosomiasis in east and central African Countries also highlighted high prevalence in lake areas, streams, farming areas and fishing camps.

2.2 Effects of Schistosomiasis

Many studies show that schistosomiasis mostly affects children and young women (Mutengo, 2009 and Chipeta et al. 2014). The clinical manifestation includes haematuria, anemia, and cystitis which when left untreated, leads to squamous cell cancer of the bladder. Pearce (2002) writes of parasites living in veins near the bladder or intestines, laying thousands of eggs that tear and scar tissues of the intestines, liver, bladder, and lungs, causing bladder cancer and genital schistosomiasis a condition in which eggs pass through the cervix in women or tastes in men. This was confirmed by Mutengo (2009) who showed that there was an increased number of genital schistosomiasis especially in middle aged women in Zambia too. Carter Centre (2012) added the fact that in communities already burdened by poverty and ravaged by scourges of other conditions such as malaria and tuberculosis; schistosomiasis weakens the body's resistance to other infections and prevents children from reaching their full potential. Chipeta et al. (2014) also found that the disease burden has its biggest toll in children with a varied spectrum of morbidity including recurrent ill health leading to impaired growth and development, and low level of intelligence leading to poor school performance. If individual live for years without knowing they are infected with schistosomiasis, their livers, lungs, bladder and intestines will not sustain damage. The liver and spleen may progressively grow larger, and the abdominal blood vessels may have hypertension. Occasionally, if eggs are found in the spinal cord or brain, it may result in spinal cord inflammation, paralysis or seizures. Children who have been repeatedly infected may suffer from malnutrition, anemia and learning disabilities. They may also have distended bellies.

Bhagwandeen (1976), attributed carcinoma of the bladder in Zambia to concomitant *S. haematobium* infection. Carcinoma of the bladder was the third most important malignancy seen in the country and accounted for nearly 9% of all malignancies seen in the Department of Pathology at the University Teaching Hospital.

2.3 Prevention and control

Much of observational research conducted basically target recommendations for prevention and control. Approaches to schistosomiasis control include chemotherapy, health education, provision of safe water supplies, and installation of adequate sanitation facilities. Molluscicides are also used for focal intermediate host snail control. Chemotherapy is the most widely used control strategy with heavily reliance on Praziquantel (PZQ) as the drug of choice. However, Kesha et al. (2011) believe that the continuity of screening and treatment increases knowledge of disease and means of prevention thereby leading to the decrease in prevalence. Rollenson et al. (2012) discussed the need to raise global awareness to the possibility of schistosomiasis elimination by working with and providing support to endemic countries. He also outlines main interventions as preventive chemotherapy using praziquatel, snail control, improvement in water and sanitation, and behavior change strategies supported by information, education and communication materials.

Landoure et al. (2012) recommends that in persistent prevalence and relatively high level intensity of schistosomiasis infection, repeated chemotherapy and other control measures implemented should be intensified in order to achieve the goal of schistosomiasis elimination. In addition, closer monitoring and evaluation of activities were needed in the program to monitor drug tolerance and adjust the treatment focus. WHO (2013) also recommends epidemiological surveillance, health education, improvement in hygiene and sanitation, water and regular treatment of high risk groups. Carrilho et al. (2002) of Brazil felt that proper diagnosis and treatment of severe forms of schistosomiasis infection and treatment of the entire infected population will interrupt the parasite cycle as a control measure. Freund et al. (2005) states that the government through the Ministry of Education was just concerned with deworming and as a result introduced a program called School Health and Nutrition (SHN) in the year 2000 in schools.

2.4 Conclusion

Literature has proven the high prevalence and intensity of schistosomiasis among children of <15 years and young women in Africa. The disease is highly associated with communities who lived in houses without toilets, use unsafe sources for drinking water, live closer to ponds/lakes/streams/rivers and practice wet farming and fishing.

CHAPTER 3: METHODOLOGY

3.1 The Study Design

This was a systematic review of published literature evaluating environmental determinants of schistosomiasis in relation to the prevalence of the disease in Africa. The study includes a meta-analysis that is meant to assess associations between identified environmental determinants and prevalence of schistosomiasis in observational studies.

3.2 Data Search

3.2.1 Study Setting

In this systematic review only cross-sectional studies on schistosomiasis that were conducted in Africa were reviewed. These include available published studies conducted after the year 2000. However, only articles published between 2000 and 2014 on environmental determinants of schistosomiasis prevalence are included.

The search was conducted with Google Scholar, PubMed and Embase between 15^{th} December 2014 and 3^{rd} February 2015. These databases provided a total of 492 articles. 402 articles were obtained from Google Scholar, 41 from PubMed and 49 from Embase. The articles were recovered using the following key search words:

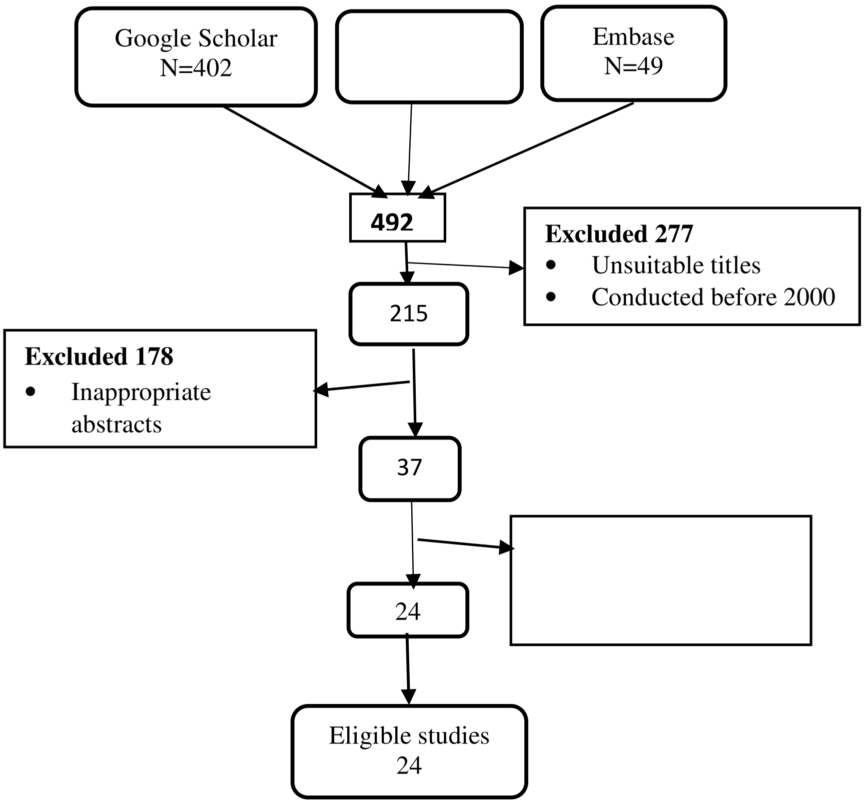
- Environmental determinants
- Schistosomiasis prevalence.

3.2.2 Selection criteria

The selection criteria for articles included studies that focused on schistosomiasis prevalence and the environmental determinants that include water and sanitation issues, fishing and wet farming (rice fields) as well as surface water points such as lakes, ponds and streams/rivers. The original research papers must have been written in English.

Selection was thus carried out based on a plan for inclusion and exclusion criteria as shown in the procedure below:

Figure 3.1: Procedure for searching articles



The inclusion and exclusion criteria was directed by the suitability of the title, the year the study was conducted, eligibility of abstract, duplicates and unrelated outcomes.

24 eligible studies were selected for inclusion in this review. All were cross sectional studies. For the purpose of this study, the sample size was the sum of respondents from the 24 studies.

The evaluation of each article's finding was based on the assessment of study design, selection of participants, evidence of bias, validity of the measurement of exposures and outcomes; and reported strength of measures of association or differences in prevalence.

3.2.3 Study areas

The selected studies were conducted in the following areas:

- 11 in West Africa predominantly Nigeria and Ghana,
- 8 in East Africa predominantly Ethiopia,
- 1 in Central Africa,

- 2 in Southern Africa and
- 2 in North Africa.

3.2.4 Settings for Studies

Among the selected studies, 17 were carried out in schools, while 3 were carried out in both schools and communities and 4 were carried out in communities only, including rice growing areas.

For studies that were conducted in school settings, participants were mainly drawn from lower classes because of the probability of exposure is much higher. For instance, Nagi et al. (2014) in their study selected only grade four (4) class from eight (8) primary schools. Another example is the study conducted by Oluwasogo et al. (2013), in which school children between 5 and 15 years of age were used as participants. Both male and female pupils were included as participants, with the overall age range between 5 and 20 years.

For community based studies, the participants were drawn from among residents within the range of streams, lakes, lagoons, swamps and rice fields. All four studies recruited participants who lived in these areas. Out of the aggregated respondents, the age range was between 10 and 61years. For instance, Sammy et al. (2013) drew research respondents from rice fields some of whom were well 61 years of age. One study included only children aged 1 to 15 both in and out of school. Gender was well balanced as male and female were enrolled.

3.3 Data Abstraction and Processing

3.3.1 Data Abstraction

A spreadsheet data capturing form from Excel was created and used for data abstraction. Details of information abstracted included study identification (Journal and Volume), study title, authors' names, year published, sample size, gender, age, outcome variable (prevalence) and predictor variables or environmental determinants (crater and ponds/river water washing/swimming, open field sanitation, use of piped, wells/borehole water, fishing and wet farming). The study details were then transferred to Review Manager 5 (REvMan5) Meta –analysis and systematic review/analysis package for further processing. The following are some of the characteristics of the studies:

Table 3.1: Study Characteristics

S/N	Study	Study Population and Setting	Sample Size	Gender		Age (Years)			Occupation			Schistosomias is Prevelence	
				Male	Female	5-9 yrs	10-14 yrs	15 over	Pupils	Farmer	Fish men	# Affd	%
1	Chidi G. 2006	School pupils in Imo State, Nigeria	487	272	215	55	192	295	272	213	0	55	11%
2	Megbaru Alemu 2014	School pupils in Umolante, South Ethiopia	405	211	194	49	336	69	405	0	0	51	13%
3	Alembrhan Assefa 2013	School pupils in Mekelle city, Tigray, Northern Ethiopia	457	267	190	114	292	51	457	0	0	109	24%
4	Dzidzo Regina Yirenya2011	School pupils farmers and fishermen in Volta Basin of Ghana	3301	1606	1695	53	263	3301	257	1572	542	1534	47%
5	A.A. Ejima 2010	School pupils in Kogi State of Nigeria	1104	861	243	55	1104	55	1104	0	0	206	19%
6	Lubaihayo John 2008	School pupils in Western Uganda	370	189	181	18	94	27	370	0	0	103	28%
7	Abebe Alemu 2011	School pupils in zarima, northwest Ethiopia	319	157	162	47	151	121	319	0	0	121	38%
8	Alaa H. Abou Zeid 2013	School pupils in Southern Kordofan state Sudan	2302	1575	727	665	1177	460	2302	0	0	545	24%
9	Kebede Deribe 2011	School pupils in South Darfur, Sudan	811	445	366	182	296	157	811	0	0	454	56%
10	Huldah C. Sang 2014	School pupils in South Nyanza, Western Kenya	3420	2052	1368	500	2420	30	3420	0	0	769	23%
11	Abdoulaye Dabo 2014	School pupils in Bamako, Mali	1761	902	859	1462	299	54	1761	0	0	259	15%
12	Bayeh Abera 2011	School pupils in Ethiopia	778	397	381	293	485	49	778	0	0	57	7%
13	Rine C. Reuben 2013	School pupils in Lafia, Nasarawa State, Nigeria	160	123	37	27	58	75	160	0	0	26	16%
14	Sammy Olufemi Sam-Wobo 2013	Farmers/workers in Ogun State, Nigeria	243	100	143	29	25	189	0	243	0	9	4%
15	Nworie, O 2012	School pupils in Ebonyi State, Nigeria	500	236	264	320	150	30	500	0	0	49	10%
16	U. S. UGBOMOIKO 2010	Farmers/workers and fishermen in south–western Nigeria	1023	545	478	367	312	344	0	955	68	634	62%
17	C. Simoonga 2006	School pupils in Lusaka province, Zambia	1912	1912	1243	669	450	1300	162	0	0	185	10%
18	C Uneke 2006	School pupils in Embonyi State, Nigeria	876	478	398	247	205	26	876	0	0	235	27%
19	Olalubi A 2013	School pupils in Igbokuta, Lagos State, Nigeria	102	40	62	34	68	50	102	0	0	80	67%
20	Atupele P. Kapito-Tembo 2009	Sampled only school pupils in Blantyre, Malawi	1139	584	555	624	420	95	1139	0	0	119	10%
21	HUMPHREY D. MAZIGO 2010	School pupils in North Western Tanzania	400	196	204	83	210	107	400	0	0	257	64%
22	A.E.J Okwori 2014	Farmers and fishermen in North Central Nigeria	192	100	92	71	121	55	0	172	20	93	48%
23	Sachiyo Nagi 2014	School pupils in Mbita District, Western Kenya	310	138	172	50	155	155	310	0	0	245	79%
24	Francis Anto 2013	School pupils out of school in Irrigation Scheme in Rural Northern Ghana	920	573	347	50	740	110	473	447		439	48%
		Total	**23292**									**6634**	

3.3.2 Data Processing

The Review Manager 5 systematic and meta-analysis software was used to process the articles and perform different statistical tests to assess the publication bias and randomization of the selection process. Among the test that were conducted was the forest plot, the funnel plot and Cochran's Q test for heterogeneity. These tests were performed to estimate effect sizes or odds ratios, Chi-square^2, P-values, 95% confidence interval and relative weights of individual studies.

3.4 Study limitations

All the 24 studies did not have major limitations that could have had negative influence on the effect size of this review. The data bases, search words, language of publication and publication bias for all studies done on schistosomiasis prevalence did not lead to underestimating or overestimating effect size for this study.

3.5 Ethical consideration

The protocol for this research was submitted and approved by ERES Converge ethical committee.

No ethical issues arose during search for articles for this study as these were obtained from freely accessible websites on the internet. The websites were Google Scholar, Pubmed and Embase. However, a letter of authority to conduct the study was obtained from ERES ethical committee. Attempt was made to obtain permission from Review Manager Software for my inclusion among reviewers used by the software team. Since all the articles obtained were freely accessible on the internet, no online authority from websites and authors of certain articles was obtained. However, ethical issues recorded by individual selected articles were strictly upheld and adhered to as if they were for this study.

CHAPTER 4: RESULTS

4.0 Introduction

A total of twenty-four studies were included in the analysis. All were cross sectional studies and were within the period 2000 - 2014 in Africa. They all investigated the prevalence and associated environmental determinants.

4.1 Respondent's Characteristics

For this analysis, data was available from all the 24 eligible studies. Data obtained from these studies were as shown in the table below:

Table 4.1: Respondent's Characteristics

Variable	Number	%	# Infected	% Infected
Gender				
• Male	13290	57%	3720	28%
• Female	10002	43%	2914	29%
Total	23292	100%	6634	28%
Age				
• 5-9 Years	6064	26%	2189	36%
• 10-14years	10023	43%	3251	32%
• 15 years and Above	7205	31%	1194	17%
Total	23292	100%	6634	28%

Studies samples ranged from 102 and to 3420 with the total respondents being 23292. Among these respondents, 57% were male while 43% were female. The studies respondent ages ranged between 5years and just above 15years.

Of all these 28% had schistosomiasis infection, with individual study prevalence ranging from 4% to 79%. The prevalence by gender was 28% male and 29% for female. This revealed that there was both male and female had equal chances of being infected with schistosomiasis. Meanwhile, 36% of respondents 5-9 years, 32% of 10-14years and 17% of the 15years and above were infected.

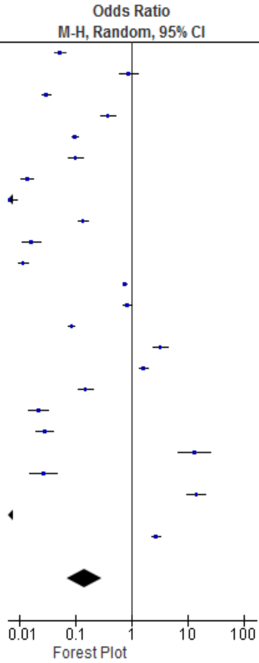
4.2 Effect Size

The effect size of this study was measured through the forest plot for effect size as shown in the table below:

Table 4.2: Forest Plot for effect size and Bias

Study or Subgroup	Infected Events	Infected Total	Not Infected Events	Not Infected Total	Weight	Odds Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F
A.A. Ejima 2010	206	1104	898	1104	4.2%	0.05 [0.04, 0.07]	−	+	+	+	?	+
A.E.J Okwori 2014	93	192	99	192	4.2%	0.88 [0.59, 1.32]	−	+	+	+	?	+
Abdoulaye Dabo 2014	259	1761	1502	1761	4.2%	0.03 [0.02, 0.04]	−	+	+	+	?	+
Abebe Alemu 2011	121	319	198	319	4.2%	0.37 [0.27, 0.51]	+	+	+	+	?	+
Alaa H. Abou Zeid 2013	545	2302	1757	2302	4.2%	0.10 [0.08, 0.11]	−	+	+	+	?	+
Alembrhan Assefa 2013	109	457	348	457	4.2%	0.10 [0.07, 0.13]	−	+	+	+	?	+
Atupele P. Kapito-Tembo 2009	119	1139	1020	1139	4.2%	0.01 [0.01, 0.02]	−	+	+	+	?	+
Bayeh Abera 2011	57	778	721	778	4.2%	0.01 [0.00, 0.01]	−	+	+	+	?	+
C Uneke 2006	235	876	641	876	4.2%	0.13 [0.11, 0.17]	+	+	+	+	?	+
Chidi G. 2006	55	487	432	487	4.2%	0.02 [0.01, 0.02]	+	+	+	+	?	+
Christopher Simoonga 2006	185	1912	1727	1912	4.2%	0.01 [0.01, 0.01]	−	+	+	+	?	+
Dzidzo Regina Yirenya2011	1534	3301	1767	3301	4.2%	0.75 [0.68, 0.83]	+	+	+	+	?	+
Francis Anto 2013	439	920	481	920	4.2%	0.83 [0.69, 1.00]	+	+	+	+	?	+
Huldah C. Sang 2014	769	3420	2651	3420	4.2%	0.08 [0.08, 0.09]	−	+	+	+	?	+
HUMPHREY D. MAZIGO 2010	257	400	143	400	4.2%	3.23 [2.42, 4.31]	−	+	+	+	?	+
Kebede Deribe 2011	454	811	357	811	4.2%	1.62 [1.33, 1.97]	−	+	+	+	?	+
Lubaihayo John 2008	103	370	267	370	4.2%	0.15 [0.11, 0.21]	−	+	+	+	?	+
Megbaru Alemu 2014	51	407	354	407	4.2%	0.02 [0.01, 0.03]	−	+	+	+	?	+
Nworie, O 2012	49	590	451	590	4.2%	0.03 [0.02, 0.04]	−	+	+	+	?	+
Olalubi A 2013	80	102	22	102	4.1%	13.22 [6.78, 25.77]	+	+	+	+	?	+
Rine C. Reuben 2013	26	186	160	186	4.1%	0.03 [0.01, 0.05]	−	+	+	+	?	+
Sachiyo Nagi 2014	245	310	65	310	4.2%	14.21 [9.65, 20.92]	−	+	+	+	?	+
Sammy Olufemi Sam-Wobo 2013	9	243	234	243	3.9%	0.00 [0.00, 0.00]	+	+	+	+	?	+
U. S. UGBOMOIKO 2010	634	1023	389	1023	4.2%	2.66 [2.22, 3.18]	+	+	+	+	?	+
Total (95% CI)		**23410**		**23410**	**100.0%**	**0.14 [0.07, 0.30]**						
Total events	6634		16684									

Heterogeneity: Tau² = 3.34; Chi² = 6086.12, df = 23 (P < 0.00001); I² = 100%
Test for overall effect: Z = 5.18 (P < 0.00001)



Risk of bias legend
(A) Random sequence generation (Selection bias)
(B) Blinding participants and personnel (Performance bias)
(C) Blinding outcome assessment (Detection bias)
(D) Incomplete outcome data (attrition bias)
(E) Selective reporting (reporting bias)
(F) Other bias

From the above forest plot, the effect size was estimated using a Z score 5.18 (P=0,001). Observations from the forest plot showed that all eligible studies had varied individual effect sizes, indicating that a random effect model was the most appropriate. This therefore demanded that the distribution of population effect size is generated from a distribution of different study populations.

The random effect size was also demonstrated by showing the weight for each study which was between 3.9% and 4.2%, justified by the confidence intervals. The studies with confidence interval crossing one such as Ejima (2010), Anto (2013) and Yirenya (2011) had a lower effect size. The summary effect size for all the studies however was significant as was shown on the forest graph with P=0,001.

4.2.1 Overall effect size

In order to estimate an overall effect from the selected studies, there was need to conduct a test showing that the effects found in the individual studies are similar enough for one to be confident that a combined estimate will be a meaningful description of the set of studies. This is a test for heterogeneity.

The test used for heterogeneity in this study is the Cochran's Q test. This test is the kind that shows the Chi square that has a classical measure which when performed, tests the significance of heterogeneity. The statistic describes the percentage of variation across studies that are due to significant heterogeneity rather than random chance. The Cochran's Q test values that were found are shown in table 4.3.

Table 4.3: Cochran's Q test for heterogeneity

Q-valueChi^2	Degree of freedom (Q)	P-value	I-squared
6086.12	23	0.00001	I00%

- The Q test for heterogeneity showed largest heterogeneity. This is because I-squared result is at 100%. An I squared of more than 70% is considered very high and means that the studies being studied have very high variability.

- The estimate for overall effect as shown on table 4.1: Z=5.18 and (P=0.001). reveals considerable statistical significant

Basing on the estimate for overall effect significance and the fact that this effect measure is random at 100% heterogeneity, raises an issue on whether the outcomes of the studies should even be combined. However it is possible that they could be synthesized and results assessed together.

4.2.2 Risk of bias

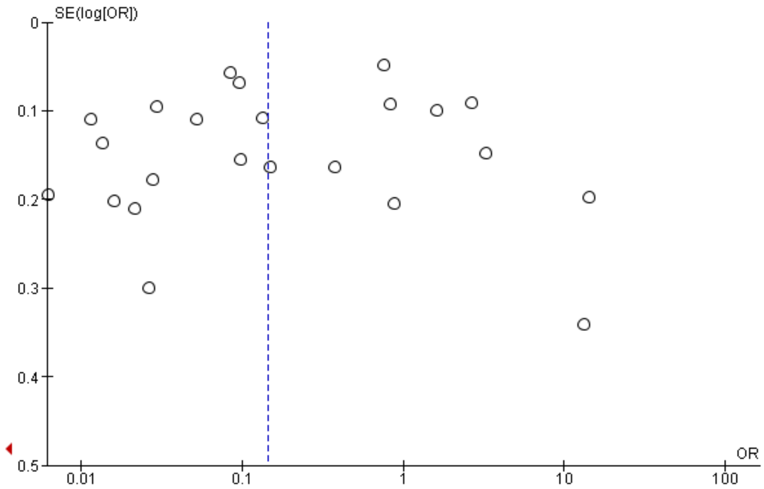
The forest plot effect size show risks biases based on the opinion of the reviewers. These include:

- The random sequence bias (Selection bias).
- Blinding participants and officers bias as well as blinding for outcome bias:
- Incomplete outcome data bias (attrition bias):
- Selective reporting bias (reporting bias)

4.2.3 Publication Bias

Publication bias is assessed using a funnel plot. The funnel plot portrays studies as they appear in the published literature as representative of the population of completed studies. It appears as a plot of measure of study size on the vertical axis as a function of effect size on the horizontal axis. For this study the funnel plot measuring publication bias is as shown below:

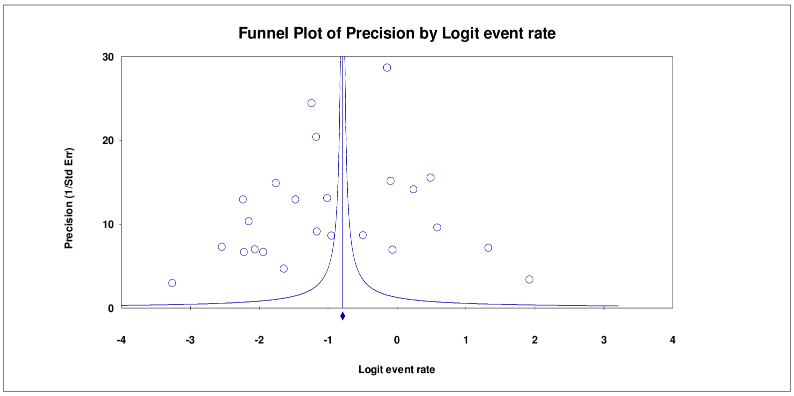
Figure 4.1: Funnel Plot for Publication Bias



Basing on the Odd's Ratio, the above funnel plot gives scattered plots without a funnel with most studies appearing around 0.1 and 0.2 Y-Axis showing that they were large studies. However, for the X - Axis, most studies tended to cluster away from the mean effect size that was odds ratio of 1.0 showing the random nature of the studies. This depicts lack of a pattern for the standard error and therefore the studies were not distributed symmetrically about the combined effect size, signifying the presence of publication bias.

The relationship between effect size and precision was also assessed basing on the logit event rate. This is as shown in figure 4.2.

Figure 4.2: Funnel Plot for Precision



The plot shows that the amount of bias captured by the funnel plot was largely very subjective.

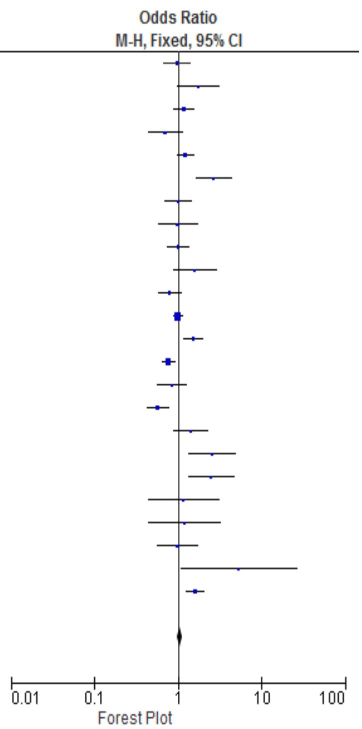
4.3 Gender

In assessing the significance of gender to schistosomiasis prevalence, all 24 studies were eligible for analysis. These were as shown in table 4.4.

Table 4.4: Forest Plot showing the effect of gender on schistosomiasis prevalence

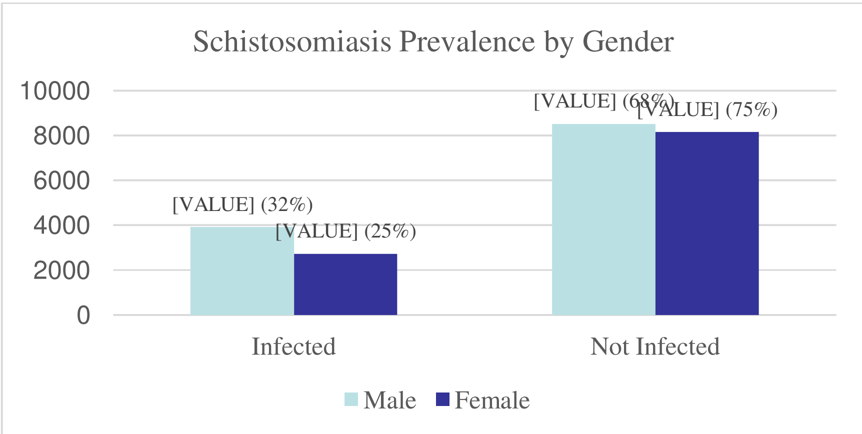
	male		Female			Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% CI
A.A. Ejima 2010	160	861	46	243	3.1%	0.98 [0.68, 1.41]
A.E.J Okwori 2014	55	100	38	92	1.0%	1.74 [0.98, 3.08]
Abdoulaye Dabo 2014	141	902	118	859	5.5%	1.16 [0.89, 1.52]
Abebe Alemu 2011	53	157	68	162	2.4%	0.70 [0.45, 1.11]
Alaa H. Abou Zeid 2013	391	1575	154	727	8.5%	1.23 [0.99, 1.52]
Alembrhan Assefa 2013	82	267	27	190	1.2%	2.68 [1.65, 4.34]
Atupele P. Kapito-Tembo 2009	61	584	58	555	2.8%	1.00 [0.68, 1.46]
Bayeh Abera 2011	29	397	28	381	1.4%	0.99 [0.58, 1.70]
C Uneke 2006	128	478	106	398	4.5%	1.01 [0.75, 1.36]
Chidi G. 2006	36	272	19	215	1.0%	1.57 [0.87, 2.83]
Christopher Simoonga 2006	111	1243	74	669	4.7%	0.79 [0.58, 1.08]
Dzidzo Regina Yirenya2011	746	1606	788	1695	22.0%	1.00 [0.87, 1.14]
Francis Anto 2013	296	573	143	347	4.6%	1.52 [1.16, 2.00]
Huldah C. Sang 2014	423	2052	346	1368	17.6%	0.77 [0.65, 0.90]
HUMPHREY D. MAZIGO 2010	122	196	135	204	2.7%	0.84 [0.56, 1.27]
Kebede Deribe 2011	222	445	232	366	6.8%	0.57 [0.43, 0.76]
Lubaihayo John 2008	59	189	44	181	1.7%	1.41 [0.89, 2.23]
Megbaru Alemu 2014	35	211	14	194	0.7%	2.56 [1.33, 4.92]
Nworie, O 2012	33	236	16	264	0.7%	2.52 [1.35, 4.71]
Olalubi A 2013	32	40	48	62	0.4%	1.17 [0.44, 3.10]
Rine C. Reuben 2013	23	123	6	37	0.4%	1.19 [0.44, 3.18]
Sachiyo Nagi 2014	109	138	136	172	1.4%	0.99 [0.57, 1.72]
Sammy Olufemi Sam-Wobo 2013	7	100	2	143	0.1%	5.31 [1.08, 26.10]
U. S. UGBOMOIKO 2010	366	545	268	478	5.0%	1.60 [1.24, 2.07]
Total (95% CI)		**13290**		**10002**	**100.0%**	**1.06 [0.99, 1.12]**
Total events	3720		2914			

Heterogeneity: Chi² = 100.35, df = 23 (P < 0.00001); I² = 77%
Test for overall effect: Z = 1.67 (P = 0.10)



The above forest plot compares the schistosomiasis prevalence between male and female respondents. The odds ratios and the forest graph show in all studies except for Sammy (2013) that both males and females had equal chances of getting the schistosomiasis disease. The overall effect also shows an odds ratio of 1.06 (95% CI 0.09, 1.12) with the forest graph seen at 1. This means lack of significance. This is supported by the statistical figure on gender as shown below:

Figure 4.3: Schistosomiasis Prevalence by Gender

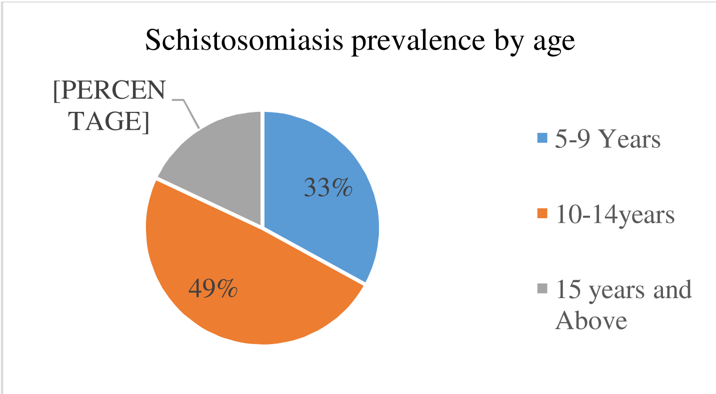


The graph shows the numbers of infected participants in relation to the total participants by sex. Comparing between the two among rates for infection versus not infected, the percentage rate was 32% for male and 25% for the female. Of the 6634 infected participants, when compared to 50% simple test, males were at 59% and females were at 41% showing that males were more likely to be infected by schistosomiasis than females.

4.4 Respondents Age

In assessing the significance of age to schistosomiasis prevalence, all the 24 studies were eligible for analysis. These were as shown in figure 4.4.

Figure 4.4: Schistosomiasis prevalence by age



The above pie chart shows combined schistosomiasis prevalence statistics by age groups. The chart reveals that of the 6634 respondents, respondents aged 10-14years were the most affected with 49%, followed by 5-9years with 33%. Those in age>15years were the least affected with only 18%.

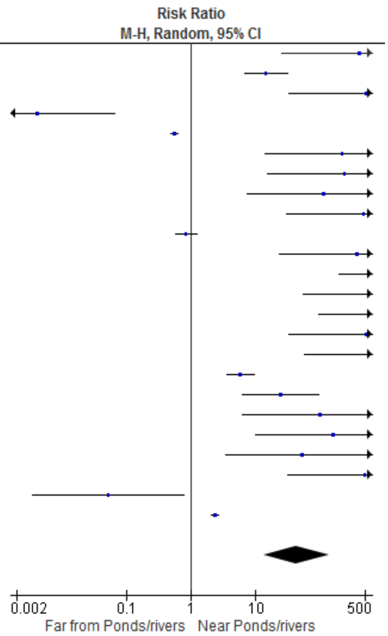
4.5 Proximity to rivers/streams and ponds

In assessing the significance of Proximity to rivers/streams and ponds to schistosomiasis prevalence, all the 24 studies were eligible for analysis. These were as shown in table 4.5.

Table 4.5: Plot for effect of Proximity to rivers/streams on schistosomiasis prevalence

	Near ponds/rivers		Far from ponds/rivers			Risk Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% CI
A.A. Ejima 2010	206	206	0	206	3.9%	413.00 [25.92, 6580.81]
A.E.J Okwori 2014	87	93	6	93	4.9%	14.50 [6.68, 31.50]
Abdoulaye Dabo 2014	259	259	0	259	3.9%	519.00 [32.55, 8275.46]
Abebe Alemu 2011	0	121	121	121	3.9%	0.00 [0.00, 0.07]
Alaa H. Abou Zeid 2013	193	545	352	545	5.0%	0.55 [0.48, 0.62]
Alembrhan Assefa 2013	109	109	0	109	3.9%	219.00 [13.78, 3479.35]
Atupele P. Kapito-Tembo 2009	119	119	0	119	3.9%	239.00 [15.04, 3799.08]
Bayeh Abera 2011	57	57	0	57	3.9%	115.00 [7.28, 1816.87]
C Uneke 2006	235	235	0	235	3.9%	471.00 [29.55, 7508.07]
Chidi G. 2006	25	55	30	55	5.0%	0.83 [0.57, 1.21]
Christopher Simoonga 2006	186	186	0	186	3.9%	373.00 [23.42, 5941.33]
Dzidzo Regina Yirenya2011	1534	1534	0	1534	3.9%	3069.00 [192.05, 49043.52]
Francis Anto 2013	439	439	0	439	3.9%	879.00 [55.07, 14030.92]
Huldah C. Sang 2014	769	769	0	769	3.9%	1539.00 [96.35, 24582.65]
HUMPHREY D. MAZIGO 2010	257	257	0	257	3.9%	515.00 [32.30, 8211.51]
Kebede Deribe 2011	454	454	0	454	3.9%	909.00 [56.94, 14510.55]
Lubaihayo John 2008	88	103	15	103	4.9%	5.87 [3.65, 9.43]
Megbaru Alemu 2014	49	51	2	51	4.7%	24.50 [6.29, 95.42]
Nworie, O 2012	49	49	0	49	3.9%	99.00 [6.28, 1561.14]
Olalubi A 2013	80	80	0	80	3.9%	161.00 [10.16, 2552.16]
Rine C. Reuben 2013	26	26	0	26	3.9%	53.00 [3.40, 826.17]
Sachiyo Nagi 2014	245	245	0	245	3.9%	491.00 [30.80, 7827.82]
Sammy Olufemi Sam-Wobo 2013	0	9	9	9	4.0%	0.05 [0.00, 0.79]
U. S. UGBOMOIKO 2010	446	634	188	634	5.0%	2.37 [2.08, 2.70]
Total (95% CI)		**6635**		**6635**	**100.0%**	**43.03 [13.19, 140.36]**
Total events	5912		723			

Heterogeneity: Tau² = 7.29; Chi² = 2321.05, df = 23 (P < 0.00001); I² = 99%
Test for overall effect: Z = 6.24 (P < 0.00001)



The above forest plot compares the Schistosomiasis prevalence between participants who were living closer to rivers/streams and ponds and those living away. The risk ratios for all individual studies apart for Alemu (2011), Chidi (2006) and Sammy (2010) revealed that the respondents who were living closer to rivers/streams and ponds were more at risk of getting schistosomiasis than those living far. The combined risk ratio of 43.03 (95% CI13.03, 140.36), with the forest graph seen between 10 and 500 as well as the overall effect Z=6.24 (p=0.00001) also showed significance for participants living closer to rivers/streams and ponds.

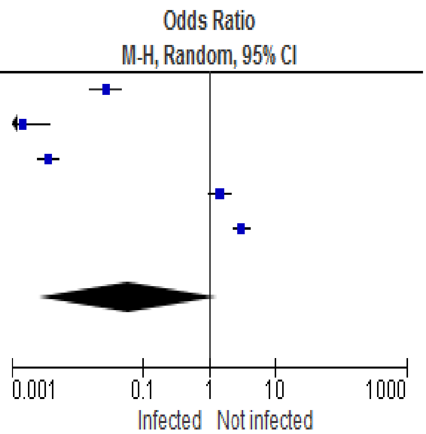
4.6 Wet Farming/Fishing

In assessing the significance of wet farming/fishing to schistosomiasis prevalence, only 5 studies were eligible for analysis. These were as shown in table 4.6.

Table 4.6: Forest plot showing the effect of wet farming/fishing on schistosomiasis prevalence

	Infected		Not Infected			Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% CI
A.E.J Okwori 2014	30	213	183	213	20.0%	0.03 [0.02, 0.05]
Chidi G. 2006	9	243	234	243	19.8%	0.00 [0.00, 0.00]
Francis Anto 2013	58	1023	965	1023	20.1%	0.00 [0.00, 0.01]
Sammy Olufemi Sam-Wobo 2013	105	192	87	192	20.1%	1.46 [0.97, 2.18]
U. S. UGBOMOIKO 2010	285	447	162	447	20.1%	3.09 [2.36, 4.07]
Total (95% CI)		**2118**		**2118**	**100.0%**	**0.06 [0.00, 1.34]**
Total events	487		1631			

Heterogeneity: Tau² = 12.70; Chi² = 1087.55, df = 4 (P < 0.00001); I² = 100%
Test for overall effect: Z = 1.77 (P = 0.08)



The above forest plot compares the schistosomiasis prevalence between respondents who were practicing wet farming/fishing and those who were not. The odds ratios for the five included individual studies revealed that only 2 of them were significant. The overall odds ratio of 0.06 (95% CI 0.00, 1.34) was not significant. This therefore indicates that both participants practicing wet-farming and fishing and those that were not, had a very low risk of getting schistosomiasis. This is supported by the overall effect Z = 1.77 and P value of 0.08 signified lack of significance. The large span diamond effect also reveals that the significance was very low indicating that the evidence was not strong enough.

4.7 Unsafe water and Poor Sanitation

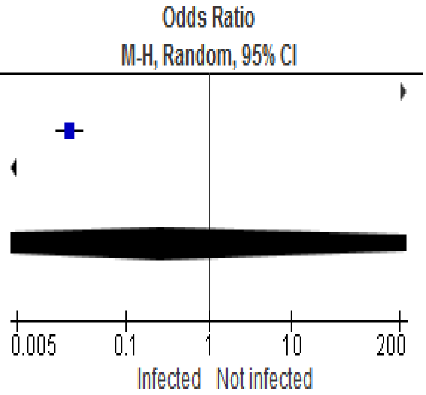
Only 3 studies were used to assess the influence of sanitation on schistosomiasis prevalence. These were as shown in table 4.7.

Table 4.7: Forest plot showing the effect of Sanitation on schistosomiasis prevalence

	Infected		Not infected			Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% CI
Abebe Alemu 2011	121	121	0	121	32.9%	59049.00 [1162.28, 2999956.27]
Alaa H. Abou Zeid 2013	68	545	474	545	33.7%	0.02 [0.01, 0.03]
Sachiyo Nagi 2014	1	245	244	245	33.3%	0.00 [0.00, 0.00]
Total (95% CI)		**911**		**911**	**100.0%**	**0.26 [0.00, 423057.77]**
Total events	190		718			

Heterogeneity: Tau² = 157.73; Chi² = 233.22, df = 2 (P < 0.00001); I² = 99%

Test for overall effect: Z = 0.18 (P = 0.85)



The above forest plot compares the schistosomiasis prevalence between participants who had poor sanitation and those with good sanitation. The odds ratios for the three included individual studies revealed that only one study was significant. The overall odds ratio of 0.26 (95% CI =0.00, 423057.77) did not show significance. This therefore indicates that participants having poor sanitation had equal chances of getting schistosomiasis with those who had good sanitation. This was supported by the forest graph that stood between <0.005 and >200 and the overall effect Z=0.18(P=0.85) showing lack of significance.

CHAPTER 5: DISCUSSION

5.1 Introduction

This review is designed to determine environmental determinants that are associated with schistosomiasis prevalence from published observational studies carried out in Africa between 2000 and 2014.

This chapter focuses on the following themes; the existence of relationship between prevalence and poor sanitation, association between prevalence and proximity to ponds/lakes/streams/rivers and existence of correlation between prevalence and wet farming and fishing. Other areas include age and gender in relation to schistosomiasis prevalence. And findings showed prevalence was highly associated with people living closer to rivers/streams and ponds than those living far away emphasizing the fact that all water bodies were the leading environmental determinant to schistosomiasis.

5.2 General Discussion

From the 23410 total respondents of which 57% were male and 43% female. The infection ratio among them as compared with none infected respondents was 46% for male and 33% for female equivalent to 1:1 was not significant. This showed that males and females had similar chances of being infected with schistosomiasis.

However when infection rate between the two gender elements was computed among the infected participants it was found that 59% of them were male and 41% were female showing marked significance. This meant that males were actually more likely to be infected by schistosomiasis than females. This was largely due to the fact that male children and adults were more likely to have higher water contact activities such swimming, farming and fishing. This assertion is supported by Oluwasogo (2013) whose results showed that the males were generally more infected and with higher intensity than the females. He stated that this was presumably due to higher water contact activities by males particularly in the swamp-rice farming and fishing, where parents engage every male in their household in the profession. He further stated that other regular water contact activities such as swimming and bathing in cercariae infested streams and rivers were male dominated.

The overall age range was 5-9 years = 7055, 10-14 years= 7768 and >14 years was 8469. Of all the participants, 6634 (28%) had schistosomiasis infection. It must also be noted that most affected age group is 10-14yrs with 64% of the participants in the age group infected followed by 5-9years of age. This was supported by Chidi G. et al. (2006) who among his findings asserted that the highest prevalence of schistosomiasis was in the age group of 10-15 years. This was statistically significant. This was mainly because children within this age group find it more adventurous to venture into swimming and playing in water as well as being assigned to draw water and wash clothing and domestic utensils. Another study by Assafa et al. (2013), also found the high schistosomiasis prevalence in 10 -14 years age group and stated that this might be due to higher rate of water contact leading to re-infection respectively.

5.3 Heterogeneity

The study found a large scale heterogeneity of I-squared 100% in prevalence of schistosomiasis infection from the total number of 23292 participants drawn from all twenty four eligible studies. This is because the studies appear so varied, in terms of different population types, different age groups, different sex combinations and different ways of sampling. This means that it would not be appropriate to rely on the estimated overall effect sizes.

The variation in studies settings and sampling methods as well as the high heterogeneity, does not however prevent the effect from being synthesized and read as a combined measure. This combined effect size could be used though cautiously. In other words, since the studies were conducted in very different situations it may be difficult to combine them.

Basing on the Z score of 5.18 and P value of 0.001, the study reveals considerable statistical significant. This therefore means that the estimates could be believed, acceptable and relied upon.

5.3.1 Risk of bias

The random sequence (selection bias) for selecting respondents was diverse among the eligible studies. The bias was probably high for studies with school children identified as respondents. This was possibly due to a preplanned desire to sample school children in selected schools. The other studies that involved the community had low selection bias.

Although blinding respondents and officers bias as well as blinding for outcome bias was low in all studies, assessment of this bias could not be ignored. Incomplete outcome data bias (attrition bias) was also low. This is because in cross sectional studies, results of studies are immediate and losses are minimized. Reviewers were uncertain with selective reporting bias (reporting bias) as it was not clear whether any outcomes were measured and not reported. No other source of bias was identified in all studies.

5.4 Environmental determinants

This review suggests varying associations between prevalence and environmental determinants. Most studies that measured prevalence also outline specific factors leading to the same. The differences observed in the studies may be due to weakness in study designs, inadequate sample sizes, differences in the measurement of outcome variables and inadequate control of bias such as selection and reporting bias.

5.4.1 Proximity to rivers/streams and ponds

The results of this study have shown high schistosomiasis prevalence among participants living closer to rivers/streams and ponds than those living far away emphasizing the fact that all water bodies are the leading environmental determinant to schistosomiasis prevalence. It shows the estimated overall effect of $Z=6.24$ and $P<0.001$ revealingconsiderable statistical significance. This is in addition to the combined risk ratio of 43.03 (95% CI 13.03-140.36), suggesting its significance for participants living in these areas. Sang et al (2014) in her study entitled *S. Heamatobiam* hot spots in Southern Nyanza, also attributed higher prevalence of urinary schistosomiasis to high level of exposure due to inhabitant's dependence on infected water bodies. The study area has small ponds which are used for fishing, household utilization and swimming. Kapito-Tembo et al. (2009) as well highlighted the fact that there was a higher prevalence rate of urinary schistosomiasis in his study area because of the high level of exposure to infection because of inhabitants' habits, lifestyle and dependence on the infected contaminated water bodies. He stated that significant risk factors such as swimming/drinking contaminated water, washing of clothes in streams and playing/bathing in rivers had been implicated for the high intensity of urinary schistosomiasis in that community.

Rivers/streams and ponds were therefore noted to be a major environmental determinant to schistosomiasis prevalence.

5.4.2 Wet Farming/Fishing

Schistosomiasis prevalence among participants practicing wet farming/fishing was found to be low in this review. The study reveals that the odds ratio for studies was not significant. The overall odds ratio of 0.06 (95% CI 0.00, 1.34) was not significant. This is supported by the overall effect Z = 1.77 and P value of 0.08 signified lack of significance as the evidence was not strong enough. This therefore indicates that both participants practicing wet-farming and fishing and those that were not, had a very low risk of getting schistosomiasis. This finding opposes Anto et al. (2013) who in his study found high association between water contact activities and prevalence of the infection. He isolated children who worked on tomato farms as highly infected. He concluded that bathing in the canals, washing of clothes and working on tomato farms were found to be risky water contact activities associated with schistosomiasis infection. He went on to say that children who engage in all three activities in the irrigation site had a very high risk of being infected with schistosome parasites.

Sammy (2013) also stated that children engaged in swimming, fishing and irrigation especially after school hours were more likely to be infected with schistosomiasis. This practice exposes the children to risk of infection, since the level of exposure or contact with water containing cercariae of the parasite and the risk of infection were related.

This study however, has shown that wet-farming/fishing has no association to schistosomiasis prevalence.

5.4.3 Unsafe water and Poor Sanitation

Schistosomiasis prevalence in participants who had poor sanitation and those with good sanitation was found to be completely insignificant. The odds ratio for the three included individual studies that revealed lack of significant effect. The overall odds ratio of 0.26 (95% CI 0.00, 123057.77) and the overall effect Z=0.18(P=0.85) did not show significance. This therefore means that having poor sanitation does not put participants on risk of getting schistosomiasis. However, some studies show significance when poor sanitation leads community members to use rivers/streams and ponds thereby exposing themselves to schistosomiasis parasites. For instance, Zeid et al. (2013) stated that some of the factors such as household clustering, occupation, poverty, sanitation and urbanization were associated with these helminthic infections including schistosomiasis. He went on to say that parasite prevalence was observed between family with poor water sources and sanitation. This finding does not directly associate poor sanitation with this disease.

5.5 Conclusion

This study highlighted insights on the schistosomiasis prevalence and leading environmental health determinants. Findings of this study indicate that living close to water bodies is associated with schistosomiasis prevalence while wet farming and fishing has a low part to play. It is the opinion of this researcher that when unsafe water and sanitation leads to usage of rivers/streams, would lead to exposure to the disease.

5.6 Recommendations

Following the study revelations of schistosomiasis prevalence and conclusion on important environmental determinants, it is necessary to make the following recommendations to Governments in Africa:

1. Promotion of health education and communication with messages that will focus on individual attitude change regarding schistosomiasis. Changes in positive individual attitude are key to effective behavior change in a community. This will assist in reducing continuous exposure to schistosomiasis infested rivers and streams
2. Provision of safe water through sinking of borehole and good sanitation by constructing public toilets so as to reduce usage of rivers/streams and ponds.
3. There is need to conduct comprehensive studies to investigate further environmental determinants that are influencing the high schistosomiasis prevalence rate among children and young women in Africa.

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APPENDICES

Appendix 1: Data Capturing Form

S/N	Title of study	Name of Author	Year Published	Sample Size	Outcome Variable	Predictor Variables (Environmental Determinants)				
					Schisto Prevalence	Water supply	Sanitation	Water points	Fishing	Wet Farming

Appendix 2: Information sheet and consent form

The University of Zambia
School of Medicine
Department of Public Health

P.O. Box 50110

Lusaka

The ______________________________

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Request for authority to use Information

We are students from the University of Zambia conducting a systematic review study of environmental determinants of Schistosomiasis (Bilhazia) Prevalence in Africa. This involves review of already existing studies on this subject matter from various sources including your organization. It is for this reason that I am requesting for your permission to include the following articles/data bases:

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

The information from this/these articles/data bases will be useful in ensuring adequate and credible evidence will be realized for community benefit.

You have the right to withdraw or refuse to participate in the study before questions are asked or during the course of the interview.

Your consideration will be highly appreciated.

Name of Interviewer: ....

Signature: .... Date: ……………………

Appendix 3: ERES Approval Letter