In the name of Allah, the most Gracious, the most Merciful

Occurrence of *Strongyloides stercoralis* in rural areas adjacent to Dhaka city

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January, 2019

DEDICATED

TO

MY BELOVED PARENTS

PREFACE

It is hereby declared that , the work presented in this thesis is the result of original research . I also declare that I have not submitted this material , either full or in part , for a degree at this or any other institution.

14.07.19

Laila Fahria

Registration No: 200

Session: 2013-2014

Certificate

This is to certify that the thesis entitled "Occurrence of *Strongyloides stercoralis* in rural areas adjacent to Dhaka city" prepared by Laila Fahria, Registration No. 200, Sesson : 2013-2014 for the degree of Masters of Philosophy to the University of Dhaka is a record of original research carried out in the Parasitology Laboratory, Department of Zoology, University of Dhaka , Dhaka under my supervision. It is further certified that the entire work presented in this thesis based on the result of author's own investigations, and no part of this thesis has been submitted before in substance for any degree. The thesis is hereby approved as to the style and contents for submitting to the University of Dhaka.

ABegum
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Abstract

Strongyloidiasis is one of the most important forms of helminthiasis in tropical countries. Infection with *Strongyloides stercoralis* is widely distributed throughout equatorial and temperate region. People remain infected years after the original exposure because this parasite has the ability to reinfect the same host; worms can multiply unchecked in immunosuppressed people, leading to life-threatening disseminated strongyloidiasis. The present study was conducted to find out the occurrence of *Strongyloides stercoralis* in two rural areas and street dwellers of Savar and Gazipur district which are adjacent to Dhaka city. A total of 160 stool samples were collected from the respondents of age range (00-60) years of both gender (53 male & 107 female) of the selected areas. In the present investigation the stool samples were collected from Savar and Gazipur district between December 2016 to December 2017. Sampling was done by random selection method and the stool samples were examined through Direct smear method, Harada-Mori culture method and Formal-ether concentration method (highest prevalence 9.1% and 10%).

In Savar, a total of 100 stool samples of respondents were examined, of which 33 were male and 67 were female. In Gazipur, out of 60 stool samples of the respondents 20 were male and 40 were female. In Savar, the prevalence of male was 12.12% and female was 10.44 % and in Gazipur district, the prevalence of both male and female was 10%. The rate of prevalence of *S. stercoralis* in each male sample was statistically significant ($p=0.06$, $p<0.05$). In different age groups the highest prevalence rate (30% and 28.57%) was found in the age group of (51-60) years and the lowest prevalence (0%) was in the age group of (11-20) years in both district. Out of 160 respondents total number of the service holders were 66, labors 17, housewives 33, students 11 and others 33. The highest rate of infection was 27.27% and 33.33% in day labors and the lowest was found among service holders 4.87% and 4% in Savar and Gazipur respectively. Between two types of houses prevalence was higher than in tin shed (11.53% and 12.90 %) in Savar and Gazipur district. The highest infection rate (12.06 % and 11.42%) was found in insanitary toilet users. Infection rate among supply water users and tube well water users were 13.43%, and 12.19% and 6.25 % , 3.38% in Savar and Gazipur respectively. In Savar, Out of 100 respondents the highest prevalence was found 16.66% in (15001-20000tk) monthly family income and the lowest prevalence was found 10.69 % in (5001-10000tk) monthly family income. Illiterate respondents showed the highest prevalence (15.2 % and 17.85 %) respectively. The highest prevalence (18% and 16.66%)

was found in the participants of family members who suffered the diarrheal disease before three months. The respondents having irregular nail cutting habit showed the highest infection rate at (20.45% and 23.07%). Highest prevalence (12.06% and 11.42%) was found who did not use soap after defecation. Bare footed respondents showed infection rate at (12.76%, 14.28%) whereas (7.54% and 9.37%) who use shoe. Highest prevalence (13.46% and 15.62%) was observed in rainy season in Savar and Gazipur respectively. Other helminthic parasites detected in the stools of the respondents were *Ascaris lumbricoides* (37% and 38.33%) , *Trichuris trichuira* (15% and 16.66%), *Enterobius vermicularis* 15% in both study area. However, positive stool cultures showed significant associations with irregular nail trimming, walking bare-foot and irregular hand washing after defecation ($p<0.05$).The prevalence rate is also associated with occupation, poor sanitation, educational status and quality of drinking water. This study confirms the existence of *Strongyloides stercoralis* infection in the selected rural areas adjacent to Dhaka city.

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CHAPTER 1

Introduction

Introduction

Strongyloides stercoralis is a human pathogenic parasitic roundworm causing the disease strongyloidiasis. Its common name is threadworm. The *Strongyloides stercoralis* nematodes can parasitize humans. The adult parasitic stage lives in tunnels in the mucosa of the small intestine. The genus *Strongyloides* contains 53 species. *Strongyloides stercoralis* has been reported in other mammals, including cats and dogs.

Neglected tropical diseases (NTD) are a group of chronic, disabling and disfiguring conditions occurring predominately in and often in a setting of extreme poverty. It is found in either remote rural communities or in urban rural affected mainly children who are the most vulnerable to these diseases. Over a billion people, one in every six suffers from one or more NTDs Reasons why these diseases have been received relatively with little attention are: firstly, they cause lower morality rates compared to " big three" diseases (HIV/AIDS, tuberculosis and malaria), secondly they are not found in developed countries and thirdly little research is done on this diseases. In 2006, Global Network for Neglected Tropical Diseases was lunched by the Washington-based Sabin Vaccine Institute to raise the profile and mobilize resources for treating and eliminating NTDs.

It has been reported that approximately 85% of the NTD disease burden results from helminth infections. *Ascaris*, hookworm, whipworm, pin worm (*Enterovious vermicularis*) and *Strongyloides* are known as soil transmitted helminthes (STHs) all of which are listed as NTD. However *Strongyloides stercoralis* is classified as "the most neglected of neglected tropical diseases." This nematode is found in much of the tropical and subtropical regions of the world and was originally described by Normand (1876) as the type species of the genus.

Strongyloides stercoralis most notably found in the tropics and the subtropics, but it can occur in temperate climates as well. Because of the variety of hosts which it can parasitize, the worm can be found in various areas around the world. In North America, it has primarily been found in large cities, specifically, New York City, Chicago and Montreal. There is also a high incidence of *Strongyloides stercoralis* in Asia, Africa, tropical America, the Pacific Islands, and even in parts of the former Soviet Union. (Cheng, 1986; Roberts and Janovy, 2005).The threadworm *Strongyloides stercoralis* is a common intestinal nematode affects 30-100 million people worldwide (Bethony *et al.*, 2006; Olsenetal.,2009).

Soil-transmitted helminthes (STH) refers to a group of parasitic diseases in humans caused by intestinal roundworms such as hookworms (*Ancylostoma duodenale)* and (*Necator americanus*), roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*) , *Strongyloides stercoralis* collectively called soil-transmitted helminthes(STHs), which are transmitted through contaminated soil. It has become the most common parasitic infection of humans worldwide. Approximately two billion people (about a third of global population) are infected as of the latest estimate, and four billion at risk, surpassing even the all-time most prevalent parasitic disease, malaria. Its main cause, likes for many types of helminth infections, is lack of sanitation, such as the practice of open defection and lack of hygiene such as hand washing. (Ziegelbauer 2012). The largest numbers of cases occur in impoverished rural areas of Subsaharan Africa, Latin America, Southeast Asia and Chaina (WHO). It is regarded as one of the world's most important causes of intellectual and physical retardation (Bethony 2006).

The soil-transmitted threadworm, *Strongyloides stercoralis,* is one of the most neglected among the so-called neglected tropical diseases (NTDs). In endemic world-wide, yet more prevalent in hot and humid climates as well as poor countries with inadequate sanitary conditions. NTDs are endemic in developing regions of Africa, Asia and Americas. The difficult diagnosis and irregular excretion of larvae lead to an underreporting of infection rates.

Strongyloidiasis is endemic in areas where sanitation conditions are poor and where the milieu is warm and humid (Hall *et al*., 1996). The helminthic infection is transmitted through ingestion of the nematode eggs in the soil, which is contaminated through excrements. Therefore, the disease is most prevalent in 70 countries of worm and moist climates where sanitation and hygienic are poor and waters are unsafe, including the temperate zones during warmer months. STH is categorized among NTDs because it inflicts tremendous disability and suffering, which can be clinically treated, yet negligible attention has been given for many years.

Bangladesh is one of the smallest and developing countries in the world. The total area of this country is 147,570 sq km is situated on a fertile alluvial plain formed by large rivers. The population is about 157.9 million (according to tentative report of Economic Review -2015). Dhaka, with a big population of more than 13 million represents a city of highly congested population (National Web Portal of Bangladesh). A large part of this population resides in the rural areas with no provision of safe water supply and safe excreta disposal system.

The heavy rainfall, climate and atmospheric condition, fertile soil, water sources and socio-economic condition are suitable for transmission of the parasitic infection. Helminthic infestation due to nematodes is a major public health problem of wide spread endemicity in this country due to many factors like, poor hygienic habits, poor standard of living, lack of health education, ignorance, poverty, poor socio-economic conditions and general insanitary condition of the majority of the population.

Moreover, everyday people migrate from rural area to Dhaka city in search of shelter and work making living condition worse. Children are most vulnerable and helpless among all the members of the rural family. They are mostly affected in their living condition leading to suffer from various disease and malnutrition, 6 among 20 children usually die before they reach the age of 5 years.

The prevalence of intestinal parasitodis is very high in Bangladesh (Muazzem and Ali 1969, Islam 1984). With an ever-increasing population leading to overcrowding and unhygienic practices these parasites pose a serious threat that is compounded by limited resources. About 80% people live in the rural areas (Chowdhury 1979, 1981). Correct identification of a parasite is the first step to ensure a combat against these parasitism and infectious diseases.

Definitive diagnosis of stongyloidiasis is by detection of larvae in stool. Direct smear, formal-ether concentration (FEC), Harada-Mori culture are common coprological methods used to detect larva of *S. stercoralis* in stools . Faeces, the most frequent specimens, are usually examined in the laboratory by microscopic examination, which essentially consists of direct wet mount preparation, concentration, and permanent staining. Microscopic observation of wet mounts remains the most widely used method for identifying ova and cyst of parasites from stool specimens (Valentine and Lalitha 2001). Wet mount preparation of stool is extensively used in stool microscopy in a parasitological laboratory for the diagnosis of intestinal parasitic infections (Parija and Srinivasa 1999).

The intestinal nematode *S. stercoralis*is endemic in many communities throughout tropical and temperate regions, and is responsible for a wide range of symptoms (GROVE, 1989a) . The transmission of *S. stercoralis* involves contamination of the environment by first stage rhabditiform larvae from the faeces of infected people. Third-stage infective filariform larvae may mature within 24 to 48h by direct development from rhabditiform larvae , or in 2-6 d by indirect development involving a single free-living generation. Infection occurs by skin penetration.

In most of these countries, little is known about the actual prevalence and distribution of *S. stercoralis*. One reason for this lack of knowledge pertains to the time- and resource-intensive diagnostic methods used to detect *S. stercoralis* infection.

Potential reasons for the current prevalence include: long lasting infections, populations not targeted with mass drug administration (MDA) programs being infected, low efficacy of commonly used drugs in MDA programs, and under-diagnosis resulting in infections not being treated.

Strongyloides stercoralis is an intestinal helminth that infects humans through contact with soil containing the larvae. Immunosuppressed patients with chronic strongyloidiasis are at high risk of developing strongyloides hyper infection syndrome, a life threatening complication whereby larval proliferation leads to systemic sepsis and multi organ failure. If strongyloidiasis is diagnosed early, however, it is easily treatable with oral antihelmintic drugs.

Infection usually results in asymptomatic chronic disease of the gut, which can remain undetected for decades. However, in patients receiving long-term corticosteroid therapy, hyper infection can occur, resulting in high mortality rates. Severe complication with clumsy infection of strongyloidiasis may lead to substantial mortality as high as 87% (Ericsson *et al.*, 2001).

Strongyloidiasis is a persistent disease and thus infection remains throughout the life by its auto infective cycle. Under some condition like immunocompromise, this auto infective cycle may diverted into potentially fatal hyperinfection syndrome (HS), characterized by increased numbers of infective filariform larvae in stool and sputum and clinical manifestations of the increased parasite burden and migration, such as gastrointestinal bleeding and respiratory distress(Keiser 2004).

Strongyloides stercoralis has high prevalence in societies where fecal contamination of soil or water is high (Segarra-Newnham 2007). Hence, it is a very rare infection in developed countries, it is highly prevalent in urban areas where sanitation standards are poor. Rural dwellers specially contain this parasite for their poor system and unhygienic condition.

Strongyloidiasis is endemic in Africa and West Indies, South Asia, South America, Pakistan and Bangladesh. The recent corpological studies in rural areas of Dhaka, confirmed its continued existence in Bangladesh.(Segarra-Newnham 2007)

Immunocompromised patients are particularly at risk of developing potentially fatal disseminated stongyloidiasis but patients with chronic disease are asymptomatic or have only mild signs, Therefore, the study of the disease or public awareness has long been ignored in South East Asia especially in Bangladesh.

Research has not yet been established in Bangladesh to provide all-important information to prevent and cure of this parasitic infection. Some studies were done by Hall *et al* 1994 that provides the risk factors for infection, carried by a questionnaire (Dorris *et al* 2000). Strongyloidiasis has been received little attention for a long time; however, a study highlighted this as a public health concern in Bangladesh (Sultana 2012, Sultana 2013). Studies in Dhaka show high prevalence in rural with poor hygiene and sanitation. Furthermore, more extensive studies are required to find out the extent of infection especially in rural communities where the main occupation is farming and agriculture.

My study will be in order to find out the present infective status of *Strongyloides* in Bangladesh. Moreover, burden of disease will be determined in the high-risk groups in different areas in Bangladesh. This research will attempt to provide more information and identify the risk factors of this infection in rural areas. The sources of infection can then be targeted so that treatment and control programs are more effective.

1.2 Identification of problems:

In Bangladesh *S. stercoralis* is very common due to poor hygienic habits and living conditions of the majority of the population. Muttalib (1975) carried out a study in the newly admitted students of the University of Dhaka. Among them 32% was infected by *S. stercoralis.* Huq and Yasmin (1981), from public health institution, Mohakhali, Dhaka, studied 593 stool samples from Mirpur and Mohakhali area. They found 0.03% *S. stercoralis* infection among those samples. Sultana surveyed parasitic infestation in different rural area of Dhaka city (Sultana 2012). According to her study, larvae of *S. stercoralis* were detected in 34(23.1%) stool samples using the Harada Mori culture method. The reasons behind this are the favorable environmental factor for the growth like, soil, condition, humidity, socio-economic pattern, congested population, lack of education, lack of provision for safe disposal of human excreta and lack of supply of pure drinking water etc. On other hand, reverse situation in the developed countries leading to a less prevalence of those intestinal worms.

1.3 Background of the work :

Intestinal parasitic disease notably protozoan and helminthic diseases have been the cause of major health problems in our country like other developing countries of Subsaharan Africa, Latin America, Southest Asia and China. A number of studies on the epidemiology have been carried out in Bangladesh. Among the few works the studies were done by Muttalib(1975), Huq and Sheikh (1981), Sultana(2012).They have reported in their studies about a very high prevalence rate of intestinal parasites. Among them *Strongyloide stercoralis, Ascaris lumbricoides*, *Trichuris trichuira* and hookworm are the commonest parasites in our country. Factors like poverty, unhygienic condition , poor sanitation, illiteracy, ignorance, floods, malnutrition and over population are frequently held responsible for high incidence of parasite infection.

This chapter covers the general background of *S. stercoralis* with more emphasis in areas which concern my research. I review the occurrence of *S. stercoralis* emphasizing the disease endemicity and associated risk factors with basic biology of this parasite. Since diagnosis of strongyloidiasis is an issue to be improved, detail of current different techniques and the limitations of those methods are also reviewed. I also highlighted the immunological changes during *Strongyloides* infection, treatment and management of Strongyloidiasis.

1.4 Hypothesis

S. stercorslis is a skin penetrating parasite. It frequently infects people of all ages. These infected people remain a source of infection in the community due to their improper hygienic habit, lacking in knowledge about parasite infestation.

Strongyloidiasis occurs at a high prevalence in societies where soil is contaminated by faeces. It occurs in all age groups and is associated with altered immune state, chronic disease and low socio-economic status. Therefore, in developing countries where the sanitation is not good, stongyloidiasis may become a significant infection. Thus, strongyloidiasis is a public health concern in this developing country. Research on this disease has not yet been established in Bangladesh. A couple of studies over 15 years ago only highlighted the risk factors through questionnaire for this parasitic infection in Bangladesh. More details investigation of the current epidemiological status in Bangladesh is needed to be carried out.

1.5 Risk factors for strongyloidiasis

Risk factors of acquiring Strongyloidiasis are living in or visiting an endemic area, consuming poor quality drinking water as well as bathing in rivers. Immigrants from endemic areas, returned travelers and ex-prisoners of war have been reported as high-risk groups. A study in northern Iran reported a high prevalence of Strongyloidiasis in a population working either in the garden or in agriculture. The faecal contamination of the environment seems to increase the chance of more people being infected especially in tropical countries.

Higher prevalence of Strongyloidiasis due to poor hygiene and sanitation are reported. A higher risk of *S. stercorslis*is infection in endemic countries is documented among the people in Bangladesh who either use the community latrines or live in a house with earth floors. A recent study in Bangladesh observed high prevalence of infection in rural residents with a habit of irregular nail trimming, walking bare-foot and irregular hand washing after defecation. Over crowded conditions within families are indicated as predisposing factor for Strongyloidiasis in Jamaica . Risk factors which enhance the chance of exposure to infective larval stages depend both on the level of disease endemicity in the community and survival of the parasite in the environment.

1.6 Modifying Factors and Variables

The variables which are used in this study are:

1. Age
2. Sex
3. Occupation
4. Type of house
5. Type of latrine
6. Quality of drinking water
7. Monthly family income
8. Number of family members
9. Educational qualification
10. History of diarrhea in family members
11. Nail cutting habit
12. Hand washing habit
13. Being bare foot
14. Season

1.7 Objective of the study

The following are the objectives of the study:

1. To find out the occurrence of *S. stercorslis* in different rural communities adjacent to Dhaka city.
2. To study the burden of disease in high-risk group in Bangladesh by the stool examination.
3. To find out other parasitic infection within the same communities.
4. To observe the association of *S. stercorslis* infection to other helminth.
5. To see the household potential risk factors in rural areas especially in Bangladesh, as the living standard is not satisfactory for controlling the worms.
6. To observe the prevalence on the basis of age and sexes in Bangladesh and the magnitude of the problem of parasites among healthy adults and adolescents.
7. To see the seasonal variation of prevalence of *S. stercorslis.*

CHAPTER 2

Review of Literature

Review of Literature

The soil-transmitted nematode, *Strongyloides stercoralis* is one of the most-neglected of all neglected tropical diseases. It is globally distributed, favoring the humid, wet climates of the tropics and subtropics. Strongyloidiasis is rampant in Bangladesh as in other developing countries. A gross difference in socio-economic status, personal health care, age group, habitats etc. were observed in a number of studies carried out in Bangladesh as well as other developing countries. Previous literature about related work provides us valuable information on human strongyloidiasis and also the socio-economic status of the infected population. There are numbers of literatures are available relevant to this study. Review of literature about infestation of *Strongyloides stercoralis* enables us to know about many aspects which are relevant to the study.

Muttalib (1975) carried out a study on intestinal parasites in University of Dhaka students. He collected 933 stool samples of newly admitted students of University of Dhaka. Those students were from different villages of Bangladesh. The study observed 40.6% infestation of *A. lumbricoides*, 16.6% infestation of *T. trichiura*, 7.1% infestation of *A. duodenale*, 32% infestation of *S. stercoralis*, 11.7% infestation of *E. histolytica* and 1.87% infestation of *Giardia*. The occurrence of 57.3% parasitism in this study was reported (Muttalib 1975).

Chowdhury M.R. (1978) carried out a study with intestinal parasites. He examined 5372 specimens of stool within two groups of population of the armed forces (3242 cases) and civil group (2130 cases). It was found that 52.6% of the population had intestinal parasitic infestation. The infestation was more prevalent among females. These were three common infestations, Helminthiasis was 31.83%, Amoebiasis 15.19% and Giardiasis was 9.57%. In this study, out of 5372 stool samples 1245(23.18%) were positive for *A. lumbricoides*. 555(10.33%) were positive for *T. trichiura*, 337(6.27%) were positive for *S. stercoralis*, and 15 (0.28%) were positive for *E. histolytica* . Helminthiasis occurred more frequently in AF(armed force) group than in the civil group. The occurrence of amoebiasis on the other hand were more in civil group than other (Chowdhury 1978).

Haq and Yasmin (1981), worked on the public health institution Mohakhali, Dhaka studied 593 stool samples from Mirpur and Mohakhali area. The persons were under the age of 20 years. Out of 593 stool samples , parasite positive cases were 373 (63%). Among them *A.*

*lumbricoides was 39.4%, T. trichiura was 22.7%, E. histolytica was 8.6%,Giardia*was *1% and S. stercoralis* was 0.3% (Haq and Yasmin 1981).

Mangali-A (1992) surveyed intestinal parasitic infestations of three coastal and two island villages of Compalagian district, South Sulawesi , Indonesia. A total of 398 fecal samples were examined by using Kato-Katz thick smear, Harada-mori culture , either concentration technique on 380 fecal samples.Soil transmitted helminth infection were highly prevalent with the overall positive rates which were as follow: *A. lumbricoides(* 25.3%) ,infestation of *T. trichiura(* 89%), hook worm (68.3%) and infestation of *S. stercoralis* (2.3%).

Mahdi NK (1993) worked on Diagnostic methods for intestinal parasites in Southern Iraq with reference to *Strongyloides stercoralis.* Three hundred and thirty-two stool samples were examined for the presence of intestinal parasites including *Strongyloides stercoralis.* Each sample was processed and examined by direct smear formalin-ether and Harada Mori culture methods. Nine parasites were recovered from patients attending Basrah Teaching Hospital, Southern Iraq during 1989. The prevalence rate of infection was 64.2%. It was higher in rural(72.4%) than in urban(57.5%) region ($p > 0.01$). Sex distribution was 120(36.1%) males and 87 (26.2%) females ($p < 0.05$). The most common parasites were *Blastocystis hominis, Giardia lamblia, E. histolytica, Hymenolepis and Strongyloides stercoralis.*(MahdiNK 1993).

Andrew Hall (1994) also did study in urban rural community in Bangladesh in 1994. His finding showed one hundred and two of 880 subjects (11.6%) had a detectable infection with *Strongyloides stercoralis* at least one of the three six- monthly examinations; 34(3.9%) at the first examination , 43(4.9%) at the second and 44(5.0%) at the third examination (Hall 1994).

Another work of Andrew Hall on house hold aggregation of *Strongyloides stercoralis* infection showed the presence of *Strongyloides stercoralis* in Bangladesh. He observed 880 individuals examined on 3 occasions, 102 (11.6%) had an infection with *S. stercoralis* detected on at least one examination , as reported previously . Most infected individuals had an infection detected at only one or 2 of the three rounds of the examination, which was attributed mainly to the insensitivity of the method of parasitological examination rather than to the or cure of infections during the study (David 1995).

P. Roman-Sanchez (2003) worked on high prevalence of *Strongyloides stercoralis* among farm workers on the Mediterranean coast of Spain: analysis of the predictive factors of infection in developed countries. A study was made of *Strongyloides stercoralis* infection in a random and representative sample of farm workers in a tourist region in Spain based on the detection of larvae of triple stool samples. The prevalence infection was 12.4% (95% confidence interval [CI] 8.4-16.4).(P. Roman-Sanchez 2003)

Peter Stainmann (2007) worked on Occurrence of *Strongyloides stercoralis* in Yunnan Province, China, and Comparison of Diagnostic Methods . Multiple stool samples from a random population sample were subjected to the Kato-Katz method, an ether-concentration technique, the Koga agar plate method, and the Baermann technique. Among 180 participants who submitted at least 2 stool samples, we found a *S. stercoralis* prevalence of 11.7%. Males had a significantly higher prevalence than females (18.3% *versus* 6.1%, p=0.011), and infections were absent in individuals <15 years of age. Infections were only detected by the Baermann (highest sensitivity) and the Koga agar plate method, but neither with the Kato-Katz nor an ether-concentration technique. The examination of 3 stool samples rather than a single one resulted in the detection of 62% and 100% more infections when employing the Koga agar plate and the Baermann technique, respectively. The use of a mathematical model revealed a 'true' *S. stercoralis* prevalence in the current setting of up to 16.3%(Peter Stainmann 2007).

Mar-cos *et al.* (2008) worked on Strongyloides hyperinfection syndrome which is an emerging global infectious diseses. *S. stercoralisis* only parasite of soil-transmitted helminthes (STH) group which can cause auto infection and thus ultimately lead to high parasite intensity specifically in immune-compromised individuals. The hyperinfection syndrome (HS) caused by *Strongyloides stercoralis* has a high mortality rate (15% to 87%). A variety of risk factors and predisposing conditions have been described, malnutrition secondary to chronic *Strongyloides* diarrhoea; HS is an example of an emerging tropical infection migrating to developed countries and requiring greater clinician awareness

Sultana (2012) surveyed parasitic infestation in 2012 in different rural areas of Dhaka city. *Strongyloides stercoralis* larva was detected by microscopy in only one specimen which failed to show larva in culture. No larva were found by microscopic examination of FEC. Larva were detected in 34 (23.15%) stool samples using Harada Mori culture method but in only 15(10.2%) of these by APC. There was no association between detection of *Strongyloides stercoralis* larva in stool with either age or sex (Sultana 2012).

Azar Shokri (2012) studied on prevalence of *Strongyloides stercoralis* and other intestinal parasitic infections among mentally retarded residents in central institution of Southern Iran. A cross-sectional study was carried out in central rehabilitation institution of Hormozgan province in summer 2010. Fecal samples of all 133 residents (72 males and 61 females) aged 3-52, were collected in triplicate. Specimens were examined by direct smear, formalin-ether concentration techniques and stained by permanent Trichrome, Ziehl –Neelsen stains. Statistical analysis was conducted by SPSS 13.5 Intestinal parasitic infections were seen in 48.5% (64 out of 133 subjects: 53.4% in males and 46.6% in females). *Strongyloides stercoralis* with 17.3% showed the highest incidence followed by *Entamoeba coli* (9.8%) *Blastocystis hominis* (7.5%), *Giardia lamblia* (2.3%), *Endolimax nana* (2.3%), *Hymenolepis nana* (0.8%), *Oxyuris vermicularis* (0.8%)and *chilomasix mesnili*(0.8%). Double infection were found to be as : *Strongyloides stercoralis+ Giardia lamblia(2.3%), Entamoeba coli + Giardia lamblia (1.5%), Entamoeba coli+Blastocystis hominis*(1.5%), *Oxyuris vermicularis +Entamoeba coli* (0.8%), *Strongyloides stercoralis* + *Entamoeba coli* (0.8%), respectively (Azar Shokri 2012).

Manganelli L (2012) worked intestinal parasite infections in immigrant children in the city of Rome, related risk factors and possible impact on nutritional status. A convenience sample was collected of two hundred and forty seven immigrant children from the age group of 0 to 15 years. Thirty-seven children (15%) tested positive to parasites of the following species: *Blastocystishominis, Entamoeba coli, Giardia duodenalis, Enterobius vermicularis, Ascaris lumbricoides* and *Strongyloides stercoralis.* Amonospecific infection was detected in 30 (81%) out of 37 parasitized children while the others (19%) presented a poly parasitism. The major risk factors were housing, i.e. living in shacks, cohabitation with other families (p/0.01). Children classified in lower high Z-scores had a significantly greater prevalence of parasites (30.9%) than the others (P/0.01) (Manganelli L 2012).

Fabian Schar (2013) studied on global distribution and risk factors of *Strongyloides stercoralis*. A literature search was performed in PubMed for articles published between January 1989 and October 2011. A total of 354 studies from 78 countries were included for the prevalence calculations, 194 (62.4%) were community based studies 121(34.2%) were hospital based studies and 39 (11.0%) were studies on refugees and immigrants. In numerous African, Asian and South American resource-poor countries, information on *Strongyloides stercoralis* is lacking (Fabian Schar 2013).

Schar (2015) worked on Occurrence of and risk factors for *Strongyloides stercoralis* infection in South-East Asia. In South-East Asia, many countries provide the ideal ecological and economic setting for high *S. stercoralis* infection rates. Yet, in most of these countries, little is known about the actual prevalence and distribution of *S. stercoralis*. One reason for this lack of knowledge pertains to the time- and resource-intensive diagnostic methods used to detect *S. stercoralis* infection. The Koga Agar culture method and the Baermann method are considered to be the best coprological diagnostic methods for field settings today. Both detect the parasite with high sensitivity. This sensitivity can be increased further by examining stool samples for several consecutive days, thereby increasing the chances of detecting low-intensity chronic infections. Diagnostic challenges, however, lead to the omission of *S. stercoralis* in studies of soil-transmitted helminths and few studies focus on *S. stercoralis*, specifically. These factors lead to an underreporting of the nematode's prevalence, not only in South-East Asia but worldwide. We have reviewed the scientific literature of the last 25 years and estimated country-wide prevalence rates for South-East Asia. We aim to summaries what is known today about the prevalence of *S. stercoralis* in South-East Asia, as well as to ascertain the risk factors and diagnostic methods most commonly applied (Schär, Giardina, Khieu, Muth, Vounatsou, Marti , Odermatt).

Khiue (2014) worked in rural Cambodia on high prevalence and spatial distribution of *Strongyloides stercoralis* from February and June 2010. In this study among 2,396 participants from 60 villages in Preah Vihear Province, Northern Cambodia. Among 2,396 participants, 44.7% were infected with *Strongyloides stercoralis*. Of 1,071 strongyloidiasis cases, 339(31.6%) were among school children and 425 (39.7%) were found in individuals under 16 years. The incidence of *Strongyloides stercoralis* infection statistically increased with age . Infection among male participants was significantly higher than among females(OR:1.7; CI:1.4-2.0; P/ 0.001).Participants who defecated in latrines were infected significantly less than those who did not (OR:0.6; 95% CI:0.4-0.8; P= 0.001)(Khiue 2014).

Sinniah B (2014) studied on Prevalence of intestinal parasitic infections among communities living in different habitats and its comparison with one hundred and one studies conducted over the past 42 years (1970 to 2013) in Malaysia. Faecal samples were examined using the direct smear and formal ether sedimentation techniques. A total of 342 children were examined amongst whom 24.6% were positive for intestinal parasitic infections. Results showed that 32.3% of rural children, 20.6% of urban squatters and 5.4% of children from flats were positive for one or more parasites. The most common parasite encountered was *Trichuris trichiura* (20.2%) followed by *Ascaris lumbricoides* (10.5%) and hookworm (6.7%). No case of hookworm was reported in urban children whereas 12.2% of rural children were positive. The most common protozoan parasite detected was Entamoeba coli (3.2%) followed by Giardia intestinalis (1.8%), Entamoeba histolytica (1.8%) and Blastocystis hominis (1.2%). Nearly one-fifth (18.4%) of the children had single infection followed by double (12.0%) and triple infections (1.2%). Orang Asli (indigenous) children (44.3%) had the highest infection rate followed by Indians (20.2%), Malays (14.0%) and Chinese (11.9%). Twenty-eight studies carried out on plantation communities with regards to intestinal parasitic infections in Malaysia from 1970 to 2013 showed a steady decline in the prevalence rate ranging from 95.0% in the seventies to 37.0 % in 2012. Intestinal parasitic infections were more common in Orang Ashli communities with prevalence ranging from over 90% in the seventies and fluctuating below 70% in most studies between 2000 to 2013 except for two studies that showed a prevalence of 98.2% and 100%. The prevalence rate among urban squatters, urban residents and those living in flats showed dramatic decrease in prevalence rate (Sinniah B2014).

Rina Lisette Girard Kaminsky (2016) studied unsuspected *Strongyloides stercoralis* infection in hospital patients with comorbidity in need of proper management. She worked at the University Hospital, Honduras from March 2009 to February 2011.In this case thirty five (5 %) of 712 patients had *S. stercoralis* larvae in one stool sample; 62.8 % came from rural areas and 91.7 % were poor; 68.5 % (24/35) were 21 years old or older. Eight patients (22.8 %) had no predisposing illness; 3 (8.6 %) received steroid treatment, 29/35 (82.8 %) presented with persistent diarrhea and 24/35 (68.5 %) presented following comorbidities: HIV/AIDS (31.4 %), alcoholism alone (11.4 %) or with other associated illness (8.6 %), malignancy(8.6 %), renal failure (5.7 %) and hyperthyroidism (2.8 %) Rina Lisette Girard Kaminsky (2016).

Jennifer K. Ketzis Anne Conan (2017) studied on estimating occurrence of *Strongyloides stercoralis* in the Caribbean island countries: Implications for monitoring and control. Few data are available for the prevalence of *Strongyloides stercoralis* in the Caribbean region. This frequently under diagnosed soil-transmitted helminth (STH) can result in long- term low intensity chronic infections that are asymptomatic or can cause varied intestinal disturbances. With auto infections, infections lasting over 60 years can occur and hyper infections lead to high morbidity and mortality. Historical literature was searched to determine the prevalence of *S. stercoralis* in the Caribbean island countries with some additional countries and islands included for comparative data. A previously published model was used to calculate prevalence taking in to account the sensitivity of the diagnostic methods used. Data for 17 islands/Caribbean countries were found and sufficient data were located to calculate prevalence for 14 locations. Prevalence ranges from <1% to 20.3% and while it has decreased in many islands it has not decreased at the same rate as other STHs in the last 40 years within the Caribbean region (JenniferK.KetzisAnneConan(2017).

CHAPTER 3

Materials and Methods

Materials and Methods

3.1 Study area:

The study area was conducted in two selected areas adjacent to Dhaka city for the present research. These are rural and street dwellers of Savar and Gazipur. The name of the rural area of Savar are Genda, Pandhoa. Selected rural areas of Gazipur are Barotopa, Gazipura. Now, some of theses areas are considered as semi –urban area because there are some structural changes that have occurred in last five years like brick road communication, water supply, electricity and setting of water- seal latrines. In addition to these changes, some new industries also lay down up there, but most of the people are illiterate and don't concern about their personal hygiene.

Socio Demography of Selected area

In this study the areas which were selected showed different prevalence of *Strongyloides stercoralis* according to difference of socio demographic fact like income, education, house types, toilet types, source of drinking water etc. The place which were dirty, supply of water was not clear, people lived in crowded place , large family members and don't bother about the hygienic condition possessed a high prevalence of helminthiasis. On the other hand the people maintaining hygiene condition and living a higher standard of life had a low or no prevalence of parasitic prevalence of parasitic helminthes infection.

3.2 Study population:

Both children and adults were involved in study population. Sampling was done by simple random technique. Every house was visited and dwellers were asked few questions to fill up the questionnaire. The present study followed the purposive technique.

3.3 Sample Size:

160 stool samples were collected from selected areas. Respondents were both male and female.

3.4 Period of Study:

SI. No.	Name of milestones	Starting Date	Completion Date
1.	Collecting samples	2016 December	2017 December
2.	Stool detection with Demographic detail	2016 December	2017 December
3.	Data analysis & Thesis writing	2017 December	2018 December

3.5 Research Materials:

1. Filter paper
2. 10% Formalin
3. Ether
4. Normal saline
5. Glass slide
6. Cover slip
7. Petridishes
8. Pipette
9. Test tube
10. Centrifuge machine
11. Tap water

3.6 Collection of stool samples:

The following procedures were maintained while collecting the stool samples:

1. The container was clean and leak proof
2. Fresh stool was collected for microscopic or concentration technique.
3. An air space was kept inside the container and on the top of the container.
4. Occasionally suitable preservations were used like refrigerator
5. Every specimen was properly labeled with the age, sex and date of collection with time.

3.7 Preservation of stool samples:

In my research Formalin preservation method was followed to preserve stool sample.

Formalin preservation:

- 10% formalin
- Formaldehyde (U.S.P)-100 ml
- Saline solution(0.85%)-900ml
- Preparation: Dilute 100 ml of formaldehyde with 900ml of 0.85% saline solution (distilled water may be used instead of saline solution).

Note: Ratio-3 parts of 10% formalin: 1 part of stool and emulsified (3:1).

Methods

In my research three methods were adopted to identify the problems. These are-

1. Direct saline smear
2. Formal-Ether concentration(FEC) for sedimentation
3. Harada-Mori culture for culture

Collected samples were examined by direct microscopy and formal-ether concentration method. Ova positive cases were singled out for larvae culture to identify the *S. stercoralis* and also other larva and eggs.

3.8 Examination of stool:

A. Physical or microscopic examination: It is important to determine the following observation:

1. Colour of stool
2. Consistency (i.e. whether it is formed, semi formed, unformed or fluid).

B. Microscopic examination of fecal specimen:

1. Direct microscopy in saline preparation
2. Concentration technique: Formal-ether concentration technique

Procedure of tests:

3.9 Direct saline smear:

To prepare the direct fecal smear, a drop of saline (0.85% NaCl) was placed on the center of a clear slide. With an applicator about 2mg of feces (1 mg is approximately 1cubic mm) was selected and without spreading the drop of saline, using a piece of stick and mix until 2 gm. sample was suspended. Any gross fibers or particles were removed and covered with a 22x22mm glass. Avoided air bubbles by drawing one ages of the cover slip slightly into the suspension and it was lowering almost to the slide before letting it fall. If the preparation was unsatisfactory , it was discarded. No time was wasted on a preparation that could only yield doubtful results in negative.

The entire saline preparation was superficially examined under microscope by using the 10X objective.

Parasites were normally found from fecal samples are larvae of *Strongyloides stercoralis* and egg of *Ascaris lumbricoides, Trichuris trichiura* , *Enterobius vermicularis* .

3.10 Formal-Ether concentration(FEC)

The number of parasitic forms of helminthic parasites in fecal specimens is often too low to be observed microscopically in direct wet mounts or in stained smear preparation. In such cases, the use of concentration techniques increases the chances of detecting parasitic organisms. The two most commonly used stool concentration techniques are sedimentation and flotation.

Sedimentation techniques are preformed commonly in general diagnostic laboratories because they are easier to perform and less prone to technical errors.

Equipment used:

- Electrical centrifuge machine
- Centrifuge tube
- Application sticks: wooden, soft stick

3.10.1 Reagents required for Formal-Ether Concentration:

- Pure ether or acetate
- Formaldehyde
- NaCl solution

3.10.2 FEC technique (Monica Cheesbrough 1987):

1. Using rod or stick, emulsify as estimated 1 gm of feces in about 4-5 ml NaCl solution contained into a screw-cap tube.

   Note: Include in the sample of feces, parts from the surface and center of the specimen.
2. Add a further 3-4ml of 10% V/V formal water, cup of bottle and mix by shaking for about 15 seconds by using vortex mixture.
3. Sieve and emulsified feces, collecting the sieve suspension to centrifuge tube.
4. centrifuge for 5 minutes at 3000 rmp.
5. Pot off the suspended debris.
6. Add 7ml normal saline and 3ml ether and then mix by hand.

Caution: Ether is highly flammable , therefore use well away from an open flame e.g. flame for burner of a gas refrigerator , Bunsen burner or spirit lamp. Ether vapor is anesthetic; therefore make sure the laboratory is well-ventilated.

7. Mix by shaking and again centrifuge for one minute at 2-3 speed.
   After centrifuging the parasites sedimented to the bottom of the tube and the fecal debris collected in a layer between the ether and formal water as given below:
   a) Layer ether
   b) Layer debris
   c) Layer formaldehyde
   d) Layer sediment containing parasites
8. Using a stick or the stem of a plastic bulb pipette, loosen the layer of fecal debris from the side of the tube and rapidly invert the tube to describe the ether , fecal debris and formal water. The sediment will remain.
9. Add little amount of normal saline and allow the fluid from the side of the tube to drain to the bottom of the tube.
10. Using a plastic bulb pipette or Pasteur pipette, mix the sediment. Expel the sediment back carefully into centrifuge tube by counting the total number of drops.
11. Next put 1-2 drops on a clean glass slide i.e. sample drop and cover with a cover glass. Record the total drop and sample drop.
12. Examine microscopically the entire preparation using the 10X objectives with the consider iris close sufficiently to give good contrast. Use the 40X objective to identify small cysts and eggs. If cysts are present , run a small drop of iodine under the cover glass to confirm their identity.
13. Count the number of *S. stercoralis* and hookworm eggs in the entire preparation. This will give the approximate number of eggs per gram(EPG) of feces.
14. Systematically examine the entire surface of each coverslip with the 10x objective or, if needed for identification, higher power objectives of the microscope in a systematic manner so that the entire coverslip area is observed. When organisms or suspicious objects are seen, switch to higher magnification (40X) to see more detailed morphology of the object in question.

3.11 Harada-Mori culture:

Harada-Mori method (triplicate) was used to culture *S. stercoralis.* Two grams of stool was used for culture replicate; thus a total of 6 gm of stool was used in Harada-Mori methods. Cultures were incubated at 25°-28°C for a weak and examined daily. Any specimen, in which at least one larva was identified by either direct microscopy or culture, was regarded as positive. Positive samples were confirmed by microscopic examination of *Strongyloides* larva for morphological structure (Gracia LS.2001).

3.12 Identification of the Findings:

Two types of larvae are found:

(A) Rabditiform larvae (B) Filariform larvae

(A) Rabditiform Larvae: These are developed directly from the gravid females and are found in the lumen of the bowel. They measure from 200 to 250 µm in length by 16 mm by breath ; they have short mouth and double –bulb esophagus. The rabditiform larvae voided with the faeces and may undergo development in the soil-direct and indirect cycle.

Although the rhabditiform larvae appear similar to hookworm larvae , there are key identifying features seen in *Strongyloides stercoralis* which separate the two such as a muscular cup shaped esophagus , an extremely short buccal cavity of only a few micrometers and a large genital primordium . These rhabditiform larvae emerge into the lumen of the small intestine towards colon where they may moult once and become second-stage larvae which are generally passed with the faeces and are deposited in the soil.

Strongyloides larvae have very similar morphology to those of hookworm, fortunately their buccul cavities distinguish the two. A short buccal cavity distinguishes the *Strongyloides* rhabditiform larvae from the rhabditiform larvae of hookworm, as it is generally longer in hookworm, as shown in the drawings on the left. The rhabditiform stages of each worm can also be distinguished by their different esophageal structure.

(B) Filariform Larvae: These are longer and more slender than the rhabditiform larvae. They have short mouths and cylindrical esophagus. They constitute the infective stage and enter the body of the human host through the skin. Filariform larvae are slender and have a notched tip of the tail.(http://www.wadsworth.org/parasitology/critiquesOct03.htm)

The mouth of the filariform larvae is a small pore containing a shallow mouth capsule with a narrow compressed buccal tube enclosed by the anterior portion of the pharynx is encircled by a nerve ring extending posteriorly to about 40% of the length of the larva. The pharynx leads into the straight intestine which consists of 11 pairs of dorsal and ventral cells. At the midpoint of the intestine, a small transparent genital rudiment is present in the pseudo coelom. The gastrointestinal tract opens to the exterior through an excretory pore located along the mid ventral line of the body of the larva. The cuticle of this filariform larva forms two narrow, adjacent parallel flanges called lateral alae that extend along the lateral lines to the tip of the worm's tail. The alae in the tail giving its bifurcated or trifurcated appearance (notched tail) are the unique characteristic of these larvae. This filariform larvae then burrow into the mucosa and enter the circulation directly causing autoinfection.

3.13 Terminology:

$$\text{Prevalence} = \frac{\text{Number of infected}}{\text{Total number of host examined}} \times 100$$

[Margolis *et.al.*1982]

3.14 Season:

Summer-March to May

Rainy-June to October

Winter-November to February

(Chowdhury, 1978).

3.15 Data Analysis:

The rate of prevalence of each parasites specie was determined and compared statistically using regression method. Differences in the prevalence rate of parasites were considered statistically significant when the $p \leq 0.05$ at the 95% confidence level.

CHAPTER 4

Overview of *Strongyloides stercoralis*

Overview of *Strongyloides stercoralis*

Strongyloides stercoralis is a pathogenic parasite that is very prevalent in the tropical and subtropical regions of the world and is endemic in the Southeastern United States. Its common name is threadworm. In the UK and Australia, however the term threadworm can also refer to nematodes of genus *Enterobius*, otherwise known as pinworms. (Vanderkooi 2000) (Wekipedia 2016).

Strongyloidiasis is caused by the female nematode *Strongyloides stercoralis*. In its classic life cycle, *Strongyloides* travels from the skin to the lungs and then to the gastrointestinal (GI) tract of its host. The *Strongyloides stercoralis* nematode can parasitize humans. The adult parasitic stage lives in tunnels in the mucosa of the small intestine. The genus *Strongyloides* contains 53 species and *S. stercoralis* is the type species. *S. stercoralis* has been reported in other mammals, including cats and dogs. However, it seems that the species in dogs is typically not *S. stercoralis*, but the related spices *S. canis*. Non-human primates are more commonly infected with *S. fuelleborni* and *S. cebus*, although *S. stercoralis* has been reported in captive primates. Other species of *Strongyloides*, naturally parasitic in humans, but with restricted distributions, are *S. fuelleborni* in central Africa and *S. kellyi* in Papua New Guinea.

4.1 Scientific classification

Kingdom: Animalia

Phylum: Nematoda

Class: Secernentea

Order: Rhabditida

Family: Strongyloididae

Genus: *Strongyloides*

Species: *S. stercoralis*

Binomial Name: *Strongyloides stercoralis* (Bavay, 1876).

English common name: Thread worm

4.2 Geographic Distribution

S. stercoralis has a very low prevalence in societies where fecal contamination of soil or water is rare. Hence, it is a very rare infection in developed economies. In developing countries, it is less prevalent in urban areas than in rural areas (where sanitation standards are poor). *S. stercoralis* can be found in areas with tropical and subtropical climates.

Strongyloidiasis was first described in the 19th century in French soldiers returning home from expeditions in Indochina. Today, the countries of the old Indochina (Vietnam, Cambodia, and Laos) still have endemic strongyloidiasis, with the typical prevalence being 10% or less. Regions of Japan used to have endemic strongyloidiasis, but control programs have eliminated the disease. Strongyloidiasis appears to have a high prevalence in some areas of Brazil and Central America. It is endemic in Africa, but the prevalence is typically low (1% or less). Pockets have been reported from rural Italy, but current status is unknown. In the Pacific islands, strongyloidiasis is rare, although some cases have been reported from Fiji. In tropical Australia, some rural and remote Australian Aboriginal communities have very high prevalence of strongyloidiasis.

In some African countries (e.g., Zaire), *S. fuelleborni* was more common than *S. stercoralis* in parasite surveys from the 1970s, but current status is unknown. In Papua New Guinea, *S. stercoralis* is endemic, but prevalence is low. However, in some areas, another species, *S. kellyi*, is a very common parasite of children in the New Guinea Highlands and Western Province.

Knowledge of the geographic distribution of strongyloidiasis is of significance to travelers who may acquire the parasite during their stays in endemic areas.

Because strongyloidiasis is transmittable by textiles, such as bedclothes and clothing, care must be taken never to use hotel bed sheets in endemic areas. Personal sleeping bags and using plastic slippers when showering are very important when travelling in tropical regions.

Estimates of the number of people infected vary with one estimate putting the figure at 370 million worldwide. Local prevalence can exceed 40% in some tropical and subtropical countries.

4.3 Habitat

Free–living *Strongyloides stercoralis* prefer the moist soil of warm climates. In the parasitic generation, the most common habitat in the host is the mucosal lining of the small intestine. Rarely, filariform larvae have been observed to take up residence in the lining of the bronchi and trachea and lay their eggs there after transforming to adults. (Cheng 1986).Their habitat is classified into temperate, tropical, terrestrial and fresh water regions. Terrestrial biomes are desert or dune, savanna or grassland, chaparral, forest, rainforest, scrub forest and mountains. Aquatic biomes are lakes and ponds, rivers and streams and temporary pools. Wetlands are marsh and swamp. Other habitats are urban, suburban and agricultural areas.

4.4 Habits

The three most important definitive hosts for *Strongyloides stercoralis* are human, dogs and cats. They frequently use other mammals as hosts as well, though with much less frequency. Parasitic females feed on the tissue of the host's internal organs which includes the intestines as well as the lungs. Free-living adults and rhabditiform larvae feed on organic debris in soil or water.

Pharyngeal glands and intestinal epithelium produce digestive enzymes to feed on the host's fluids. Extracellular digestion begins within the lumen and is finished intracellularly. (Barnes 1987, Cheng 1986)

4.5 Morphology

The parasite has an unusual developmental cycle involving the formation of eggs, free-living and parasitic larvae, free-living male and female adult worms, as well as parasitic parthenogenetic female worms. Eggs appear as small oval thin-shelled bodies, measuring 50-58µm in length by 30-34µm in width, and are partially embryonated at the 2-8 cell stage of development.

Free-living larvae (L1 and L2) measure up to 350µm in length and have a rhabditiform pharynx (with a muscular esophagus for feeding on particulate material). Infective third-stage larvae (L3) measure up to 600µm in length and have a filariform pharynx (with a long fine esophagus for sucking fluids after penetrating host tissues). These larvae do not feed in the soil and are unsheathed with a closed mouth and a pointed notched tail.

Parasitic adult females live within the small intestinal mucosa. The digestive system of the female parasitic worm contains a cup-shaped mouth, a long cylindrical pharynx also called the esophagus leading to the intestine which is a long straight tube ending at the rectum and the anus. Pharynx is constricted and surrounded by a nerve ring with a triradiated structure. The excretory system consists of two excretory canals along the entire length of the worm and the excretory pore is located on the mid-ventral line of the body. Parasitic females have very simple reproductive system where the anterior branch extends to the pharynx and bends back and lie parallel to the intestine. Both sexes also possess a tiny buccal capsule and cylindrical esophagus without a posterior bulb. In the free-living stage, the esophagi of both sexes are rhabditiform . Males can be distinguished from females by two structures: two spicules and a gubernaculum. Males also have a pointed tail.

4.6 Life cycle

Strongyloides stercoralis is an important parasitic worm that can infect humans, other primates and occasionally cats and dogs. Humans acquire strongyloidiasis by contact with soil, food or water containing invasive filariform larvae of *Strongyloides stercoralis* . Even though theses larvae have the ability to penetrate the skin, the parasite can also infect humans by ingestion of contaminated water or food.

The life cycle of *Strongyloides* is basically comprised of 2 parts: a free-living cycle outside of the host as rhabditiform larvae and a parasitic life cycle as infective filariform larvae (filariae). The complex life cycle of *Strongyloides stercoralis* , alternates between free living and parasitic cycles and its potential for autoinfection within the host has been well described by G. A. Schad in 1989.

The *Strongyloid's* life cycle is heterogenic it is more complex than that of most nematodes, with its alternation between free-living and parasitic cycles, and its potential for autoinfection and multiplication within the host. The parasitic cycle is homogony, while the free-living cycle is heterogenic. The heterogenic life cycle is advantageous to the parasite because it allows reproduction for one or more generations in the absence of a host.

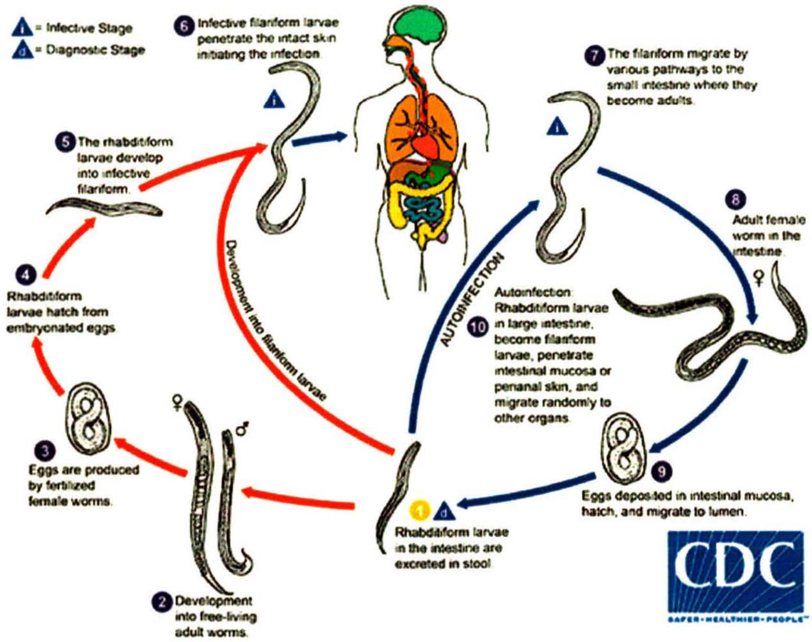

Fig 1. Life Cycle of *Strongyloides stercoralis*

In the free-living cycle, the rhabditiform larvae passed in the stool can either molt twice and become infective filariform larvae (direct development) or molt four times and become free-living adult males and females that mate and produce eggs from which rhabditiform larvae hatch. In the direct development, first-stage larvae (L1) transform into infective larvae (IL) via three molts. The indirect route results first in the development of free-living adults that mate; the female lays eggs, which hatch and then develop into IL. The direct route gives IL faster (three days) versus the indirect route (seven to 10 days). However, the indirect route results in an increase in the number of IL produced. Speed of development of IL is traded for increased numbers. The free-living males and females of *S. stercoralis* die after one generation; they do not persist in the soil. The latter, in turn, can either develop into a new generation of free-living adults or develop into infective filariform larvae. The filariform larvae penetrate the human host skin to initiate the parasitic cycle.

Filariform larvae from the soil remain viable in either moist soil or water for several days, which penetrate the human skin and proceed into the submucosa, then into the venous circulation, and then toward the right heart and lungs. During the maturation process, *Strongyloides* larvae induce alveolar capillary bleeding and potent eosinophilic inflammation, resulting in eosinophilic pneumonitis. From the alveoli, the larvae continue to migrate up the pulmonary tree and trachea. The cough reflex helps to push the larvae out of the bronchial tree and trachea. However, once the larvae reach the larynx, they are swallowed and travel to the stomach and small bowel. The larvae enter the mucosa in the duodenum , undergo 2 molts and inside the GI tract, *Strongyloides* larvae mature into diminutive adult females that measure approximately one tenth of one inch (ie, 220—250 μm). which begin reproducing and completing the life cycle.

The infectious larvae penetrate the skin when it contacts soil. While *S. stercoralis* is attracted to chemicals such as carbon dioxide or sodium chloride, these chemicals are not specific. Larvae have been thought to locate their hosts via chemicals in the skin, the predominant one being urocanic acid, a histidine metabolite on the uppermost layer of skin that is removed by sweat or the daily skin-shedding cycle. Urocanic acid concentrations can be up to five times greater in the foot than any other part of the human body. Some of them enter the superficial veins and are carried in the blood to the lungs, where they enter the alveoli. They are then coughed up and swallowed into the gut, where they parasitize the intestinal mucosa of the duodenum and jejunum. In the small intestine, they molt twice and become adult female worms.

The females live threaded in the epithelium of the small intestine and, by parthenogenesis, produce eggs, which yield rhabditiform larvae. Only females will reach reproductive adulthood in the intestine. Within the intestinal lumen, the eggs hatch into non infective rhabditiform larvae, which are excreted, along with stool, into the environment (ie, soil). It takes about two weeks to reach egg development from the initial skin penetration. By this process, *S. stercoralis* can cause both respiratory and gastrointestinal symptoms. The worms also participate in autoinfection, in which the rhabditiform larvae become infective filariform larvae, which can penetrate either the intestinal mucosa (internal autoinfection) or the skin of the perianal area (external autoinfection); in either case, the filariform larvae may follow the previously described route, being carried successively to the lungs, the bronchial tree, the pharynx, and the small intestine, where they mature into adults; or they may disseminate widely in the body. To date, occurrence of autoinfection in humans with helminthic infections is recognized only in *Strongyloides stercoralis* and *Capillaria philippinensis* infections. In the case of *Strongyloides*, autoinfection may explain the possibility of persistent infections for many years in persons not having been in an endemic area and of hyper infections in immunedepressed individuals. (Wekipedia 2016)

4.7 Zoonotic transmission

Dogs can act as a host for this parasite both in the wild and in the laboratory but transmission from dog to human has been difficult to prove. A molecular genetic analysis has shown that there are two populations of this parasite in dogs, one of which is exclusive to dogs and a second that is common to dogs and humans. These two genotypes may be separate species. The identity of the genes suggests that dog to human transmission may occur.

4.8 Autoinfection

S. stercoralis is unique in its ability to replicate in the human host permitting ongoing cycles of autoinfection. Strongyloidiasis can consequently persist for decades without further exposure to exogenous infection. This means that the parasite never reaches the soil; instead, it re-enters the host via enteral circulation (endo autoinfection) or perianal skin (exo autoinfection). In addition, hands (eg, dirty fingers and fingernails) or food contaminated with stool can carry infective filariform larvae from the anus back to the host (the fecal-oral route). Thus, parasites can remain in the human body for the remainder of the host's life.

Filarifrm larvae, migrating to the exterior , can reinfect the host by penetrating the skin and travelling in the blood to the lung.(Cheng 1986, Roberts and Janovy 2000).

An unusual feature of *S. stercoralis* is autoinfection. Only one other species in the *Strongyloides* genus, *S. felis*, has this trait. Autoinfection is the development of L1 into small infective larvae in the gut of the host. These autoinfective larvae penetrate the wall of the lower ileum or colon or the skin of the perianal region, enter the circulation again, travel to the lungs, and then to the small intestine, thus repeating the cycle. Autoinfection makes strongyloidiasis due to *S. stercoralis* an infection with several unusual features.

Persistence of infection is the first of these important features. Because of autoinfection, humans have been known to still be infected up to 65 years after they were first exposed to the parasite (e.g., World War II or Vietnam War veterans). Once a host is infected with *S. stercoralis*, infection is lifelong unless effective treatment eliminates all adult parasites and migrating autoinfective larvae.(http://en.wikepedia.org/wiki/*Strongyloides_stercoralis*).

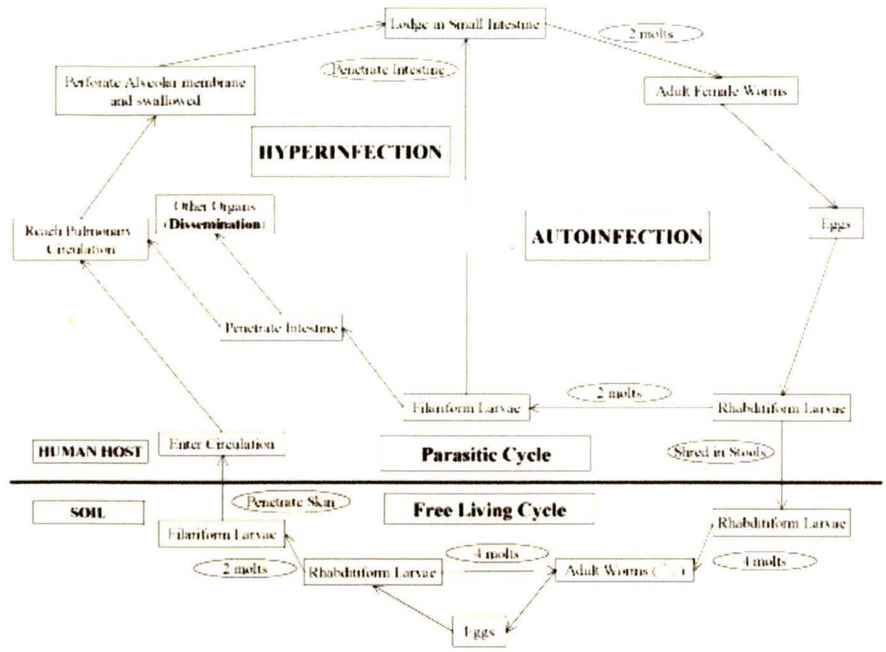

Fig 2. Route of the life cycle of *Strongyloides stercoralis*

4.9 Immunology

A prolonged coexistence occurs between the host and the parasite after the entry of infective filariform larvae into the human host. This balance become interrupted when the immune system is depressed.

After the first primary infection an immunity develops which prevents reinfection and the *Strongyloides* larvae and adult worms remain confined to the intestine and tissue invasion is prevented. The immunity may be diminished in immune-suppressive states which reduce the resistance of the body, leading to an extensive tissue invasion by the adult worm. An infected individual when exposed to reinfection responds by tissue hypersensitivity with eosinophilia and giant urticaria. Serum antibody develops in Strongyloidiasis and gives a cross reaction with filarial complement fixation test (K,D. Chatterjee, 2009)

4.10 Pathogenicity

Infection with *Strongyloides stercoralis* is known as strongyloidiasis. The following lesions may be observed:

1. Skin Lesions(2 types): An urticarial rash at the site of entry and a linear, erythematous urticarial wheal around the anus caused by migrating filariform larva.
2. Pulmonary Lesions: Hemorrhages in the lung alveoli and bronchopneumonia. These develop during migration of filariform larva through the lungs and form an avenue of escape into the alveoli. These areas are often infiltrated with eosinophil cells.
3. Intestinal Lesions: Intractable diarrhea with blood and mucus, produced by the mechanical movements of the female parasites. Microscopically small tunnels through which parasitic females have burrowed their ways may be seen; congestion hemorrhages, round cell infiltration and desquamation of epithelial cells are observed.
4. Blood Changes: A marked eosinophilia and a moderate leukocytosis during the invasive stage.

4.11 Symptoms

Many people infected are asymptomatic at first. Symptoms include dermatitis: swelling, itching, larva currents, and mild hemorrhage at the site where the skin has been penetrated. Spontaneous scratch-like lesions may be seen on the face or elsewhere. If the parasite reaches the lungs, the chest may feel as if it is burning, and wheezing and coughing may result, along with pneumonia-like symptoms (Löffler's syndrome). The intestines could eventually be invaded, leading to burning pain, tissue damage, sepsis, and ulcers. Stools may have yellow mucus with a recognizable smell. Chronic diarrhea can be a symptom. In severe cases, edema may result in obstruction of the intestinal tract, as well as loss of peristaltic contractions.

Strongyloidiasis in immune competent individuals is usually an indolent disease. However, in immune compromised individuals, it can cause a hyper infective syndrome (also called disseminated strongyloidiasis) due to the reproductive capacity of the parasite inside the host. This hyperinfective syndrome can have a mortality rate close to 90% if disseminated. (Igra-Siegman 1981, Marcos 2008)

Immunosuppressive drugs, especially corticosteroids and agents used for tissue transplantation, can increase the rate of autoinfection to the point where an overwhelming number of larvae migrate through the lungs, which in many cases can prove fatal. In addition, diseases such as human T-lymphotropic virus 1, which enhance the Th1 arm of the immune system and lessen the Th2 arm, increase the disease state. Another consequence of autoinfection is the auto infective larvae can carry gut bacteria back into the body. About 50% of people with hyper infection present with bacterial disease due to enteric bacteria. Also, a unique effect of auto infective larvae is larva currens due to the rapid migration of the larvae through the skin. Larva currents appears as a red line that moves rapidly (more than 5 cm or 2 in per day), and then quickly disappears. It is pathognomonic for auto infective larvae and can be used as a diagnostic criterion for strongyloidiasis due to *S. stercoralis*.

Hyper infection syndrome represents an acceleration of the normal life cycle of *S. stercoralis,* leading to excessive worm burden within the traditional reproductive route (the skin, gut, and lungs), while disseminated strongyloidiasis involves widespread dissemination of larvae outside of the gut and lungs, often involving the liver, brain, heart, and urinary tract. Occasionally, strongyloidiasis is associated with gut translocation of bacteria and bacteremia. Commonly reported organisms include gram-negative rods such as *Escherichia coli* and gram-positive cocci such as *Streptococcus bovis*. Thus, the presence of *S. bovis* bacteremia should prompt a search for strongyloidiasis, in addition to a search for GI malignancies.

The clinical presentation of hyper infection syndrome is similar to that of classic strongyloidiasis, which includes nausea, vomiting, diarrhea, weight loss, abdominal pain, GI hemorrhage, cough, fever, and dyspnea. However, due to increased parasite turnaround and dissemination, patients with hyper infection syndrome and disseminated disease often have catastrophic clinical manifestations such as shock, disseminated intravascular coagulation, meningitis, renal failure, and/or respiratory failure.

4.12 Diagnosis

Definitive diagnosis of strongyloidiasis is by detection of larvae in stool. Recovery of parasites from duodenal contents, sputum, tissue samples or body fluid is less common. Diagnosis is however, difficult in chronic infection with low larval output especially in chronic cases. Patients at risk who present with symptoms like eosinophilia, diarrhea, abdominal pain, urticarial and larva currens should be screened for *Strongyloides stercoralis*.

Routine screening for strongyloidiasis of all patients prior to corticosteroid therapy, other immunosuppressive therapy or organ transplantation is recommended.

Locating juvenile larvae, either rhabditiform or filariform, in recent stool samples will confirm the presence of this parasite (Roberts 2005). Still, diagnosis can be difficult because of the varying juvenile parasite load on a daily basis.

Diagnosis of *Strongyloides* hyperinfection syndrome and/or disseminated disease can be very difficult to establish and entails a high level of suspicion. Some experts argue that the mere presence of eosinophilia is enough reason to search for this parasite. In the case presented by Grover and coworkers, an esophagogastroduodenoscopy (EGD) was performed because of the patient's unrelenting nausea and vomiting, and mild erythema was found in the fundus and antrum of the stomachs.

4.13 Treatment

The first-line therapy for strongyloidiasis is ivermectin , which achieves eradication rates of approximately 80%. It is the drug of first choice for treatment because of higher tolerance in patients. Thiabendazole (mintezol) was used previously, but, owing to its high prevalence of side effects (dizziness, vomiting, nausea, malaise) and lower efficacy, it has been superseded by ivermectin and as second-line albendazole (albenza, GlaxoSmithKline). However, these drugs have little effect on the majority of these autoinfective larvae during their migration through the body. Hence, repeated treatments with ivermectin must be administered to kill adult parasites that develop from the auto infective larvae. This means at least two weeks' treatment, then a week's pause, then again treatment. Follow-up treatment and blood tests are necessary for decades following infection.

Often, a single course of treatment is insufficient. Thus, if symptoms do not resolve after the initial therapy, it is imperative that diagnostic studies (stool, duodenal fluid, and/or endoscopy) be repeated to determine the persistence of the *Strongyloides* infection and whether a second course of therapy should be given. Resolution of eosinophilia does not always indicate clearance of *Strongyloides*. Because it is difficult to clinically confirm eradication of the infection, many experts prefer to repeat a 2-day course of therapy 1 week after the initial course, with careful follow-up in patients with persistent symptoms and/or infection.

In the UK, mebendazole and piperazine are currently (2007) preferred. Mebendazole has a much higher failure rate in clinical practice than albendazole, thiabendazole, or ivermectin.

4.14 Prevention and control

Ideally, prevention, by improved sanitation (proper disposal of feces), practicing good hygiene (washing of hands), etc., is used before any drug regimen is administered.

Since *S. stercoralis* reproduces by parthogenesis and it also shows autoinfection ability inside the host body, management of this disease is difficult. To our knowledge , no studies have investigated prevention and management strategies to control and eradicate strongyloidiasis. However, improvements in diagnosis, chemotherapy and a better understanding of the epidemiology of the infection as well as the dynamics of transmission could improve approaches to control of any helminth infection. A long term control program is necessary to be effective at reducing the prevalence of *S. stercoralis* from endemic communities.

Reduction in level of *S. stercoralis* in the environment can be achieved by improving personal hygiene measures like proper sanitation and community education of those living in high risk communities about risk factors for infection, protection and hygiene. Installation of human waste deposal system is required for those living in poor and crowded communities to prevent further spread of this worm. Laboratory personnel and people working in institute where personal hygiene is poor should be aware that this infection is spread by skin contact with infected faeces and secretions.

4.14.1 Mass Drug Administration

Mass chemotherapy of both infected and uninfected people in endemic communities can be a successful way of controlling strongyloidiasis. The prevalence of strongyloidiasis dropped from 19% to 0.5% in a rural community of Costa-Rista by giving the mass treatment of all members in urban communities. A similar result was observed when thiabendazole was given as a treatment of all members in urban communities. Prevalence rate dropped 13% to 3% in one community and 17% to <1% in another and this lower prevalence was sustained for one year after the treatment. Mass treatment with albendazole and or ivermectin reduced the prevalence rate from 9% to 2% in an island of Japan . Later in 1991, Whitworth found that ivermectin MDA for control of filariasis was also effective in controlling strongyloidiasis.

4.14.2 Vaccine for strongyloidiasis

Ivermectin is the drug of the first choice for the treatment because of higher tolerance in patients (Johnston 2005).

In 2011, resistance of ivermectin was observed in soil transmitted nematodes and *Onchocerca volvulus* ; this suggest that there is a potential for development of ivermectin resistance to ivermectin *S. stercoralis*. Thus, a vaccine against strongyloidiasis is needed especially to prevent hyper infection, which is harder to treat in people with concurrent potentially fatal disease.

4.15 Chemoattractant

This parasite depends on chemical cues to find a potential host. It uses sensor neurons of class AFD to identify cues excreted by the host. *S. stercoralis* is attracted to nonspecific attractants of warmth, carbon dioxide, and sodium chloride. Urocanic acid, a component of skin secretions in mammals, is a major chemo attractant. Larvae of *S. stercoralis* are strongly attracted to this compound. This compound can be suppressed by metal ions, suggesting a possible strategy for preventing infection.

4.16 Reproduction

Females may produce a pheromone to attract males. The male coils around a female with his curved area over the female genital pore. The gubernaculum, made cuticle tissue, guides spicules which extend through the cloaca and anus. Males use spicules to hold female during copulation. Nematode sperm are amoeboid like and lack flagella. (Barnes,1987; Cheng, 1986, Roberts and Janovy, 2000).

Prasitic female can reproduce through parthenogenesis and lay eggs that hatch into rhabditiform larvae. Adult worms mate and produce eggs which hatch into rhabditiform larvae and develop into infective filariform larvae after 2 moults.

4.17 Behavior

Rhabditiform larvae of *Strongyloides stercoralis* molt four times becoming sexually mature adults. However, if the external environment becomes unfavorable, they will metamorphose into non-feeding filariform larvae that can infect human or some other hosts. As mentioned earlier, if the filariform larvae entre the host through the skin, they must migrate to the intestine via the host's tissues. For years, it has been thought that the larvae are carried to the lungs by the blood. It is believed that they inhabit the alveoli by traveling through the right atrium and ventricle of the heart. The pulmonary artery eventually brings them to the lungs where they move up the bronchi and trachea and eventually are coughed up and swallowed. The filariform larvae then mature in the intestine . This has only proven to be the case in human. In dogs the filariform larvae do not seem to travel through the lungs but seem to get to the intestine through any route. During the auto infective phase, filariform larvae reenter the host through the lower gut mucosa or the perianal skin.(Cheng,1986, Roberts and Janovy, 2000).

4.18 Summary

Strongyloidiasis can involve many organs and, therefore, can have unspecific and unusual clinical manifestations, making the infection difficult to diagnose. Furthermore, lack of familiarity with this condition can have catastrophic consequences. Due to its unique life cycle, *Strongyloides* is capable of infecting a host until death of the host. Strongyloidiasis can be a severe disease, causing both hyper infection syndrome and disseminated disease, particularly in transplantation patients. Thus, any patient who came from or traveled to an endemic area of the world may potentially be infected with this parasite, particularly if symptoms and blood and/or tissue eosinophilia are present. Clinicians should search for strongyloidiasis in any patient awaiting transplantation who has epidemiologic risk factors or clinical or laboratory signs of the condition.

CHAPTER 5

Observation and result

Observation and Result

A total 0f 160 stool samples were collected to observe the prevalence of *S. stercoralis* infection from Genda, Pandhoa area in Savar and Barotopa, Gazipura area in Gazipur district. Out of 160 stool samples 100 samples were collected from Savar and 60 samples were collected from Gazipur.

RESULTS

5.1. Overall Prevalence of *S. stercoralis* infection and other helminthic infection (Table 1a& 1b)

Out of 160 collected samples, 17 (10 in Savar and 7 in Gazipur) were positive for *S. stercoralis* infection and 67 were positive for other helminthic infection in Savar and 42 in Gazipur. Other finding of helminthes were *Ascaris lumbricoides, Trichuris trichuira and Enterobius vermicularis.*

Table-1a: Overall prevalence of *S. stercoralis* infection and other helminthic infection found in stool samples in Savar.

Out of 100 samples examined, prevalence of *S. stercoralis* 10% and other helminthes 67%. So, total is 77% for helminth infestation found.

Location			**Savar**		
Total samples Examined	Total No. of positive for *S. stercoralis* Infection	Prevalence of positive for *S. stercoralis* infection (%)	Total samples of other helminth Examined	Total No. of positive for other helminthic infection	Prevalence of positive for Other helminthic infection (%)
100	10	10	100	67	67

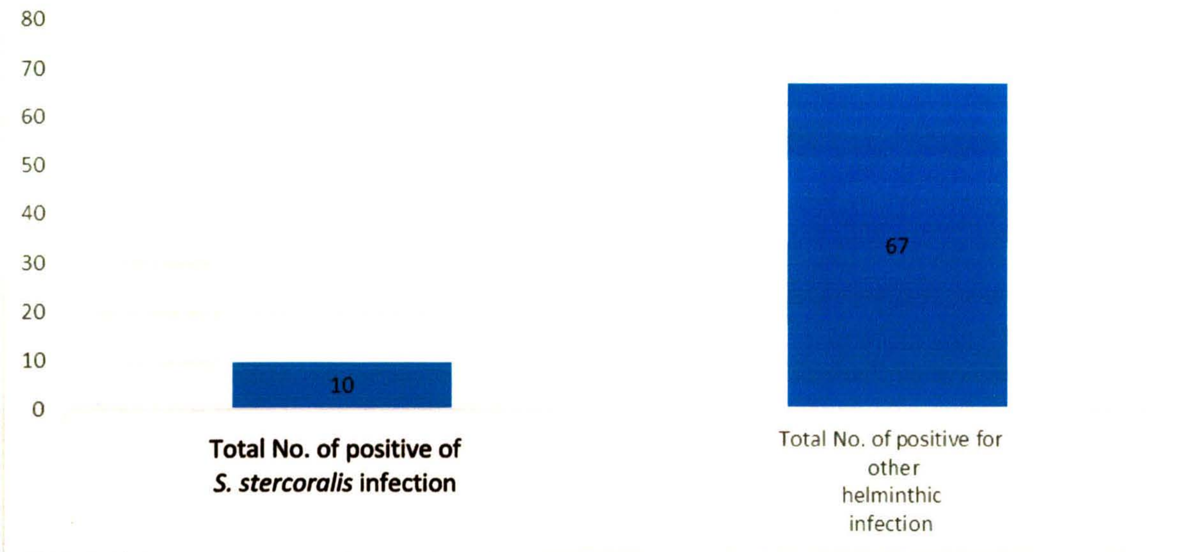

Fig 3. Overall prevalence of *S. stercoralis* infection and other helminthic infection found in stool samples in Savar .

Table-1b. Overall prevalence of *S. stercoralis* infection and other helminthic infection found in stool samples in Gazipur .

Location			**Gazipur**		
Total samples Examined	Total No. of positive for *S. stercoralis* Infection	Prevalence of positive for *S. stercoralis* infection(%)	Total samples of other helminth Examined	Total No. of positive for other helminthic infection	Prevalence of positive for Other helminthic infection(%)
60	**7**	**11.66**	**60**	**42**	**70**

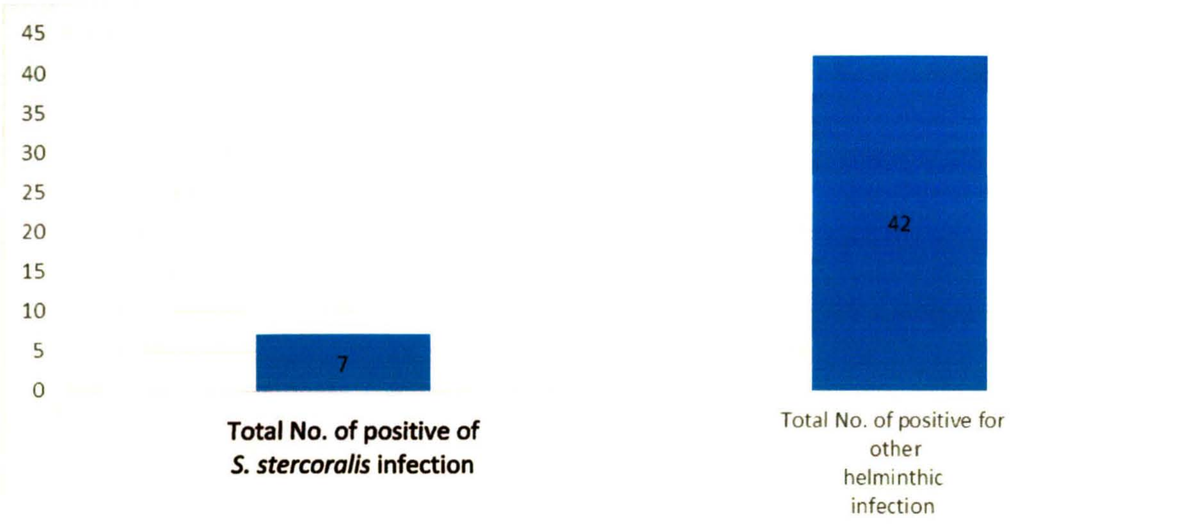

Fig 4. Overall prevalence of *S. stercoralis* infection and other helminthic infection found in stool samples in Gazipur .

5.2. Prevalence of *S. stercoralis* infection based on gender. (Table 2a,2b)

Out of 160 respondents participated in our study, 53 were males and 107 were females. 33 stool samples of male and 67 stool samples of female were collected from Savar and 20 stool samples of male and 40 stool samples of female were collected from Gazipur.

In Savar, the prevalence of male was 12.12% and female was 10.44 %. So, the prevalence in male was higher than female. The rate of prevalence of *S. stercoralis* in each male sample was not statistically significant ($p=0.02$, $p>0.05$). The rate of prevalence of *S. stercoralis* in each female sample was statistically significant ($p= 0.004$, $p<0.05$).

In Gazipur district, the prevalence of male and female were both 10%. The rate of prevalence of *S. stercoralis* in each male sample was statistically significant ($p=0.06$, $p<0.05$). The rate of prevalence of *S. stercoralis* in each female sample was not statistically significant ($p=0.02$, $p> 0.05$).

Table 2a. Prevalence of *S. stercoralis* infection in male and female hosts of Savar.

Location: Savar				
Sex	Total number of sample examined	Total No. of Infected host	Prevalence (%)	P value
Male	33	4	12.12	0.02
Female	67	7	10.44	0.004

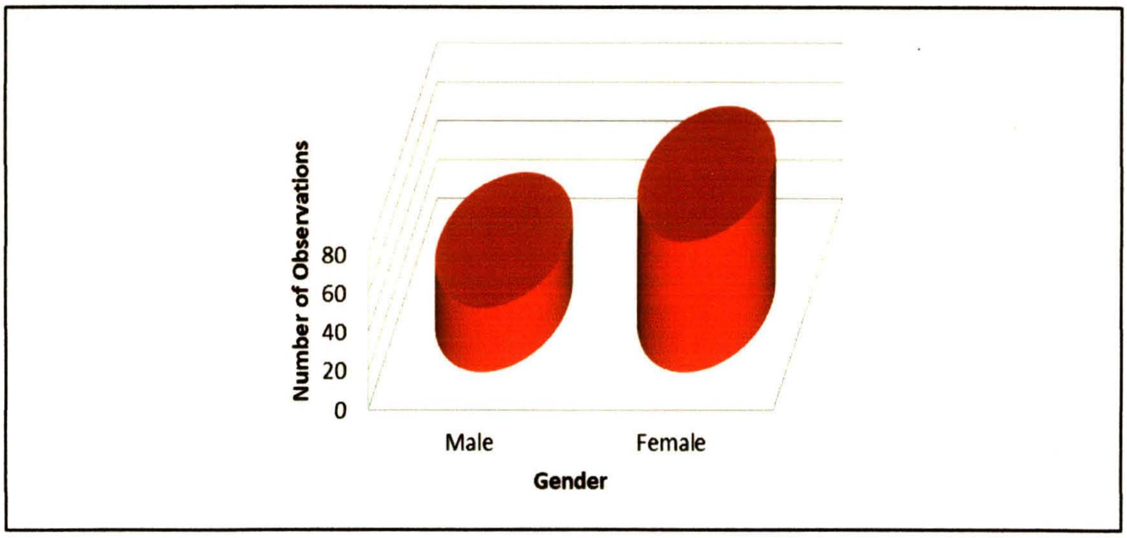

Fig 5. Prevalence of *S. stercoralis* infection in male and female hosts of Savar.

Table 2b. Prevalence of *S. stercoralis* infection in male and female hosts of Gazipur.

Location: Gazipur				
Sex	Total number of sample examined	Total No. of Infected host	Prevalence (%)	P value
Male	20	2	10	0.06
Female	40	4	10	0.02

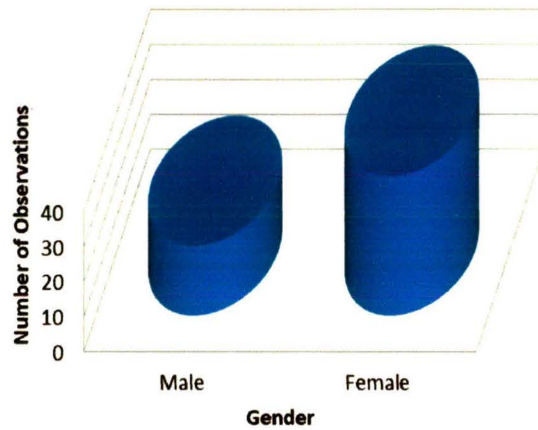

Fig 6. Prevalence of *S. stercoralis* infection in male and female hosts of Gazipur.

5.3 Prevalence of *S. stercoralis* infection based on age groups of the respondents. (Tables 3a,3b)

Occurrence of *S. stercoralis* infection based on age of the respondents shows that larvae were found in 17 samples (10.62%). The highest prevalence 30% was found in the age group of (51-60) years in Savar and 28.57% was found in the same age group in Gazipur district. The lowest prevalence (0%) was in the age group of (11-20) years in both district. The present study demonstrated that the prevalence of *S. stercoralis* infection in respondents aged (51-60) years old was higher than that in respondents below 50 years. The relation between age group and infection rate is statistically significant ($p<0.05$).

In Savar , the prevalence was observed 8.7 % in (00-10 years) , 0% in (11-20) years,15.79% in (21-30) years, 12.5 % in (31-40) years, 5.2% in (41-50) years, 30% in (51-60) years. The rate of prevalence of *S. stercoralis* in sample of age group (00-10) was not statistically significant (p=8.9, p >0.05) , age group (11-20) was statistically significant (p=0.00, p<0.05) , age group (21-30) was not statistically significant (p=0.04, p >0.05) , age group (31-40) was statistically significant (p=0.07, p <0.05) , age group (41-50) was not statistically significant (p=5.2, p >0.05), age group (51-60) was statistically significant (p=0.06, p<0.05) .

Table3a. Prevalence of *S. stercoralis* infection based on age groups of the respondents in Savar .

Location: Savar				
Age groups(years)	Total samples examined	No. of Infected host	Prevalence (%)	P value
00-10	23	2	8.69	0.1
11-20	13	0	0	0
21-30	19	3	15.79	0.04
31-40	16	2	12.5	0.07
41-50	19	1	5.26	5.2
51-60	10	3	30	0.06

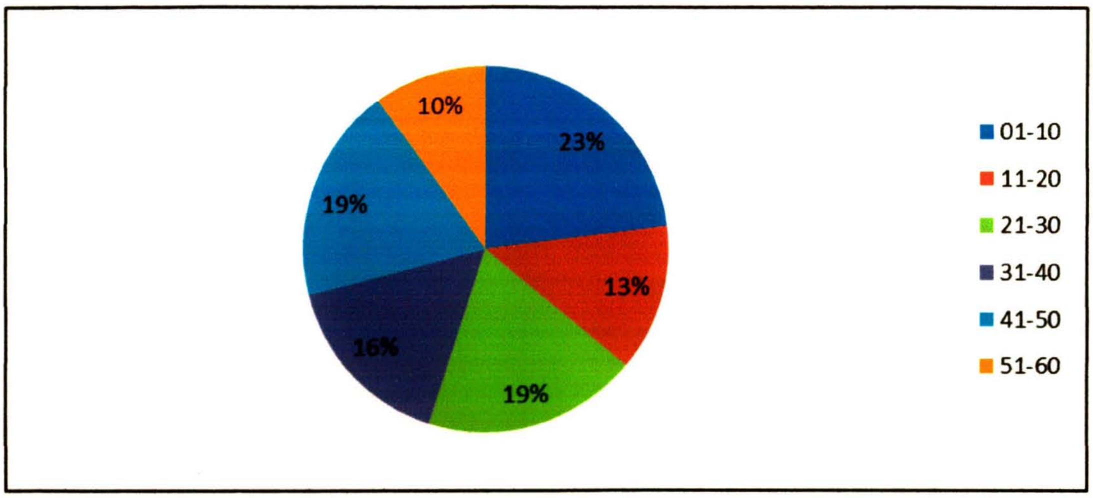

Fig 7. Prevalence of *S. stercoralis* infection based on age groups of the respondents in Savar.

In Gazipur, the prevalence was observed 7.69 % in 00-10 years, 0% in 11-20 years,8.33% in 21-30 years, 10 % in 31-40 years, 9.09% in 41-50 years and 28.57 % in 51-60 years . The rate of prevalence of *S. stercoralis* in sample of age group 01-10 was statistically significant ($p=0.0007$, $p<0.05$), age group 11-20 was statistically significant ($p=0.00$, $p<0.05$) , age group 21-30 was statistically significant ($p=0.003$, $p<0.05$), age group 31-40 was statistically significant ($p=0.003$, $p<0.05$), age group 41-50 was statistically significant ($p=0.002$, $p<0.05$), age group 51-60 was not statistically significant ($p=0.11$, $p>0.05$) .

Table3b. Prevalence of *S. stercoralis* infection based on age groups of the respondents in Gazipur district.

Location: Gazipur				
Age groups(years)	Total samples examined	No. of Infected Host	Prevalence (%)	P value
00-10	13	1	7.69	0.0007
11-20	7	0	0	0
21-30	12	1	8.33	0.003
31-40	10	1	10	0.003
41-50	11	1	9.09	0.002
51-60	7	2	28.57	0.11

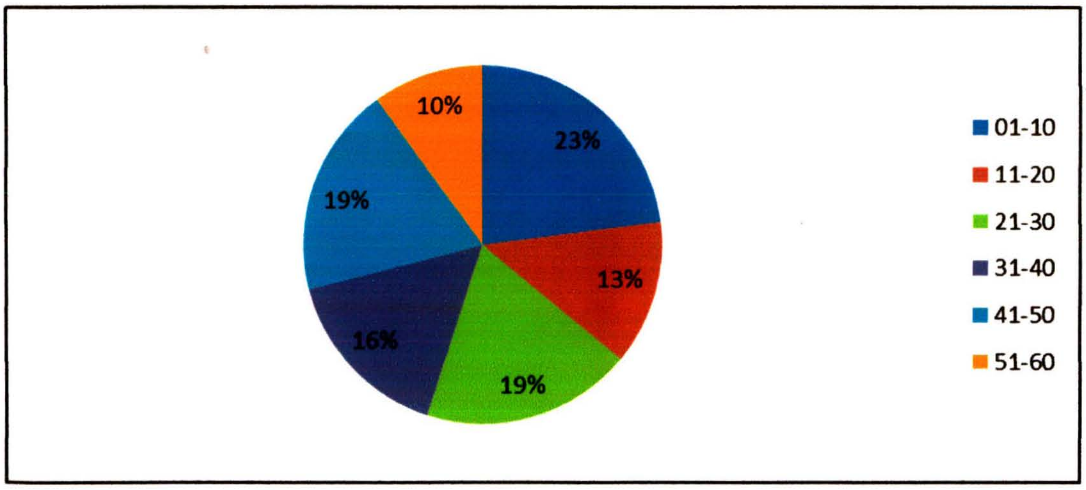

Fig 8. Prevalence of *S. stercoralis* infection based on age groups of the respondents in Gazipur district.

5.4. Prevalence of *S. stercoralis* infection based on occupation(Table4a, 4b)

Occurrence of *S. stercoralis* infection based on different occupations of the respondents was also studied. Total samples were divided into five groups which were service, labor, housewife, student and others. Out of 160 respondents total number of the service holders were 66, labors were 17, housewives were 33, students were 11 and others were 33. The highest rate of infection 27.27% and 33.33% were found in day labors and the lowest rate of infection was found among service holders were 4.87% and 4% in Savar and Gazipur respectively.

In Savar, the prevalence of infection based on occupation by *S. stercoralis* were 4.87%, 27.27% ,14.28%, 14.28 % and14.28 % respectively. The rate of prevalence of *S. stercoralis* in samples of service holders were statistically significant (p=.06, p<0.05), samples of labors were statistically significant (p=0.06, p <0.05), samples of housewives were not statistically significant (p=0.04,p >0.05), samples of students were not statistically significant (p=0.01, p >0.05), samples of others were not statistically significant (p=0.04, p >0.05).

Table4a. Prevalence of *S. stercoralis* infection based on occupation in Savar.

Location: Savar				
Occupation	Total cases Examined	Positive Cases	Prevalence (%)	P value
Service	41	2	4.8	0.06
Labor	11	3	27.27	0.06
Housewife	21	3	14.28	0.04
Student	7	1	14.28	0.01
Others	21	3	14.28	0.46

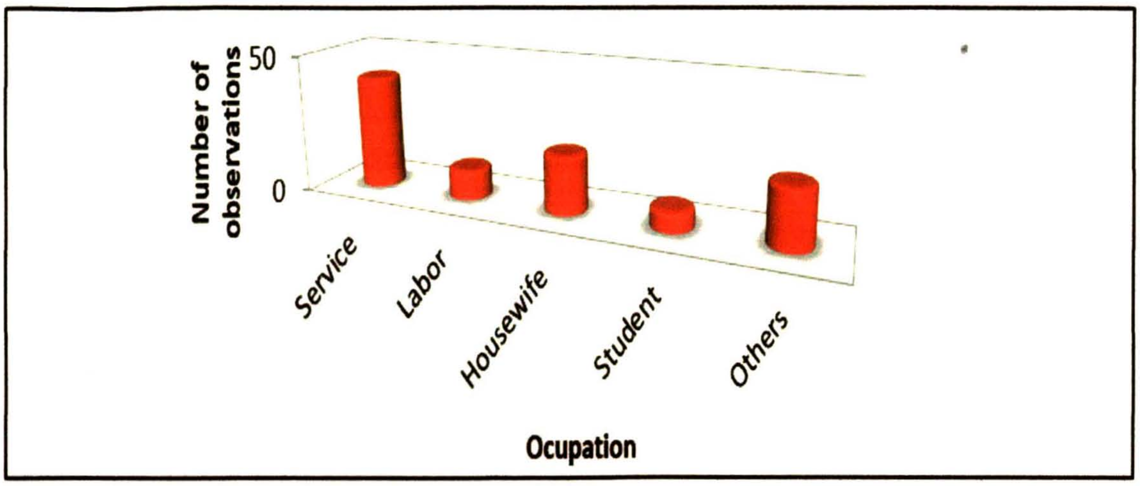

Fig 9. Prevalence of *S. stercoralis* infection based on occupation in Savar.

In Gazipur, the prevalence of infection by *S. stercoralis* were 4.00% ,33.33 % ,8.33%, 0 % and 8.33% respectively. So, the rate of prevalence of *S. stercoralis* in sample of service holders were statistically not significant (p=4.06, p>0.05), samples of labors were not statistically significant (p=0.13 , p > 0.05), samples of housewives were statistically significant (p=0.001, p<0.05),sample of students were statistically significant (p=0.00, p < 0.05), samples of others were statistically significant (p=0.001, p<0.05).

Table4b. Prevalence of *S. stercoralis* infection based on occupation in Gazipur.

Location : Gazipur				
Occupation	Total cases Examined	Positive Cases	Prevalence (%)	P value
Service	25	1	4	4.06
Labor	6	2	33.33	0.13
Housewife	12	1	8.33	0.001
Student	4	0	0	0
Others	12	1	8.33	0.001

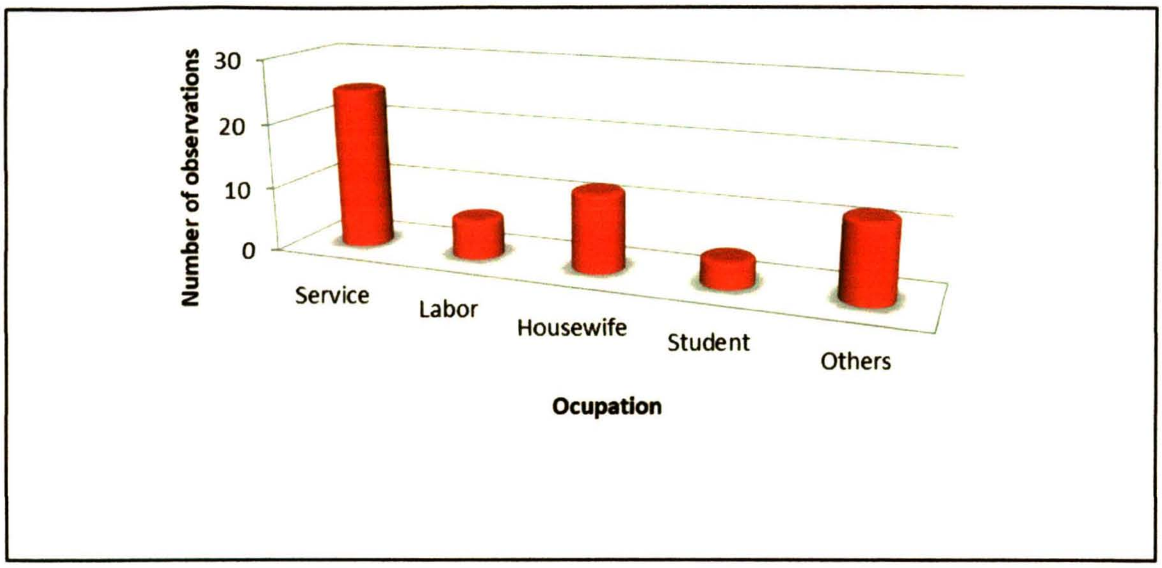

Fig 10. Prevalence of *S. stercoralis* infection based on occupation in Gazipur.

5.5 Distribution of *S. stercoralis* infection based on different types of house (Table 5a, 5b).

The selected areas had mainly two types of houses. One was tin shed with mud floor and another was tin shed with cement floor house. Infection rate found in the first type of house was11.53 % and 12.90 % and in the later type was 8.33% and 10.34% in Savar and Gazipur district . The highest rate of infection occurred in tin shed with mud floor type houses.

The rate of prevalence of *S. stercoralis* in sample of tin shed with mud floor was not statistically significant (p=0.02, p>0.05) in Savar. The rate of prevalence of *S. stercoralis* in each sample of tin shed with cement floor was not statistically significant (p=0.02, p>0.05) in Savar.

Table5a. Distribution of *S. stercoralis* infection based on different types of house in Savar.

Location: Savar				
Housing	Total cases Examined	Positive Cases	Prevalence (%)	P value
Tin shed with mud floor	52	6	11.53	0.02
Tin shed with Cement floor	48	4	8.33	0.02

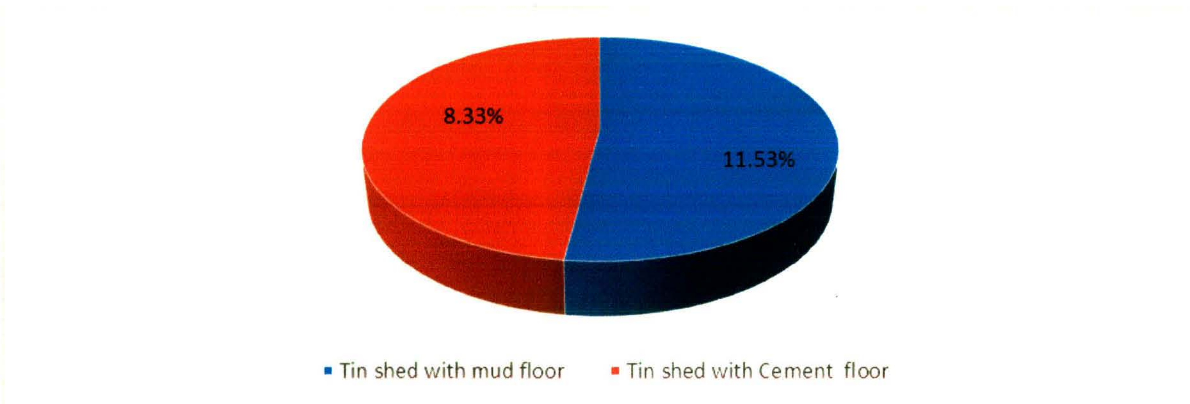

Fig 11. Distribution of *S. stercoralis* infection based on different types of house in Savar.

The rate of prevalence of *S. stercoralis* in sample of tin shed with mud floor was not statistically significant (p=0.02, p>0.05) in Gazipur.The rate of prevalence of *S. stercoralis* in each sample of tin shed with cement floor was not also statistically significant (p=0.04, p>0.05) in Gazipur.

Table5b. Distribution of *S. stercoralis* infection based on different types of house in Gazipur.

Location : Gazipur				
Housing	Total cases Examined	Positive Cases	Prevalence (%)	P value
Tin shed with mud floor	31	4	12.9	0.02
Tin shed with Cement floor	29	3	10.34	0.04

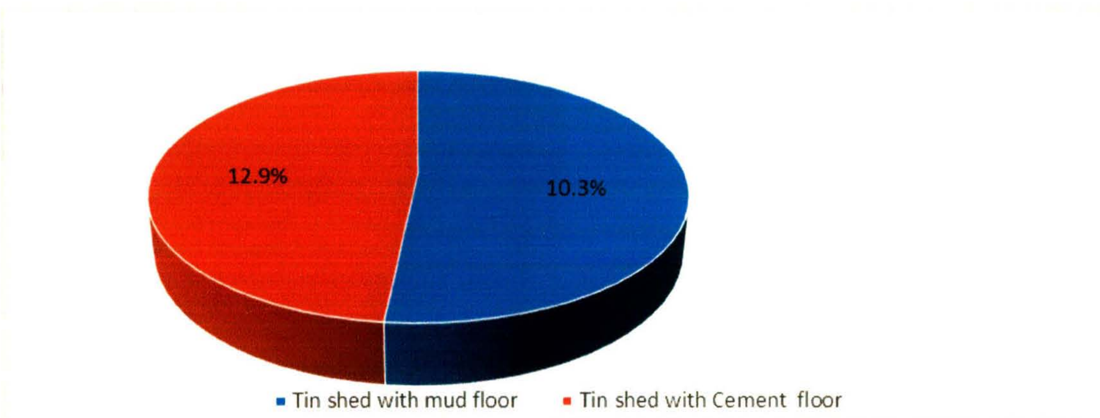

Fig 12. Distribution of *S. stercoralis* infection based on different types of house in Gazipur.

5.6 *S. stercoralis* infection according to types of toilet (Table 6a,6b).

In this study the participants used the insanitary and sanitary toilet. 12.06 % and 11.42% infection rate was found in insanitary toilet users, 9.52% and 8.00% infection rate was found in sanitary toilet users. The highest prevalence found in insanitary toilet users and the lowest prevalence found in sanitary toilet users.

In Savar, the rate of prevalence of *S. stercoralis* in sample of insanitary toilet was statistically significant ($p=.0004$, $p<0.05$). The rate of prevalence of *S. stercoralis* in sample of sanitary toilet was not statistically significant ($p= 0.02$, $p>0.05$).

Table6a. *S. stercoralis* infection according to types of toilet in Savar.

Location: Savar				
Site of respondent's defecation	Total samples examined	No. of Infected	Prevalence (%)	P value
Insanitary	58	7	12.06	0.004
Sanitary	42	4	9.52	0.02

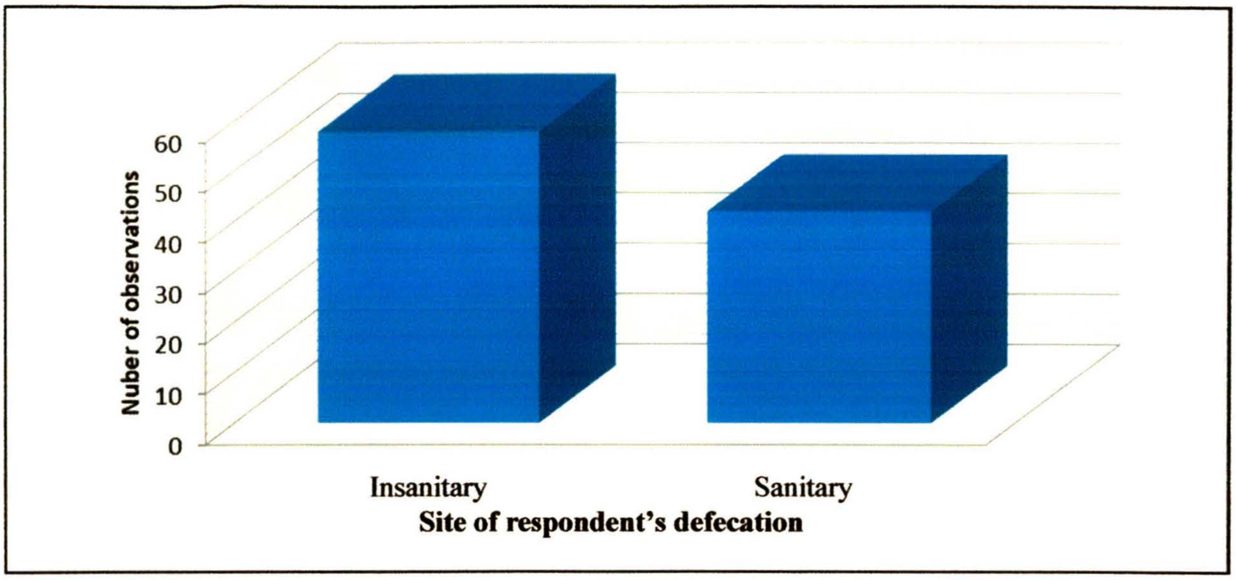

Fig 13. *S. stercoralis* infection according to types of toilet in Savar.

In Gazipur, the rate of prevalence of *S. stercoralis* in sample of insanitary toilet was not statistically significant ($p = 0.02$, $p > 0.05$). The rate of prevalence of *S. stercoralis* in sample of sanitary toilet was not statistically significant ($p = 0.03$, $p > 0.05$).

Table 6b. *S. stercoralis* infection according to types of toilet in Gazipur.

Location: Gazipur				
Site of respondent's defecation	Total samples examined	No. of Infected	Prevalence (%)	P value
Insanitary	35	4	11.42	0.02
Sanitary	25	2	8	0.03

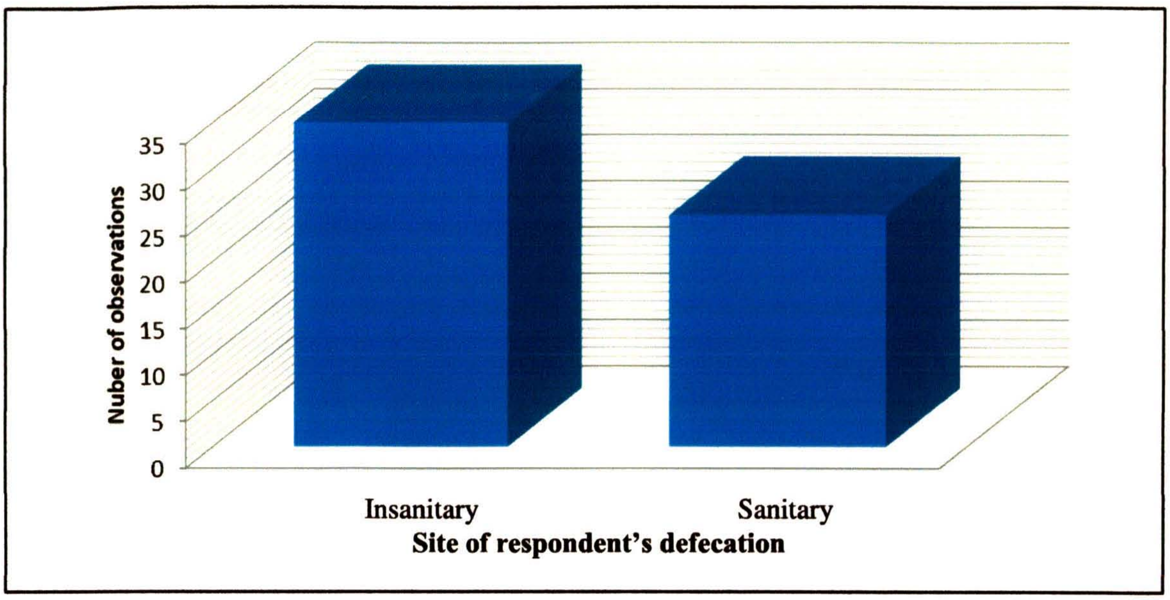

Fig 14. ***S. stercoralis*** **infection according to types of toilet in Gazipur.**

5.7 Relation of *S. stercoralis* infection and source of drinking water (Table 7a, 7b).

The occurrence of *Strongyloides stercoralis* infection in respondents based on the source of drinking water was also examined. Here among 160 respondents 108 (67 in Savar & 41 in Gazipur) used supply water and 52 (32 in Savar & 20 in Gazipur) used tube well water. Infection rate among supply water user and tube well water user was 13.43 % , 12.19% and 6.25 % , 3.38% in Savar and Gazipur respectively. All of them usually brought water from a neighbor's house or from road side supply water.

In Savar, the rate of prevalence of *S. stercoralis* in sample of supply water was statistically significant ($p=0.0001$, $p<0.05$) and the rate of prevalence of *S. stercoralis* in sample of tube well water was also statistically significant ($p=0.06$, $p<0.05$) .

Table7a. Relation of *S. stercoralis* infection and source of drinking water in Savar.

Location: Savar				
Source of drinking water	Total cases Examined	Positive Cases	Prevalence (%)	P value
Supply Water	67	9	13.43	0.001
Tube well Water	32	2	8	0.02

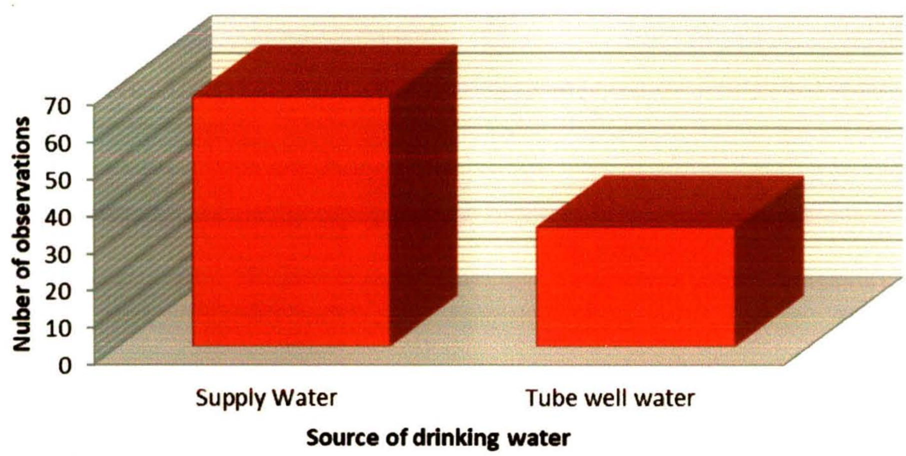

Fig 15. Relation of *S. stercoralis* infection and source of drinking water in Savar.

In Gazipur, the rate of prevalence of *S. stercoralis* in sample of supply water was not statistically significant (p=0.01, p>0.05) and the rate of prevalence of *S. stercoralis* in sample of tube well water was also not statistically significant (p=3.3, p>0.05) .

Table7b. Relation of *S. stercoralis* infection and source of drinking water in Gazipur.

Location: Gazipur				
Source of drinking water	Total cases Examined	Positive Cases	Prevalence (%)	P value
Supply Water	41	5	12.19	0.01
Tube well Water	20	1	5	3.38

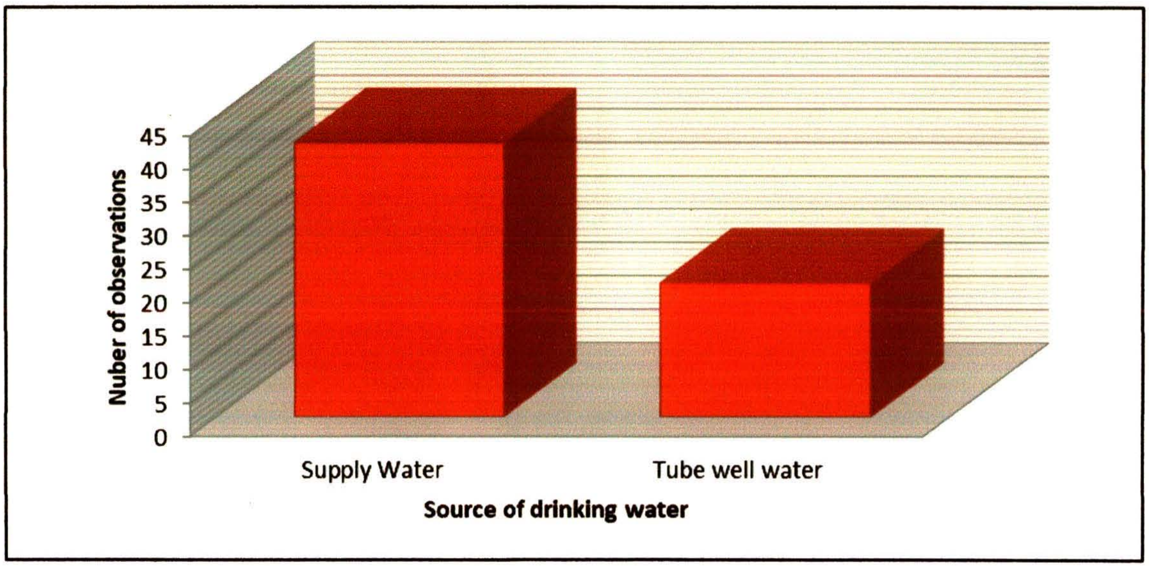

Fig 16. Relation of *S. stercoralis* infection and source of drinking water in Gazipur.

5.8 Prevalence of *S. stercoralis* infection in relation to monthly family income (Table 8a, 8b).

Prevalence of *S. stercoralis* infection in relation to monthly family income was also studied. In Savar, Out of 100 respondents the highest prevalence was found 16.66% in (1000-5000 tk) monthly family income. The lowest prevalence was found 10.69 % in (5001-10000tk) monthly family income. No infection was found in, (15001-20000 tk) and (20001-25000 tk) monthly family income.

The rate of prevalence of *S. stercoralis* in sample of monthly income (1000-5000 tk) was statistically significant ($p=0.08$, $p<0.05$), monthly income (5001-10000 tk) was statistically significant ($p=0.007$, $p<0.05$), monthly income (10001-15000 tk) was not statistically significant ($p=0.04$, $p>0.05$) and monthly income (15001-20000 tk) was statistically significant ($p=0.00$, $p<0.05$).

Table 8a. Prevalence of *S. stercoralis* infection in relation to monthly family income in savar.

Location: Savar				
Monthly family income	No. of Observed Samples	No. of Infected hosts	No.of prevalence (%)	P value
1000-5000	12	2	16.66	0.08
5001-10000	59	6	10.69	0.007
10001-15000	28	4	14.28	0.02
15001-20000	2	0	0	0
20001-25000	0	0	0	0

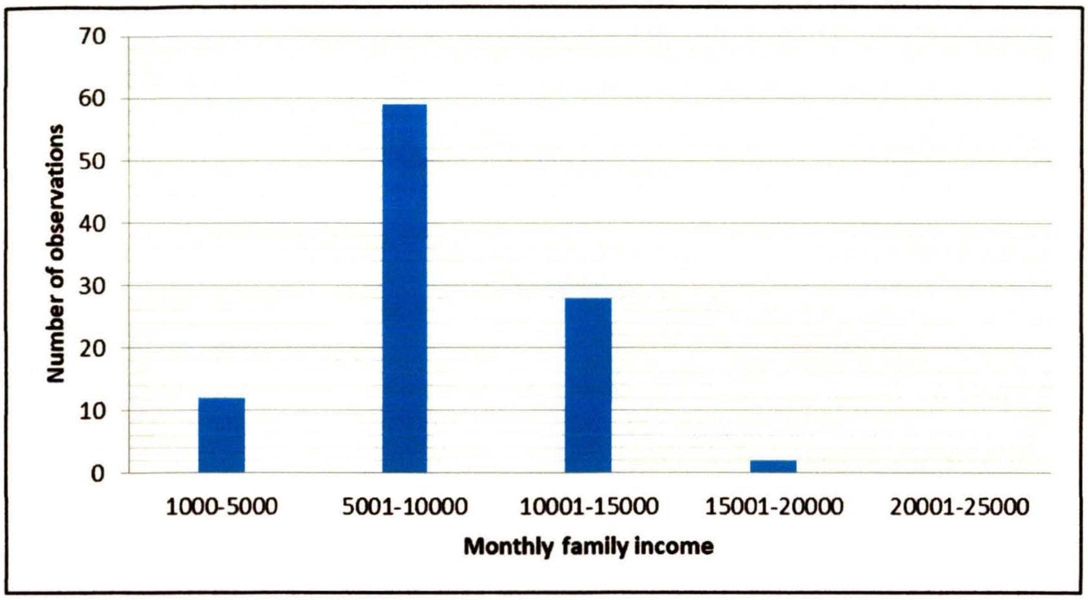

Fig 17. Prevalence of *S. stercoralis* infection in relation to monthly family income in savar.

In Gazipur , Out of 60 respondents the highest prevalence was found 33.33 % in (5001-10000tk) monthly family income. The lowest prevalence was found 5.88 % in (10001-15000tk) monthly family income. No infection was found in, (15001-20000) and (20001-25000tk) monthly family income.

The rate of prevalence of *S. stercoralis* in sample of monthly income (1000-5000 tk) was not statistically significant ($p=0.02$, $p>0.05$), monthly income (5001-10000 tk) was not statistically significant ($p=0.04$, $p>0.05$), monthly income (10001-15000 tk) was statistically significant ($p=0.0001$, $p<0.05$), monthly income (15001-20000 tk) and (20001-25000 tk) was statistically significant ($p=0.00$, $p<0.05$).

Table 8b. Prevalence of *S. stercoralis* infection in relation to monthly family income in Gazipur.

Location: Gazipur				
Monthly family income	No. of Observed Samples	No. of Infected hosts	No.of prevalence (%)	P value
1000-5000	6	1	16.66	0.02
5001-10000	35	3	33.33	0.04
10001-15000	17	1	5.88	0.0001
15001-20000	1	0	0	0
20001-25000	0	0	0	0

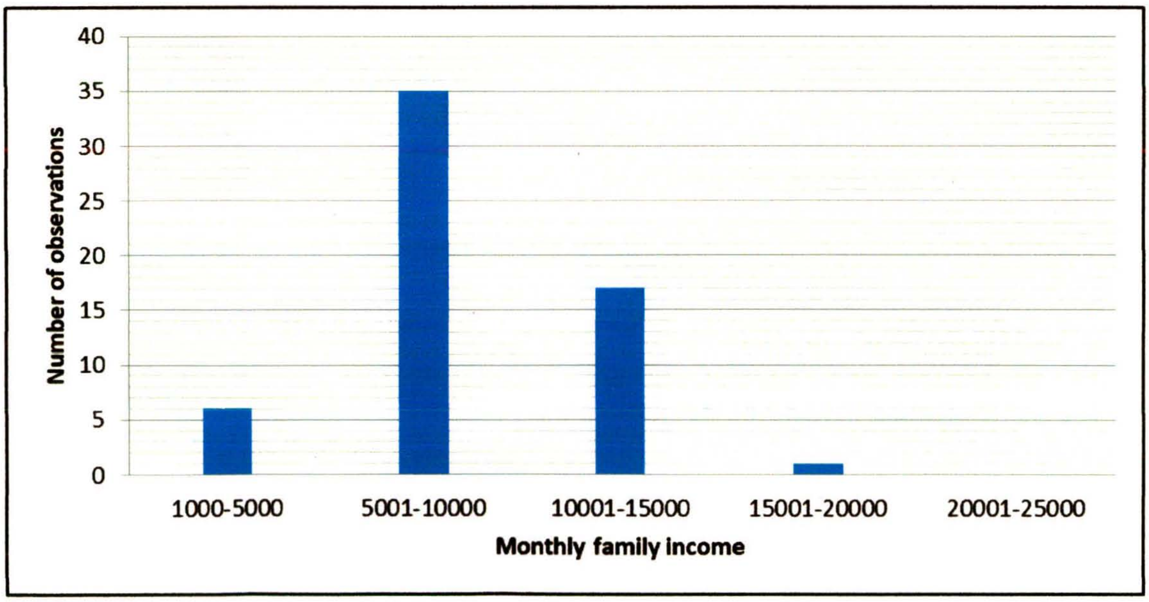

Fig 18. Prevalence of *S. stercoralis* infection in relation to monthly family income in Gazipur.

5.9 Prevalence of *S. stercoralis* infection in relation to number of family members (Table-9a, 9b).

Out of 160 respondents participated in our study, prevalence of *S. Stercoralis* infection in relation to number of family members also examined. The family members were divided into five groups.

In Savar, out of 100 samples 12(8.3 %) was in (1-3) family members, 75 (10.66%) was in (4-6) family members, 10 (20 %) was in (7-9) family members. No prevalence was found in (10-12) and (13-15) family members. The highest prevalence was found in 20 % in the family members of (7-9) .

The rate of prevalence of *S. stercoralis* in each sample of 1-3 members was statistically significant ($p=0.001, p<0.05$), sample of (4-6) members was statistically significant ($p=0.002$, $p <0.05$), sample of (7-9) members was statistically significant ($p=0.09$, $p <0.05$), sample of (10-12) members was statistically significant ($p=0.00$, $p<0.05$), sample of (13-15) members was statistically significant ($p=0.000$, $p <0.05$).

Table9a. Prevalence of *S. stercoralis* infection in relation to family members in Savar.

Location: Savar				
No. of family members	No. of Observed Samples	No. of Infected hosts	No. of prevalence (%)	P value
1-3	12	1	8.3	0.001
4-6	75	8	10.66	0.002
7-9	10	2	20	0.09
10-12	2	0	0	0
13-15	0	0	0	0

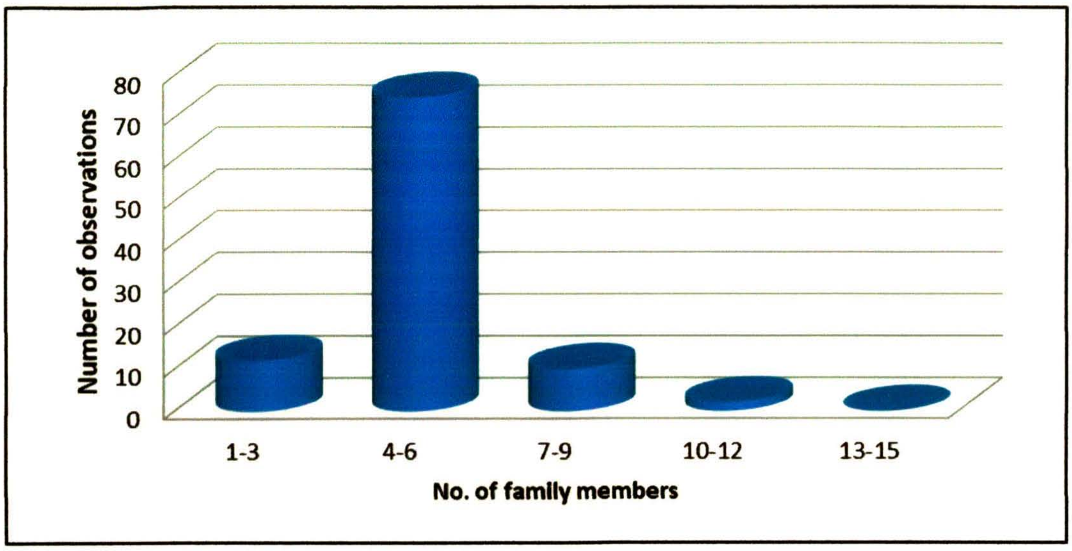

Fig 19. Prevalence of *S. stercoralis* infection in relation to family members in Savar.

In Gazipur , out of 60 samples 8 were in (1-3) family members, 45 (11.11 %) were in (4-6) family members, 16 (16.66 %) were in (7-9) family members. No prevalence was found in (10-12) and (13-15) family members. The highest prevalence was found in 16.66 % in the family members of (7-9) .

The rate of prevalence of *S. stercoralis* in samples of (1-3) members were statistically significant (p=0.00, $p < 0.05$), samples of (4-6) members were not statistically significant (p=0.01, $p > 0.05$), sample of (7-9) members were not statistically significant (p=0.02, $p > 0.05$), samples of (10-12) members were statistically significant (p=0.00, $p < 0.05$), samples of 13-15 members were statistically significant (p=0.000, $p < 0.05$).

Table 9b Prevalence of *S. stercoralis* infection in relation to family members in Gazipur.

Location: Gazipur				
No. of family members	No. of Observed Samples	No. of Infected hosts	No.of prevalence (%)	P value
1-3	8	0	0	0
4-6	45	5	11.11	0.01
7-9	6	1	16.66	0.02
10-12	2	0	0	0
13-15	0	0	0	0

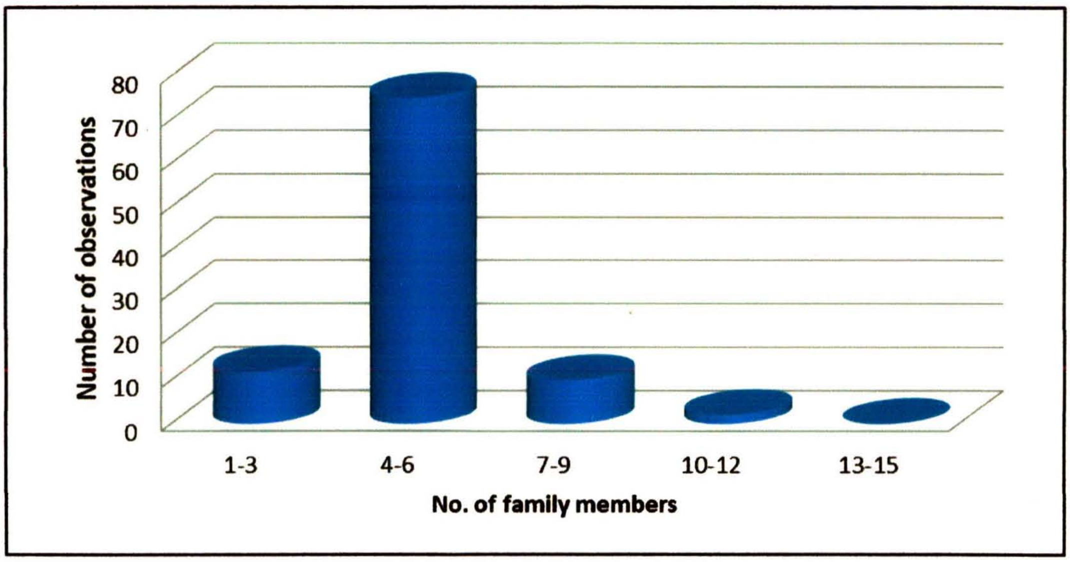

Fig 20. Prevalence of *S. stercoralis* infection in relation to family members in Gazipur.

5.10 Prevalence of *S. stercoralis* infection in relation to educational qualification (Table 10a, 10b).

Occurrence of *S. stercoralis* infection in relation to educational qualification of the respondents were also studied. In Savar, Out of 100 respondents total number of illiterate were 46 , up to class V passed participants were 38 , up to class X passed participants were 13, up to S.S.C. passed participants were 2. There was no H.S.C. passed participants. Their prevalence of infection by *S. stercoralis* was 15.2 % in illiterate, 7.89% in up to class five respondents, 0 % in up to S.S.C. passed respondents. So, the highest rate of infection were found 15.2 % in illiterate respondents and the lowest infection rate was 0.04% up to class five respondents.

The rate of prevalence of *S. stercoralis* in samples of illiterate were statistically significant (p=0.004, p<0.05), samples up to class V were not statistically significant (p=0.04, p >0.05), samples up to class 10, sample of S.S.C. passed and sample of H.S. C. were statistically significant (p=0.00, p <0.05).

Table10a. Prevalence of *S. stercoralis* infection in relation to educational qualification in Savar.

Location: Savar				
Educational status	No. of Observed Samples	No. of Infected hosts	No.of prevalence (%)	P value
Illiterate	46	7	15.2	0.004
Up to class V	38	3	7.89	0.04
Up to class X	13	0	0	0
S.S.C.	2	0	0	0
H.S.C.	0	0	0	0

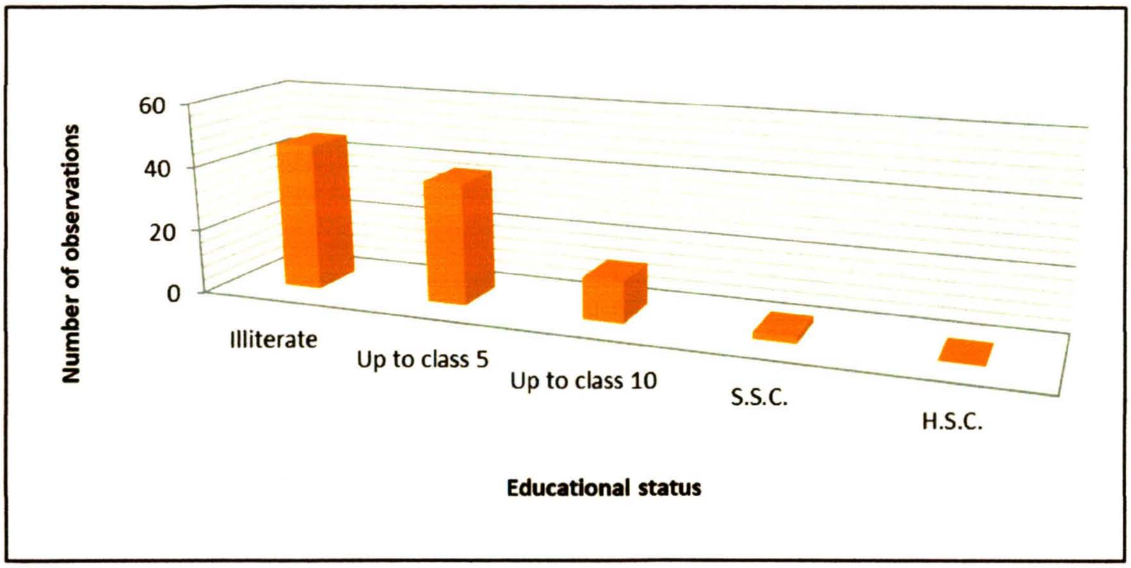

Fig 21. Prevalence of *S. stercoralis* infection in relation to educational qualification in Savar.

In Gazipur, Out of 60 respondents total number of illiterate were 28 , up to class V passed participants were 23 , up to class X passed participants were 8, up to S.S.C. passed participants were 2. There was no H.S.C. passed participants. Their prevalence of infection by *S. stercoralis* was 17.85 % in illiterate, 8.69 % in up to class five passed respondents, 0 % in up to S.S.C. passed respondents. The highest rate of infection were found 17.85 % in illiterate respondents and the lowest infection rate was 0.06% up to class five respondents.

The rate of prevalence of *S. stercoralis* in samples of illiterate were not statistically significant ($p=0.01$, $p>0.05$), samples up to class five were statistically significant ($p=0.06$, $p < 0.05$), samples up to class 10, samples of S.S.C. passed and samples of H.S. C. were statistically significant ($p=0.00$, $p <0.05$).

Table10b. Prevalence of *S. stercoralis* infection in relation to educational qualification in Gazipur.

Location: Gazipur				
Educational status	No. of Observed Samples	No. of Infected hosts	No.of prevalence (%)	P value
Illiterate	28	5	17.85	0.01
Up to class V	23	2	8.69	0.06
Up to class X	8	0	0	0
S.S.C.	2	0	0	0
H.S.C.	0	0	0	0

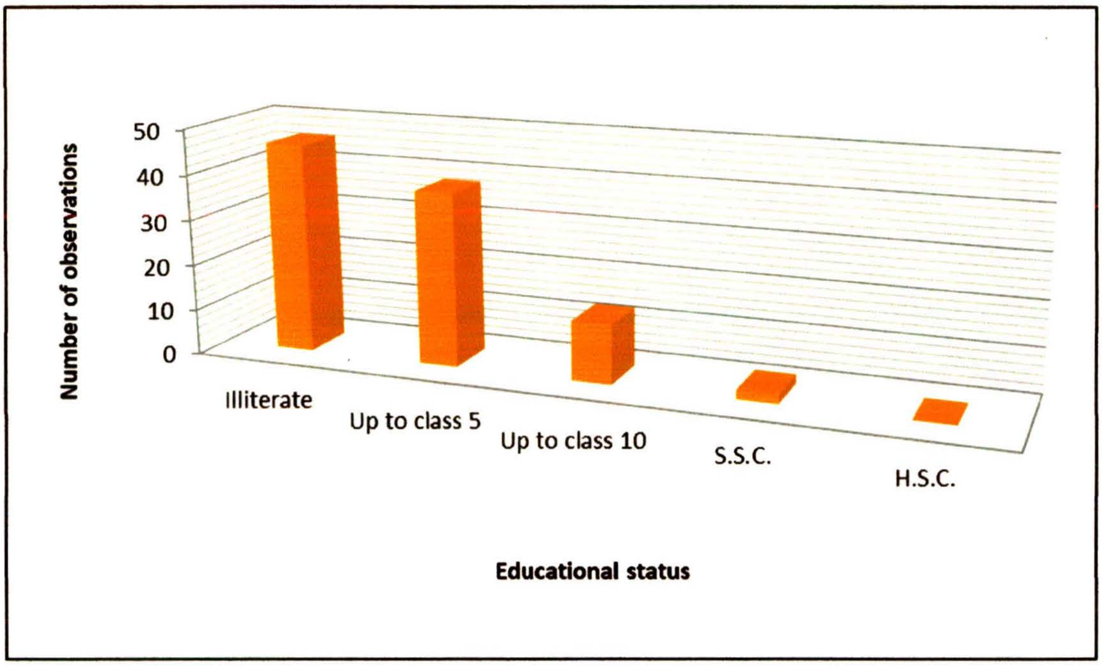

Fig 22. Prevalence of *S. stercoralis* infection in relation to educational qualification in Gazipur.

5.11 Prevalence of *S. stercoralis* infection in relation to the history of diarrhea in family members (Table 11a, 11 b).

Prevalence of *S. stercoralis* infection in relation to the history of diarrhea in family members also studied. History of diarrhea in family members were divided into two categories. The first category the family members who was suffered the diarrheal disease before three months and the other was who did not suffer the diarrheal disease before three months. 18% and 16.66% infection rate found in the first category and 4% and 3.33% infection rate found in second category in Savar and Gazipur accordingly. The highest prevalence was found in the participants family members who suffered the diarrheal disease before three months and then who did not suffer the diarrheal disease before three months.

In Savar, the rate of prevalence of *S. stercoralis* in sample no. 1 was statistically significant ($p=0.001$, $p<0.05$), The rate of prevalence of *S. stercoralis* in sample no. 2 was statistically also significant ($p=0.06$, $p<0.05$).

Table11a. Prevalence of *S. stercoralis* infection in relation to the history of diarrhea in family members in Savar.

Location: Savar				
History of diarrhea in family members	No. of Observed Samples	No. of Infected hosts	No. of prevalence (%)	P value
Yes	50	9	18	0.001
No	50	2	4	0.06

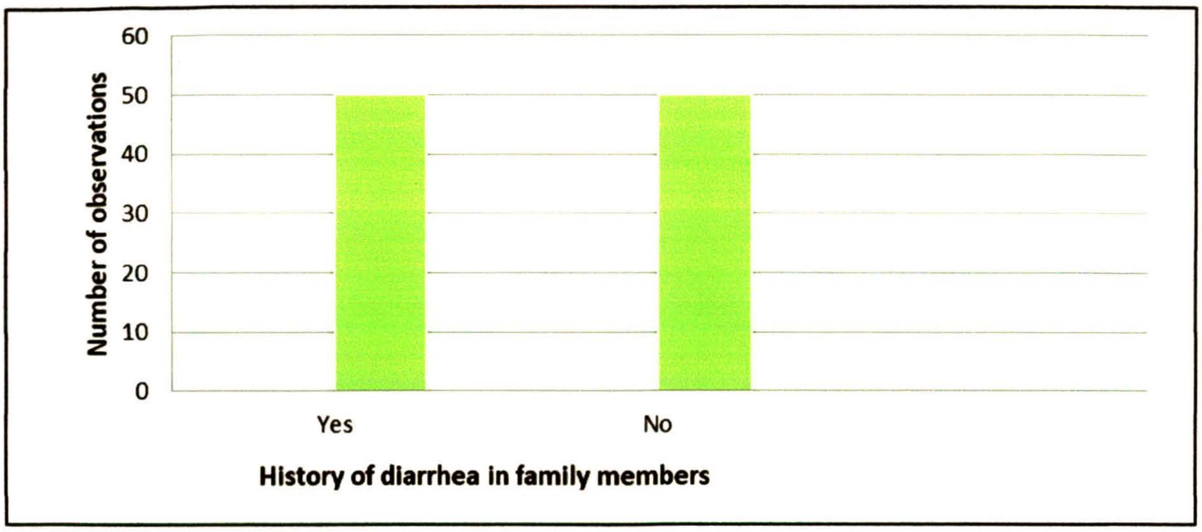

Fig 23. Prevalence of *S. stercoralis* infection in relation to the history of diarrhea in family members in Savar.

In Gazipur, the rate of prevalence of *S. stercoralis* in sample no. 1 was not statistically significant (p=0.01, p>0.05), The rate of prevalence of *S. stercoralis* in sample no. 2 was not also statistically significant (p=5.12, p>0.05).

Table11b. Prevalence of *S. stercoralis* infection in relation to the history of diarrhea in family members in Gazipur.

Location: Gazipur				
History of diarrhea in family members	No. of Observed Samples	No. of Infected hosts	No.of prevalence (%)	P value
Yes	30	5	16.66	0.014
No	30	1	3.33	5.12

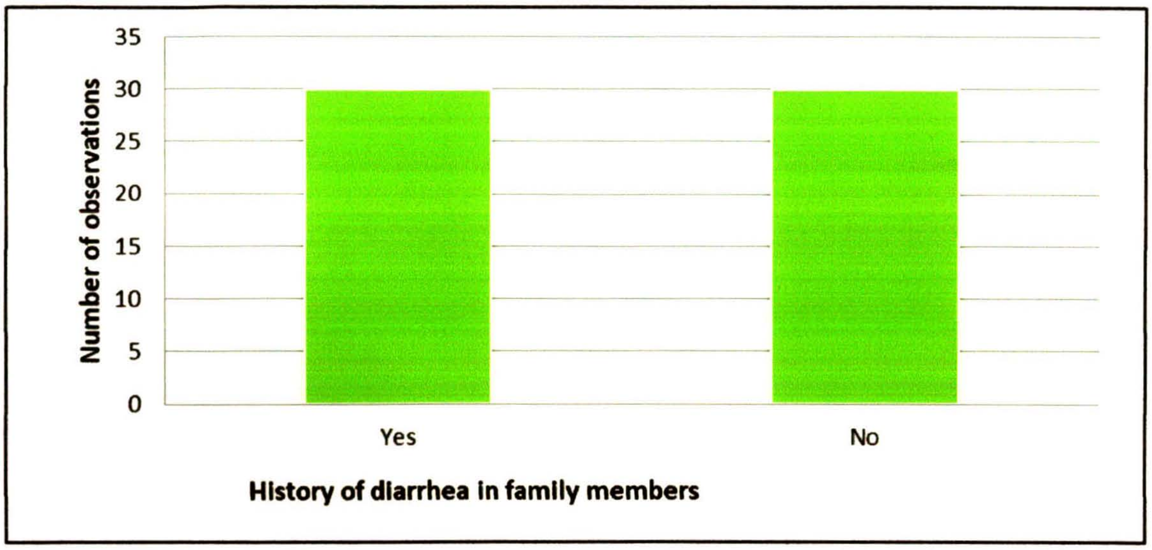

Fig 24. Prevalence of *S. stercoralis* infection in relation to the history of diarrhea in family members in Gazipur.

5.12 Prevalence of *S. stercoralis* infection in relation to the history of diarrhea who suffered before three months (Table 12a, 12 b).

Prevalence of *S. stercoralis* infection in relation to the history of diarrhea also examined in this study. History of diarrhea of participants were divided into two categories. The first category who was suffered the diarrheal disease before three months and the other were who did not suffer the diarrheal disease before three months. 16.98%, 19% infection rate found in the first category and 2.08 %, 3.57% infection rate found in second category in Savar and Gazipur accordingly. The highest prevalence was found in the participants family members who suffered the diarrheal disease before three months and than who did not suffer the diarrheal disease before three months.

In Savar, the rate of prevalence of *S. stercoralis* in sample no. 1 was statistically significant ($p=0.001$, $p<0.05$), The rate of prevalence of *S. stercoralis* in sample no. 2 was not statistically significant ($p=3.77$, $p > 0.05$).

Table12a. Prevalence of *S. stercoralis* infection in relation to the history of diarrhea in Savar.

Location: Savar				
History of diarrhea in family members	No. of Observed Samples	No. of Infected hosts	No.of prevalence (%)	P value
Yes	53	9	16.98	0.001
No	48	1	2.08	3.37

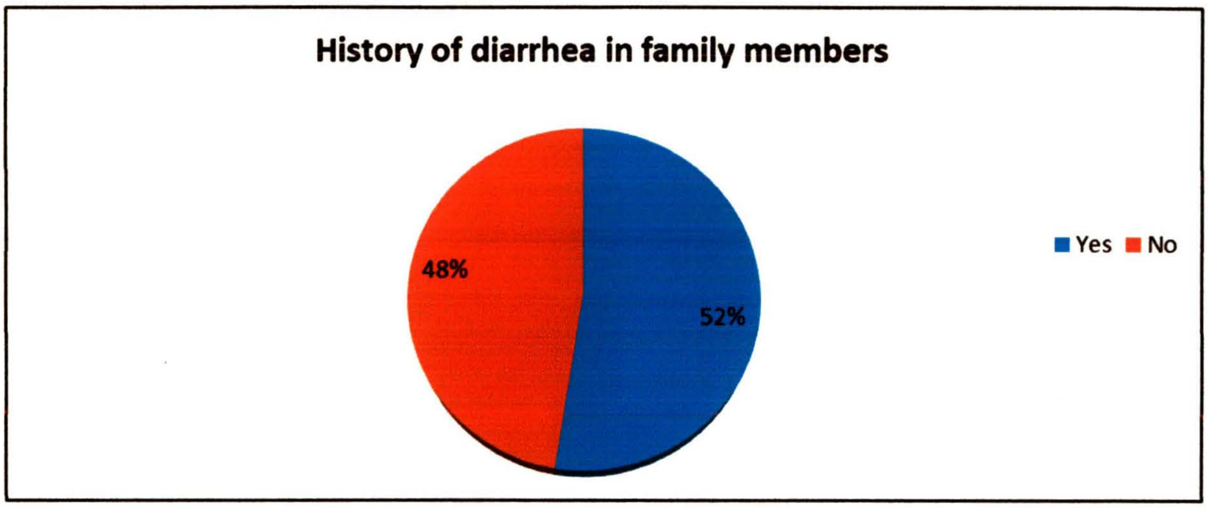

Fig 25. Prevalence of *S. stercoralis* infection in relation to the history of diarrhea in Savar.

In Gazipur, the rate of prevalence of *S. stercoralis* in sample no. 1 was statistically significant (p=0.007, p<0.05), The rate of prevalence of *S. stercoralis* in sample no. 2 was not statistically significant (p=1.17 , p> 0.05).

Table12b. Prevalence of *S. stercoralis* infection in relation to the history of diarrhea in Savar.

Location: Gazipur				
History of diarrhea in family members	No. of Observed Samples	No. of Infected hosts	No.of prevalence (%)	P value
Yes	31	6	19.35	0.007
No	28	1	3.57	1.17

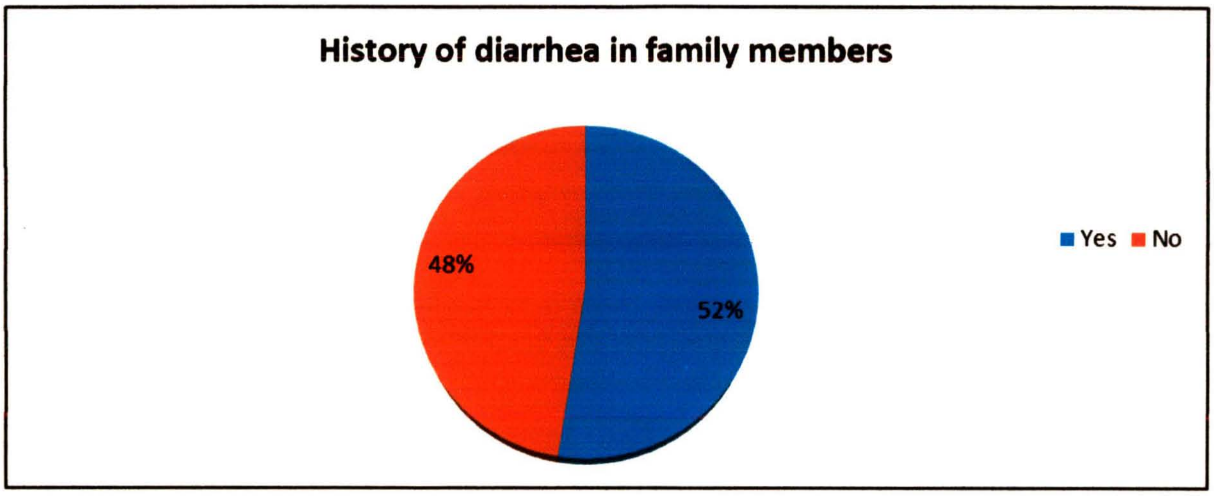

Fig 26. Prevalence of *S. stercoralis* infection in relation to the history of diarrhea in Savar.

5.13 Prevalence of *S. stercoralis* infection in relation to nail cutting habit (Table 13a, 13b).

Out of 160 respondents participated in our study, prevalence of *S. stercoralis* infection in relation to nail cutting habit also examined. In this study 160 participants were divided into two categories. The first category who was irregular, who did not sharp their nail regularly and the second category who shaped their nail regularly. Among two categories the highest prevalence was found 20.45% and 23.07% in Savar and Gazipur respectively who were irregular in nail cutting habit.

In Savar, the rate of prevalence of *S. stercoralis* in sample of irregular nail cutting habit was statistically significant ($p=0.001$, $p < 0.05$), the rate of prevalence of *S. stercoralis* in sample of regular nail cutting habit was not statistically significant ($p=1.65$, $p > 0.05$)

Table13a. Prevalence of *S. stercoralis* infection in relation to nail cutting habit in Savar.

Location: Savar				
Nail cutting habit	No. of Observed Samples	No. of Infected hosts	No.of prevalence (%)	P value
Irregular	44	9	20.45	0.001
Regular	56	1	1.78	1.6

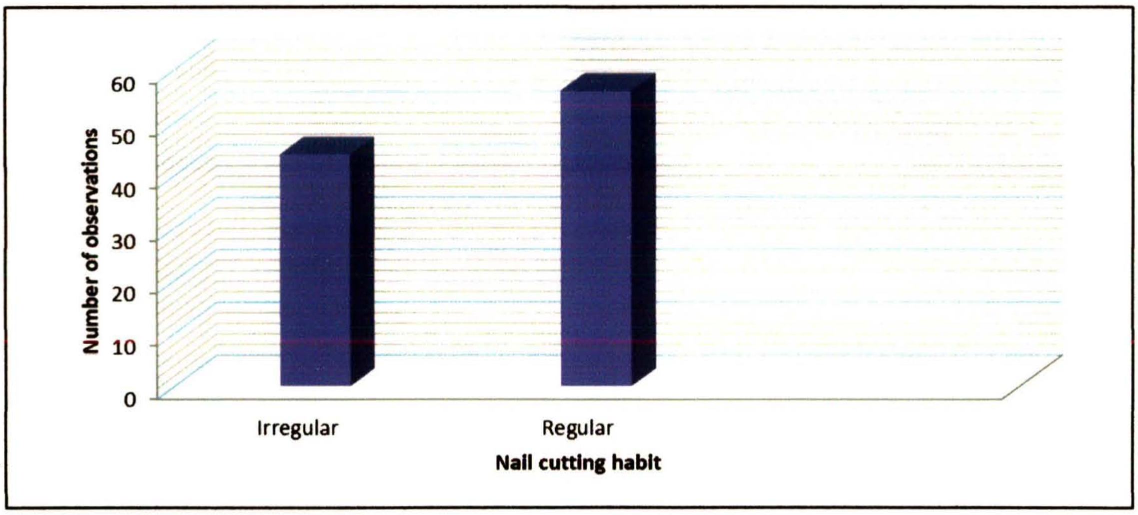

Fig 27. Prevalence of *S. stercoralis* infection in relation to nail cutting habit in Savar.

In Gazipur, the rate of prevalence of *S. stercoralis* in sample of irregular nail cutting habit was statistically significant ($p=0.007$, $p < 0.05$), the rate of prevalence of *S. stercoralis* in sample of regular nail cutting habit was not statistically significant ($p=1$, $p > 0.05$)

Table13b. Prevalence of *S. stercoralis* infection in relation to nail cutting habit in Gazipur.

Location: Gazipur				
Nail cutting habit	No. of Observed Samples	No. of Infected hosts	No.of prevalence (%)	P value
Irregular	26	6	23.07	0.007
Regular	34	1	2.94	1

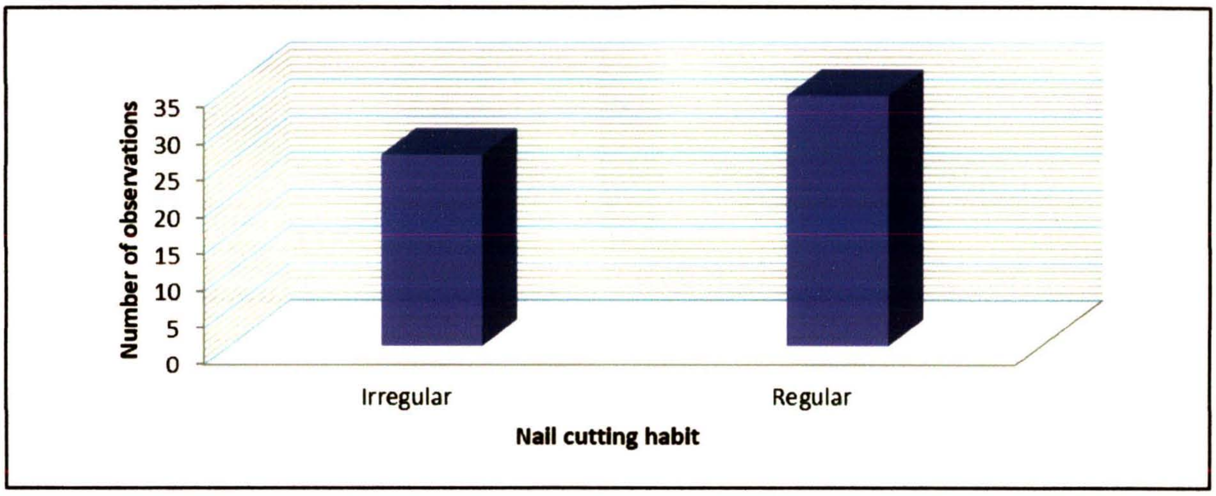

Fig 28. Prevalence of *S. stercoralis* infection in relation to nail cutting habit in Gazipur.

5.14 Prevalence of *S. stercoralis* infection on the basis of hand washing habit by soap after defecation (Table 14a, 14b).

Prevalence of *S. stercoralis* infection on the basis of hand washing habit by soap after defecation was also properly examined. Out of 160 participants were divided into two categories. The first category who use soap and water after defecation and the second category who did not use soap after defecation. The highest prevalence was found in second category 12.06% and 11.42% in Savar and Gazipur respectively.

In Savar, the rate of prevalence of *S. stercoralis* in each sample of soap and water was not statistically significant ($p=0.02$, $p >0.05$), the rate of prevalence of *S. stercoralis* in each sample of with water only was statistically significant ($p=0.004$, $p<0.05$)

Table14a. Prevalence of *S. stercoralis* infection on the basis of hand washing habit by soap after defecation in Savar.

Location: Savar				
Hand washing	No. of Observed Samples	No. of Infected hosts	No.of prevalence (%)	P value
Soap and water	42	4	9.52	0.02
With water only	58	7	12.06	0.004

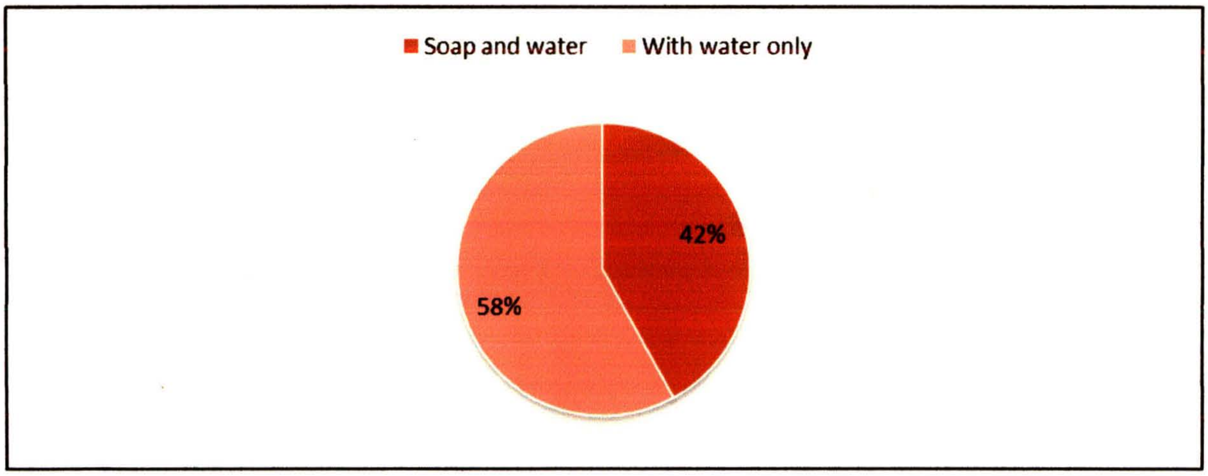

Fig 29. Prevalence of *S. stercoralis* infection on the basis of hand washing habit by soap after defecation in Savar.

In Gazipur, the rate of prevalence of *S. stercoralis* in each sample of soap and water was statistically significant ($p=0.06$, $p < 0.05$), the rate of prevalence of *S. stercoralis* in each sample of with water only was not statistically significant ($p=0.02$, $p> 0.05$)

Table14b. Prevalence of *S. stercoralis* infection on the basis of hand washing habit by soap after defecation in Gazipur.

Location: Gazipur				
Hand washing	No. of Observed Samples	No. of Infected hosts	No.of prevalence (%)	P value
Soap and water	25	2	8	0.06
With water only	35	4	11.42	0.02

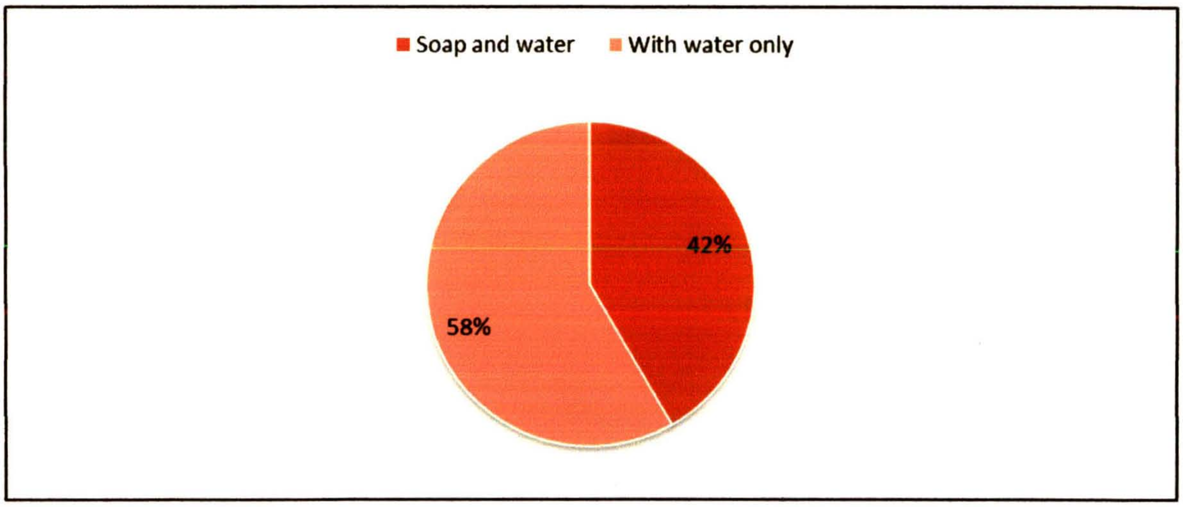

Fig 30. Prevalence of *S. stercoralis* infection on the basis of hand washing habit by soap after defecation in Gazipur.

5.15 Prevalence of *S. stercoralis* infection found in different used method (Table 15a, 15 b).

Total 160 stool samples were examined for the *S. stercoralis* infection in this study. Three methods were used ; direct smear, formal ether concentration method and Harada-Mori culture method. Highest prevalence 9.1%, 10% found in Formal ether concentration method in Savar and Gazipur respectively. The lowest prevalence 1% and 0 % in Savar and Gazipur was found in direct smear and Harada-Mori culture method respectively.

In Savar, the rate of prevalence of *S. stercoralis* in Direct smear method and Harada Mori Culture was not statistically significant (p=8.3, p>0.05). In Formal ether concentration method was statistically significant (p=0.001, p <0.05).

Table15a. Prevalence of *S. stercoralis* infection found in different method in Savar.

Location: Savar				
Method	No. of Observed Samples	No. of Infected hosts	No.of prevalence (%)	P value
Direct smear	100	1	1	8.3
Formal ether concentration	100	9	9.1	0.001
Harada –Mori Culture	100	1	1	8.3

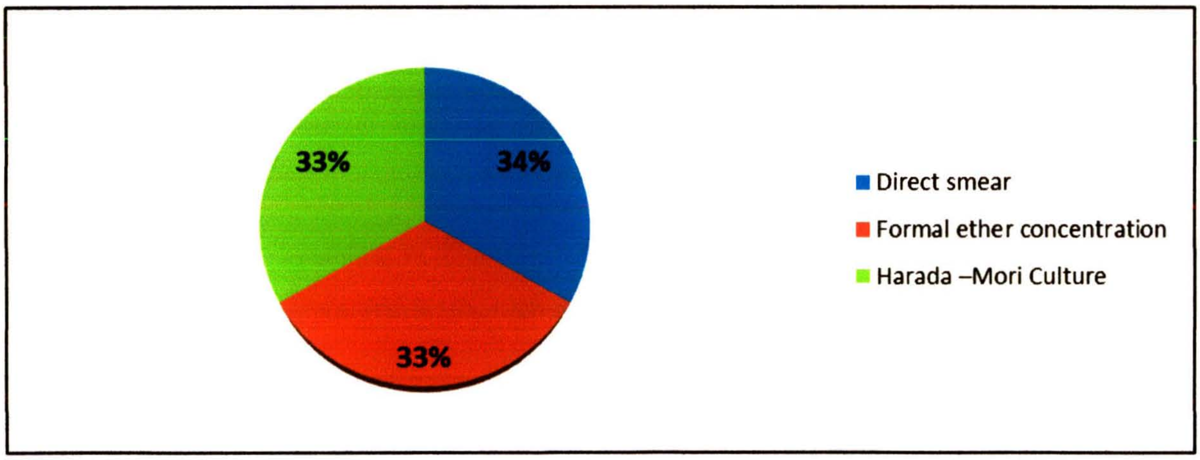

Fig 31. Prevalence of *S. stercoralis* infection found in different method in Savar.

In Gazipur, the rate of prevalence of *S. stercoralis* in Direct smear method and Harada Mori Culture was statistically significant (p= 0.00, p< 0.05). In Formal ether concentration method was also statistically significant (p=0.0007, p <0.05).

Table15b. Prevalence of *S. stercoralis* infection found in different method in Gazipur.

Location: Gazipur				
Method	No. of Observed Samples	No. of Infected hosts	No.of prevalence (%)	P value
Direct smear	60	0	0	0
Formal ether concentration	60	6	10	0.0007
Harada –Mori Culture	60	0	0	0

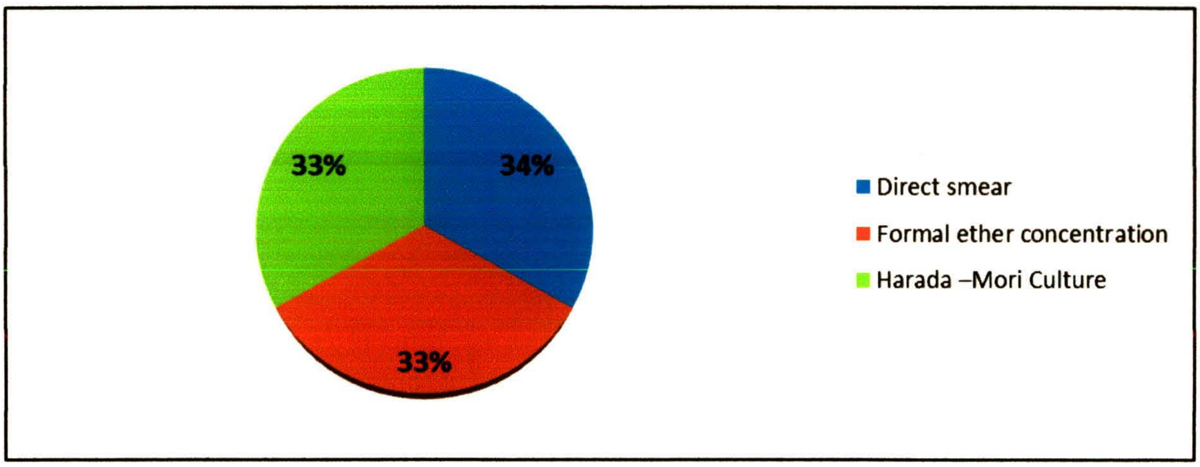

Fig 32. Prevalence of *S. stercoralis* infection found in different method in Gazipur.

5.16: *S. stercoralis* infection and household habit (wearing shoes or being bare footed (Table16a, 16 b)

The study reveals that the people who used to walk bare footed are more likely infected by *S. stercoralis* compared to the people who used shoes. The highest prevalence were found 12.76% and 14.28% in the participants who walked bare footed in Savar and Gazipur respectively .The lowest prevalence were 7.54 % and 9.37% who used shoes.

In Savar , the rate of prevalence of *S. stercoralis* in samples who wear shoes were not statistically significant ($p=0.02$, $p > 0.05$). The rate of prevalence of *S. stercoralis* in samples who are bare footed were statistically significant ($p= 0.004$, $p<0.05$).

Table16a. *S. stercoralis* infection in relation to household habit (wearing shoes or being bare footed) in Savar.

Location: Savar				
Shoes Wearing	Total No. of Examined samples	Positive Cases	Prevalence (%)	P value
Wear shoes	53	4	7.54	0.02
Bare footed	47	6	12.76	0.004

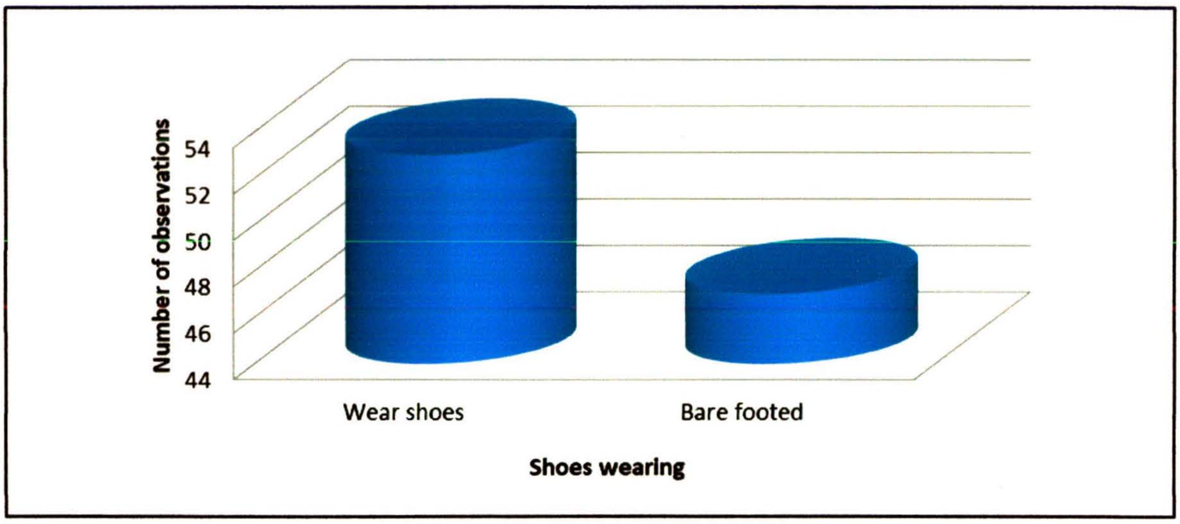

Fig 33. *S. stercoralis* infection in relation to household habit (wearing shoes or being bare footed) in Savar.

In Gazipur , the rate of prevalence of *S. stercoralis* in each sample who wear shoes was not statistically significant (p=0.04, p > 0.05). The rate of prevalence of *S. stercoralis* in each sample who are bare footed was not statistically significant (p= 0.02, p<0.05).

Table16b. *S. stercoralis* infection in relation to household habit (wearing shoes or being bare footed) in Gazipur.

Location: Gazipur				
Shoes Wearing	Total No. of Examined samples	Positive Cases	Prevalence (%)	P value
Wear shoes	32	3	9.37	0.04
Bare footed	28	4	14.28	0.02

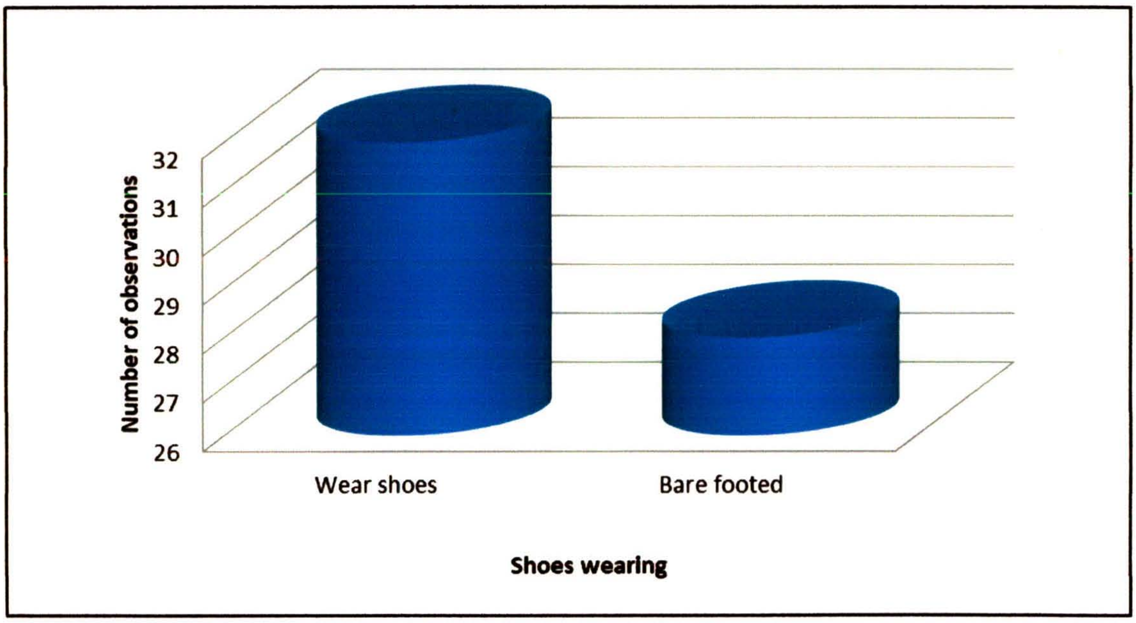

Fig 34. ***S. stercoralis*** **infection in relation to household habit (wearing shoes or being bare footed) in Gazipur.**

5.17 Prevalence of *S. stercoralis* according to seasonal variation (Table 17a, 17b).

Total 160 stool samples were collected from different seasons around the year. In summer 41 stool samples were collected and , in winter season 6 stool samples were collected and in rainy season 52 stool samples were collected in Savar. The highest prevalence 13.46 % and 15.62% were found in rainy season in Savar and Gazipur.

In Savar the lowest prevalence 8.10% was in summer season. And in winter the prevalence was 9.09% .The rate of prevalence of *S. stercoralis* in each sample of summer was not statistically significant (p=0.04, p >0.05). The rate of prevalence of *S. stercoralis* in each sample of winter was statistically significant (p=0.002, p < 0.05). The rate of prevalence of *S. stercoralis* in each sample of rainy season was statistically significant (p=0.004, p<0.05).

Table17a. Prevalence of *S. stercoralis* according to seasonal variation in Savar.

Location: Savar				
Season	No. of Observed Samples	No. of Infected hosts	Prevalence (%)	P value
Summer	37	3	8.10	0.04
Winter	11	1	9.09	0.002
Rainy	52	7	13.46	0.004

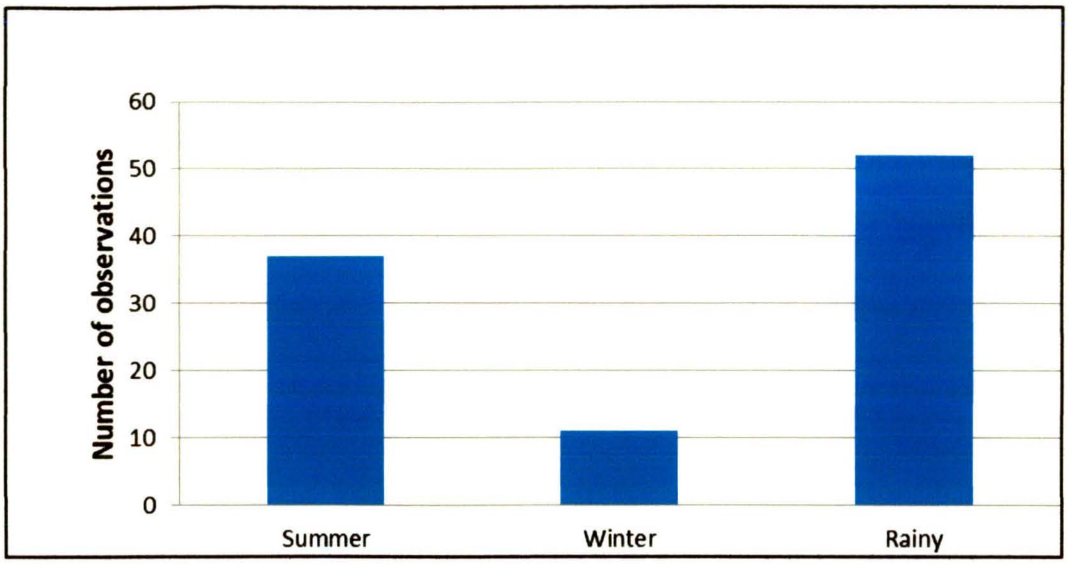

Fig 35. Prevalence of *S. stercoralis* according to seasonal variation in Savar.

In Gazipur the lowest prevalence 0% was in winter season. And in summer the prevalence was 4% .The rate of prevalence of *S. stercoralis* in each sample of summer was not statistically significant (p=4.06, p >0.05). The rate of prevalence of *S. stercoralis* in each sample of winter was statistically significant (p=0.00, p < 0.05). The rate of prevalence of *S. stercoralis* in each sample of rainy season was not statistically significant (p=0.01, p>0.05).

Table17b. Prevalence of *S. stercoralis* according to seasonal variation in Gazipur.

Location: Gazipur				
Season	No. of Observed Samples	No. of Infected hosts	Prevalence (%)	P value
Summer	25	1	4	4.06
Winter	3	0	0	0
Rainy	32	5	15.62	0.01

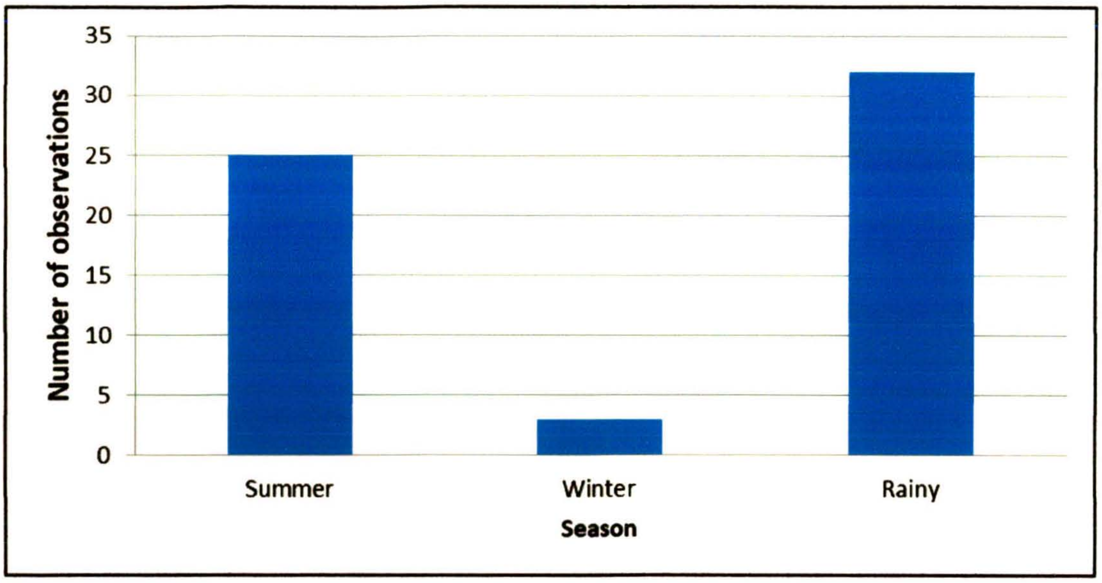

Fig 36. Prevalence of *S. stercoralis* according to seasonal variation in Gazipur.

5.18 Overall helminthic parasites identified in single stool (Table 18a, 18b).

Prevalence of *Strongyloides stercoralis* , *Ascaris lumbricoides*, *Trichuris trichuira* and *Enterobius vermicularis* were identified . In Savar, Out of 100, 10 people were infected by *Strongyloides stercoralis,* 37 by *Ascaris lumbricoides*, 15 by *Trichuris trichuira and* 15 by *Enterobius vermicularis.* Thus the prevalence were 10 % , 37 %, 15% and 15 % respectively.

Table18(a). Other helminthic parasites identified in stool samples of 100 participants examined for the presence of *Strongyloides stercoralis* in Savar .

Location: Savar		
Name of Parasites	Positive cases	Prevalence (%)
Strongyloides stercoralis	10	10
Ascaris lumbricoides	37	37
Trichuris trichuira	15	15
Enterobius vermicularis	15	15

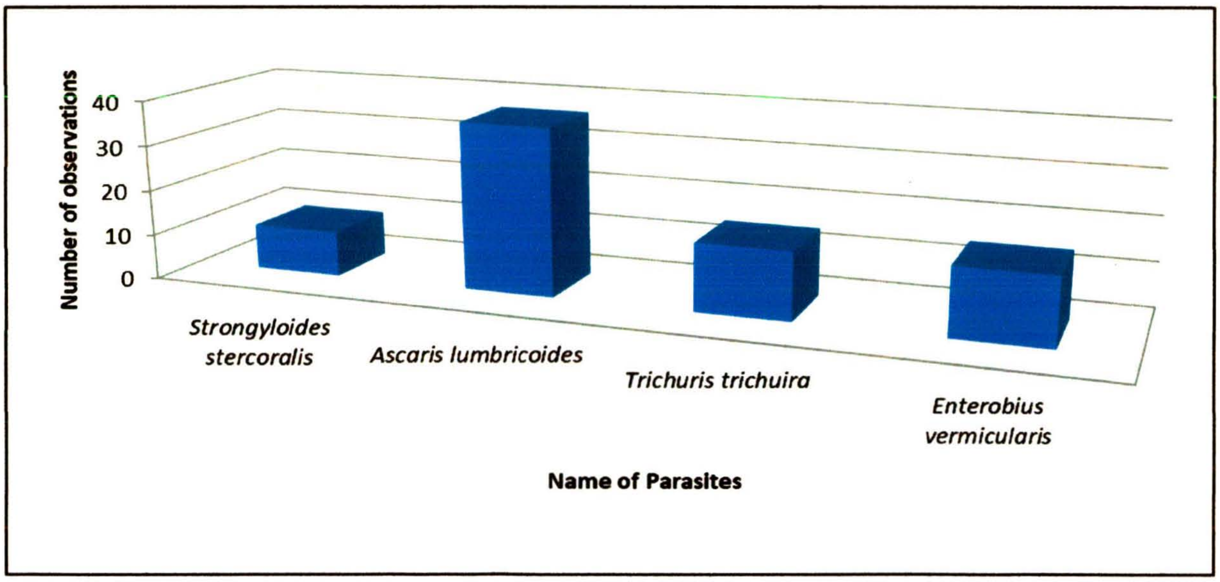

Fig 37. Other helminthic parasites identified in stool samples of 100 participants examined for the presence of *Strongyloides stercoralis* in Savar .

In Gazipur, Out of 60 respondents , 7 respondents were infected by *Strongyloides stercoralis,* 23 respondents by *Ascaris lumbricoides*, 10 by *Trichuris trichuira* and 9 by *Enterobius vermicularis.* Thus the prevalence were 11.66 % , 38.33 %, 16.66% and 15 % respectively.

Table18(b). Other helminthic parasites identified in stool samples of 60 participants examined for the presence of *Strongyloides stercoralis* in Gazipur district.

Location	Gazipur	
Name of Parasites	Positive cases	Prevalence (%)
Strongyloides stercoralis	7	11.66
Ascaris lumbricoides	23	38.33
Trichuris trichuira	10	16.66
Enterobius vermicularis	9	15

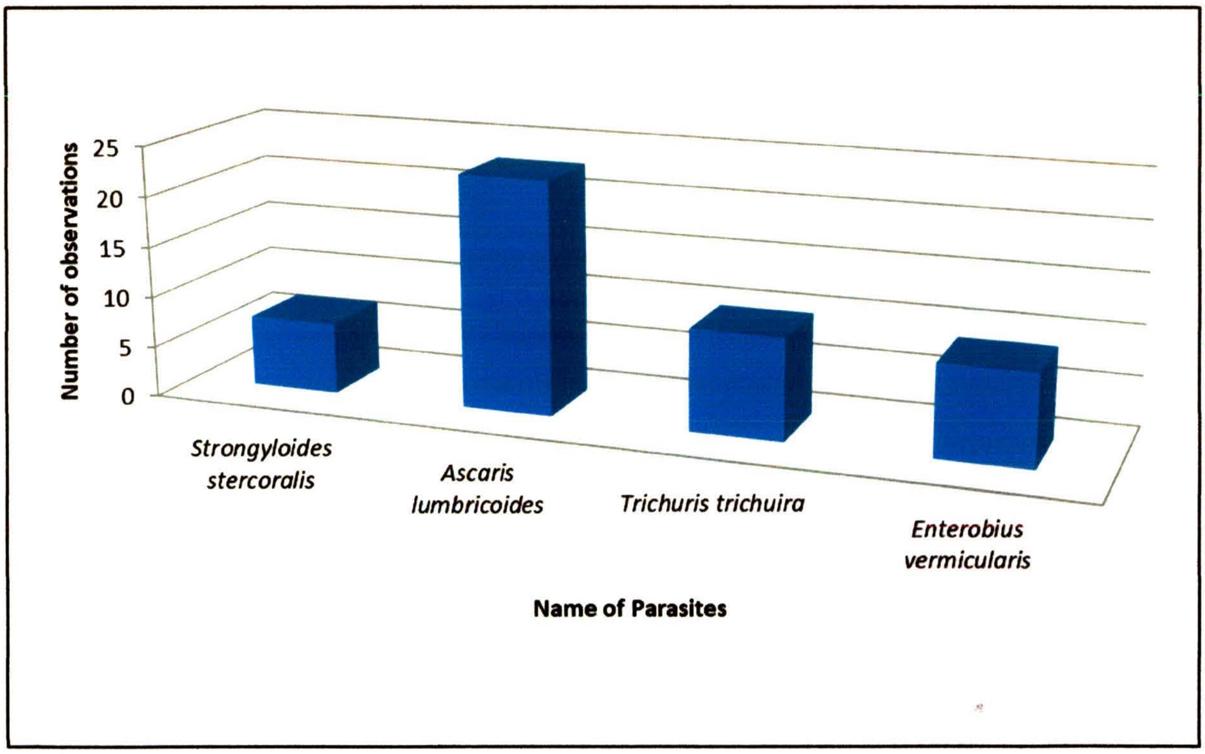

Fig 38 . Other helminthic parasites identified in stool samples of 60 participants examined for the presence of *Strongyloides stercoralis* in Gazipur district.

CHAPTER 6

Discussion

Discussion

The objective of this study was to evaluate the incidence of *Strongyloides stercoralis* infection among the rural and street dwellers people . Stongyloidiasis was found in high prevalence rate in the rural areas . Prevalence in different status showed variation , due to various type of factors. This factors can be defined as sex, age, different income level, educational qualification, population density in the family, types of house and different hand washing materials . To find out household related factors was the another major aim of this study.

Out of 160 samples collected in this study, 17 (10 in Savar and 7 in Gazipur) were positive for *S. stercoralis* infection and 67 were positive for other helminthic infection in Savar and 42 in Gazipur. Other helminthes found in this study were *Ascaris lumbricoides, Trichuris trichuira and Enterobius vermicularis.* (Table 1a, 1b).

In this study the overall prevalence of *Strongyloides stercoralis* infection in Savar , the prevalence of male was 12.12% and female was 10.44 %. So, the prevalence in male was higher than female. This result is similar to some studies which has shown significantly higher prevalence in males than females (Faust & Giraldo 1960, Cabrera 1981, Arakaki 1992, Yelifari 2005) . In their studies three groups of male (1-9 years, 10-19 years , 20-34 years) the prevalence were (11.4%, 12.1% and 14.2%) respectively . But in three same groups of female the prevalence were (10.5%, 10.5% and 11.5%) . Another study by Andrew Hall (1994) shows the similar result. The infestation rate of *Strongyloides stercoralis* infection was 10.6% in female and 12.8% in male. The infection in male was higher than female may be because of males are more susceptible to *Strongyloides stercoralis* infection than female due to their more involvement in different soil related activities like agriculture. Here p value was found 0.006 in male which is less than 0.05. So, we can say that the infection rate was related to the gender. However , this difference was statistically significant ($p<0.05$). But in female p value was found 0.0007 which was less than 0.05. So, we can say that the infection rate was related to the gender. In Savar p value was found 0.004 in female which is less than 0.05. This difference in female was statistically significant ($p<0.05$) (Table 2a).

In different age groups the highest prevalence rate (30%) was found in the age group of (51-60) years and the lowest prevalence (0%) was in the age group of (11-20) years in Savar . The relation between age and infection rate was statistically significant ($p<0.05$). This result is similar to the work of (Widjana DP 2000). *Strongyloides stercoralis* infection rate was high among participants whose age was above 18 years old. The prevalence of strongyloidiasis infection increased steadily with age to reach its maximum (42.8%) in adulthood ((> 18 years) (Widjana DP 2000). In Savar , the prevalence was observed 8.9 % in 00-10 years, 0% in 11-20 years,15.79% in 21-30 years, 12.5 % in 31-40 years, 5.2% in 41-50years and 30% in 51-60 years . The present study demonstrated that the prevalence of *S. stercoralis* infection in respondents aged 51-60 years old was higher than that in respondents below 50 years. So, the relation between age group and infection rate is statistically significant (p= 0.06, p<0.05) (Table-3a). Another result is similar to the study by Jongsuksuntigul P, Intapan PM, Wongsaroj T, Nilpan S (Jongsuksuntigul P 2003).The infection rate was high among the respondents who were above 60 years. Predominantly among 60 years old and older (28.0%) (Jongsuksuntigul P 2003). The infection rate is dependent on the different age group. So, it is shown that the infection rate is getting higher with the increasing of age. May be due to stay long time in an unhygienic area and the longiviity of the parasites persists long time.

This result is also similar to the study by Hirata in Okinawa, Japan (Tetsuo Hirata 2007) where *Strongyloides stercoralis* infection was high among the respondents who were above 80 years. Infection rate with *Strongyloides stercoralis* in age groups of 0-19 years and 20-39 years was 0.0%, in age group of 40-59 years was 1.3%, in age group of 60-79 was 6.8% and in age group above 80 years was 9.0%. This result showed no infection in child and prevalence of *Strongyloides stercoralis* infection gradually increased with age(Hirata 2007). This may be due to the recent increase in public awareness about the importance of hygienic condition and awareness about child health among parents keeping child safer from being susceptible to any infection. (Table-3a).

Occurrence of *S. stercoralis* infection based on different occupations of the respondents were also studied. Total samples were divided into five groups which were service holders, labors, housewives, students and others. Out of 160 respondents total number of the service holders were 66, labors were 17, housewives were 33, students were 11 and others were 33. The highest rate of infection (27.27% and 33.33%) were found in day labors and the lowest were found among service holders 4.87% and 4% in Savar and Gazipur respectively. But the relationship of housewives in Savar was statistically insignificant (p=0.04, p >0.05). (Table-4a).This correlates with the previous study by Sultana (2012) in Bangladesh. Another study by Yasmin (2012) on strongyloidiasis in a high risk community of Dhaka, Bangladesh shows similar result. The prevalence rate among service holders , labors, students, housewives and others were (22.2%, 30.0%, 27.8%, 17.1% and 50.0%) respectively. Thus the highest prevalence was found in labors and lowest was found in housewives. This is probably because of their unhygienic practice in daily life.

The selected areas had mainly two types of houses. One was tin shed with mud floor and another was tin shed with cement floor house. Infection rate found in the first type of house was (11.53 % and 12.90 %) and in the later type was (8.33% and 10.34%) in Savar and Gazipur district. The highest rate of infection occurred in tin shed with mud floor type houses. But the relation between type of pattern of house and *Strongyloides stercoralis* infection was statistically not significant ($p > 0.05$). However, copro analysis in an earlier study in Bangladesh showed highest risk of *Strongyloides stercoralis* infection among people who lived in a house with an earth floor. In this study people living in house with mud floor had 13.5% prevalence of *Strongyloides stercoralis* infection and living house with cement floor had 5.6% prevalence of *Strongyloides stercoralis* infection. This result is similar to the current result. May be this occurred due to transmission of infection of *Strongyloides stercoralis* occurs through mud. Infective *Strongyloides stercoralis* is a soil transmitted parasite which can infect human through soil. Infective *Strongyloides stercoralis* larva has been detected on earth floors of houses and was found community in Colombia (Faust & Giraldo 1960). So, the higher infection rate of *Strongyloides stercoralis* in mud floor house compared to cement floor house is possible. (Table 5a, 5b)

Bangladesh is one of the poorest countries in the world with a total population of 124 million, which is growing at the rate 1.8% per year. About 80% 0f the population lives in rural areas and only 44% of households have save latrines (UNICEF 1997). The present study showed the prevalence of *Strongyloides stercoralis* infection according to the pattern of different types of toilet. In this study the participants used the sanitary and insanitary toilet. In Savar, 12.06% infection rate was found in sanitary toilet users, 9.52 % infection rate was found in insanitary toilet users. Here the highest prevalence found in insanitary toilet users and the lowest prevalence found in sanitary toilet users. In Savar, the rate of prevalence of *S. stercoralis* in sample of insanitary toilet was statistically significant ($p=0.004$, $p<0.05$) and the rate of prevalence of *S. stercoralis* in sample of sanitary toilet was not statistically significant ($p=0.02$, $p>0.05$). Thomas Kuete (2015) showed the relation between toilet pattern and infection. Participants reported using latrines located either inside (55.4%) or outside (44.6%) of their household premises. Using private latrines and sharing latrines with neighboring household was not associated with reduced likelihood of *Strongyloides stercoralis* infection ($p=0.9$). However, participants who used exclusively private latrines had lower prevalence rates compared to those who used latrines located outside of households. Sanitation types did not show significant differences in infection trends between the dwellers whose those latrines were located outside of households and those with private latrines despite of the lower *Strongyloides stercoralis* infection prevalence recorded in the later group. Despite the low prevalence rates recorded for the intestinal parasitic infections, most of the sanitation facilities located outside of household were poorly constructed and often mouth-opened, uncovered and located in frequently flooded areas. These sanitation facilities were shared in most households with other households. This lack of improved sanitation facilities and occurrence of fecal-related parasitic diseases thus incites for more improvement of the sanitary facilities. (Table-6a)

The present study compared the relationship between sources of drinking water and *S. stercoralis* infection. In rural area of Savar and Gazipur, most of the people used supply water and the maximum infection rate was (13.43% and 12.19%) and tube well water users had *S. stercoralis* infection rate at (6.25% and 5%) respectively. In Gazipur, the rate of prevalence of *S. stercoralis* in sample of supply water was not statistically significant ($p=0.01$, $p>0.05$) and the rate of prevalence of *S. stercoralis* in sample of tube well water was also not statistically significant ($p=3.3$, $p>0.05$) . (Table-7b). Andrew Hall (1994) also showed source of drinking water as a factor related to *S. stercoralis* infection. In his study prevalence of *S. stercoralis* infection among common tap water users was (11.7% and 12.3%) among own tap water users. The result showed no statistically significant relation between source of drinking water and *S. stercoralis* infection. This result is related to present study. This may be caused the transmission of *S. stercoralis* through water. Usually eggs are carried by water and if it is drunk infection occurred. Eggs of *S. stercoralis* are found in soil and hatch there. Therefore, water plays a vital roll in the transmission. In case of boiled water prevalence has been shown lower than in unboiled water. This is probably contamination rate in supply water is higher than in tube well water (Table 7a,7b).

Prevalence of *S. stercoralis* infection in relation to monthly family income was also studied. In Savar, Out of 100 respondents, the lowest prevalence was found 10.69 % in (5001-10000 tk) monthly family income. No infection was found in, (15001-20000 tk) , (20001-25000 tk) and (25001-30000 tk) monthly family income. The highest prevalence rate showed 16.66% in the lower class family members whose monthly income was (1000-5000 tk) (Table 8a) . This result is similar to the work of (Pitisuttithum P 1090). In his study the average personal family incomes were low (less than US 1000/year), about 56% people came from middle class families (US 2000-4000/year).The strongyloidiasis rate was 30.5% in the middle class family (Pitisuttithum P 1090). Lower class family members may be not conscious about their health.They always suffer from lack of food, habitat, healthy environment, proper medical treatment, education etc. As a result various parasitic infections found at a highest rate in lower class family.

Out of 160 respondents participated in present study, prevalence of *S. Stercoralis* infection in relation to the number of family members also examined. The family members were divided into five groups. In Savar, out of 100 samples 12(8.3%) was in (1-3) family members, 75 (10.66%) was in (4-6) family members, 10 (20%) was in (7-9) family members. No prevalence was found in (10-12) and (13-15) family members. The highest prevalence was found in 20% in the family members of (7-9) In Gazipur, out of 60 samples 8 was in (1-3) family members, 45 (11.11%) was in (4-6) family members, 16 (16.66%) was in (7-9) family members. No prevalence was found in (10-12) and (13-15) family members. The highest prevalence was found in 16.66 % in the family members of (7-9) . In Savar, the rate of prevalence of *S. stercoralis* in each sample of 1-3 members was statistically significant ($p=0.001$, $p < 0.05$), sample of 4-6 members was statistically significant ($p=0.002$, $p <0.05$), sample of 7-9 members was statistically significant ($p=0.09$, $p <0.05$), sample of 10-12 members was statistically significant ($p=0.00$, $p<0.05$), sample of (13-15) members was statistically significant ($p=0.000$, $p<0.05$). In Gazipur, The rate of prevalence of *S. stercoralis* in each sample of 1-3 members was statistically significant ($p=0.00$, $p < 0.05$), sample of 4-6 members was not statistically significant ($p=0.01$, $p > 0.05$), sample of 7-9 members was not statistically significant ($p=0.02$, $p >0.05$), sample of 10-12 members was statistically significant ($p=0.00$, $p<0.05$), sample of 13-15 members was statistically significant ($p=0.000$, $p < 0.05$) (Table 9a, 9b). But may be in the rural area people live in a small room with gathering about 5 to 6 members. The parasite egg and larvae can be transferred through bedcover, clothes and others materials which are used combinely. As a result infection occurred and hampers the body (Table 9a,9b).

Occurrence of *S. stercoralis* infection in relation to educational qualification of the respondents was also studied. In our country about 43% of the rural population is illiterate (UNICEF 1997). In Savar, Out of 100 respondents total number of illiterate were 46 , up to class V passed participants were 38 , up to class X passed participants were 13, up to S.S.C. passed participants were 2. There was no H.S.C. passed participants. Their prevalence of infection by *S. stercoralis* was 15.2 % in illiterate, 7.89% in up to class five respondents, 0 %

in up to S.S.C. passed respondents. So, the highest rate of infection were found 15.2 % in illiterate respondents and the lowest infection rate was 0.04% up to class five respondents. The rate of prevalence of *S. stercoralis* in each sample of illiterate was statistically significant ($p=0.004$, $p<0.05$), sample up to class V was not statistically significant ($p=0.04$, $p>0.05$), sample up to class 10, sample of S.S.C. passed and sample of H.S. C. was statistically significant ($p=0.00$, $p<0.05$). In Gazipur, Out of 60 respondents total number of illiterate were 28 , up to class V passed participants were 23 , up to class X passed participants were 8, up to S.S.C. passed participants were 2. There was no H.S.C. passed participants. Their prevalence of infection by *S. stercoralis* was 17.85 % in illiterate, 8.69 % in up to class five passed respondents, 0 % in up to S.S.C. passed respondents. So, the highest rate of infection were found 17.85 % in illiterate respondents and the lowest infection rate was 0.06% up to class five respondents. The rate of prevalence of *S. stercoralis* in each sample of illiterate was not statistically significant ($p=0.01$, $p>0.05$), sample up to class 5 was statistically significant ($p=0.06$, $p<0.05$), sample up to class 10, sample of S.S.C. passed and sample of H.S. C. was statistically significant ($p=0.00$, $p<0.05$) (Table10a,10b). May be illiterate responds were not aware about the affect of strongyloidiasis. They have no educational knowledge about parasite infection. This result is similar to the work of (Pitisuttithum P 1990). He found highest prevalence rate in the illiterate persons about 35%. May be the illiterate respondents are not aware about the affect of strongyloidiasis. They have no educational knowledge about parasite infection. So the prevalence rate is higher among illiterate participants.

Prevalence of *S. stercoralis* infection in relation to the history of diarrhea in family members also studied. History of diarrhea in family members were divided into two categories. The first category the family members who was suffered the diarrheal disease before three months and the other was who did not suffer the diarrheal disease before three months. 18% and 16.66% infection rate found in the first category and 4% and 3.33% infection rate found in second category in Savar and Gazipur accordingly. (Table -11a-b) The highest prevalence was found in the participants family members who suffered the diarrheal disease before three months and than who did not suffer the diarrheal disease before three months But there is no association between infection and diarrhea in family members in Gazipur. This result is statistically significant ($p=0.01$, 5.1 ; $p>0.05$)(Table-11b) .This result is similar to the study of (Fabian Schar 2013) . He showed a wide range of infection prevalence among the history of diarrhea in family members. The lowest prevalence rate was found 1.0% (95% CI: 0.0-

3.0%) while the highest reported was 76.0%(95%CI: 39.0-99.0%) showing no statistically significant difference. Case-control studies on patients with and without diarrhea are relatively scarce , especially studies reporting on *S. stercoralis*, of which he could only identify four. Because diarrhea is one of the symptoms associated with *S. stercoralis* infection as well as with other soil transmitted helminth (STH) –infections, it remains unclear whether diarrhea can be considered as a risk factor or if infection with STHs leads to a higher prevalence of diarrhea .

Prevalence of *S. stercoralis* infection in relation to the history of diarrhea in participants also examined in this study. History of diarrhea of participants were divided into two categories. The first category who was suffered the diarrheal disease before three months and the other were who did not suffer the diarrheal disease before three months. . 16.98% infection rate found in the first category and 2.08 % infection rate found in second category in Savar (Table-12a). The highest prevalence was found in the participants family members who suffered the diarrheal disease before three months than who did not suffer the diarrheal disease before three months This result is similar to the work of (Dada-Adegbola HO 2010). He worked on the prevalence , risk factors and features of strongyloidiasis among diarrhea patients. Diagnosis was made by microscopic examination of stool in saline preparation and formal -ether concentration.1090 patients , 562(51.6%) males and 528 (48.4%) females consisting 380 (34.9%) children and 710 (65.1%) adults who had diarrhea were studied. The prevalence rate for the parasite among diarrhea patients was 3.0% . While risk factors for infection remains contact with the contaminated soil, malnutrition, steroid therapy (Dada-Adegbola HO 2010). Predominant clinical presentations are abdominal pain, chronic diarrhea and bloating and weight loss. *S. stercoralis* should be considered in diarrhea patients who are malnourished or immunosuppressed .

Out of 160 respondents participated in our study, prevalence of *S. Stercoralis* infection in relation to nail cutting habit also examined. In this study 160 participants were divided into two categories. The first category who was irregular, who did not sharp their nail regularly and the second category who shaped their nail regularly. Among two categories the highest prevalence was found 20.45% and 23.07% in Savar and Gazipur respectively who were irregular in nail cutting habit. This result is statistically significant ($p=0.007, 0.001; p< 0.05$). Some of the eggs may remain attached with the nail during work and defecation. The contaminated nails may infect during the time of eating. Normally many of the children and other person have the habit of cutting nails by their teeth and sucking their finger. Infestation rate was higher among those people who had irregular habit of nail cutting (Table 13a,13b)

Prevalence of *S. stercoralis* infection on the basis of hand washing habit by soap after defecation was also properly examined. Out of 160 participants were divided into two categories. The first category who use soap and water after defecation and the second category who did not use soap after defecation. The highest prevalence was found in second category 12.06% and 11.42% in Savar and Gazipur respectively. But there is no association between rate and use of soaps after defecation. This result is not statistically significant (p=0.02 in Savar ; p >0.05) (Table14a,14b). The present result correlates with previous study (Thomas Kuere 2015) in Cameroon. 53.5% of participants reported washing their hands before eating. However, they did not systematically washed hands with soap. Hand washing before eating did not significantly influence infection trends by any of the protozoa (p >0.05). However, this hygiene practice showed a significant influence on strongyloidiasis. Infection prevalence rate was significantly low among those who systemically washed hands before eating. 86.7% participants systematically washed their hands after defecation and 13.3% did not . Systematic hand washing practice after defecation significantly lowest. However, *Strongyloides* was found only among participants who declare to systematically wash hand after defecation. Hand washing practices showed a significant intestinal parasite infection reduction compared to those who did not wash. The difference was more significant when it occurred before eating than after defecating . A reliable assessment could be undergone to highlight whether participants systematically washed hands with soap or no.

Total 160 stool samples were examined for the *S. stercoralis* infection in this study. Three methods were used ; direct smear, formal ether concentration method and Harada-Mori culture method. Highest prevalence 9.1%, 10% found in Formal ether concentration method in Savar and Gazipur respectively. The lowest prevalence 1% and 0 % in Savar and Gazipur was found in direct smear and Harada-Mori culture method respectively. In Savar, the rate of prevalence of *S. stercoralis* in Formal ether concentration method was statistically significant (p=0.001, p <0.05), but in Direct smear method and Harada Mori Culture was not statistically significant (p=8.3, p>0.05). (Table-15a) The present resulte is similar to the study of Mahdi NK 1993. The prevalence rate infection was 64.2%. Formalin –ether concentration method was 3.75 times better than the direct smear method in diagnosis of strongyloidiasis (Mahdi NK 1993). The Harada-Mori culture is recommended in patients with undiagnosed diarrhea and where strongyloidiasis is endemic or suspected.

The study reveals that the people who used to walk bare footed are more likely infected by *S. stercoralis* compared to the people who used shoes. . The highest prevalence was found (12.76 % and 14.28%) in the participants who walked bare footed in Savar and Gazipur respectively .The lowest prevalence was (7.54 % and 9.37%) who used shoes (Table-16a, 16b). The present work is compared to the work of Felix Reichert, Daniel Pilger and Angela Schuster, Brazil (Felix Reichert 2016). In their study the highest risk was associated with the habit of always walking barefoot on sandy ground or soil (OR=23.4; 95%CL,8.0-68.6). Multivariable risk factor analysis revealed that always walking bare foot on sandy ground or soil was the most important independent risk factor. Most of the tracks (62.4%) were located on the feet which reflect the fact that many people walked barefoot. Unhygienic living conditions and practices as well as limited access to healthcare may explain the higher proportion of superinfected . The feet were the most common localization for strongyloidiasis.

In this study the highest prevalence was found in the rainy season. In rainy season the weather is moist and the soil ground getting wet . So, it is easy for *Strongyloides* to penetrate the skin. Here infection rate was found prevalence (13.46 % and 15.62%) was in rainy season in Savar and Gazipur which was highest than the infection found in summer and winter was (8.10% , 4%) and (9.09%, 0%) respectively (Table 17a, 17b). This work is similar to the result of Felix Reichert 2016. Seasonal variation in strongyloidiasis prevalence in the Amazonas region, where the climate is hot and humid throughout the whole year, remains to be clarified. Outside brazil and overall prevalence between (0.2% and 4.4%) during the dry and the rainy season, respectively.

Other helminthic infection also has been found in this study. Among these in Savar, 37 people were infected by *Ascaris lumbricoides*, 15 by *Trichuris trichuira* and 15 by *Enterobius vermicularis.* Thus the prevalence were (37 %, 15% and 15 %) respectively. In Gazipur, 23 people were infected by *Ascaris lumbricoides*, 10 by *Trichuris trichuira* and 9 by *Enterobius vermicularis*. Thus the prevalence were (38.33 %, 16.66% and 15 %) respectively (Table 18a,18b). These parasites were also observed in other studies. The result is closely similar to the result observed by Yori 2006, Yasmin 2012 .

The result arising from this research contribute to knowledge of occurrence of strongyloidiasis, which could form the basis of further extensive surveys in Bangladesh to identify sources of infection and also the modern treatment and control programs can be developed.

CHAPTER 7

Conclusion

Conclusion

The soil-transmitted nematode, *Strongyloides stercoralis* is one of the most-neglected of all neglected tropical diseases. It is globally distributed, favouring the humid, wet climates of the tropics and subtropics. Inadequate sanitary conditions promote the spread of *S. stercoralis* infection.

The present study has been done to find out the occurrence of *Strongyloides* infection among the people of the low society of the rural areas adjacent to Dhaka city. Strongyloidiasis is a common public health problem in the developing and underdeveloped countries including Bangladesh. The prevalence of strongyloidiasisis rampant in Bangladesh. It is creating an extra load on the public health in our country, which is bowing due to over population.

This investigation on occurrence of strongyloidiasis conducted with the respondents of some rural areas adjacent to Dhaka city, Bangladesh. A significant association of *Strongyloides* infection in people has been found with their educational status, source of drinking water and sanitation types ($p<0.05$). Other facts like age , gender discrimination, occupation, type of house, using of shoe, using of soaps, trimming nails were also considered for fulfilling this study.

The prevalence of *Strongyloides* infection in low society may be high due to high change of contamination with infected people . In low society as people can't provide accommodate place to their family member, nutritional food, good sanitation , necessary materials which keep them clean as a result they easily become infected . Most of the participants in the rural area of Bangladesh are poor and illiterate. They don't have a clear concept about the *Strongyloides* infestation. Illiteracy , unhygienic practices and superstations are thus make a vicious combination for *Strongyloides* infection among them.

This work has been focused on existence of *Strongyloides* infection in some rural areas adjacent to Dhaka city, Bangladesh. Through presenting the data there was also shed some light on the disease status and distribution Of *Strongyloides stercoralis* in different rural areas adjacent to Dhaka city. However it appears that there is a general decline in *Strongyloides* infestation and this is probably related to the improvement of the general living condition and sanitation of the poor people.

This parasitic nematode can infect patients for decades and go undetected in those who are immune competent. When immune system is weakened either by debilitating disease , malnutrition or immunosuppressive therapy , an ensuing hyper infection with *Strongyloides stercoralis* can occur. Successful treatment of this infection depends on an early diagnosis and removal of this worm before sepsis develops. Detection of this infection remains difficult . Optimal treatment regimens have not been properly studied and there is a need to determine the best chemotherapeutic does to permanently remove this parasite from its human lost.

CHAPTER 8

Recommendation

Recommendation

It is clear that *Strongyloides stercoralis* infestation is a major health problem in rural dwellers in Bangladesh. Therefore great emphasis must be focused on those factors which are responsible for infection. From this study it is recommended that-

1. Wearing shoes can prevent strongyloidiasis.
2. Avoid taking or eating raw vegetables and water without boiling.
3. After defecation and before taking food hands should be clean with soap.
4. Educational facilities of the people specially for women should be improved.
5. To improve sanitation different recommended toilets provided in the rural area.
6. Pure drinking water supply should be ensured by strict monitoring of the microbiological status of the supplied water. In addition, people should be encouraged to use purified or boiled water.
7. Mass media i.e. radio, television etc. should play roles to disseminate information about parasitic disease and control measures.

CHAPTER 9

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CHAPTER 10

Annexure

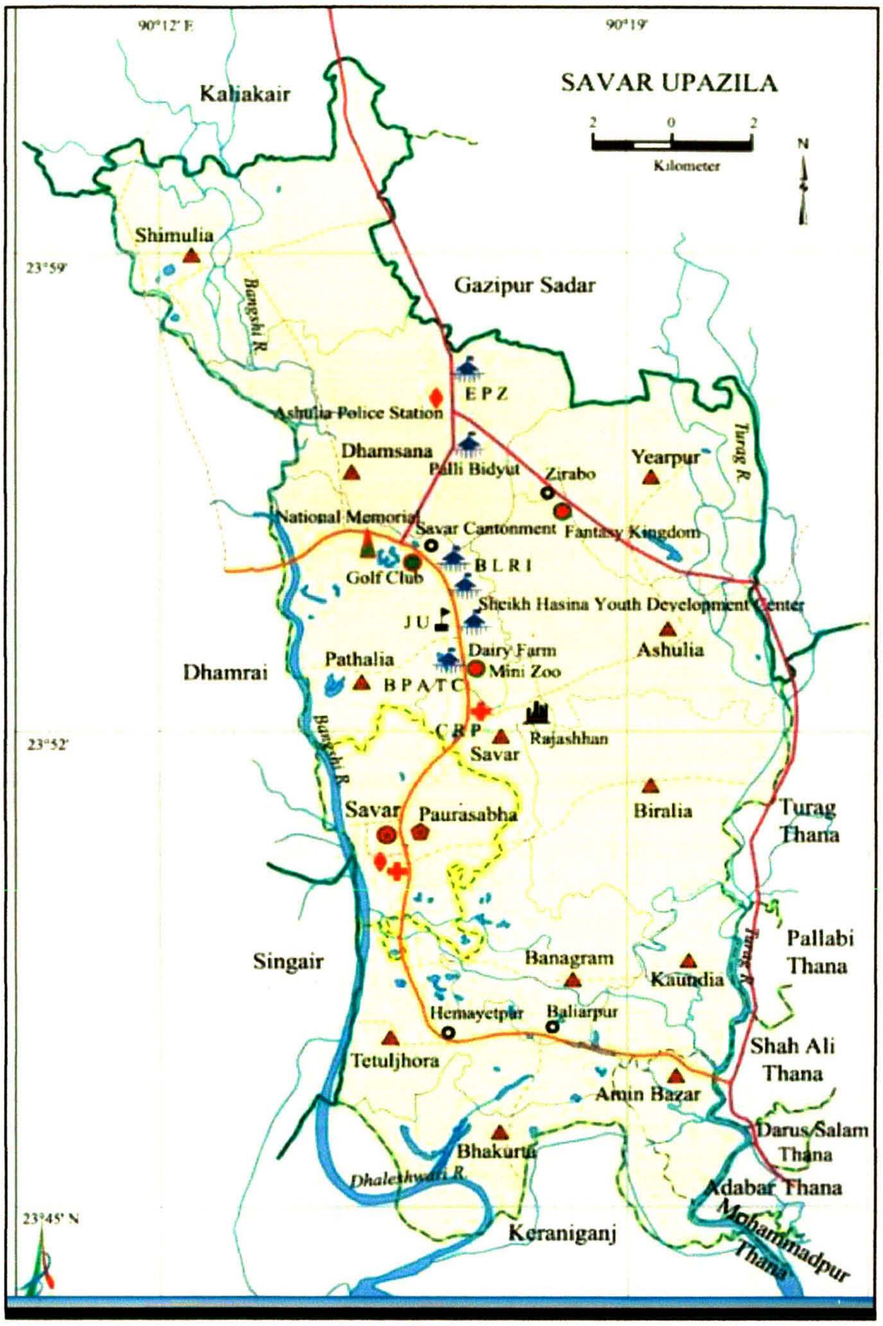

Fig 39. Map of Savar Upazila (Page no.-19)

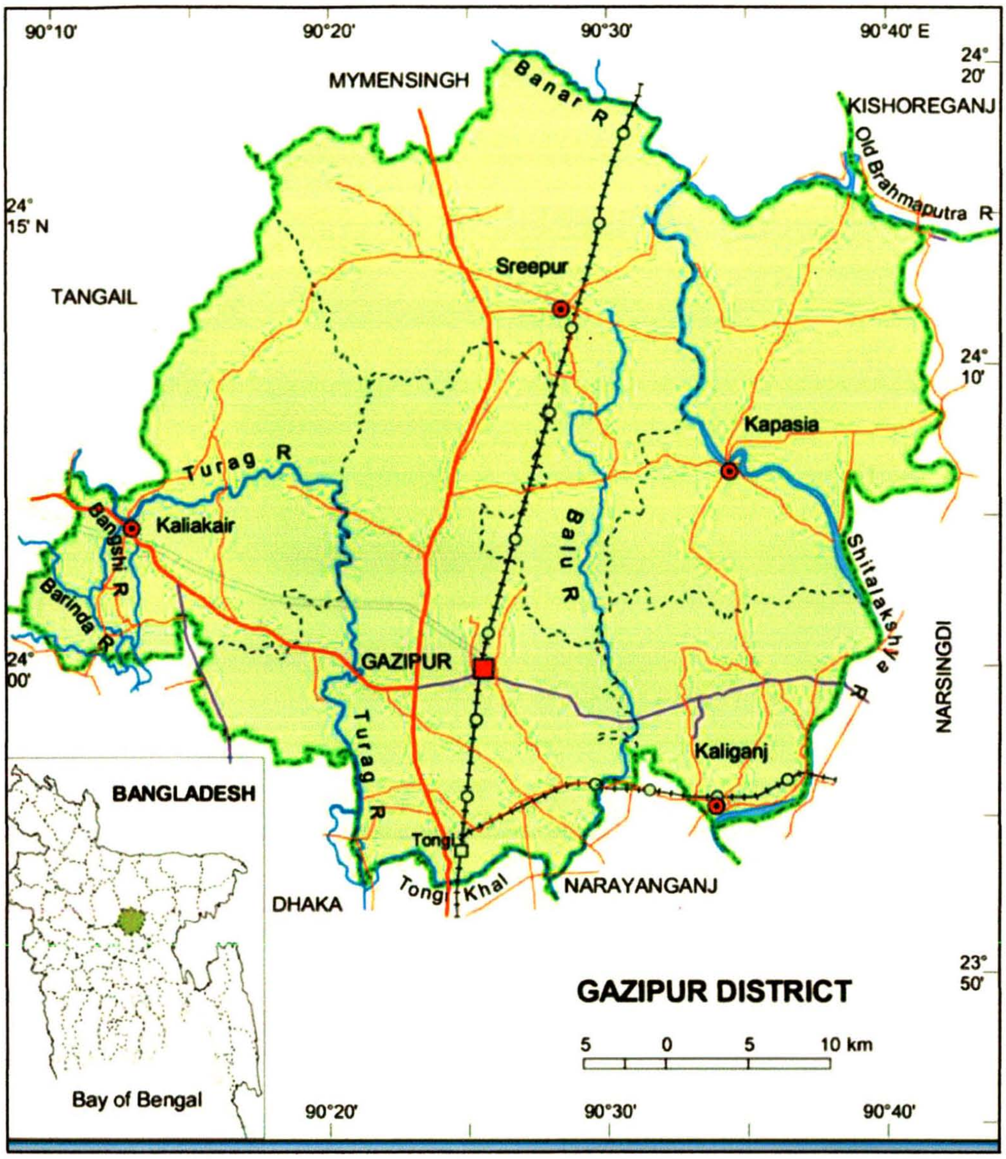

Fig 40. Map of Gazipur district (Page no.-19)

Fig 41. Rhabditiform larva of Strongyloides stercoralis in stool specimen (Page no.- 25).

Fig 42. *Stongyloides stercoralis* first-stage rhabditiform (L1) larvae (Page no.-25)

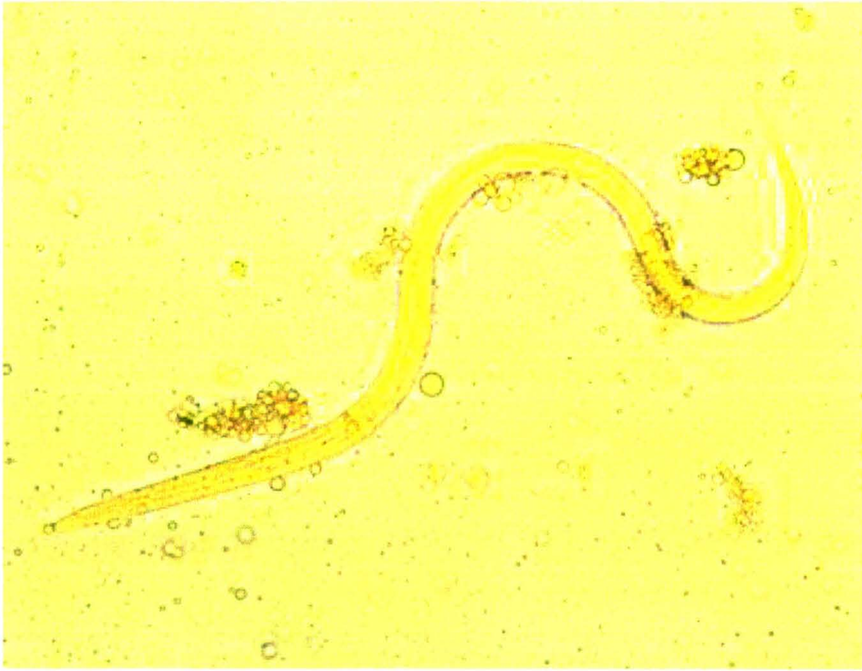

Fig 43. Filariform (L3) larva of *S. stercoralis* in an unstained wet mount (Page no.-25)

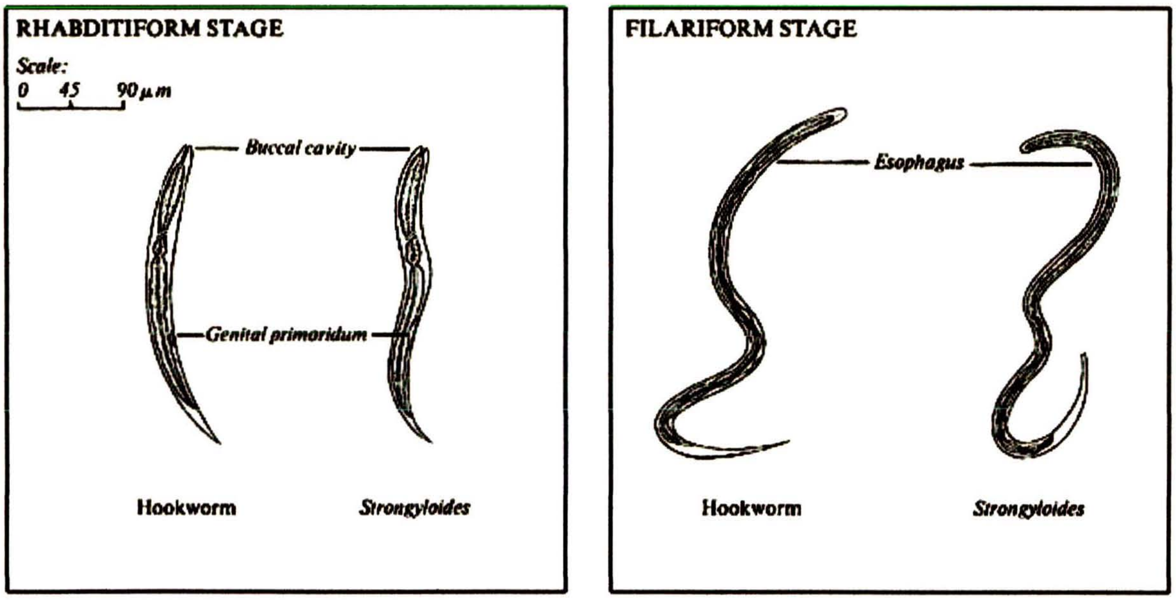

Fig 44. Difference between *Strongyloides* larvae and hook worm (Page no.- 26)

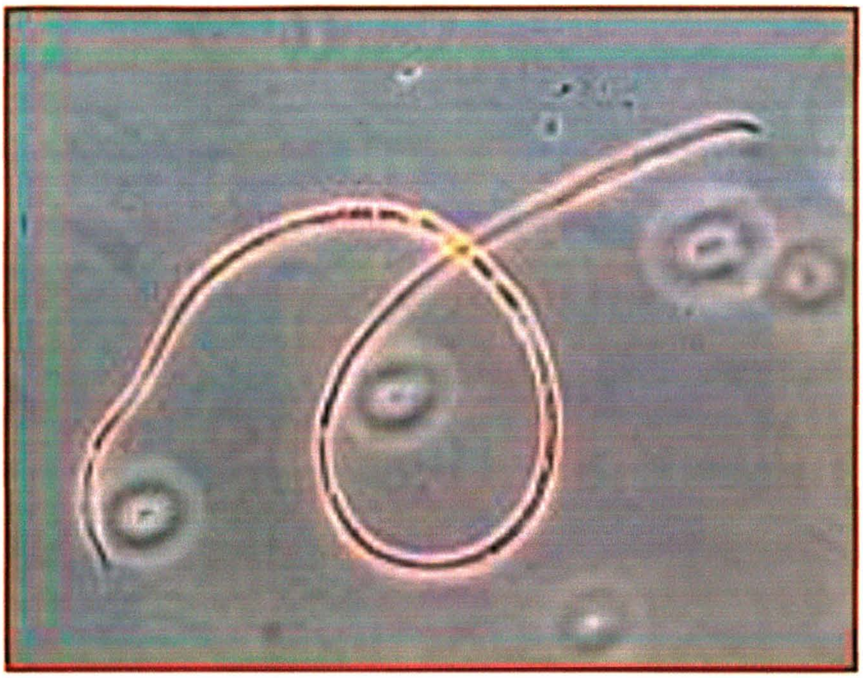

Fig 45. Adult parasitic female in stool specimen (Page no.- 31)

Fig 46. Free-living adult male *S. stercoralis*. The presence of the spicule (red arrow)

(Page no.-31)

Fig 47. Free living adult male *S. stercoralis*, showing a spicule (red arrow). A smaller, rhabditiform larva lies adjacent to the adult male (Page no.- 31)

Fig 48. Adult free-living female *S. stercoralis* alongside a smaller rhabditiform larva. The developing eggs in the adult female (Page no.- 31)

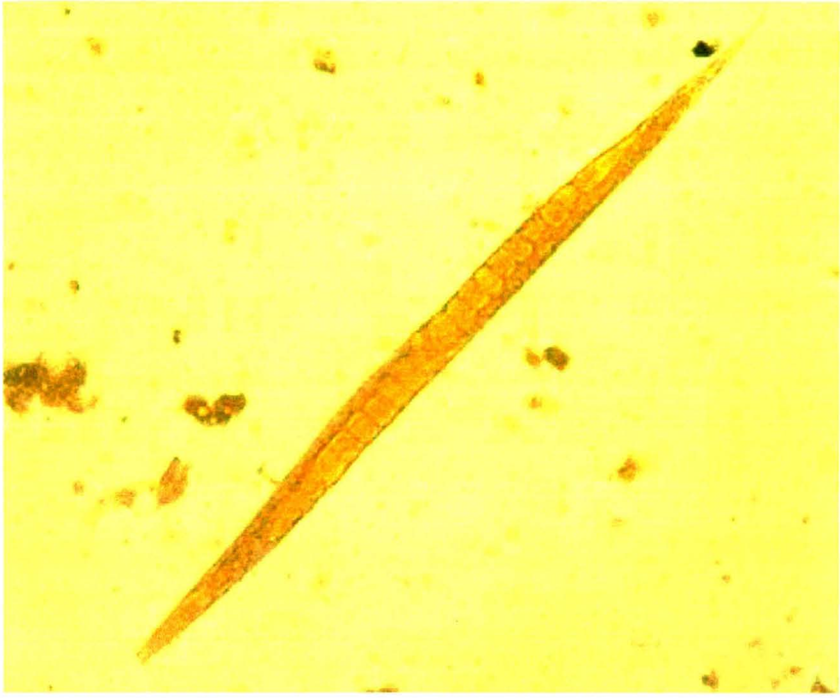

Fig 49. Adult free-living female *S. stercoralis*. The row of eggs within the female's body (Page no.- 31)

Fig 50. *S. stercoralis* infected skin (Page no.- 36)

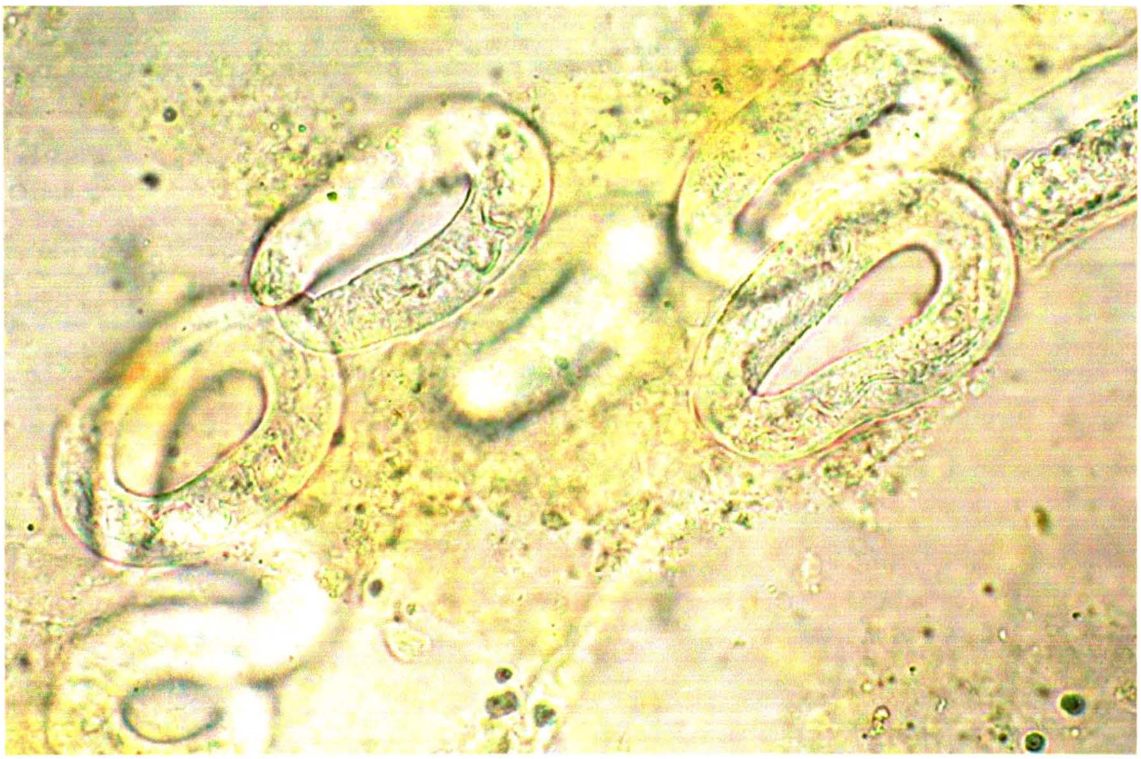

Fig 51. Embryonated eggs of Strongyloides stercoralis in bronchial fluid from a fatal case of disseminated strongyloidiasis (Page no.- 36)

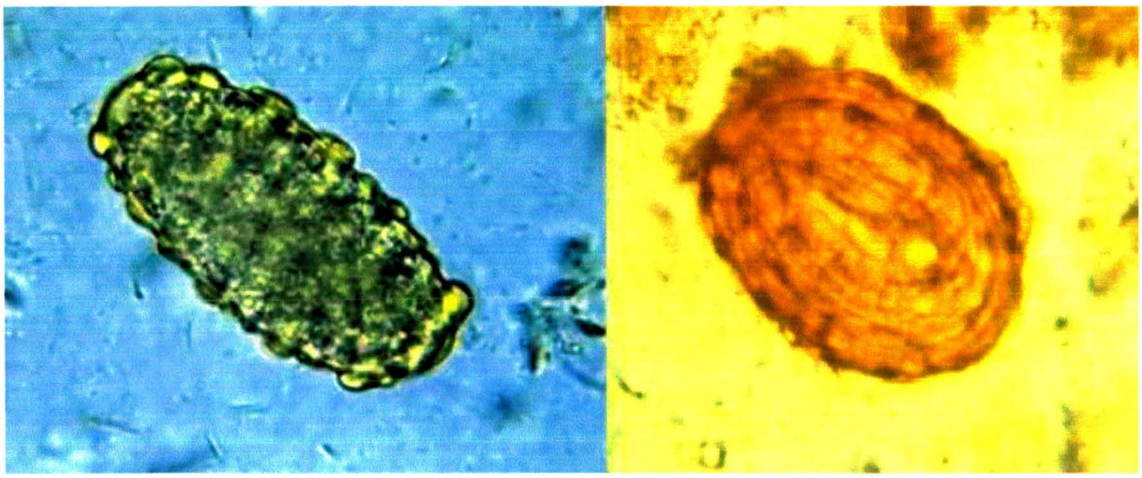

Fig 52. Unfertilized (left) and fertilized (right) *Ascaris lumbricoides* eggs. (wet prep) (SOURCE: PHIL 411/4821 - CDC/Dr. Mae Melvin) (Page no.- 26)

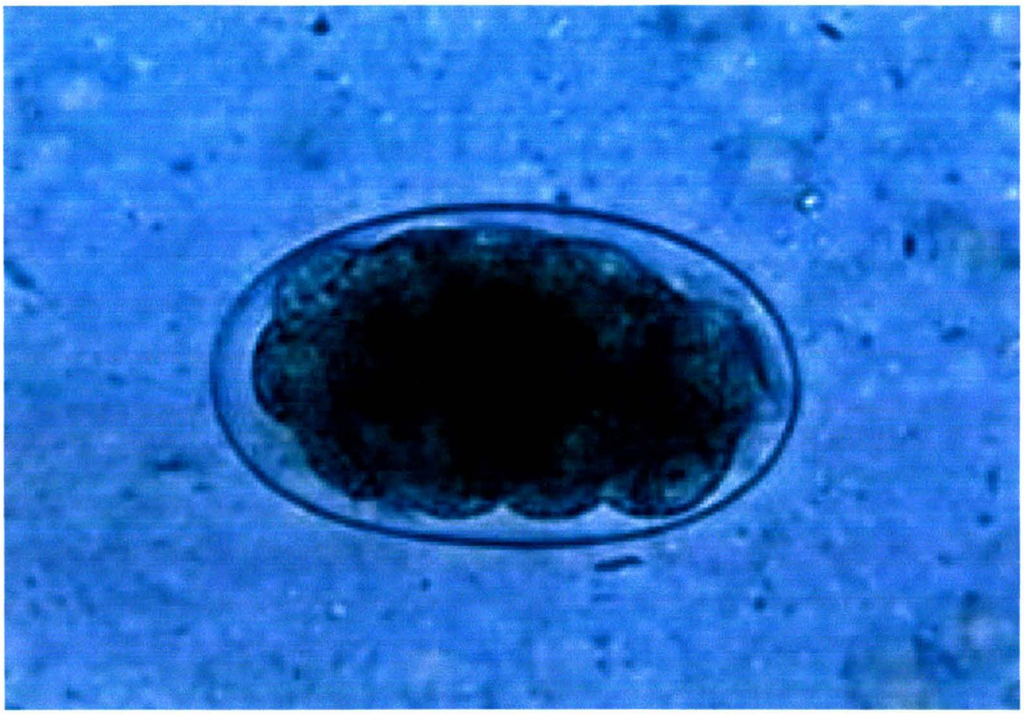

Fig 53. Hookworm egg, normally passed in feces during the 4 - 8 cell stage. (SOURCE: PHIL 5220 – CDC) [Page no.- 22]

Fig 54. *Trichuris trichuria* ovum with its opercular plugs, shown as white gaps at either end of the egg. (Saline wet prep) (SOURCE: PHIL 652 – CDC/Dr. Mae Melvin) [Page no.- 22]

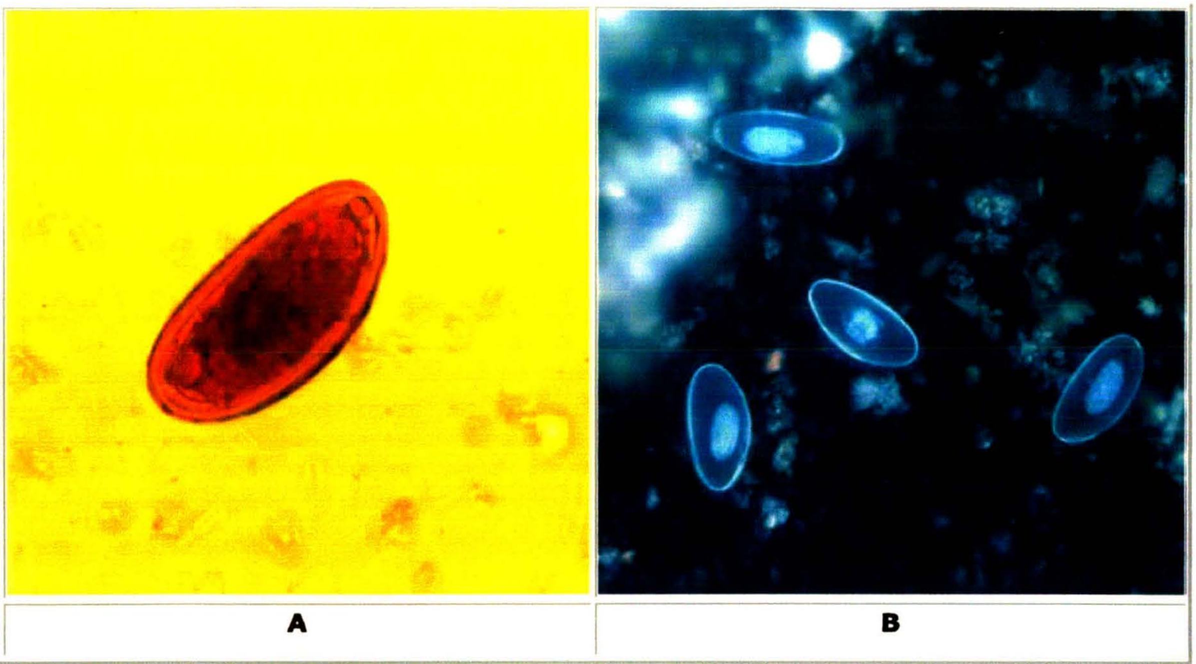

Fig 55A. Egg of *E. vermic*ularis in an iodine-stained wet mount from a formalin concentrate. Image contributed by the Kansas State Public Health Laboratory.
Fig 55B. Eggs of *E. vermicularis* viewed under UV microscopy. (Page no.- 22)

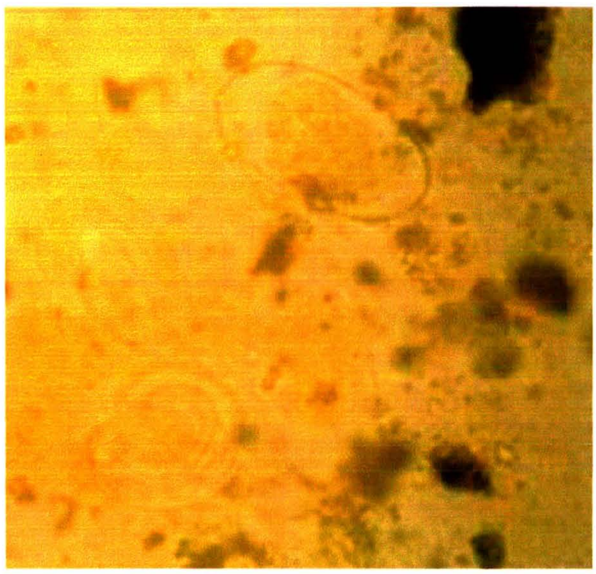

Fig 56. Thin shelled ova of *Strongyloides stercoralis*. Measuring 50µm by 30µm, they are smaller than Hookworm eggs. (SOURCE: CDC) [Page no.- 24]

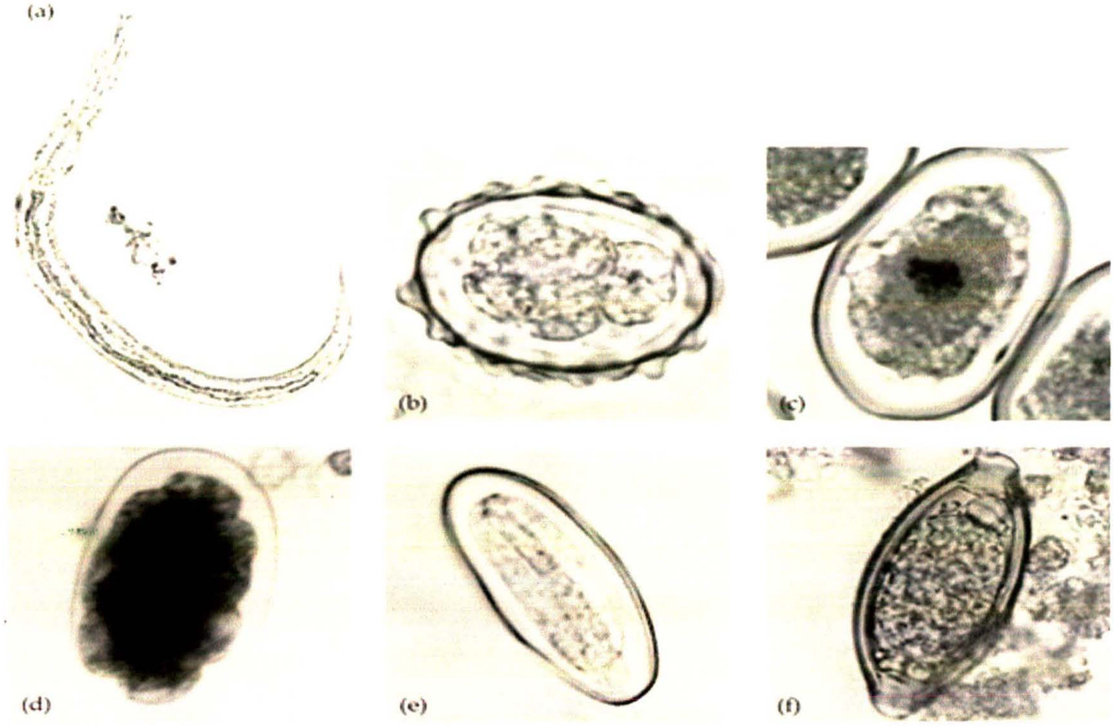

Fig 57. Nematode eggs and larvae (a) *Strongyloides stercoralis* rhaditiform larva (b) *Ascaris lumbricoides* fertilized egg with developing larva (c) *Ascaris lumbricoides* unfertilized egg (d) hookworm egg (e) *Enterobius vermicularis* egg (f) *Trichuris trichiura* egg (Page no.- 22)

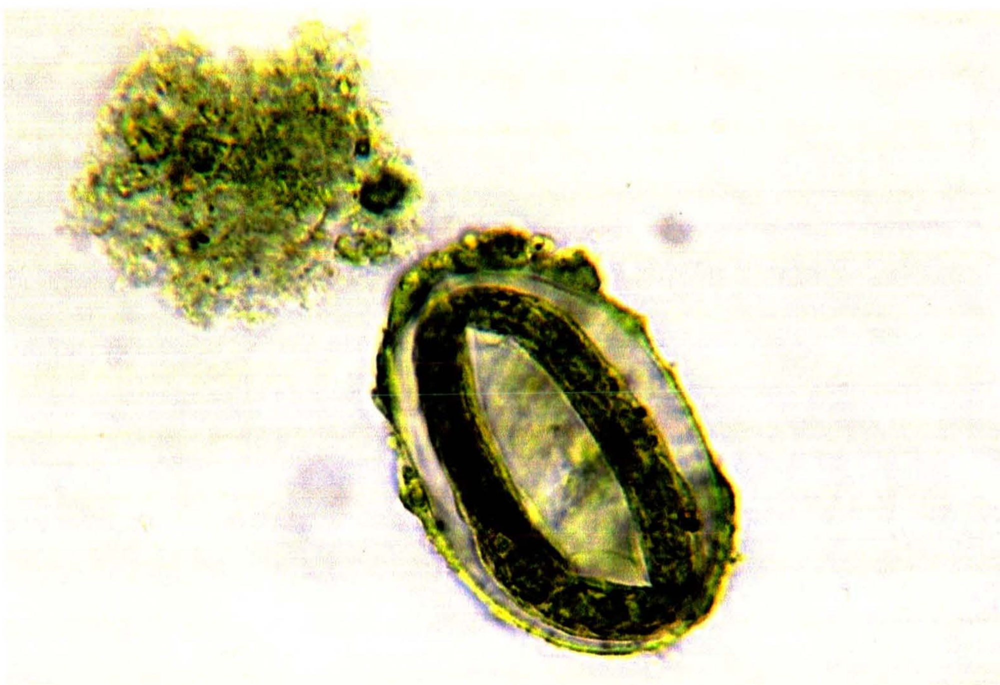

Fig 58. *Strongyloides stercoralis* egg containing larva (feacal concentrate) [Page no.- 24]

Fig 59. ***Strongyloides stercoralis*** **larva (Page no.- 25)**

Fig 60. Rhabditiform larva of ***Strongyloides stercoralis*** **(Page no.- 25)**

Fig 61. Lack of supply water is a big problem in rural area. Few family got it in an unhygienic way (Page no.- 8)

Fig 62. People drink unhygeinic water which cause diseases (Page no.- 8)

Fig 63. Shared kitchen community in Gazipur district (Page no.- 8)

Fig 64. Bare footed ladies are cooking in an unhygienic way (Page no.- 8)

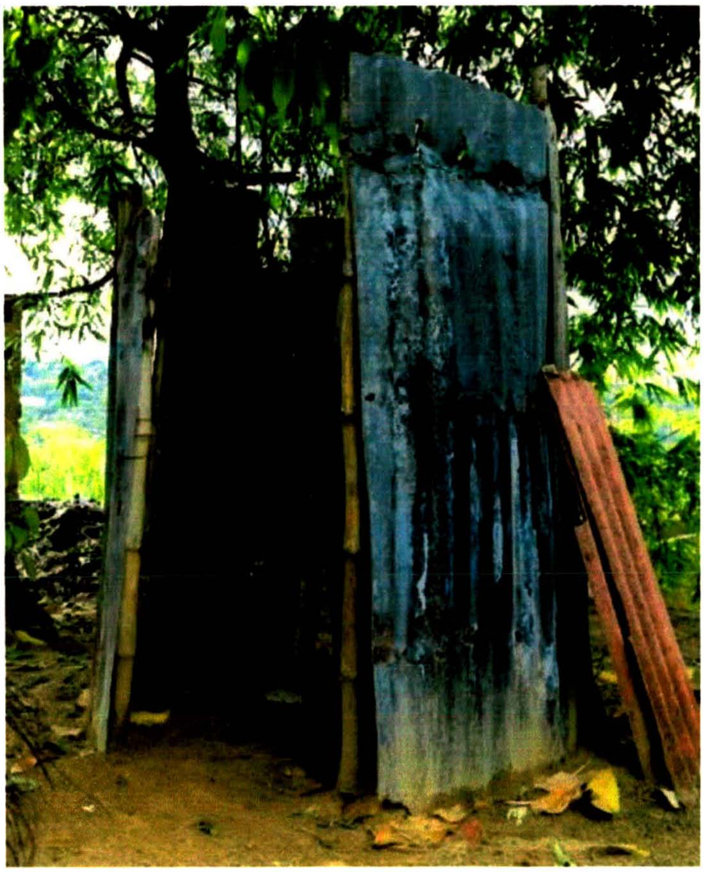

Fig 65 . Insanitary toilet (Page no.- 8)

Fig 66 . Rainy season is the proper time to spread disease (Page no.- 9)

Fig 67. Unhygienic life leading in a congested room (Page no.- 8)

DATA SHEET

ID NO. | | | | | Date: First collection | | | | | | |

A. Socio-Demographic Factors:

1. Name: Sex:
2. Age:
3. Father's /Husband' Name:
4. Address: Present:
5. Past: a)

   b)
6. Educational qualification:
7. Occupation:
8. Average Monthly Family Income in Taka:
9. No. of Family Members:
10. Type of House:
11. Type of Toilet:
12. a) History of Diarrhea: b) History of Diarrhea in family member:
13. Personal Hygiene: Use of shoes........   Shaping nail:.........

    Use of soap after toilet.....

B. Family Information:

Name of husband/wife with ID:

Number of children:

Name of the children with age and ID:

Laboratory Findings:

Strongyloides stercoralis—Pos / Neg

Other parasites identified—AL/ TT/ EV/Protozoa-