Soil Transmitted Helminthic Infections (STH) in Children and it's Impact on their Health in India

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A thesis submitted in partial fulfilment of the requirement for the degree of Master of Public Health

by

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INDIA

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is my own work.

Signature:……………………………………………

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Executive Summary

Soil-transmitted helminth (STH) infections are a major public health problem especially in the developing nations. The disease burden depends on the regional ecological conditions and also on the local standards of the social and economic development of the people. The species of soil-transmitted helminths that infect humans are concentrated in the tropical and subtropical parts of the developing world. These include the large roundworm, *Ascaris lumbricoides*, the whipworm *Trichuris trichuria*, and the hookworm *Ancylostoma duodenale*.

Overall and specific objectives of the study:

The general objectives of the study was to describe impact of STH infections on the health of school children of 4-15 years of age in India and the role of schools in reducing those infections. The specific objectives were to explore the factors affecting the transmission of STH among children of age 4-15 years, describe the strategies employed to reduce the burden of STH infections among the children of age groups 4-15 years in India and identify the best practices to be adopted for control of STH infections and to develop recommendations that would inform the Government, to establish effective program for control of STH.

Findings:

The study found that the prevalence of STH infection is high in India which are common in children aged 4-15 years and can be controlled with deworming agents as it gets rid of the worms from children. The deworming programmes if done in a holistic manner such as supplementation of iron and folic acid and vitamin A in the diet have shown that they are beneficial in improving the overall health of children.

Conclusion:

The programmes of the government should also be aimed to improve the sanitation facilities of the areas where deworming is done. Since the infection robs the children's mental and physical growth at a crucial stage leading to a loss of human resources of the country. Prevention is better and it should be promoted which include

1. Good personal hygiene like washing hands before eating and after using the toilet.
2. Clean and safe preparation of food
3. Always use slippers or shoes
4. Proper use of toilet facilities
5. Environmental sanitation

It is a serious problem and all the requisites for the breeding of the disease is present in India be it social, environmental, climatic or cultural. STH infections since they affect children of 4-15 years of age it simply jeopardizes the future of the country.

List of Abbreviations

STH - Soil-Transmitted Helminths, Helminthiasis, or Helminthiases or Geohelminths

DALY- Disability Adjusted Life Years
Any STH- Represents a person infected with any one or more of the three categories of STH namely *Ascaris lubrocoides, Trichuris trichuria,* or hookworms (either *Ancylostoma* or *Necatur americanus)*

AL- *Ascaris lumbricoides*

TT- *Trichuris trichura*

HW- Hookworm (either *Ancylostoma* or *Necatur americanus)*

WHO – World Health Organisation

NFHS 1– National Family Health Survey (1992-93)
NFHS 2- National Family Health Survey (1998-99)
NFHS 3 - National Family Health Survey (2005-06)

ICDS- Integrated Child Development Services

INHP- Integrated Nutrition and Health Program

SMCS- Safe Motherhood and Child Surival program

CRS- Catholic Relief Services

DEVTA- Deworming and Enhanced Vitamin A trial

UP- Uttar Pradesh

Case Definition for Soil Transmitted Helminthiasis (STH)

Suspect Worm Infestation

Most individuals with intestinal worm infestation are asymptomatic, acute infestion may present as epigastric pain, peri umblical pain & diarrhoea. Larva penetration in case of Hookworm may cause maculopapular dermatitis at the site of penetration, peri anal pruritis is seen in children with *Enterobius vermicularis* infestation. Migration of larva to lungs produces transient pneumonitis

Symptoms:

Chronic worm infestation is associated with iron deficiency anaemia, weakness & lassitude. Heavy & chronic infestation of Trichuris with co-infection of *Entamoeba histolytica* can cause dysentery and resemble hookworm disease, acute appendicitis or amoebic dysentery . Children may show irritability, failure to thrive, precipitation of protein energy malnutrition and pot belly, occasionally patients may give a history of passing worms in stools in which case description of worms may also be available to arrive at specific diagnosis, oral expulsion of round worms is also sometimes seen.

Confirmed case of worm infestation

Demonstration of eggs in stools for Ascaris, Trichuris trichuria, Hook worm and strongyoids species is undertaken .
For enterbius infection in children ova can be detected in peri anal region using NIH swab, blood examination for eosinophilia and microscopic anemia may indicate helminthiasis.
Ultra sonography is used to see round worms infestation in cases presenting as intestinal obstruction or billiary colic.

CHAPTER 1: BACKGROUND INFORMATION

Introduction

Soil-transmitted helminth (STH) infections are a major public health problem especially in the developing nations. The disease burden depends on the regional ecological conditions and also on the local standards of the social and economic development of the people (Ukpai et al 2003) STH infects over one billion people in the world (Crompton DW, 1999). Each year, 60,000 deaths occur due to *Ascaris lumbricoides*, 65,000 due to hookworms and 10,000 due to *Trichuris trichiura.* Prevalences are high in Children particularly for Ascaris and Hook worm as Children are most susceptible to the adverse effect of infection which to poor growth, reduced physical activity, impaired cognitive function and learning ability in them (World Health Report, 2000) .
The species of soil-transmitted helminths that infect humans are concentrated in the tropical and subtropical parts of the developing world. Nematodes have a widespread prevalence and distribution that result in hundreds of millions of human infections. These include the large roundworm, *Ascaris lumbricoides*, the whipworm *Trichuris trichiura*, and the hookworm *Ancylostoma duodenale* (Hotez PJ et al, 2003) .
The STH situation in the world is very grave as 2 billion people are infected with soil-transmitted helminths, accounting for up to 40% of the global morbidity from infectious diseases, exclusive of malaria (Bundy DAP,1995)

Table Showing Global Burden of Soil Transmitted Helminths (STH)

Type of Helminth	No. of Infections (Millions)	No. of Deaths (Thousands)
A. lumbricoides	1450	60
Hookworm	1300	65
Trichuris trichiura	1050	10

Source : Crompton DWT 1999

The greatest numbers of soil-transmitted helminth infections occur in tropical and subtropical regions of Asia, especially China, India and Southeast Asia, as well as in Sub-Saharan Africa. Of the 1-2 billion soil-transmitted helminth infections worldwide, approximately 300 million infections result in severe morbidity, which are associated with the heaviest worm burdens (Hotez PJ et al, 2003) . The public health importance of STH infections ranks the highest in morbidity rate among school aged children who often present with heavy infections. These children are vulnerable to nutritional deficiency (Bethony J et al, 2006). The infections have been shown to have a negative impact on the physical

fitness and cognitive performance of the pupils. Intestinal obstruction, anaemia, malnutrition, dysentery syndrome, fever, dehydration, vomiting and colitis are the major complications associated with STH infections (Cooper, E. 1991).
It is well established that indiscriminate disposal of human faeces, poor personal hygiene, and inadequate water supply contribute to high levels of STH infections (Bundy DAP, 1995) . This is of prime importance in health of many populations in third world countries where illiteracy, poverty, and associated poor environmental sanitation practices have been implicated in the heavy burden of *helminthiasis* among children (Bundy DAP 1995, Wagbatsoma UAet al, 2000, Oyerinde JPO, 1999). The relative contribution of environmental climatic and behavioural factors in the transmission of intestinal *helminthic* infections has been evaluated (Crompton DWT, 1999). However, even more significant are the consequences of heavy infection: the physical growth retardation, cognitive and educational impairments, which have led to calls for school-based periodic anthelminthic drug deworming programs (Chigozie J et al, 2007).

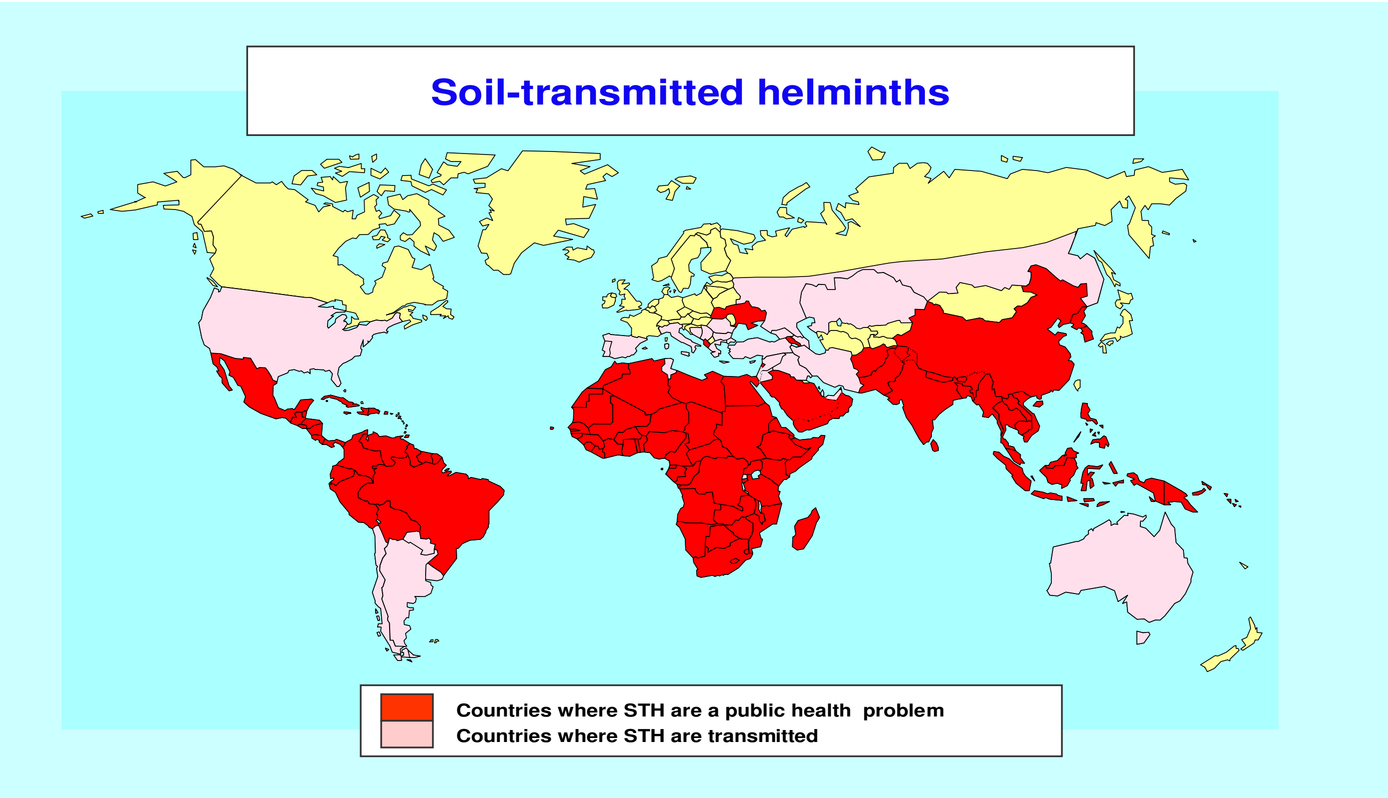
Table showing Main causes of disease burden in children (4-15 Years) in developing countries

Disease	DALYs Lost (In Millions)	Rank
Intestinal Helminthiasis	16.6	1
Pertusis / Polio/ Measles/Tetanus	11.8	2
RTI (Respiratory Tract Infections)	10.4	3
WBD (Water Borne Diseases)	8.7	4
TB	6.9	5
Malaria	6.4	6

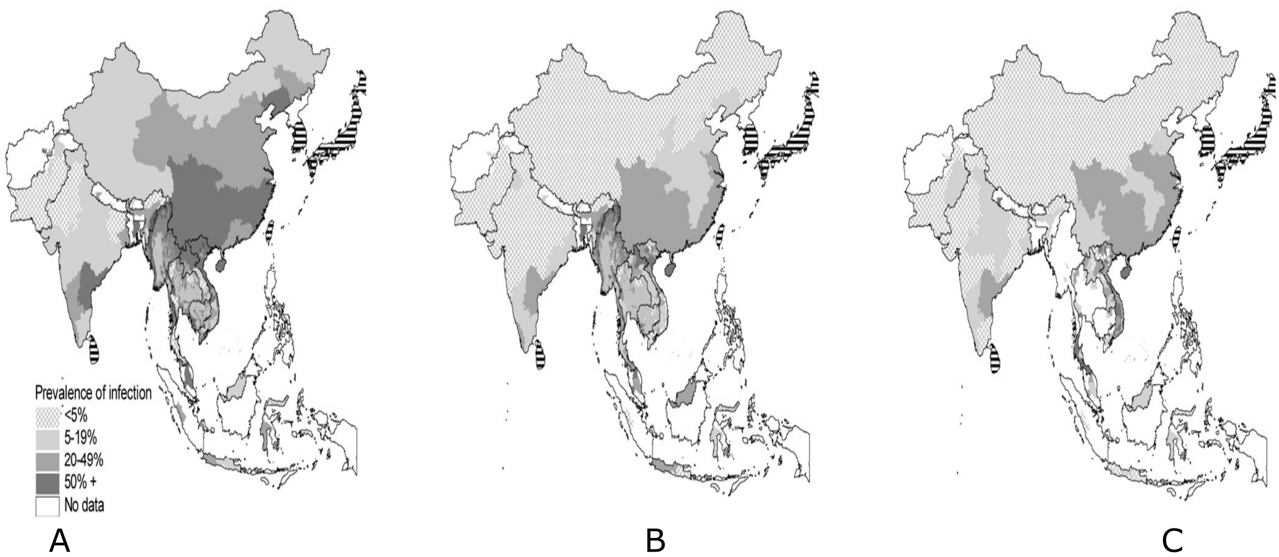
Source : Crompton DWT 1999

Soil Transmitted Helminthes (STH) survey in Union Territory of Lakshadweep conducted during February-March 2004 has shown 83.2% prevalence in school going children (Bora D et al 2005). Another study in India had reported 92.6% prevalence in children (Naish S et al 2004). The extent of the magnitude of the problem in India is not well documented. The published reports of sample surveys are not representative or comparable due to variations in sampling techniques and type of laboratory tests applied.

The intensity of infection also varies widely between individuals and between groups in a given community. While many people may be infected, most will have only light infections and only a few will be heavily infected. The transmission of these worms relates to contaminated soil, which becomes conducive with the menace of open-air defecation which is very common in the rural areas of India and in the slums of urban areas in India.



STH : Global Scenario



A B C

Ref: Simon Brooker, **Archie CA Clements**, and **Don AP Bundy 2006**

Fig: Prevalence of STH infection by province in Asia. (a) *A. lumbricoides*, (b) *T. trichiura* and (c) hookworm. Horizontal hatched areas indicate areas where sustained control has resulted in prevalence levels of <5%; white areas indicate a lack of data. Data were derived by published surveys or reviews: Afghanistan, Bangladesh, Cambodia, China, India, Indonesia, Lao PDR, Malaysia, Myanmar, Pakistan, Thailand, Pacific Islands; Vietnam. In Cambodia and Myanmar, where empirical data are lacking, prevalence of *A. lumbricoides* and *T. trichiura* is estimated from RS-based prediction models.

From the figures and data it is evident that STH is prevalent in South east Asia and the world at large.

General Objective of this thesis :

The general objective of the study is to describe impact of STH infections on the health of school children of 4-15 years of age in India and the role of schools in reducing those infections.

The specific objectives are :

1. To Explore the factors affecting the transmission of STH among children of age 5-14 years
2. To Describe the strategies employed to reduce the burden of STH infections among the children of age groups 5-14 years in India
3. To identify the best practices to be adopted for control of STH infections.
4. To develop recommendations that would inform the Government, to establish effective program for control of STH infections among Children of age 5-14 years.

Chapter 2 : Methodology:

Literature search and review:

Literature review was done using search engines such as PUBMED, KIT library,VU Library, WHO library Google Scholar. Various websites such as the National Institute of Communicable diseases (NICD), New Delhi, Minstry of Health and Family welfare, Government of India, Central Bureau of Health Intelligence, New Delhi, National institute of Health and Family Welfare (NIHFW) , New Delhi .
Published and unpublished Grey literature such as reports from nongovernmental organizations (NGOs),e mail correspondence with my colleagues and friends.

Key words : *Soil Transmitted Helminthiasis, Anaemia, Children, Deworming, India.*

Map of India showing places of STH surveys

Chapter 3 :

Review of Literature

Significance and impact of STH

Background Information :

The causative agents for soil-transmitted helminths (STHs) in humans are *Ascaris lumbricoides* (roundworm), *Trichuris trichiura* (whipworm), *Ancylostoma duodenale* and *Necator americanus* (hookworm). They have different modes of entry into the human being. In case of *A. lumbricoides* and *T. trichiura* infective larvae are ingested with the eggs whereas in case of hookworms entry occurs by penetration through the skin. The development of *T. trichiura* occurs directly in the large intestine where they moult into adult worms whereas *A. lumbricoides* and hookworms develop in the small intestine after migration through the respiratory tract and subsequent swallowing. The adult worms mate and produce large numbers of eggs (*A. lumbricoides* produce up to 200,000 per day, *T. trichiura* and hookworms produce 5,000–20,000 per day) after 4–6 weeks. *A. duodenale* larvae can undergo a hypobiosis state in the human body under certain conditions for several months(Schad, G. A. *et al*, 1973). Eggs can remain viable in the soil for several months (*A. lumbricoides* and *T. trichiura*) and larvae several weeks (hookworms) in appropriate conditions.

Adult worms in hosts feed on nutrients, proteins and blood especially for hookworms and can cause intestinal obstruction in case of *A. lumbricoides*. STHs contribute to malnutrition, iron deficiency anaemia and affects cognitive performance (Crompton, D. W, 2000, Bundy, D. A. P. & Cooper, E. S 1989, Brooker, S et al,1992). Morbidity is associated with the intensity of infection, which peaks in school-age years and is then reduced by lower exposure and increased immune response (Bundy D. A. P, 1992).

STH infections are associated with poverty, lack of sanitation, lack of hygiene and overpopulation (Crompton, D. W. *J*, 1999) . Hence STH infections are endemic in most tropical countries where such conditions exist, and its distribution also is also closely related to soil characteristics and climate which can be easily tracked by geographic information systems and remote sensing (Brooker, S. & Michael E, 2000). Traditionally these occur in rural areas and urban slums of cities in developed countries which is a major public health concern (Crompton, D. W. & Savoli, L 1993). The major endemic areas are south and south-west China, southern states of India, south-east Asia, sub-Saharan Africa, and Central and South America(De Silva, N. R. *et al*,2003). Coastal areas are also associated with high rates of transmission (Lwambo, N. J. S. *et al*,1992) . In some areas *A. duodenale* is endemic; these regions include south and west China, and India. *A. duodenale* thrives in these harsh climates owing to its ability to undergo arrested development in host tissues (Schad, G. A. *et al*, 1973). *A. duodenale* infections also occur in Egypt, Northern Australia and in a few areas in Latin America including Northern Argentina, Paraguay and Peru (Brooker, S et al in press) . Infections with both the species of hookworms species is common worldwide. China, Southeast Asia, Coastal regions of West Africa and Central Africa has the highest rates of occurrence of Ascaris infection.

High prevalence of Trichuris infections is in found in Central Africa, southern India and Southeast Asia. Prevalence of Hookworm infection is common in sub-Saharan Africa, South China and Southeast Asia.
Globally 2 billion people are infected with STHs and 50% of these infections occur in China, which has the highest prevalence. Trichuriasis and hookworms amount to 700–800 million infections each. China and sub- Saharan Africa have the largest number of hookworm cases with,200 million infections each. These numbers are derived from China's nationwide survey completed in early 1990s (Nokes C etb al 1992) India has low prevalence of hookworms.

Reports from WHO in 1998, have estimated that more than 40% of the tropical disease burden of tropical countries other than malaria is due to schistosomiasis and soil-transmitted helminthiasis (World Health Report, 1999). Using mathematical model, the total disability-adjusted life years (DALYs) lost due to STH can be calculated using extrapolations from available epidemiological estimates and aggregating them to the national, regional and global levels (Chan, M. S,1997) As per the WHO Expert Committee on the Prevention and Control of Schistosomiasis and Soil transmitted Helminthiasis, 39.0 million DALYs are lost each year (Chan, M. S 1997) which is comparable with 35.7 million for malaria and 46.5 million for tuberculosis (World Health Report of an Expert Committee, 2002). Hence STHs are very significant parasitic infections of humans.

Transmission and ecology

The life cycle of STHs can be generalized to make it easier to understand their life cycle. The adult stage of the parasite spends some part of its life in the hosts' intestine: *A. lumbricoides* and hookworm in the small intestine; *T. trichiura* in the colon. In the intestine they reproduce sexually and produce eggs, which are passed through the faeces outside.

The adult worms survive in the host for several years and produce a large number of eggs. The eggs remain viable in the soil for several months (*A. lumbricoides* and *T. trichiura*) and larvae for several weeks (hookworms), dependent on prevailing environmental conditions. *A. duodenale* larvae can undergo hypobiosis (arrested development at a specific point in the nematode life cycle) in the human body under certain environmental conditions for several months. Infection occurs through accidental ingestion of eggs (*A. lumbricoides* and *T. trichiura*) or penetration of the skin (by hookworm larvae).

The transmission of STH infections can be summarized by the basic reproductive number (R0). This is defined as the average number of female offspring produced by one adult female parasite that attains reproductive maturity, in the absence of density dependent constraints (Anderson, RM.et al,1991). R0 values of between 1 and 6 are estimated, with rates intrinsically highest for *T. trichiura* and lowest for hookworm. In practice, epidemiological studies fail to differentiate between the main hookworm species, *A. duodenale* and *N. americanus*, which will have different epidemiological and ecological characteristics.
Increases in R0 give rise to increases in infection prevalence (percentage of individuals infected) and infection intensity (number of worms per human host). The dynamic processes involved in STH transmission, such as free-living infective stage development and survival, depend on the prevailing environmental conditions (Pavlovsky, EP, 1966. Anderson, RM 1982) .

The survival of the infective stages in the environment is temperature dependent. Experimental studies suggest that the maximum development rates of free-living infective stages occur attemperatures between 28 and 32 °C, with development of *A. lumbricoides* and *T. trichiura* arresting below 5 and above 38 °C (Beer RJ. 1976, Seamster AP 1950, Smith G, Schad GA 1999) and development of hookworm larvae ceasing at 40 °C (Udonsi JK, Atata G. 1987) *A. lumbricoides* eggs are more resistant to extreme temperatures than *T. trichiura* eggs (Bundy DAP, Cooper ES 1989). Moisture content of the soil and relative atmospheric humidity have been shown to have a profound influence on the development
and survival of ova and larvae. Higher humidity is associated with faster development of ova and at low humidity (<50%) the ova of *A. lumbricoides* and *T. trichiura* fail to embryonate (Otto GF 1929, Spindler LA 1929). The abundance of hookworm larva is related to atmospheric humidity (Nwosu ABC, Anya AO 1980, Udonsi JK, Nwosu ABC et al,1980).

Morphology and Life cycle of STH

1.Morphology of Ascaris lumbricoides (AL):

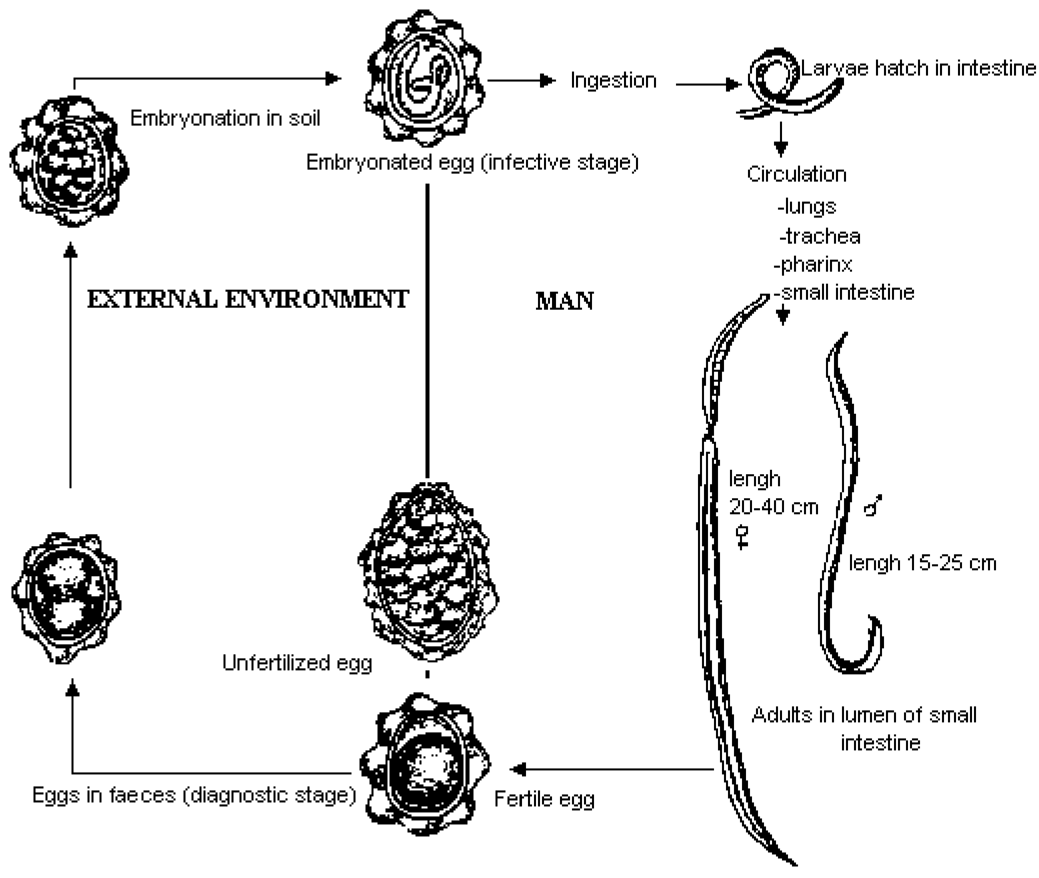
Ascaris is a large intestinal roundworm and resembles the common earthworms found in the soil. Female worms can be as long as 20-35 cms, and the males tend to be smaller, not larger than 30 cms. They range in width from 2-6 mm. Mature worms are cylindrical, creamy white or light brown. They tend to have tapered ends. The worms have a thick cuticle, 3 lips at its head, small teeth, and its own digestive tract. The fertilized eggs are oval shaped, and they are about 65 to 40 um in size. The eggs are brown or yellow brown, and they have a thick shell.

Bolus of *Ascaris*

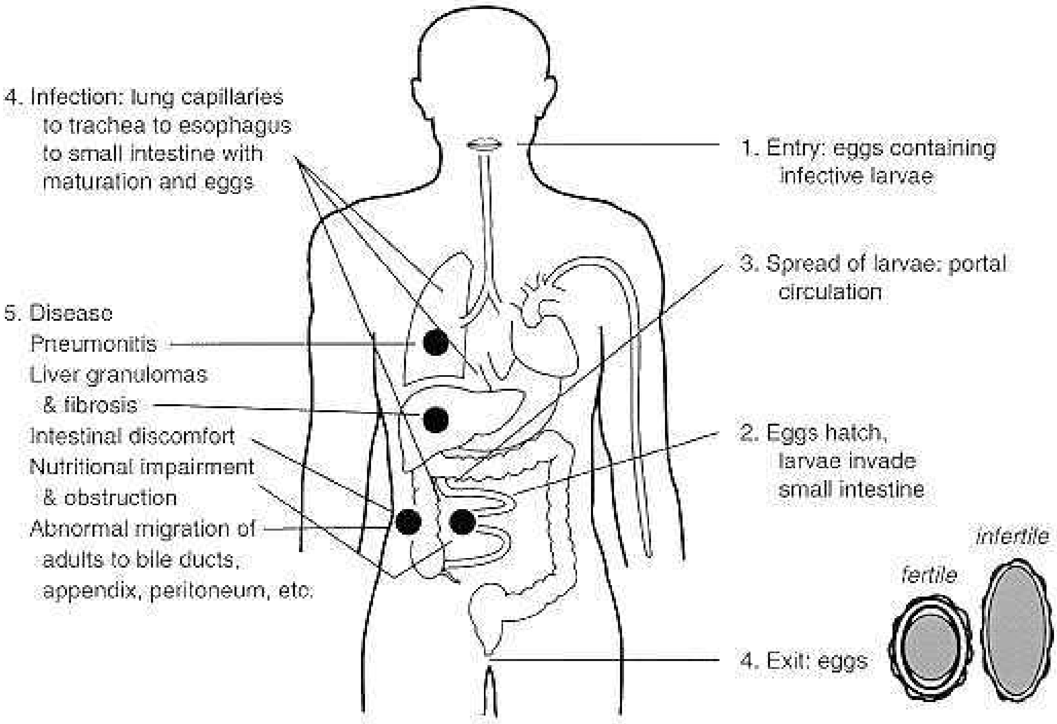
Life cycle of Ascaris lumbricoides

Eggs of Ascaris are found in warm moist soil which is infected by human faeces. Injestion is by swallowing of unwashed raw fruits and vegetables. They can even be by untreated, unfiltered water that has washed off contaminated soils. Eggs pass through the stomach and arrive in the duodenum where the larvae emerges from the egg and burrow through the intestinal lining into the tissue underneath and continue on until they push through blood vessel walls and are carried off in the bloodstream.

The larvae are carried through the liver and heart, and arrive in the lungs, where they break out into the airspace. In the lungs, the larvae grow by passing through several stages of development. By the time they are ready to leave the lung, about nine days have passed since the eggs were swallowed. Larvae travel up the airways or are coughed up. Those that are subsequently swallowed survive their second trip through the stomach only if they are sufficiently mature to withstand the acid conditions there.
Larvae remain in the small intestine of host and continue to mature. Female worms grow to 45cm in length as compared to males which are smaller. Mature females begin producing eggs that are mixed with intestinal contents and are passed in the stool.
When an infected human defecates in the open air, eggs are introduced into the soil. In warm moist environment the eggs become infective to another person in a couple of weeks time. When conditions are cold, dry eggs can remain dormant for long periods of time, then mature when the environment is suitable for growth of eggs .
Ascaris lumbricoides is exclusively a human parasite, as it does not infect dogs, cats, or other domestic animals, with the possible exception of pigs. The worms live, on average, for a year and a female can produce up to six million eggs in her lifetime.



LIFE CYCLE of *ASCARIS LUMBRICOIDES*
Adapted and redrawn from NCDC



Life cycle of AL inside human body

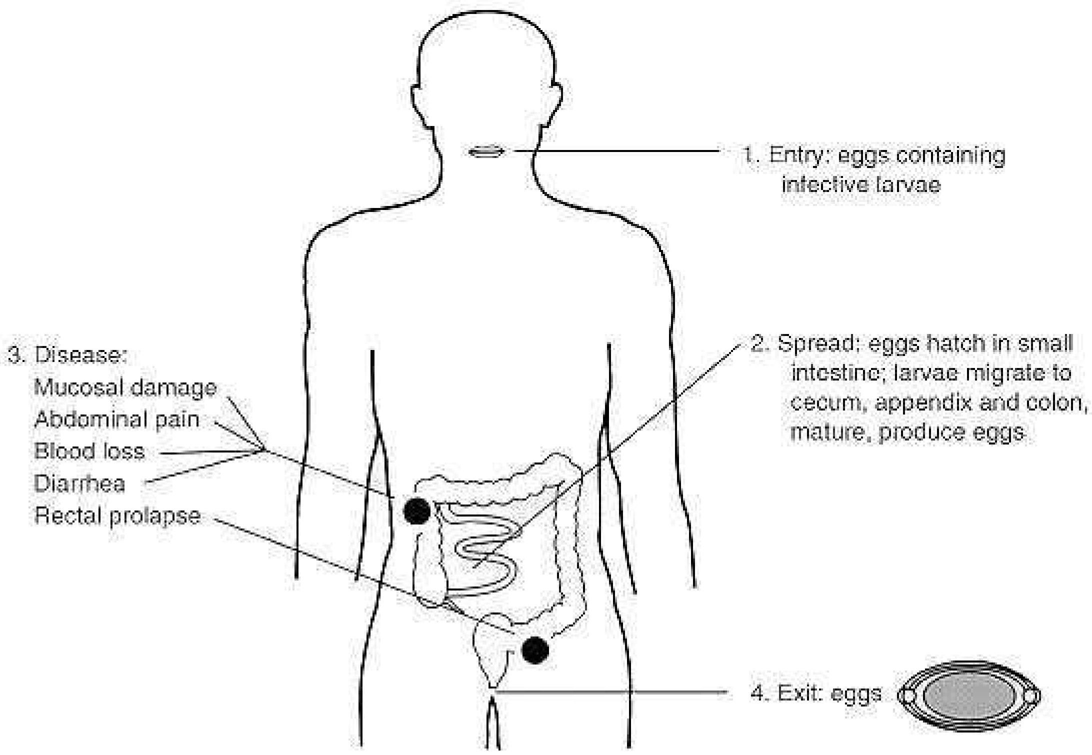
2. Morphology of Trichuris trichura (TT)

Trichuris trichiura is known as whipworm because of the long, narrow anterior end and the short and robust posterior end give the worm the look of a whip. The worms are threaded through the mucosa and attach by their proximal end. Females worms are around 45 mm in length are larger than males worms, they are rounded posteriorly, whereas the males have a coiled posterior. The characteristic eggs are brown and barrel-shaped with prominent bipolar blister-like protuberances; they measure 22 µm by 52 µm.

Female and male adult *Trichuris* worms, easily visible with naked eye but much smaller than *Ascaris*
Source : Oracle ThinkQuest Education Foundation, 2006

Life cycle of Trichuris trichuria

Females worms produce 2,000 to 10,000 eggs per day. These pass in the stool and embryonate in the soil. Under favorable conditions, they become infective in around 3 weeks. After ingestion, embryonated infective eggs hatch up in the small intestine. The infective larvae enter into the villi and continue to develop. New worms move to the cecum, penetrate the mucosa, and complete their development. Females start to lay eggs in about 3 months after infecting the host.



Life cycle of Trichuris trichura(TT)

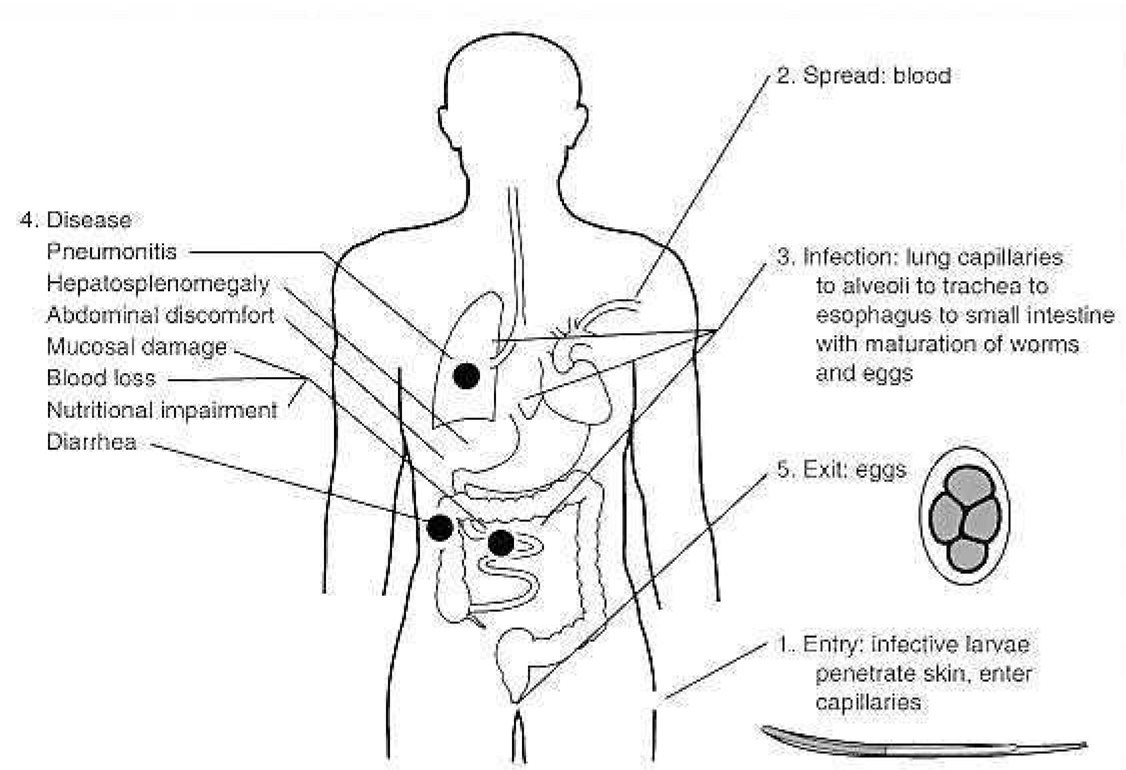
3. Morphology of Hookworm (HW)

The two major hookworm species that infect humans are: the Old World hookworm *Ancyclostoma duodenale* and the New World hookworm *Necator americanus.* The worms are cylindrical and grayish white and the females are approximately 1 cm long.The males are smaller in size as compared to females. The differentiating characteristics between the two species involve the buccal capsule and the male bursa. The bell-shaped bursa which is used for attachment to the female during copulation, is membranous and symmetrical and has finger-like rays that are arranged differently in different species. The differentiating feature is in the buccal capsules in *N americanus* has two ventral semilunar cutting plates, while as in *A duodenale* has four ventral teeth. Female *A duodenale* hookworms produce 10,000 to 20,000 eggs per day as compared to N *americanus* which produce 5,000 to 10,000 eggs per day. The eggs of both species are oval shaped, having thin shell and transparent. Eggs in stools when fresh contain embryos which is four or eight-cell stage. The eggs from these species are impossible to differentiate from each other and measure 55 to 79 mm by 35 to 47 mm. The first-stage of the worm called rhabditiform larva develops within the egg and has a thick-walled, long, narrow buccal cavity. The muscular esophagus of the worm is flask-shaped and occupies the anterior one-third of the body. Slender third-stage of the worm called as filariform larvae measures 500 to 700 mm in length. The mouth is closed, and the esophagus occupies one-third of the body.

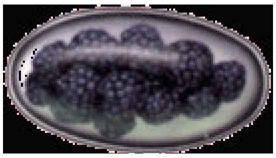
The tail of the worm is pointed. The rhabditiform larvae of the two species cannot be differentiated, but the filariform larvae *of N americanus* have dark, sharp buccal spears and a striated cuticle seen clearly at the posterior end and these characteristics are not seen in *A duodenale.*

Life cycle of HW

Adult hookworms attach to the jejunal mucosa of small intestine, and the females produce eggs that pass in the stool. In favourable environment, the eggs hatch in 1 to 2 days. The rhabditiform larvae which emerge feed on organic debris, molt twice, and develop into slender, infective filariform larvae in around 5 to 8 days. These larvae do not feed if they are unable to penetrate a host, they die in a few weeks time. Once they penetrate the skin, they enter the venules and are carried to the heart and lungs where they grow and eventually break out into the alveoli of lung and pass up the respiratory tract . After ingestion, they attach to the intestinal mucosa and become sexually mature in 5 to 6 weeks time. Though infections persist for as long as 14 years, most terminate in 2 to 6 years. Infection by ingestion of larvae can also occur.



Life Cycle of Hook Worm



Hookworm Egg Passes
Hookworm Larvae Living in Soil
in Stool

Source : Hookworm Eggs and Larvae Adapted from (Mar Vista Animal Medical Center, 2004)

Table Showing the Agent, life cycle and manifestations of STH				
Sl. No.	**Characteristics**	**Ascaris lumbricoides (AL)**	**Ankylostoma duodenale (HW)**	**Trichuris trichiura (T.T)**
1.	Habitat in human	Adult live in small intestine	Duodenum and jejunum & suck blood. Worm change their position every few hours leaving the same area to bleed	Mucosa of caecum and colon
2.	Length Female worm Male worm	 20-40 cm smaller than female (15-25 cm)	 About 1.25 cm About 0.8 cm	 4-5 cm Smaller than female (3-4cm). The anterior 2/3 of the body is slender and threaded into the mucosa, and the posterior end is thick, giving a whip-like appearance
3.	Life span of the worm	1 year	1 year	5 years
4.	Liberation of eggs per day	2,00,000	5,000 –25,000	2,000- 14,000
5.	Embryonation and maturation in soil	2-3 weeks and remain infective in soil for several months or years	24 hours at 27- 35ºC	10-14 days
6.	Transmission	Ingestion of infective eggs through contaminated food and water	Penetrate the skin usually between the toes and legs, on contact	Contaminated vegetable
7.	Clinical manifestations	• Passing of worm in stools or occasionally from mouth or nose • Malnutrition • Growth retardation • Intestinal obstruction • Hypersensitivity	• Iron deficiency anaemia	• Bloody diarrhoea • Hypoproteinaemia • Anaemia • Growth retardation

Prevention and control schemes

In a variety of endemic regions, a great number of efforts have been attempted to reduce the burden of infection and disease due to STH's. These interventions could be categorized as environmental, personal, and chemotherapeutical interventions. The degree of success of such interventions is time and again related to the structure and functioning of the health sector.
These aspects of control and prevention will be discussed in greater detail in both the Results' and the Discussion sections of this thesis.

World Health Organistion (WHO) : Primary and Secondary Prevention Through Anthelminthic Treatment .

Secondary prevention is achieved through anthelminthic treatment of children with the goal of decreasing morbidity and mortality. This occurs by decreasing parasitic burden, which results in decrease in the incidence of complications like intestinal obstruction especially with round worm infection. Studies have shown deworming can result in improved nutritional status, improved growth, improved school attendance and performance, reduction in anemia, improved birth outcomes, and improved work capacity (Adams, 1994; Drake et al., 2000; Stephenson,1993a, 1993b). These results can be seen in short periods of time and do not require total elimination of the worm population from the patient. Any reduction in intensity of infection can be beneficial. Results of the cognitive improvement has been shown in Jamaica and Kenya (Ashwathi, 2000; Partners for Parasite Control, 2005).

Primary prevention is achieved through a longer period of time and involves processes to reduce the incidence of infection. As deworming takes place few individuals have heavy infection.

They therefore eliminate stools with fewer eggs, and thus fewer eggs enter the environment. With fewer eggs in the soil the transfer of infection is less, even with no change in personal hygiene or sanitary situation. This benefit may not be longstanding if anthelminthic medications are stopped.

The WHO has taken the leading role in global deworming efforts, publishd expert reports, clinical guide lines, laboratory guides, and educational material for teachers, program administrators, and health care workers (Montresor, 2004; Montresor et al., 2003; World Health Organization, 1991, 1994, 2002, 2003, 2004, 2005). Programs using these guidelines and aids have proven to be clinically beneficial, cost effective, safe in multiple settings in developing countries, and simple to administer (World Health Organization, 2002, 2004).

Pharmacotherapy is the mainstay of all control programs as infrastructure improvement is a costly and long-term goal.

Education on basic personal hygiene, sanitation, and basic helminthic disease transmission is included in many programs. WHO goals include conducting prevalence studies aimed at school children because they are easy to reach, cooperative with providing stool samples, and usually have the highest prevalence of disease in the community.

Soil Transmitted-Helminths in India

The magnitude of the problem in India, based on results of surveys by sampling techniques and laboratory tests during the period 1972–1996 and during 1999-2006 revealed an overall prevalence between 22%-85% of STH among Children of age group 4-15 years. Soil Transmitted Helminthes (STH) survey in Union Territory of Lakshadweep conducted during February-March 2005 has shown 83.2% prevalence in school going children (Bora D et al, 2005). Another study in India had reported 92.6% prevalence in children (Naish S et al, 2004)

The states of India with high prevalence as revealed by the survey conducted by the National Institute of Communicable Diseases, New Delhi, India is shown in the table below.

Table showing States with high prevalence of helminthic infection in India

***AL* Prevalence**	***HW* Prevalence**	***TT* prevalence**
Southern district, Orissa (85%)1978	Singur, West Bengal (49%) 1977	A&N island (80%) 1974
Daman (73%) 1994	Balasore, Orissa (48%) 1972	Nilgiri hill, Tamil Nadu (49%)1995
Mahasu, Himachal Pradesh (68%) 1971	Lower Subansiri district, Arunachal Pradesh (45%) 1981	Dhanbad, Bihar (47%) 1980
Delhi slum (66%) 1971	East Siang district, Arunachal Pradesh (40%) 1981	Kolkata slum, West Bangal (44%) 1968
Goa (65%) 1995		Kakinada, Andhra Pradesh (41%) 1975
Amritsar, Punjab (64%) 1994		Coonoor, Tamil Nadu (32%)1975
Kurukshetra, Haryana (59%) 1993		
*Status of STH in UT of Lakshadweep (83.2%) 2005 AL -50.6%		TT- 75.2% Dual Infection (AL,TT) -42.6%
**STH infection in Southern Indian Village (92.6%) 2004 AL-91%	HW- 54%	TT-72%
***STH infections in Kashmir, India (46.7%) 2007. AL- 28.4%		TT- 4.7%

Source : Monthly News letter of National Institute of Communicable Disease, India * (Bora D et al , 2005) **(Naish S et al 2004. ***(Showkat Ahmad Wani et al, 2007)

Surveys Conducted in 1999-2003

National Institute of Communicable Diseases, Delhi undertook 11 studies for the estimation of prevalence and intensity (eggs per gram) of soil transmitted helminths in different ecological zones of the country during March 1999 to September 2003, as per WHO guidelines for sampling and laboratory tests (Kato-Katz technique).

Ecologically, the surveyed areas were classified as hilly area (Gangtok), desert area (Jodhpur), coastal area (Kozhikode, Alleppy and Ganjam), plain area (Alwar, Bhiwani, Nagaon, Balia and Chitradurga) and tribal areas (Bastar).

Detail findings of the surveys are given in Table below . Hilly and coastal areas had higher overall prevalence rate, among surveyed areas, but the highest prevalence was found in Chitradurga urban area (41.1%), where *AL* prevalence was 39.7%. *TT* prevalence was

highest in Kozhikode (25.0%). Among rural and urban areas, urban areas of Bhiwani and Chitradurga were found to have comparatively higher prevalence rate than

the rural areas, while it was higher in rural areas of Alwar and Jodhpur than in urban areas.

However, the intensity of infection was found to be light to moderate in all the surveyed areas except that one child from Chitradurga town, had high intensity of *AL* infection. Moderate intensity of *AL* infection was found in one child in Alwar urban, in 3 children in Chitradurga town, in 2 children in Gangtok and in 6 children in Alleppy. Three children from Alleppy had moderate intensity *TT* infection. In Kozhikode, 38, 1 and 15 had moderate intensity infection of AL, HW and TT respectively.

Table showing STH Prevalence in Surveyed Areas : 1999 - 2003

Place		Cumulative Prevalence (%)	AL		HW		TT	
			Prevalence (%)	Mean epg	Prevalence (%)	Mean epg	Prevalence (%)	Mean epg
1. Bhiwani	R	1.3	1.3	25.3	0	0	0	0
	U	2.2	1.5	0.9	0	0	0.7	0.4
	T	1.8	1.4	12.9	0	0	0.4	0.2
2. Alwar	R	10.2	4.5	3.2	6.7	6.4	0.6	0.2
	U	6.1	3.4	20.3	1.7	1.7	1.0	1.3
	T	8.3	4.0	11.5	4.1	4.3	0.8	0.7
3. Chitradurga	R	4.9	4.1	26.0	0.8	0.5	0	0
	U	41.1	39.7	280.1	0.3	0.2	1.0	1.2
	T	24.7	23.6	164.9	0.6	0.3	0.6	0.7
4. Jodhpur	R	0.9	0.3	0.4	0.6	0.9	0	0
	U	0	0	0	0	0	0	0
	T	0.5	0.2	0.2	0.3	0.5	0	0
5. Gangtok	R	34.1	30.7	180.4	4.3	2.7	4.0	1.4
6. Allepy	C	31.6	15.2	253.4	3.9	7.0	21.6	54.9
7. Kozhikode	C	35.6	25.7	1158.4	0.7	7.5	25.0	91.7
8. Nagaon	U	32.4	27.9	727	2.7	4.2	12.6	41
9. Balia	R	41.9	36.9	688	5.1	56	1.6	3
10.Ganjam	C	24.4	2.7	16	8	10	17.3	43
11.Bastar	R	15.7	0.3	2	15.7	164	0.3	0.002
R=Rural, U=Urban, T=Total, C=Coastal, AL=*Ascaris lumbricoides*, HW = *hook worm*, TT = *Trichuris trichiura*								

Risk factors for STH

- Poverty
- Poor living conditions
- Poor sanitation and water supply
- Poor quality of soil and climate (high humidity & temperature)
- Poor personal hygiene
- Certain Practices – eg use of human fertilizer
- Poor health awareness and literacy

Survey Methodology

The underlying principle for survey methodology is based on the laboratory examination of stool specimen from school children in randomly selected schools. The laboratory test used is called the Kato-Katz technique, which consists of microscopic examination of a fixed quantity of faecal material so that a semi-quantitative diagnosis based on the number of eggs can be made. This is a useful indirect measure of the worm burden usually the greater the egg count the greater the number of female worms are present.

Where facilities for egg count by the Kato-Katz technique are not available, it is suggested that prevalence surveys may be carried out using a standard methodology (microscopic examination of saline and iodine wet mounts or fecal concentration procedure). The sampling design will be the same as for both prevalence and intensity.

Sample size - A sample size of 200 -250 individuals is adequate for each ecologically homogenous area (climate, humidity, ecology and soil) to evaluate prevalence and intensity. In different climatic and geographical zones, a separate sample of the same size (200-250) must be selected. District may also be considered as a zone for these surveys. If some areas that are ecologically and climatically different are excluded, it should be mentioned in the report. Separate surveys should be organised in rural and urban areas. When research is conducted to evaluate parameters other than prevalence and intensity of infection, such as impact of control measures on weight or hemoglobin levels, a larger sample size will be required.

Selection of schools - It is logistically simple to organize surveys in schools. All the schools in the area of the survey are listed. 8 schools are selected randomly with the help of a random number table.

Age-group - The negative impact on nutritional status is most detrimental in children in the primary school age group since this is the period of intense physical and mental development. It is also estimated that the peak prevalence is the highest in this age group (except hookworm infection). Accordingly, in each school, one class of children 9-10 years of age, is the selected randomly. All children in the class are examined. If the selected class has less than 35 children, a second class is selected and all children in both the classes are examined. If the number of children in the school is less than 35, a second class in the next nearest school may be selected.

Collection and transportation of samples

The stool samples from the selected children are collected in wide mouthed plastic containers with screw caps. A wooden spatula is also provided and children are explained the method of collection of specimen. The containers are appropriately marked and coded. It is advisable to collect all samples in the morning and to process and examine them on the same day. This makes the daily routine easier and reduces the quantities of the containers and the slides needed since they can be cleaned at the end of each day and reused. This also prevents the hatching of hookworm eggs.

The school authorities can provide considerable assistance in getting the stool specimens collected, follow-up of children for treatment and health educational activities in the schools to reduce the risk of infection with intestinal parasites. The response of the parents is also generally positive, as it is perceived to be in the interest of the child's health.

Microscopic Examination

Shape and size of the eggs - The egg of the round worm measures 55-75 µm by 35-50 µm. It is brown in colour and the surface of the egg has conspicuous bumps called mammilations. Since the adult worm produces over 200,000 eggs per day these are easily found in direct smears. The egg of a whipworm measure 50-55 µm by 22-24 µm, have an oval shape and plug-like prominence at each pole. The shell is usually dark brown in colour and smooth. Because the female worms produce smaller number of eggs, they are often present in the faeces in smaller numbers than *A.lumbricoides* eggs. The hookworm egg measures 60-75 µm by 36-40 µm and has a clear thin shell.

Laboratory examination of stool sample by Kato-Katz technique –

This technique is used to find out the prevalence and intensity of infection. The smear should be examined in a systematic manner and the number of eggs of each parasite species in every slide is counted. Later a multiplication factor is used to estimate the number of eggs per gram of faeces (when using a 50 mg template by 20; for a 20 mg template by 50 and for a 41.7 mg template by 24. The results (eggs per slide, eggs per gram) are noted down for each child separately.

Kato-Katz technique

Contents of the kit

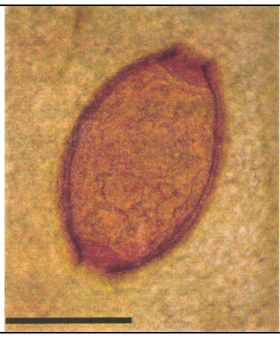
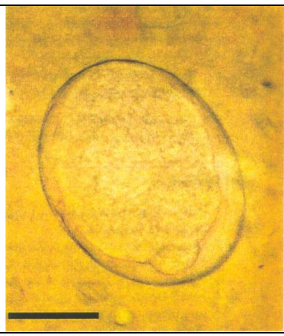
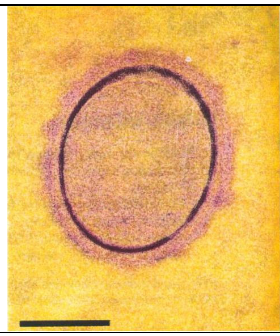
1. Kato-Katz kit
   The Kato-Katz Kit contains
   i) A roll of nylon screen 80 mesh (20m)
   ii) 400 plastic templates with a hole of 6 mm on a 1.5 mm thick template, delivering 41.7 mg of faeces.
   iii) 400 plastic spatula.
   iv) A roll of Hydrophilic cellophane,34 μm thick-20m
2. Microscope slides
3. Flat bottom jar with lid.
4. Forceps.
5. Toilet paper or absorbent tissue.
6. Newspaper.
7. Glycerol-malachite green solution or glycerol-methylene blue solution. Methods of preparation is as below:

   - (Glycerol…………………………… ………………..100ml
   - 3% aqueous malachite green, or
     3% aqueous methylene blue…… …… …….. …. 1 ml.
   - Distilled water………………….. ………………….. 100ml.

   Grind some malachite green or methylene blue powder with a pestle in a clean, dry mortar, Weigh out 3 gm. Of the powder, pour it into a bottle and add distilled water to give 100ml. Seal and label the bottle: 3% Aqueous Malachite Green or 3% Aqueous Methylene Blue. Store in a cabinet away from light.

   To prepare the solution: pour 1 ml of the 3% aqueous solution into a 250 ml. bottle. Add 100 ml. of glycerol and 100 ml. of distilled water and seal the bottle; mix thoroughly before use).

Microscopic Examination of Eggs of STH

			
Ascaris (upper), *Trichuris* (middle) and *hookworm* (lower) eggs in the same microscopic field illustrating their relative sizes.	In a Kato-Katz preparation, *Trichuris* eggs may appear larger and swollen in shape with degenerated contents. The bipolar prominences and the layers of the shell are not sharply defined.	*Hookworm* eggs in Kato-Katz preparations are often almost round in shape and the dividing ovum is increasingly difficult to see. In hot climates the glycerol will over clear the eggs and make them invisible 30-60 minutes after preparation.	Typical *Ascaris* egg as it appears in a Kato-Katz preparation.

Laboratory Procedure

i) Take a stool sample using a spatula and place it on a piece of absorbent paper.

ii) Place the nylon mesh filter on the faecal matter and press it with spatula so that part of the faeces pass through the meshes.

iii) Use the other side of the spatula to scrape off the faeces that have passed through the meshes and deposit them in the orifice of the perforated plate, which should already have been placed on a microscope glass slide.

iv) Press the faeces into the orifice of the plate until it is full.

v) Pass the side of the spatula over the perforated plate in order to remove any excess faeces. Discard spatula and the filter.

vi) Carefully lift up one end first of the perforated plate so that a cylinder of faecal material remains on the microscope slide. Discard the perforated plate.

vii) Place the pre-stained cover-slide on the cylinder of faeces.

After having placed the cover-slide on the cylinder of faeces, put other slide and press down into the place under which the faecal cylinder is located on the glass slide, so that the

viii) slide and the cover-slide. Avoid spilling the faeces.

ix) Allow the preparation to stand for 60 minutes at room temperature.

x) Place the slide under the microscope for observation and counting of the eggs.

xi) To obtain the quantitative results, convert the number of eggs found into the number of eggs per gram of faeces by the multiplication factor and by use of the Table enclosed in the kit.

Note: For the identification of Ankylostoma eggs, the preparation should be examined within a maximum of four hours after taking the sample. For all the other helminthic eggs the preservation is excellent even up to a year after preparation

Chapter 4 :

Results/Findings :

4.1 Prevalence and Intensity of Helminth Infection

A study in India has shown that stools of more than 70 percent of children have presence of ova of *Ascaris lumbricoides* (Sunderan et al, 1998) and as per the study conducted by Ahmed M, in the northern state of India that is in Kashmir have found an incidence of Ascariasis was found to be 85.1 percent (Ahmed M,1978).

As per the recent study conducted by (Showhat Zargar et al , 2008) has found a prevalence of 46.7% of STH infections among school children among 4-15 years in Srinagar , Kashmir ,India . The study showed that type of water supply used, sanitation facilities , hygiene , education of mother were associated with prevalence of STH among children.
The age group affected was showing highest prevalence of STH in 8-11 years that is 63.0%, followed by 5-8 years where the prevalence was 41.9% and it was 35.3% in 11-14yrs .

Though there was not much significant difference in the gender prevalence for STH but male are more infected 51.5% than female 41.5% .The possibility of this difference could be explained on the basis taht males are more involved to outdoor activities than females, the other possibility is that open air defecation is common in males than in females because of social and religious restrictions with the result soil contamination constitutes a risk factor for transmission of STH. A similar study on higher prevalence of STH among females than in males has been done by (Singh et al , 1984) in Varanasi, UP, India.

In the study it revealed that he source of water supply used by children and it is found that those children who used well and stream water they have greater prevalence of STH infection than those who use tap water thus it suggests that access to safe drinking water carries less risk for getting the STH infections as per the studies done by (Norhayati et al.,1998 ,Narain et al, 2000, Curtis et al. 1995)

From the study it is clear that children with good personal hygiene have lower prevalence of STH than those children living in poor hygienic conditions ($p<0.01$).The mothers education plays an important role in decreasing the prevalence of STH , it is less if the mother is educated as shown by the studies done by (Toma et al., 1999,Phiri et al., 2000).

A study conducted on the prevalence, intensity and risk factors for soil-transmitted helminth infection (STH) among school children aged between 5–9 years attending school in the fishing village in Peda Jalaripet, Visakhapatnam, South state of India by (S. Naish et al, 2004) had shown hundred and eighty nine (92.6%) of 204 children infected with one or more soil transmitted helminthes . The main worm being *Ascaris lumbricoides* (prevalence of 91%), followed by *Trichuris trichiura* (72%) and hookworm (54%). Study of age-specific prevalence and severity of infection revealed that the prevalence and intensity of *A. lumbricoides* infection was higher among younger children than older children. While aggregation of parasite infection was observed, hookworm infection was more highly aggregated than either *A. lumbricoides* or *T. trichiura*.

In another study conducted by (SA Wani et al, 2007) at District Kupwara, of Kashmir, India found that out of 312 children tested for STH infections, 222 (71.15%) were positive for various STH infestations among the children in the age group of 4-15 years
The Helminths included *Ascaris lumbricoides, Tricuris trichiura, Enterobius vermicularis* and *Taenia saginata* . The highest burden was noted for *Ascaris lumbricoides* 69.23%(216/312) followed by *Tricuris trichiura* 30.76% (96/312), *Enterobius vermicularis* 7.69%(24/312) and *Taenia saginata* 7.69% (24/312). The single infestation was found in 33.65% (105/312) and mixed infestation was found in 37.5% (117/312) of children .

Prevalence of STH among School Children in District Kupwara of Jammu and Kashmir, India

One Helminth Parasite	33.65% (105/312)
Mixed Infestation	37.5%(117/312)
Ascaris lumbricoides	44.59%(99/222)
Tricuris trichiura	2.70%(6/222)
Ascaris lumbricoides and Tricuris trichiura	31.8%(69/2220
Ascaris lumbricoides and Enterobius vermicularis	8.1%(18/222)
Ascaris lumbricoides and Taenia saginata	4.05%(9/222)
Ascaris lumbricoides, Tricuris trichiura and Enterobius vermicularis	2.7% (6/222)
Ascaris lumbricoides, Tricuris trichiura and Taenia saginata	6.7%(15/222)

Source : (SA Wani et al, 2007)

The Results suggested that *Ascaris lumbricoides* was common both in males (75%) and in female children (61%) followed by *Tricuris trichiura* which was 26.6% in males and 36.36% in female children (As shown in Table below) . It is found that presence of source of infection in the studied area and feco oral spread of the infection among the children. In addition contamination of soil especially for *Ascaris lumbricoides and Tricuris trichiura* along with overcrowding and low socio economic status increases the susceptibility to these infections. The other finding of the study revealed that infestation was higher in males (76.6%) as compared to females (63.6%) which was significant statistically ($p<0.05$) This is probably due to the fact that males are more exposed to unhygienic conditions like playing, working etc as compared to females which remain more indoors due to religious restrictions.Though the route of transmisiion of both AL and TT is feco oral route further research is needed to find out why *Tricuris trichiura* is more in females than in Males. In short the study reveals that STH is prevalent among school children and this calls for control measures for these infections.

Table Showing Gender wise prevalence of STH in Children

Parasitic Infection	Males (n=180)	Females (n=132)	Total
Ascaris lumbricoides	75% (135)	61%(81)	69.23%(216)
Tricuris trichiura	26.6%(48)	36.36%(48)	30.76%(96)
Enterobius vermicularis	13.3%(24)	0	7.69%(24)
Taenia saginata	8.33%(15)	6.81%(9)	7.69(24)

Source : (SA Wani et al, 2007)

Children in the age group of 4-15 years and are more affected as shown in the table below and in this study it was futher observed that children from 8-11 years were more infected (26.92%) followed by 4-7 year age group (24.03%) and 12-15 years age group (20.19%).

Table showing Parasitic infection with respect to Age and Gender

	Males			**Females**			
Age	**No. Screened**	**Positive**	**Percentage**	**No. Screened**	**Positive**	**Percentage**	**Overall positive percentage**
4-7	63	48	76	39	27	69.2	24.03
8-11	63	51	80	54	33	61.1	26.92
12-15	54	39	72.2	39	24	61.5	20.19
Over all	180	138	76.6	132	84	63.6	71.15

Source : (SA Wani et al, 2007)

Table Showing : Age-stratified pattern of Geo helminth infection showing greater percentage of infection of AL and TT in children aged 6-7 years.

Age group (number studied)	**5 Years (*n* = 22)**	**6 Years (*n* = 59)**	**7 Years (*n* = 55)**	**8 Years (*n* = 31)**	**9 Years (*n* = 37)**	**Total (*n* = 204)**
A. lumbricoides						
No. (%) infected	21 (96)	54 (92)	53 (96)	29 (94)	28 (76)	185 (91)
Geometric mean[a]	633	550	479	508	406	506
SD[b]	373	556	443	1060	449	608
Parameter (95% CI)	3.35 (1.08–5.61)	1.43 (0.76–2.11)	1.92 (1.03–2.81)	0.48 (0.06–0.90)	0.76 (0.23–1.29)	1.02 (0.74–1.30)
T. trichiura						
No. (%) infected	19 (86)	44 (75)	37 (67)	23 (74)	24 (64.9)	147 (72)
Geometric mean[a]	108	107	91	87	65	92
SD[b]	608	85	112	74	159	51
Parameter (95% CI)	1.63 (0.39–2.87)	0.85 (0.39–1.30)	0.98 (0.45–1.51)	0.38 (0.02–0.74)	0.93 (0.31–1.56)	0.69 (0.48–0.90)
Hookworm						
No. (%) infected	14 (64)	34 (58)	28 (51)	18 (58)	17 (46)	111 (54)
Geometric mean[a]	70	76	59	77	78	71
SD[b]	57	58	44	114	214	110
Parameter (95% CI)	0.92 (0.12–1.72)	0.81 (0.37–1.26)	0.64 (0.25–1.02)	0.29 (−0.02–0.59)	0.12 (−0.05–0.29)	0.23 (0.13–0.34)

a Geometric mean egg count calculated for infected children.
b Standard deviation of egg counts.
Source : (S. Naish et al,2004)

In another study conducted by (Ishtyak Ahmad et al, 2003) in the department of Surgery and Radio diagnosis, Srinagar, Kashmir, India found that out of 480 children studied 420 (87.5%) had infestation of *Ascaris lumbricoides*, 300 had moderate to severe infection, 120 children presented with surgical complication due to ascariasis .Hundred children had palpable worm masses and haemoglobin of less than 10 gm/dl was found in 67 cases and between 8-10 gm/dl it was found in 24 cases. It suggests that there is a strong correlation of Worm infestation with anaemia .Kashmir, India there is the dearth of safe and potable water, people use the river banks or lakes for cleaning of their clothes, washing of utlinsels, and drinking . The untreated refuse (Inculding that from House Boats which are situated in the world Famous Dal Lake) drain directly to rivers and lakes.. The Vegetables grown in these fields are contaminated with human excreta and result in various parasitic infestation.

4.2 Major Public Health Challenge in India

India has the highest number of underweight children which doubles that of Sub Saharan Africa, as per the (World Bank, 2004). As per the estimates 47 percent of the children were underweight or severly underweight and 26 percent were mildly underweight and it afflicted three quarters of the Indian children as on 1998-99. Though the level of malnutrition had decreased by 11 percent between 1992- 93 and 1998-99 . India is still lagging behind in spite of rapid economic growth .This aggravates STH situation in India and leads to increased morbidity and mortality due to parasitic infestation.

In a study in India it was found that one third of adolescent girls had a history of STH infestation. The prevalence of anemia was double in these girls (53.6%) compared to those who were not infected (25%) (Rawat et al, 2000). Various studies had been undertaken in the Indian subcontinent to prevent STH infection among children

4.3 Deworming and iron and folic acid supplementation

Study by (Kadri SM et al,2006) was conducted to ascertain the prevalence of anemia in the selected sector of Indian school going children in Kashmir (Jammu and Kashmir) and to see the effects of de-worming together with iron-folic acid supplementation and also to compare with the effects observed with iron-folic acid supplementation alone, in improving hemoglobin status in the selected group showed that the hemoglobin levels in pre-treatment and post-treatment periods are positively correlated.

The study was carried on 412 school children, randomly selected, attending schools of different districts to cover a wide geographical area. It was a randomized controlled trial. In 1st stage, 412 students drawn are further randomly divided into 2 groups of 206 students each, out of which first 206 students are given iron folic acid (I00 mg of iron + 500mcg of folic acid) for three month along with single course of de-worming agent (400 mg of Albendazole). Next the other 206 students are given iron folic acid tablets (I00 mg of iron + 500mcg of folic acid) for three months and single dose of placebo tablets in place of de-worming agent (phase 2).

Table showing the severity of anemia among children with STH infection.

Age Group	Sex	No of children Examined	Hb 12gm% & above	Hb 10-12 gm%	Hb 8-10 gm%	Hb Less than 8 gm%
5-11 years	M	208	1	53	123	31
	F	204	1	41	130	32
TOTAL		412	2	94	253	63

Source : (Kadri SM et al, 2006)

The results of the study showed that there is a significant difference between haemoglobin in both the groups. Iron and folic acid supplementation increases blood haemoglobin levels in both the groups. Supplementation of Albendazole increases blood haemoglobin level significantly (p = 0.0001). Hence the treatment was found to be effective in both the groups and the addition of albendazole as de-worming agent irrespectively produce added advantages.

In a School Health Check-up Programme in Gujrat (Gujrat School Health, 2002) showed a high number of children infected by worms although the percentage is less 3.76% in the year 2001-02, 4.2% in 2002-03,3% in 2003-04, 4.23 % in 2004-05, 4.4% in 05-06 and 4% in 06-07.I think in Gujrat school study though the percentage of children infected was low and it may not be concluded however that low prevalence of STH is not a problem even though the percentage of children affected is low but the total number of children infected is high due to greater population study. Hence it shows that there is a significant worm burden in India

Table showing the total number of children examined and the number of them infected

Sr. No.	Year	Total children	children examined	Worm Infestation
1.	2001-02	8826056	8262880	310811
2.	2002-03	8874693	8375014	348014
3.	2003-04	9184141	8767421	267583
4.	2004-05	8900345	8507684	360659
5.	2005-06	8692436	8324661	362230
6.	2006-07	8832343	8434997	333489

Source : (Gujrat School Health,2002)

Studies have shown clearly the detrimental effects of infection on educational performance and school attendance, as well as the significant improvements in language and memory development that can be realized following treatment. Helminth infections are also associated with nutritional deficiencies, particularly of iron and vitamin A, with improvements in iron status and increases in vitamin A absorption after deworming.(Stephenson L, 1993) Adolescent girls are particularly at risk of anaemia aggravated by helminthes.

4.4 Water, Sanitation and Environmental factors :

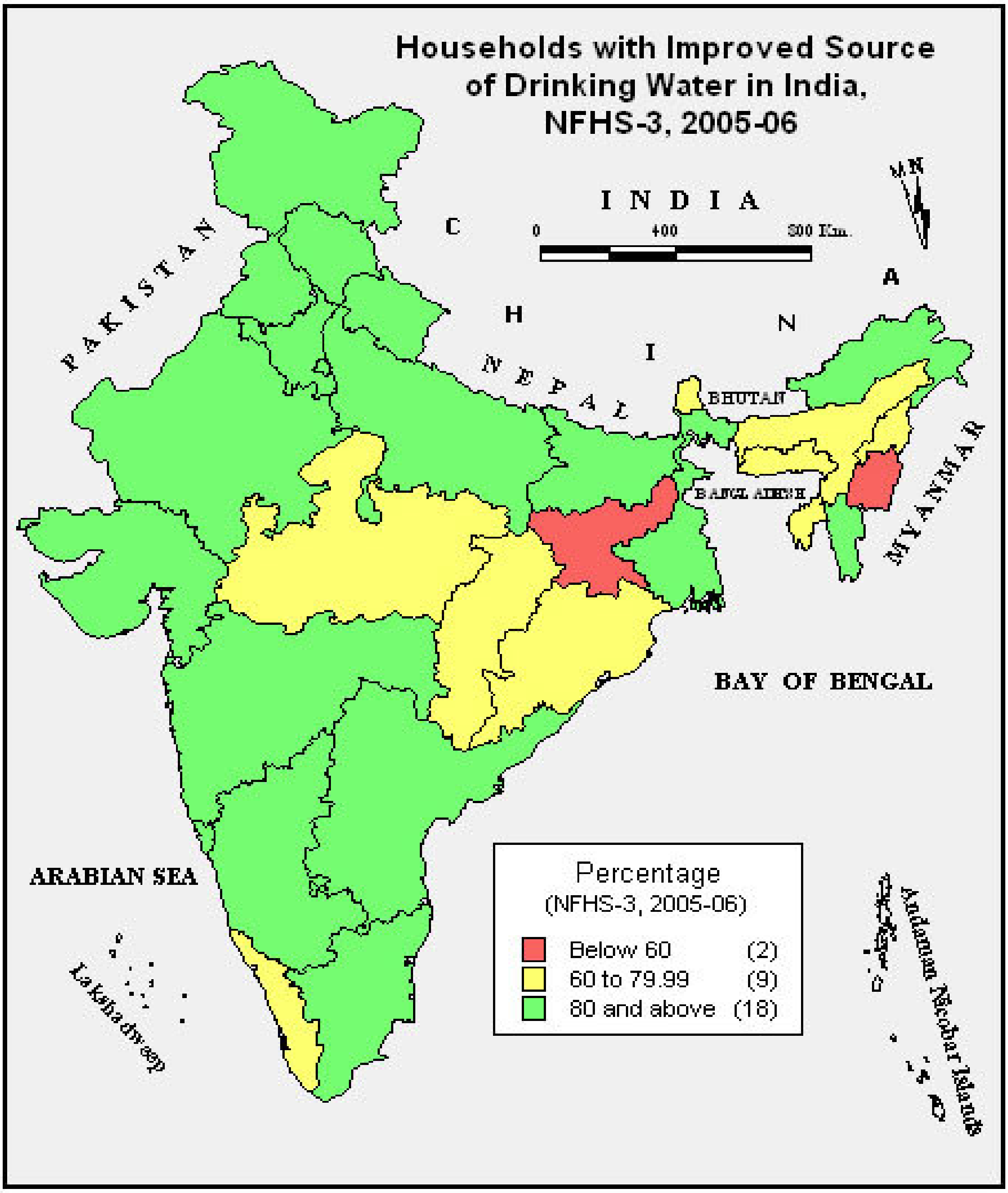
As per the National Family Health Survey- 3 (NFHS -3 India,2006) the house hold with improved source of drinking water in India revealed below 60 percent in few states 60 to 79 percent and 80 percent and above in few states as depicted in the map below and the percentage of house holds getting the water from different sources piped water (42%), hand pump (43%) and well water (12%) . The percentage of Piped water utilization has increased from 33% (as per NFHS-1) to 42% (NFHS -3) for hand pump it has increased from 35% (as per NFHS-1) to 43% (NFHS -3) and for utlisation of well water it has decreased from 26% (NFHS-1) to 12% (NFHS -3)

Percentage of House Holds by Source of Drinking Water (Source NFHS 3, Ministry of Health and Family Welfare, India)

Source : (NFHS -3 India,2006)

Urban areas and 74 percent in rural areas and the manner of disposal of child's stools 44 percent throw the faces in open fields 26 percent in the garbage, 12 percent use toilets, 9 percent put or rinse into toilet or latrine, 9 percent put or rinse into drain or ditch .

At least 72 per cent schools in South Kashmir district of Islamabad of Kashmir, India are lacking proper sanitation facilities (toilets) while in 71 per cent institutions water facility does not exist, leaving students and teachers high and dry. The official data reveals that out of total of 972 schools in Islamabad district, 707 are without toilets while 680 institutions drinking water facility does not exist. The data reveals that the Primary schools are the worst hit. "Out of 632 primary schools, 536 are without toilet facility while 528 schools don't have the drinking water facility. Similarly out of 254 middle schools in the district, 146 sans toilet facility while 142 lack the drinking water facility", the data reveals. The data also discloses the dismal sanitation conditions of High and Higher Secondary schools in the district. "Out of 59 high schools, 14 are without toilet and drinking water facility while out of 34 higher secondary schools, 10 are without toilet and 11 sans drinking water. The worst hit zones are Dooru and Shangus of District Islamabad . In Dooru, according to data, only 10 schools out of 62 have the proper sanitation and drinking water facilities. Similarly, in Shangus zone, out of 98 schools only 18 have got the required facilities (Report of Rising Kashmir Daily, 2008)



Source : (NFHS 3 India 2006)

4.5 Impact of STH on Health of Children

In a study conducted by(Showkat Wani et al ,2008) in Kashmir , India to know the relationship of STH on haemoglobin status among school children .It revealed that among 382 children subjected to stool examination 299(78.27%) were infected with *Ascaris lumbricoides*, *Trichuris trichiura*, or both. 149 (39.0%) were infected by single infection *Ascaris lumbricoides* was found in *91 (23.82%) and T. trichiura* in 58 (15.18%) children and missed infestation was found in 150 (39.26%) .

It was found a significant lower levels of haemoglobin in children with STH than in uninfected children (P<0.05) as shown in table below .

Table showing Mean hemoglobin values (g dl) in infected and uninfected children.

Type	Hb Mean _ SD	Range	95% CI	*P*-value
Infected	10.54 _ 1.5	5.6–14.5	10.37–10.71	0.02
Not infected	11.92-1.35	6.8-14.0	11.62-12.21	
Single infection	10.81-1.50	5.6-14.5	10.5-11.01	0.01
Mixed infection	10.27-1.3	5.6-13.0	10.04-10.49	
AL	11.27-1.24	8.5-14.5	11.0-11.50	0.05
TT	10.17-1.7	5.6-13.5	9.7-10.6	

Source :(Showkat Wani et al ,2008)

In a study conducted by (S Tripathi, 2004) regarding the prevalence of anaemia in children with infestation of STH out of 100 students 26 were anaemic with a positive stool examination for STH (66.76%) while as 39 were anaemic With out giving history of passing the worms (63.93%) as in the table below

Anaemia in Adolescent Girls in Relation to Passing Worms.

Girls passing worms	**Total**	**Anaemic (Number)**	**Percentage**
Yes	39	26	66.76
No	61	39	63.93
Total	100	65	65.00

Source: (S Tripathi, 2004)

As per (D. Bora et al, 2005) a total of fourteen STH surveys conducted across the India only Union Terriotery of Lakshadweep the prevalence was found to be 80%. Highest infection of AL and TT was a significant finding . Similar findings were reported from other coastal areas where TT prevalence was high. WHO recommends the classification of surveyed community into heavy, moderate and light infections on the basis of epg (eggs per gram, WHO, 1994)and community can be categorized as "High prevalence, High intensity", "High prevalence, low intensity", "Low prevalence, Low intensity "on the basis of cumulative prevalence (percentage of children positive for worms) and percentage of children with heavy intensity of infection (WHO/CTD,1998, Bora et al, 2001, Bora et al, 2003) as shown in the tables below . On the basis of category the anti helminthic is given in category 1 treatment given 2-3 times a year targeted to all school age children, and for Category 2 treatment given once a year to all school age children and category 3 case management is recommended control measure .

Table showing : Intensity thresholds for light, moderate, and heavy infections with AL, TT and HW

Helminth	**Intensity threshold**		
	Heavy	**Moderate**	**Light**
A.lumbricoides	$\geq$50,000 epg	5,000-49,999 epg	1-4,999 epg
Hookworm	$\geq$4000 epg	2,000-3,999 epg	1-1,999 epg
T.trichiura	$\geq$10,000 epg	1,000-9,999 epg	1-999 epg

epg=No. of eggs per gram of stool
Source : National Institute of Communicable Disesaes (Monthly News letter CD Alert)

Table showing : Community intervention for control of STH

Community category		Proposed intervention
I	High prevalence, High intensity	Treatment 2-3 times a year targeted to all school-age children, IEC, improvement in sanitation, water supply and appropriate waste management
II	High prevalence, low intensity	Treatment targeted to all school-age children at least once a year, IEC, supporting improvement in sanitation, and waste management
III	Low prevalence, low intensity	Case management, IEC, improvement in sanitation, water supply and appropriate waste management

Source : National Institute of Communicable Disesaes (Monthly News letter CD Alert)

4.6 Helminthic Control and the results of current control practices in India:

Morbidity due to STH infection can be controlled by periodic chemotherapy using effective drugs. Deworming to be focused on high risk groups such as school age children and women of child bearing age as per the control strategies laid by WHO . Anithelminthic drugs can be delivered through school health system or through community based interventions. As is known that poverty, inadequate sanitation, poor personal hygiene are the contributing factors for the transmission of STH infections, to improve the economic situations in the countries where STH infections are prevalent is a difficult task so stratagies have been developed by universal anihelminthic drug distribution (Urbani et al, 2001)

Four commonly used antihelminthics against STH are : Albendazole, Mebendazole, Pyrental pamoate and Levamisole . The side effects of the drugs are mild.

Albendazole is available as chewable tablets (200 and 400mgs) A single dose is effective against AL, HW and enterobiasis .It has shown better results for treatment of HW as compared to Mebendazole (Bennet et al, 200)

Mebendazole is available as chewelable tablets (100 and 500 mgs)as well as oral suspension (100mgs/5ml) A single dose is effective against AL,

HW and TT . As per WHO the ideal dose for HW and TT is 100 mgs twice daily for three consecutive days.
Pyrantel pamoate available as chewable tablets (250mgs) and given as 10 mgs/kg body weight as a single doseand is effective against AL and HW (WHO, 1995)
Levamisole available as chewable tablets (40mgs) given as 2.5mgs/kg body weight effective against AL and HW .

Drugs recommended by WHO for treatment

Drug	**Dose**
Albendazole	400 mg
Mebendazole	500 mg
Levamisole	80 mg
Pyrantel pamoate	10 mg/kg body wt.

The most commonly used drugs for the treatment of common intestinal worms are albendazole (400 mg) and mebendazole (500 mg). They are administered as a single tablet to all children, regardless of size or age. One pill can cost as little as US$0.02 and only in the most highly infected communities is treatment required more than once a year.
Current deworming strategies in India look in a holistic manner where nutrition and deworming go hand in hand that is both the strategies are integrated. The micronutrient deficiency of children is taken account of and even the sanitation of the area is taken into account. Primary school children are given a nutritious meal during the school day and are also offered two doses of albendazole during the school year. Significant nutritional improvements have been found in the children and there has been significant falls in the prevalences and intensities of soil transmitted helminth infections with such strategies. A second strategy for improving child health and involving deworming integration is the experience with vitamin A supplementation in pre-school children in Nepal. Vitamin A distribution is made twice yearly and in 2004 it was scaled up to all 75 districts, reaching up to 2 million children under 5 years of age. The programme is funded by UNICEF but the system used a capillary distribution at village level with the aid of community health volunteers. Since 2001 deworming has been added with no additional distribution cost, the albendazole being purchased by the MOH. Extremely high coverage (over 95%) led to the outstanding result of reduction in anaemia by 77% in one year, in addition to a reduction in soil-transmitted helminth infections. (USAID,2002)

Under the Title II program of USAID food aid is integrated with Government of India (GOI) and non-governmental resources to improve key child survival interventions such as immunization, breast feeding, and complementary feeding. The Title II program is being implemented by two major NGOs-CARE and Catholic Relief Services (CRS)-and reaches 7.5 million poor women and children (at the greatest risk to mortality, morbidity, and malnutrition) in remote rural and tribal villages. CARE's Integrated Nutrition and Health Program (INHP), which works within GOI's Integrated Child Development Services (ICDS), and CRS' Safe Motherhood and Child Surival (SMCS) program, which is implemented through social service societies, directly contribute to the results under this objective.

USAID has initiated discussions with the government of UP and UNICEF on a vitamin A initiative to improve coverage of vitamin A supplementation in UP. The USAID-World Bank Deworming and Enhanced Vitamin A trial (DEVTA), which covers one million children in UP, was completed in 2003. DEVTA validated the impact of concurrent vitamin A supplementation and deworming on mortality and growth of children. (USAID, 2002)

Recently recommendations are being made by the parliament to make sure that every child took Vitamin A and deworming tablets twice a year.

Malnourished children become more malnourished when infected with worms. The effects of deworming are dramatic, as illustrated by a large study conducted in India by (Awasthi et al 2000). Six-monthly deworming was able – within two years – to prevent 82% of the stunting that occurs without intervention; dewormed children showed a 35% greater weight gain. The study validated the clinical efficacy and the incremental cost-effectiveness of albendazole in improving the nutritional status of pre-school children. The results indicated that there was a statistically significant reduction in the proportion of children who become stunted at the end of 2 years with six monthly albendazole. The cost-effectiveness ratio was sensitive to clinical efficacy of albendazole and placebo.

Awasthi et al, 2000 in her study on the 'Effects of Deworming on Malnourished Preschool Children in India' had suggested that monthly deworming as a part of an ICDS program in urban slums is associated with substantial weight gain in malnourished pre-school children. The mechanism for this gain she suggests may be indirect since a negative association between ascariasis and vitamin A absorption has been described, but a study in an area of low infection prevalence showed a benefit of vitamin A supplementation that was not further enhanced by deworming. A moderate increase in weight but not height appears to be a consistent phenomenon in deworming trials of worm-affected populations. Of five published randomized trials of anthelmintic treatment that showed significantly increased growth in preschool children (Mebrahtu T, et al 2004, Alderman H, et al 2006, Dickson R et al 2000), all reported benefits in ponderal growth (Gain in weight), and only one an increase in linear growth (Gain in height). The body weight of the disadvantaged children increased but it was not followed by a statistically significant gain in height or linear growth. In the children in Lucknow the height gain was greatest for those stunted initially,and least for those wasted . The results of the study are also of similar scale to previous trials where the annual gain is typically in the range 5% to 10% above the control group (Mebrahtu T, et al 2004, Alderman H, et al 2006, Dickson R et al 2004).

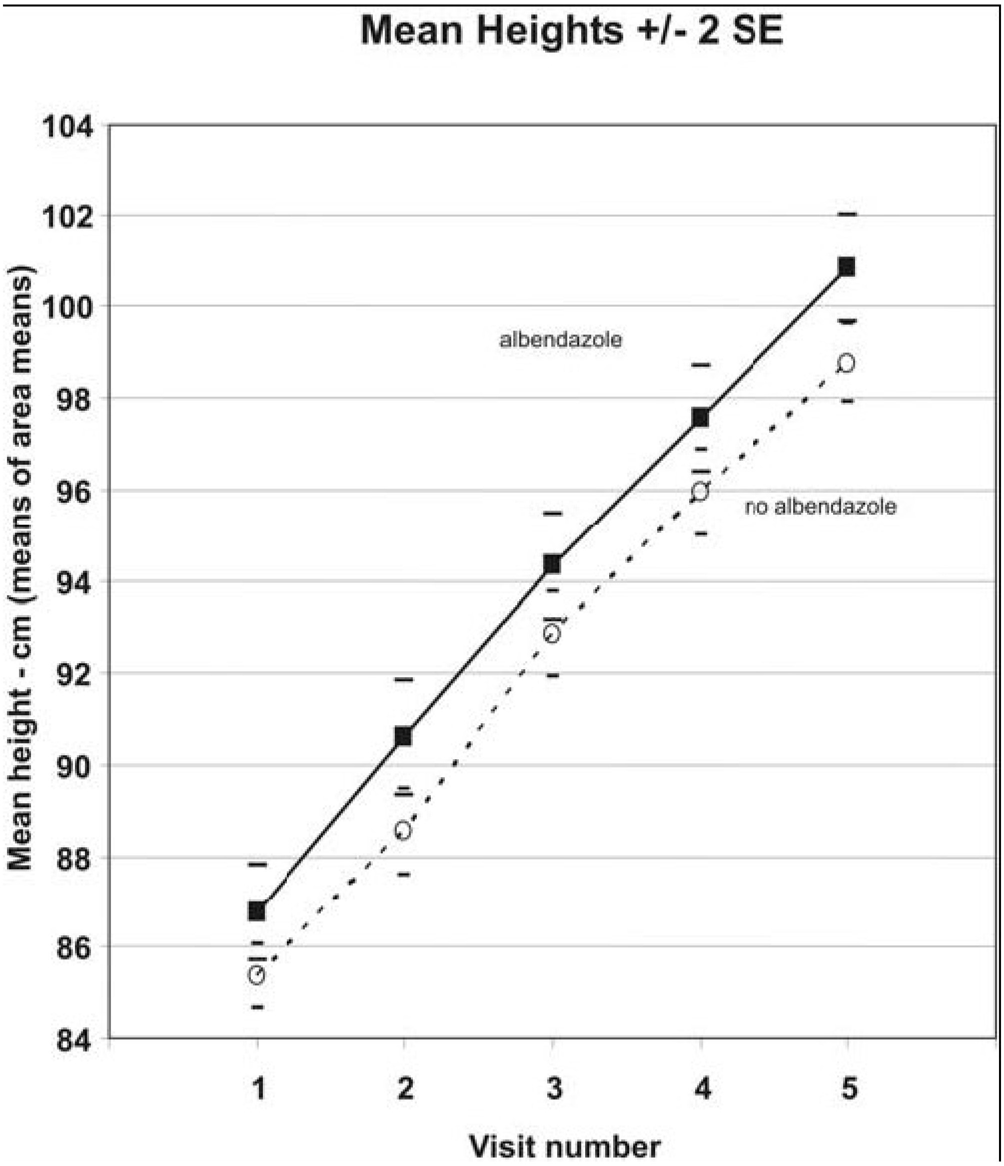


Figure : Mean Heights by Visit and Treatment showing the non significant effect of increase in height of children on deworming

Source : (Mebrahtu T, et al 2004)

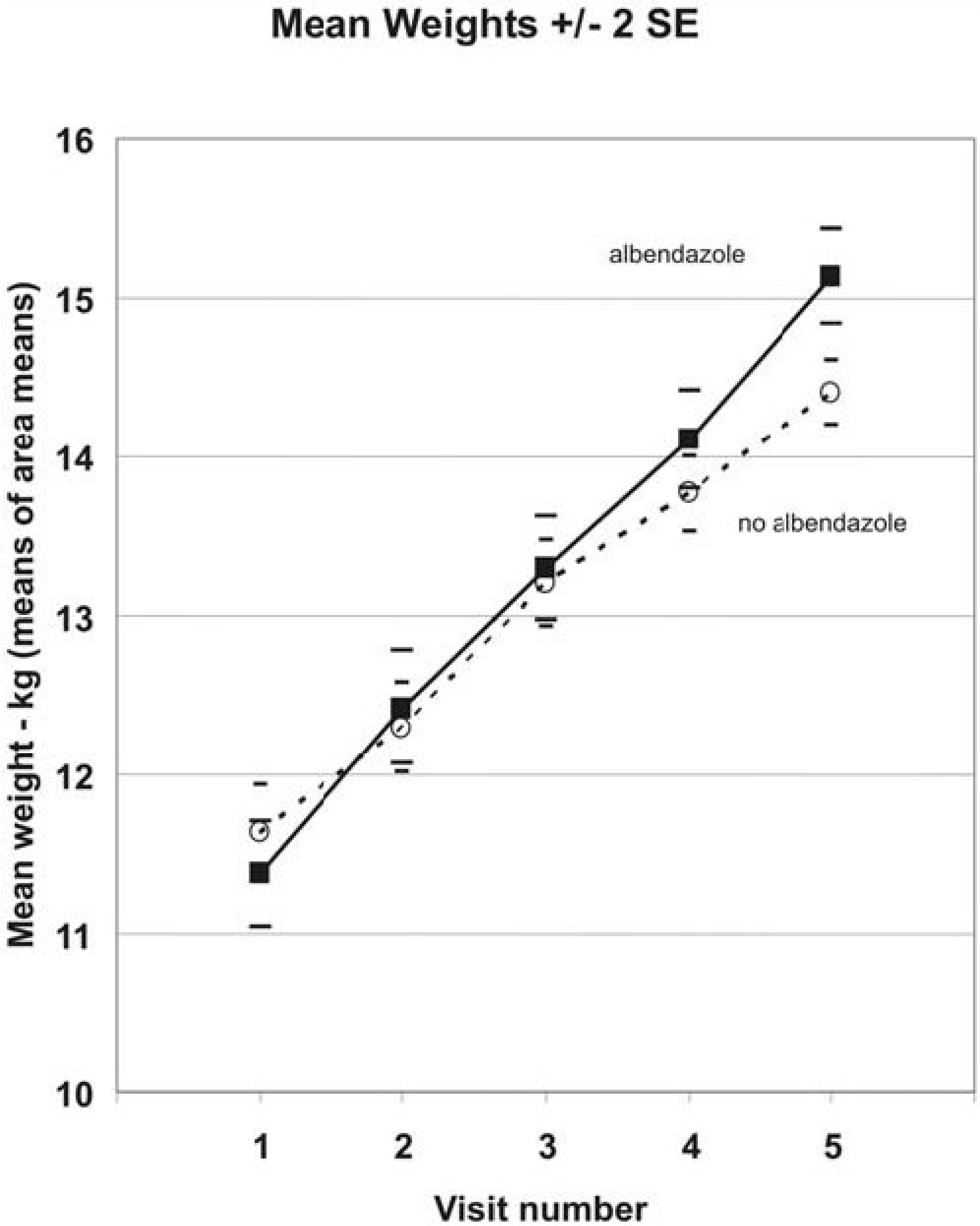


Figure :. Mean Weights by Visit and Treatment showing the effect of weight on children on deworming
Source : (Mebrahtu T, et al 2004)

School-based helminth control programmes are among the most cost-effective public health interventions for reasons that include the following:

• They use existing educational infrastructure.
• They depend on inexpensive, safe, and effective drugs.
• They have a maximal effect in reducing the morbidity and transmission of STH and schistosome infections.
• They strengthen health awareness and provide the opportunity for wider health education.

As per the researchers in Tanzania and Ghana have demonstrated the cost of delivering the ani helminthics in first five years accounts to less than 0.50 USD per child in areas where STH and Schistosomiasis are present and less than 0.25 USD per child in areas where STH is present. This cost includes the training of the teachers, procurement and distribution of drugs to students (Acta Tropica, 1999)

In Kenya a randomized evaluation of School based deworming for STH and Schistosomiasis reduced the abstinence by one quarter.Deworming was the effective method of improving school attendance among a series of educational interventions. In an investment of 4 USD for deworming an extra year of primary schooling was gained as compared to 38 USD to 99USD spent for other interventions. (Miguel E et al, 2002). In Southern USA, in early 20th Century

as per the Rockefeller hookworm control program showed a reduction of absenteeism by 23 percent and long term effects on labor income suggest benefits of childhood free of hookworms to be approximately 45 percent of adult wages (Bleakley H,2002). It suggests that deworming is efficient investment in human capital.
The results show that school-based mass deworming—where every child in a school is treated—is the most cost-effective way to increase school participation (of all the alternatives that have been rigorously evaluated). It is also one of the most cost-effective ways to improve health of children.

Chapter 5

Discussion:

The risk factors for STH transmission as mentioned earlier are poverty, poor and unhygienic living conditions, lack of proper sanitation and water supply, high humidity, temperature and soil quality, lack of personal hygiene, use of human fertilizers and poor health awareness and literacy Soil transmitted helminthiasis are common among children in different parts of the country, though variations in the prevalence in various states of India and varies from rural to urban areas. It is seen that even though in some states of India the prevalence is lower but the number of children affected is high.

There is a great deal of malnutrition and part of this malnutrition is partly attributed to STH infections. The impact of STH on the health of the children is due to anaemia among the children. The effect on ill growth of children in India and other parts of the world where it is prevalent appears to be related to STH. It is seen there is lot of abstinence in schools in different states in India and also else where in the world and part of it is attributed to STH infections. It is difficult to find the accurate details to explain the relation of one worm infestation or the other and the effect on health as it is difficult to work out.

In India there is dearth of safe and potable drinking water supply, in slums and rural areas. People residing in these areas use the river banks or lakes for cleaning of their clothes, washing of utensils, and drinking. Hence children aged 4-15 years are more susceptible to infection with STH especially in slums and rural areas where there is no proper supply of clean water and proper sanitation. Moreover the children walk barefooted. The studies also suggest the same and prevalence of STH infection is high in these areas.

The modes of transmission for the worms are feal-oral route for ascaris, trichuris and skin penetration for hookworms (Necator americanus and Ancylostoma duodenale) hence school children are the most affected due to bad habits, poor personal hygiene and playing in the infected environment especially barefooted which is common in India.

Hence it shows that STH infections is a major problem and it cause more harm by stunting the growth of children both mental and physical and thus robbing them of a proper healthy life throughout their life. Its seriousness is increased by the presence of condition suitable for the disease in India.

However there may be as we do see that if a real effort is made in a holistic manner in health improvement combining nutritional supplements, improvement of water and sanitation it can help to achieve the goal of reduction of STH burden among children.

Chapter 6 : Conclusion and Recommendations

Conclusion:

The prevalence of STH infection is high in India as shown by various studies. The prevalence of the infection is especially found in areas where poor people live especially in slums and urban areas. These areas do not have proper supply of water and there is a lack of sanitation in these areas. Personal hygiene is also poor in these areas. These areas also tropical in climate and have high humidity and STH infections occur in these areas.

STH infections are common in children aged 4-15 years and can be controlled with deworming agents as it gets rid of the worms from children. Deworming programmes should be done in a holistic manner as it should incorporate supplementation of iron and folic acid and vitamin A in the diet as studies have shown that they are beneficial in improving the overall health of children. The programmes of the government should also be aimed to improve the sanitation facilities of the areas where deworming is done.

Since the infection robs the children's mental and physical growth at a crucial stage leading to a loss of human resources of the country. Prevention is better and cause awareness should be promoted which include

1. Good personal hygiene like washing hands before eating and after using the toilet.
2. Clean and safe preparation of food
3. Always use slippers or shoes
4. Proper use of toilet facilities
5. Environmental sanitation

It is a serious problem and the all the requisites for the breeding of the disease is present in India be it social, environmental, climatic or cultural.

The problem in India should be controlled in a holistic manner as the deworming programmes should be properly directed especially in areas with rates of prevalence and in places where the conditions are suitable for the infection. The deworming programmes should also make good the nutritional requirement of the people treated. Anemia is prevalent in more than 70 percent in the states of Bihar, Madhya Pradesh, Uttar Pradesh, Haryana, Chattisgarh, Andhra Pradesh, Karnataka and Jharkhand.

The people should get access to an improved water source and improved sanitation along with the deworming programmes. There is also a need for area specific strategies in different states of India with innovative messages focusing on adverse health implications of unsafe ways of disposing children's stools. This sort of a holistic approach can only give proper results and help in eradication of STH infection. STH infections since they affect children of 5-15 years of age it simply jeopardizes the future of the country.

Recommendations:

A comprehensive control strategy for helminth infection should include:

1. Eradication of extreme poverty and hunger

Antehelminthic treatment helps the prospects of school children to help their way out of poverty (Miguel E, Kremer M. 2001, Kremer M.).The beneficial effects of deworming have shown a positive impact on professional income in later years of life. The impact of deficient nutrient intake is aggrevated by worm infestation which affect with nutrient uptake and is the main cause of anaemia anaemia (Stephenson L et al. 2000, Crompton DWT, Nesheim MC, 2002).

Children are more vulnerable to get malnourished once infected with STH infection.The effects of deworming are very much beneficial as shown by the studies conducted in India. Deworming twice in a year within two years was able to prevent 82 percent of stunting that occurs without any intervention and dewormed children showed 35 percent greater weight gain.

2. **Achieve universal primary education**

The effect of deworming on school children in developing countries can reduce the absenteeism by 25 percent and will result in higher wages . As per the estimates that 562 million school children in the developing countries, STH infections are estimated to result in 16 million cases of mental retardation in primary school children and 200 million years of primary school loss.

3. **Promote gender equality and empower women**

A girls' education plays a important role in the family. As per the saying of Great leader of India Mr . Pandit Jawahir Lal Nehru "if you educate a boy, you educate only boy and if you educate a girl you educate the whole family ". There are chances to find employment outside the agricultural sector . Though the gender gap is coming down in developing countries but still there is low percentage of girls in schools as compared to boys. Deworming programmes when combined with other measures like mid day meal and take home rations have shown a positive effect on enrolment of girls and thus improve their drop out and retention rate in schools. As per study done by Khanal P et al,2000 in Nepal among Nepali school children on deworming, providing mid day meal and food gifts for girls to take home has resulted in 43 percent growth in school enrolment among girls and in addition anaemia was improved

4. Reduce child mortality, improve maternal health

STH infestation predisposes to infectious diseases among children . As per the studies conducted in areas where malaria is a major killer disease showed that deworming and the resulting improvement in anemia improves the chances of survival in severe malaria. The reduction in anaemia following the deworming contributed to the survival and development of these children. (Stoltzfus RJ et al. 1998, Stoltzfus RJ et al, 2000)

5. Promoting good hygiene and sanitation practices

Emphasis should be given to the school children and to the caregivers on use of latrines, proper hand washing, use of foot wear through community capacity development activities and in school curriculum . Provision of adequate water and sanitation facilities at household and at community level . It should be mandatory to provide safe water supply and sanitation facilities in all schools.

6. **Deworming Programmes**

The Ministry of Health should include regular de worming programmes in school health check ups. It is important that the intestinal parasites control programmes target the heavily infected individuals who are epidemiologically important, being the major sources of infection in the community. Hookworm disease can be quickly brought under control by mass treatment of heavily infected people. The morbidity can be reduced, with appropriate inputs to improve the environmental factors. This may need investment for sanitary latrines, food hygiene, and safe drinking water, anti- helmintic drugs and health education. In the absence of sanitation, however, re-infection will occur and periodic re-treatment will be necessary. All these investments would also address other food / water borne diseases as a collateral benefit.

Educating the community with special focus on the vulnerable groups of population(children and mothers) on following lines along with the suggested chemotherapeutic intervention will yield better results. Parents and teachers can help the children by teaching them good habits which will protect them from intestinal worms and other diseases which spread through contaminated food and water. Following points may be emphasized in health education:

- Raw and uncooked food should be washed thoroughly with water before eating. Do not eat raw food directly from the field.
- Wash hands before preparing or eating food and after defecation.

- Drink water from a safe source such as a deep tube well. If water is used from dug well, regular chlorination of the water should be ensured.
- Store drinking water in clean, covered and narrow mouthed containers. If a wide mouth container is used, take out the water with a ladle. Never put hands inside the container.
- Disposing human excreta safely such as by construction of sanitary latrines so that defecation in the open fields is avoided.
- Children and adults should be encouraged to use footwear and not to walk barefoot.
- No use of human excreta as fertilizer.

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