PREVALENCE AND SEVERITY OF INTESTINAL HELMINTHIASIS AND SOME NUTRITIONAL INDICATORS IN A RURAL CHILD COMMUNITY IN MBeya DISTRICT TANZANIA

BY
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DECLARATION

This thesis is my original work and has not been submitted for a degree at any other University.

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This Thesis has been submitted for examination with our approval as University supervisors.

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DEDICATION

This work is dedicated to my family, my lovely wife Esther C. Swai, my sons Kennedy & Victor and my lovely daughter Vivian.
Acknowledgement

A number of people were helpful to me in this research project. First and foremost sincere gratitude to my supervisors Dr. J. W. Muita and A. M. Omwega for their guidance, support and interest in the research. I am grateful to Prof. A. A. Kielmann for his encouragement during the proposal development for this research. My appreciation to Dr. Chunge R. N. cf Kemri for the valuable comments and critic of the results of this work. Acknowledgment is made for Mr. Mwadime R. K. N. for his critic on the statistical aspects of this study.

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Sincere thanks to IDRC for their fellowship which enabled me to study at the University of Nairobi and conduct this study.
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Abbreviations:

CCF - Congestive Cardiac Failure.
Cm - Centimetre.
DF - Degree of Freedom.
Epg - Eggs per Gram.
Fe - Iron.
G/l - Gram per litre.
Hb - Haemoglobin.
IDRC - International Development and Research Centre of Canada.
Kg - Kilogram.
MCH - Maternal Child Health.
Mls - Millilitre.
MPS - Malaria Parasite.
P - Level of significance, usually at 5% (0.05).
SBS - Socio-economic status.
WHO - World Health Organization.
H/w - Hookworm.
HH - Household.
Definitions:

Amoeboma - A tumour in the caecum or rectum caused by Entamoeba histolytica.

Anorexia - Loss of or impaired appetite for food.

Cestode - Is a tape worm which consists of a head and a chain (strobila) of segments and lives in the intestinal tract of its host.

Clubbing fingers - Is thickening and broadening of the bulbous fleshy portion of the fingers under the nails.

Dermatitis - Inflammation of the skin.

Entamoeba histolytica - Is a genus of protozoan parasite, causes amoebiasis, with the intestinal form of disease being referred to as amoebic dysentery.

Eosinophilia - Increased eosinophils in blood

Erythema - Reddening of the skin.

Fibrosis - The formation of excessive fibrous tissue in structure.

Formed stool - Stool which is firm and does not take the shape of container.

Giardia lamblia - Is an intestinal flagellate which causes giardiasis. (Giardiasis is an infection
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Granuloma</td>
<td>Tumour formed of granulation tissue.</td>
</tr>
<tr>
<td>Hepatitis</td>
<td>Inflammation of the liver in response to toxins or infective agents.</td>
</tr>
<tr>
<td>Host</td>
<td>An organism from which a parasite takes its nourishment.</td>
</tr>
<tr>
<td>Hypertension</td>
<td>A condition in which patient has a higher blood pressure than that judged to be normal.</td>
</tr>
<tr>
<td>Insomnia</td>
<td>Sleeplessness.</td>
</tr>
<tr>
<td>Loose stool</td>
<td>Stool which adapts to shape of container and flows slowly.</td>
</tr>
<tr>
<td>Murmure</td>
<td>Abnormal sound heard on auscultation of heart or great vessels.</td>
</tr>
<tr>
<td>Nematode</td>
<td>A worm like creature that have two sexes and an intestinal canal.</td>
</tr>
<tr>
<td>Cedema</td>
<td>Abnormal infiltration of tissues with fluid.</td>
</tr>
<tr>
<td>Obligatory</td>
<td>Ability to survive only in particular set of environmental conditions i.e a parasite cannot live and produce outside a host.</td>
</tr>
<tr>
<td>Papule</td>
<td>A small circumscribed elevation of the skin.</td>
</tr>
<tr>
<td>Peritonitis</td>
<td>Inflammation of the peritoneum.</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>Inflammation of the lung due to micro-organism.</td>
</tr>
<tr>
<td>Pneumonitis</td>
<td>Inflammation of lung tissue which is due</td>
</tr>
</tbody>
</table>
to physical agents e.g. from allergic reaction.

**portal**
- That of venous blood (collected from the intestines, pancreas spleen and stomach) to the liver before return to the heart.

**pruritis**
- Itching.

**Schistosoma mansoni**
- Is an infestatation of radicles of the interior mesenteric vein with trematode parasite (genus) *Schistosoma mansoni*.

**Sprue**
- A chronic malabsorption disorder associated with glossitis indigestion, weakness, anaemia and steatorrhoea.

**Strongyloides stercoralis**
- (dwarf threadworm) of intestinal worms that can infect man.

**Syndrome**
- A group of symptoms and / or signs which occurring together, produce a pattern or symptom complex, typical of particular disease.

**Tachycardia**
- Rapid action of the heart.

**Trematodes**
- Are flukes (leaf-like or cylindrical) parasitic worm e.g. *Schistosoma mansoni*.

**Trichuris trichura**
- A genus of nematodes, (whipworm) which is (whipworm) which is a common parasite of man.
Abstract.

A cross-sectional study was carried out from June to November 1991 in three rural child communities, 2-10 years of age in Mbeya district, Tanzania. This study was to determine the prevalence of intestinal parasites and its association with nutritional status. Six hundred and eight children from 402 households were randomly sampled from the three rural villages, from which social demographic information was obtained and stool examined for parasites. The nutritional status was assessed through anthropometry and haemoglobin estimation. Confounding factors like malarial parasitaemia were studied. The overall prevalence of intestinal parasites was 10.7%. There was no significant relation between nutritional status (measured by wt/ht) and the worm loads in this child population, however an association existed between children's worm load and their haemoglobin level; whereby the higher the worm load the lower the haemoglobin level.
CHAPTER ONE

1.0 Statement of the problem

1.1 Introduction:

Intestinal parasitic infestations are distributed virtually in all regions of the world (WHO, 1987). The parasites however present large serious medical and public health problems in the developing countries, particularly in the tropical regions and have been observed to be an important cause of mortality (Calloway, 1982). Frequently, physicians and public health authorities show little interest in them.

The reasons for this may be the high prevalence and the problems of eradication or control of the diseases. It is also noted that medical care expenditure of parasitic infestation may use up a considerable proportion of the national health budget (WHO, 1981).

The commonest infestations among the top ten in the world are amoebiasis, ascariasis, hookworm and trichuriasis (Calloway, 1982). Although mortality from these may be relatively low, complications are not uncommon and many cases need hospital care (WHO, 1987).

1.2 Parasite and complications:

Among the common complications of intestinal helminthiasis are iron deficiency anaemia caused by hookworm and possibly trichuriasis (Adams, 1966, Layrisse, 1967) Chronic dysentery leading to poor growth and resultant loss of weight has been noted with Trichuris trichura (Gilman et al., 1983).

Gastrointestinal complications which include micro-abscesses, perforation of the gut, hepatitis, fibrosis and hepatomegaly have been reported from infestation with
schistosoma mansoni, enterobius vermicularia, entamoeba histolytica and Giardia lamblia (Mahmoud et al., 1982)

1.3. Prevalence of helminthiasis:

The global prevalence of intestinal helminthic infestations has been reported as hundreds of millions of parasitized people (WHO, 1987).

The prevalence of ascaris is estimated to be about 0.8 to 1.3 billion (Pawlowski and Arfaa, 1984), while human hookworm infestation affects more than 900 million people or over one fifth of the world's population (Schad and Banwell, 1984). Trichuris trichura affects an estimated 500 million people in the world (WHO, 1987).

In Tanzania, a developing country, intestinal parasites infestations are spread in rural communities of low socioeconomic background. Some of the reasons put forward for these are poor environmental sanitation as reflected by absence of latrines and inadequate or unprotected source of water supply among others (Eshuis et al., 1978).

In this country various studies have investigated the association between nutritional status and the worm burden of children however there is no information available on the Mbeya region where conditions conducive to the spread of these infestation exist.

1.4 Research Objectives.

The aim of the study was to determine the prevalence of intestinal parasitic infestation among children in a rural community and to determine the relationship between parasite load and nutritional status.

The main objective of the research was to determine the
association, between intestinal parasitic infestation and nutritional status of children 2 to 10 years of age in rural Mbeya district, Tanzania.

1.4.1 Sub-Objectives:

1) To determine the prevalence of intestinal parasitic infestation and type of parasite.
2) To determine the intestinal worm load in the study population.
3) To determine the haemoglobin level of the study children.
4) To assess the nutritional status of the study population by anthropometry (weight for height).
5) To determine any association, existing between the nutritional status and parasitic infestation.
6) To determine the monthly income of the parents whose children were included in the study.
7) To determine the education level of the parents whose children were included in the study.

1.5 Hypothesis

There is an inverse association between intestinal parasite infestation, the parasite load and the nutritional status of the individual child.

1.6 Expected benefits

The results from the study are expected to add knowledge to that existing on intestinal parasites and nutritional status in rural child communities. This will assist in planning of control programs.
CHAPTER TWO
LITERATURE REVIEW

2.0

2.1 Introduction:
Intestinal parasites known to affect man are numerous and their distribution is geographically diverse (Spuvelda, 1984). This study discusses those parasites with high prevalence in the region of study.

Intestinal parasites are so named because their life history includes a period of obligatory residence in the human alimentary tract or because they induce pathological changes in the alimentary tract (WHO, 1987, King et al., 1978).

2.2 Host-parasite relationship:
A parasite is an organism that must spend its development in another living organism known as a host (Crompton, 1984). During the relationship, the host provides the parasite with food, shelter and conditions necessary for its growth and survival. In many cases the parasite initiates the onset of disease.

A host parasite relationship has been described as a state of conflict between the injurious attacks of the parasite and the host. Parasite invariably stimulate the immune responses of their host. This does not always protect the host. Parasites often occupy rather precise sites within their hosts and co-exist for different periods of time varying from few days to several years (Crompton, 1984).

2.3 Ascariasis:
This is infestation with Ascaris lumbricoides, the largest nematode existing in nature (Paniker, 1988).
2.4 Prevalence and distribution:

The prevalence of ascaris is high in many parts of the world, complicating a public health problem. Recent estimates show that *Ascaris lumbricoides* ranks third among the ten most common human infestations with an estimated 0.8 to 1.3 billion persons infected or about one quarter of the world's population (Pawlowski et. al., 1984; Crompton et al., 1982; Walsh et. al., 1979). This represents a global worm burden of about 7,800,000,000 adult worms i.e. 1,300,000,000 persons times the expected mean of six worms per host (WHO, 1964; WHO, 1981).

Human Ascariasis is cosmopolitan in distribution and occurs in temperate as well as tropical and subtropical environments, although it is more common in areas which have a combination of predisposing factors including poverty, high population density or agricultural activity, poor sanitary practices and favourable climatic conditions. About 73% of all, *Ascaris lumbricoides* infestations have been estimated to occur in Asia, while about 12% are in Africa and 8% in Latin America (Peters, 1978).


2.5 Prevalence by age.

The prevalence differed by age category as was depicted in the study by Crompton (1985) in Burma where the rate in the under five population was ranging between 60-67% with the prevalence in 6-11 months being the lowest and highest in the 48-49 months age category (80.3%). In the children over five years of age, the prevalence is highest in the 5-9 years of
age category but declines gradually in the older children (Crompton, et al., 1986).

2.6 Nutritional status and ascariasis.

Gupta (1990), in a study in New Delhi demonstrated that children with history of passing worms had a significant lower mid arm circumference than those without similar history. Johnson et. al., (1983) however did not find any relationship between ascaris infestation and anaemia in a study in Guyana.

Two studies in East Africa have shown an association between infestation with ascaris and nutritional status. Stephenson (1979) in study in Machakos Kenya showed anthropometry and clinical evidence of chronic or acute on-chronic PCM in over 50% of children with ascaris in this of 375 children aged 6-72 months. In Tanzania Turner (1987) in a longitudinal study revealed higher stunting rates (35-71%) and substantial wasting (3-20%) among children with parasites.

Hlaing-T (1993) on studies of effect of ascariasis on childhood malnutrition which were carried out in many developing countries from Africa, Asia and Latin America, using cross-sectional and intervention studies, showed that a better nutritional status in terms of growth, lactose tolerance, Vit. A and C and albumin levels were observed among Ascaris-free or untreated than among Ascaris-infected or untreated children.

Cabrera (1980) in a study on parasite control demonstrated that Ascariasis appears to be associated with malnutrition, avitaminosis, kwashiorkor and retardation of mental and physical growth. He also suggested that Ascariasis may interfere with the host’s nutritional status in the following ways: Ingestion and absorption of food by ascaris.
digestion and storage of food, production of antienzymes; damage to intestinal wall; absorption and metabolism of vitamins and lastly toxic action on the smooth muscles of the intestines.

2.7 Hookworm infestation:

This infestation is caused by nematodes genus, *Ancylostoma duodenale* and *Necator americanus* (Rshuis et al., 1978).

2.8 Prevalence and distribution:

Human hookworms infestation is more than 900 million people, representing over one fifth of the world's population. The prevalence can vary from 80-90% in rural unsanitary conditions, while in most Tropical countries in relatively dry unsanitary areas such as Iran and parts of Pakistan it varies from 10-20% (Schad and Banwell, 1984).

*Ancylostoma duodenale* and *Necator americanus* are by far the most common hookworms. *Ancylostoma duodenale* tends to predominate in Europe and areas bordering the Mediterranean, the Middle East, North Africa, the West Coast of South America and parts of Iran, Pakistan and North India. Both species are found together in certain areas of Brazil, parts of India, and Africa and throughout East Asia, Indonesia, and the islands of South West Pacific. *Necator americanus* is the only human hookworm of North America; it predominates in large parts of South and Central America, Central Africa, South India, Indonesia and South Pacific (Beaver et al., 1984; Markell et al., 1986). In childhood, the prevalence and intensity generally increase with age, but levels of infection decline in adulthood (Schad et. al., 1975).
Chandiwana (1989) in a study in Zimbabwe indicated that 61.7% of 15 farm worker communities studied were infested with hookworm and that the intensity of infection increased with age being higher in adults.

In a similar study in Reunion prevalence of anaemia was 13.6% in the general population and highest in 21.1% in children 6 months to 2 years of age, with iron deficiency as the predominant type (Mahu et. al., 1985).

Prevalence of hookworm anaemia was studied at Kenyan Coast and Central Kenya among 19 road workers. Out of those studied 66% had hookworm which was associated with anaemia (Chunge et. al., 1985).

2.9 Nutritional status and hookworm infestation:

The role of hookworm infection in iron deficiency and anaemia has been confirmed in several recent studies (WHO 1987). *Ancylostoma duodenale* and *Necator americanus* have been estimated to cause a daily loss of blood into the small intestine of 0.14-0.26 ml. and 0.02-0.07 ml. per worm respectively. When several hundred hookworm are present in the small intestine, the daily blood loss is sufficient to cause anaemia even in well nourished children or adults (Layrisse et al., 1976).

Studies of nutritional status and growth carried out in the central highlands of Papua New Guinea, in 118 young school age children with different degrees of infestation hookworm, however, no significant difference in anthropometric, haematologic or biochemical tests of nutritional status was found between hookworm-free children and children with moderate infestation (Ostwald et. al., 1984).
2.10 **Taeniasis**

Is defined as condition of infestation with beef tapeworm (*Taenia saginata*) or pork tapeworm *Taenia solium* which occurs as a result of consumption of infected beef or pork. The adult worm lives in the small intestine commonly in the jejunum, with head embedded in the mucosa (Paniker, 1988).

2.11 **Prevalence and distribution**:

Tapeworm is especially common in areas where beef or pork is eaten raw or only lightly cooked.

Kenyan annual medical reports dating from 1916 to 1966, showed that 44.4% of individuals at a work camp, Marigat, had taenia (Chunge R. N. 1985). Mango (1967) summarised the prevalence of taeniasis in the Kenyan provinces from 1967 to 1969 from the ministry of health data and showed that Rift Valley Province had the highest prevalence with 63,182 cases, followed by Central Province with 12,000 cases.

Prevalence in Tanzania was reported to be low with mild effect on patients. (Bshuis, J.et al., 1978).

2.12 **Enterobius vermicularis**:

This is a threadworm infestation which is due to the presence in the intestine of the small nematode *Enterobius vermicularis* (Paniker 1988).

2.13 **Prevalence and distribution**:

Enterobiasis has a worldwide distribution. Unlike the usual situation where helminthic infestations are more prevalent in the poor people of the tropics, *Enterobius vermicularis* is worm infestation which is far more common in the affluent nations in the cold and temperate regions.
(Paniker, 1988).

In Kenya, Chege et al., (1985) studied the prevalence of *Enterobius vermicularis* (synonym used: *oxyuris vermicularis*), in the 1918 annual medical report, 20 out of 33 cases were reported as coming from the desert regions. In most studies where *enterobius* has been diagnosed, prevalence rates are less than 2% (Chunge et al., 1985).

2.14 The association between worm load and nutritional status

Over the past twenty five years there has been an evidence to indicate a link between heavy worm load and malnutrition in children. The findings suggest that heavy worm load limit full utilization of nutrients in the diet and reports have indicated that under-nourished children grow faster after deworming (Stephenson et al., 1983).

Ng'andu et al., (1992) revealed that heavy worm load especially with hookworm infestations has been found to be associated with weight for age percent index, thus contributing to poor nutrition.

Figarro Fletcher (1988) in study conducted on 145 toddlers, 6-36 months of age in a Suburb in Kingstone Jamaica, found that there was no difference in nutritional status between children with and without parasites.

Tripathy (1971) in a study on 12 children on the role of *ascaris lumbricoides* infestation in human nutrition, demonstrated that: *Ascaris* infestation in children can lead to marked nutritional impairment when a high parasite load is associated with a low protein intake.
CHAPTER THREE

STUDY METHODOLOGY

3.1 Introduction:

The study was conducted in Mbeya District, of Mbeya Region, which is located in the Southern highlands of Tanzania. The region is bordered by Zambia and Malawi to the South, Rukwa Region to the west, Tabora and Singida Regions to the North and Iringa region to the east (see Appendix 3). The region lies between latitudes 7\(^\circ\) 0' and 9\(^\circ\) 31' South and between longitude 32\(^\circ\) and about 35\(^\circ\) East with an average altitude of 3,000 metres above sea level.

The region covers an area of 63,622 km\(^2\) and is divided into six districts, namely Chunya, Kyela, Mbeya Rural, Ileje, Mbozi and Rungwe. The district has a total of 19,283 km\(^2\). The population of rural Mbeya district is approximately 284,000 (1978 census). The population density per km\(^2\) was 14.7 persons in 1978 census.

Mean annual rainfall in Rural Mbeya district ranges from 800 to 1500 mm. The bimodal rainfall pattern exist with long rains between early December and early March and continuing through April to the end of May. The rest of the rains come in short rain season mainly in September and October.

The district has five divisions, namely, Rujewa, (semi-urban), Ilongo, Tembela, Usongwe and Isangati. The district has 38 wards and 165 villages. The study was undertaken in Itembela and Rujewa divisions, in Rujewa and Ijombe wards. The villages in which the study was conducted are Ijombe (Typical Rural village), Ibara (Rural semi-urban village) and Mbarali (Rural Estate village). The majority of the inhabitants of the three rural villages (Ijombe Ibara and Mbarali), are from the major tribes, Safwa, Sangu, Bena and Nyakyusa.
3.2 Ijomba village (Typical rural village).

The village has an area of 400 Km² with a population of 2500 people (1988 census). It has an average altitude of 1000 metres above sea level and has an annual temperature range of approximately 0°C to 15°C. This is a highland where fog and mist is common.

Agriculture: The cash crops grown in this area are mainly pyrethrum and wheat with the main food crops being maize, Irish potatoes and beans. The horticultural crops grown are cabbage, spinach, carrot, onions, tomatoes and peas.

3.3 Ibara Village (Rural semi-urban village).

The village lies within the Usangu plains. It has an average area of 200 Km² with a population of 4,000 people (1988) census. It has an average altitude of 1500 metres above sea level and has an annual temperature range approximately 20 to 25°C.

Agriculture: The cash crop grown in this area is rice. The food crops are maize and beans.

3.4 Mbarali Village: (Rural estate village).

This village also lies within the Usangu plains. It has an area of 3,200 Km² with a population of 2400 people (1988) census. It has an attitude of 1500 metres above sea level and an annual temperature range of approximately 20 to 25°C. Mbarali village is an estate owned by the National Food Co-operation (Nafco). The estate has 358 permanent workers and 5605 temporary workers.

Agriculture: Major agricultural activities during the month include irrigation and drainage, herbicide application,
flooding and drainage, canal cleaning, sowing and fertilizer application. Rice is the only crop grown as a cash and food crop. In 1991/92 11,002.1 tons of rice were harvested from 3392.58 hectares, which is an average of 4.6 tons per hecta.

3.5 Health Facilities:

The health facilities include a Government health centre at Ibara and non-government (Parastatal) dispensary at Mbarali.

3.6 Administration:

Administratively, in all the villages, households are classified into groups of ten cell. Each ten-cell house unit is administered by a ten cell leader.

3.7 Research design:

The study population consisted of pre-school and school children 2-10 years of age, resident within the three villages. Only households with children of age between 2 to 10 years old were included with precaution that they were free of overt illness over the preceding week.

There are 5 divisions in the rural Mbeya district which formed the sampling frame. In the semi-urban area there are 10 wards, 2 wards from rural estate and 26 wards from Typical Rural villages which were all included in the sample. From each strata one ward was then randomly selected and also one village was randomly selected from each ward. Then identification of all children 2-10 years old was done and lastly, by random selection probability proportion to size, the number of study children was identified (see
3.8 Sample Size

The prevalence of helminths in the population was not known therefore a 50% rate prevalence was taken into account. The confidence limit of 95% and a range of 5% was used for determination of required sample size.

The sample size was computed using the formula below:

\[ \frac{Nz^2Pq}{d^2(N-1)+Z^2Pq} \]

This is formula used for population less than 10,000.

- \( n \) = desired Sample
- \( z \) = Confidence level (set at 95%)
- \( P \) = Expected proportional of intestinal parasite prevalence level 0.5
- \( q \) = accepted proportion of children free from parasite (1.0 - 0.5 = 0.5)
- \( d \) = accepted range of deviation from real situation or desired degree of precision set at 5% (0.05)
- \( N \) = Study Population (Total number of the population in the three villages 2500 + 4000 + 2400 = 8900 for Ijombie, Ibara and Mbarali respectively).

\[ \frac{8900(1.96)^2(0.5)(0.5)}{(0.05)^2(8899+1.96)^2(0.5)(0.5)} \]

168 is the minimum sample size.

In my study 608 children were enrolled in order to increase accuracy.
Fig 1. A Scheme of the research design

All divisions in the Mbeya Rural District
(n=5)

Identification of

- All Wards in Rural
  semi-urban (n=10)
- All wards in Rural estate/Industries (n=2)
- All Wards in Typical
  Rural areas (n=26)

Random selection of one ward from each strata

Identification of all villages in each ward

- Villages (n=50)
- Villages (n=15)
- Villages (n=100)

Random selection of one village from each ward

Identification of all children 2-10 years old

- Children (n=580)
- Children (n=217)
- Children (n=477)

Random selection of samples proportional to size

- Children 2-10 years old
  n=276 (45.5%)
- Children 2-10 years old
  n=104 (17.1%)
- Children 2-10 years old
  n=228 (37.5%)

Number of study children (n=608)
3.9 Tools used in data collection

3.9.1 Questionnaires

A structured questionnaire designed to obtain the information needed to achieve the objectives of the research was used for the research. The questionnaire was pre-tested on 110 children and parents in a rural village with an environment similar to the study area.

3.9.2 Training of Research Assistants:

The research assistants (field assistants) were trained to translate the questionnaires from English to Kiswahili and then they were given theoretical review of how measure weight and height, as initially conducted by the investigator. The training was completed in one week at least two hour session a day.

3.10 Methodology for Anthropometry.

The methodology for anthropometry was as in (bulletin of WHO, (1989) Vol. 67, No 2.).

3.10.1 Weight:

Weight was measured to the nearest 0.1 kg., using a digital weighing scale (weighing up to 130 kg.) Each child was weighed wearing only light clothing and without shoes. Zeroing of the scale was done every time before the weight was taken.

3.10.2 Height

Height was measured using a height meter, with an accuracy of 0.5 cm, where both subject and the height meter were placed to stand on a levelled base, the subject without shoes.
3.11 Examination of stool specimens.

Stool specimen were collected in suitable clean plastic containers early in the morning. A quantitative assessment of the worm load was done by estimating the number of eggs/gm. The egg count was done by using Stoll’s dilution technique (Monica, 1981).

Procedure:

Three grams of faeces was mixed with 42 ml of water in a screw tap container to give a 1 in 5 dilution of faeces. (If stool was formed specimen, sodium hydroxide 0.1 mol/l solution was used instead of water. Using a rod, the stool was thoroughly mixed with water and shaken hard to complete the mixing. By using a graduated pipette previously marked to measure the required volume 0.15 ml of the suspension was removed and transferred to a slide. The slide was covered with a long glass. The specimen was then examined systematically under the microscope power x10 with the condenser aperture reduced to sufficient contrast. Any eggs lying round the edges of the cover glass were included in the count as these were also contained in the 0.15 ml sample. The number of eggs per gram of stool was calculated according to (Monica, 1981). A factor of 5 was used. The number of eggs per gram of stool was calculated as number of eggs found times 100. For fluid stools, formed stools and unformed stools factors of 5, 4, 3 and 2 respectively were used. Two hundred (1-400) eggs per gm was considered to be mild / moderate and a 401 eggs / gram was considered heavy infestation. This categorization of warm load was arbitrary.

3.12 Determination of malaria parasites:

All children who had Haemoglobin level below 11.0 g/dl were screened for malaria parasites. The purpose of this was to check whether there was another factor causing anaemia
apart from the intestinal parasites and nutrition. The procedure was carried out by thin smear method as follows: From each child a drop of blood was taken from a finger print and was spread on a clean grease-free slide with a spreader, to give a uniform smear. After drying, the smear was stained with Giemsa stain and examined under the microscope.

3.13 Haemoglobin Level Estimation

Method used: Spencer Haemoglobinometer.

Procedure: A drop of blood sample from a finger prick on a slide was slowly inserted in a blood chamber assembly in the Spencer haemoglobinometer, where it was haemolysed using a haemolysis applicator. The colour of haemolysed blood sample was visually compared to the standardised haemoglobin colours and read directly in g/dl. (Dacie, 1984). Then Haemoglobin in g/dl was arbitrary grouped into three categories:

- Hb ≤7.99 g/dl was considered to be severe anaemia,
- 8.0-10.99 g/dl was considered to be mild/moderate anaemia,
- ≥11.0 was considered to be normal.

3.14 Age data, and Education level:

These were obtained with the attached questionnaire (appendix 4).

3.15 Data Entry and cleaning

Data collected from the field was first coded and entered into the computer using dBASE III software and analysis was then carried out using the Statistical package for social sciences (SPSS) software. The data was cleaned by checking on any out lick.
Determination of the socio-economic status:

Monthly income was considered to be salary of wife and husband plus income from other sources as described in the attached questionnaire (Appendix 4). The level of socio-economic status was arbitrarily grouped into three categories. Up to Tanzanian shs. 10,000.00 was considered to be low. From Tanzanian shs. 10,001.00 to 15,999.00 was considered to be middle and 16,000.00 was considered to be high.
CHAPTER FOUR

RESULTS

4.1 Social demographic Characteristics:

Six hundred and eight (608) children 2-10 years old from 402 households were included in the study. Two hundred and seventy six (45.5%) were children from the rural semi-urban village households, 104 (17%) from rural estate households and 228 (37.5%) from typical rural village households. Three hundred and thirteen (51.5%) were girls and 295 (48.5%) were boys. Fig. 1 below depicts the distribution of population studies by village.

<table>
<thead>
<tr>
<th>Village</th>
<th>N</th>
<th>(%)</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural Semi-Urban</td>
<td>276</td>
<td>45.5</td>
<td>128</td>
<td>148</td>
</tr>
<tr>
<td>Rural estate</td>
<td>104</td>
<td>17.1</td>
<td>50</td>
<td>54</td>
</tr>
<tr>
<td>Typical rural</td>
<td>228</td>
<td>37.5</td>
<td>117</td>
<td>111</td>
</tr>
</tbody>
</table>

The age group 2-4 years old had 227 (37%) children and 4.1-6 years old had 164 (27%) children while 6.1-8 years old group and 8.1-10 years old group had 109 (18.1%) and 108 (17.8%) children respectively. The age and sex distribution of the children studied is as in table 2 below.

Six hundred and eight (608) specimens of stool and blood were examined for intestinal parasites and for haemoglobin level respectively. Four hundred and seventy six 78.2% blood
slides for malaria parasites were examined. These were of children who had haemoglobin level below 11.0 g/dl.

**TABLE 2. DISTRIBUTION OF STUDY CHILDREN BY SEX AND AGE IN YEARS (N=608).**

<table>
<thead>
<tr>
<th>Age in Years</th>
<th>Sex</th>
<th>Number</th>
<th>2-4 yrs</th>
<th>4.1-6 yrs</th>
<th>6.1-8 yrs</th>
<th>8.1-10 yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>295</td>
<td>39%</td>
<td>25.4%</td>
<td>16.6%</td>
<td>19.0%</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>313</td>
<td>35.1%</td>
<td>28.8%</td>
<td>19.5%</td>
<td>16.6%</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>608</td>
<td>37.0%</td>
<td>27.1%</td>
<td>18.1%</td>
<td>17.8%</td>
</tr>
</tbody>
</table>

4.2 Distribution of heads of the households by level of education.

The level of education was classified by number of years in school. It was noted that 21.9% of the households had low education (0-4 years) in school (table 3). A large proportion (66.2%) about two thirds had 5-8 years of education. Only a small proportion (11.9%) had completed more than 8 years of schooling.

Mbarali village had the highest number of household head with more years of education which may also explain the higher number of employed members here.
<table>
<thead>
<tr>
<th>Village</th>
<th>Number</th>
<th>0-4 years</th>
<th>5-8 years</th>
<th>9-17 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ibara</td>
<td>183</td>
<td>22.9%</td>
<td>65.6%</td>
<td>12.5%</td>
</tr>
<tr>
<td>Mbarali</td>
<td>69</td>
<td>5.7%</td>
<td>63.7%</td>
<td>30.0%</td>
</tr>
<tr>
<td>Ijome</td>
<td>150</td>
<td>28.0%</td>
<td>58.2%</td>
<td>4.0%</td>
</tr>
<tr>
<td>All</td>
<td>402</td>
<td>21.9%</td>
<td>66.2%</td>
<td>11.9%</td>
</tr>
</tbody>
</table>

4.3 Sanitation of study population:

Two types of toilet facilities were used by this population, septic tank and pit latrines. All households studied had a toilet facilities available for their use. Table 4 depicts the type of facilities available for use to households by village. It is noted here that septic tank was uniformly used in the rural estate village while the other villages uniformly used a pit latrine. These good sanitary conditions may help to explain the lower prevalence of helminths found in this community, mainly the enterobiasis, taeniasis, hookworm and ascariasis.
4.4 Water Supply and Availability.

Source of water supply included piped water, deep well and river. As depicted in table 5, all inhabitants of Mbarali were supplied with piped water as were 99.5% of those from Ibara. The inhabitant of Ijombe village consumed water from both deep well and the river and had no piped water in their homes.
TABLE 5. DISTRIBUTION OF HOUSEHOLDS BY WATER SUPPLY.

<table>
<thead>
<tr>
<th>Village</th>
<th>Number</th>
<th>Pipe</th>
<th>Deep well</th>
<th>River</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ijombe</td>
<td>150</td>
<td>0.0%</td>
<td>64.0%</td>
<td>36.0%</td>
</tr>
<tr>
<td>Mbarali</td>
<td>69</td>
<td>100.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Ibara</td>
<td>183</td>
<td>99.5%</td>
<td>0.0%</td>
<td>0.5%</td>
</tr>
<tr>
<td>All</td>
<td>402</td>
<td>62.5%</td>
<td>24.0%</td>
<td>13.5%</td>
</tr>
</tbody>
</table>

4.5 Type of Housing.

Four types of houses were noted in this villages, namely cement brick walled with corrugated iron roof, brick walled thatched, mud walled corrugated iron roof, mud brick wall with thatched roofs. Table 6 shows the distribution of household by type of wall and roof of house. The inhabitants of Mbarali village have better housing structure with all living in better roofed houses where all houses are roofed with corrugated iron sheets.
TABLE 6. DISTRIBUTION OF HOUSEHOLD BY TYPE OF HOUSE.

<table>
<thead>
<tr>
<th>Village</th>
<th>Number</th>
<th>Corrugat. iron roof</th>
<th>Mud brick wall</th>
<th>Thatched roof</th>
<th>Brick cemented wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ibara</td>
<td>183</td>
<td>48.6%</td>
<td>49.0%</td>
<td>51.3%</td>
<td>51.0%</td>
</tr>
<tr>
<td>Mbarali</td>
<td>69</td>
<td>100.0%</td>
<td>73.2%</td>
<td>0.0%</td>
<td>36.9%</td>
</tr>
<tr>
<td>Ijombe</td>
<td>150</td>
<td>26.8%</td>
<td>90.0%</td>
<td>63.4%</td>
<td>10.0%</td>
</tr>
<tr>
<td>All</td>
<td>402</td>
<td>53.0%</td>
<td>65.0%</td>
<td>47.0%</td>
<td>35.0%</td>
</tr>
</tbody>
</table>

4.6 Distribution of study fathers and mothers by occupation.

Of the fathers included in the study, 45.5% were from Ibara (rural semi-urban village), 17.2% were from Mbarali (a rural estate village) while 37.3% were from Ijombe (a typical rural village) (table 7). It is therefore not surprising to note that 98.6% of the fathers from Mbarali were salaried staff, this being an estate owned by a co-operative for rice growing. Ninety percent of fathers from the typical rural village were also noted to be farmers while in the rural Semi-urban village there was a combination of salaried employment and peasant farming (see table (below 7).

Unlike the fathers most of the mothers (88.8%) gave their occupation as peasant farmer in all the villages. In the rural
estate village, a few of the mothers (27.5%) were involved in wage earning (table 7 below). In Mbarali where 98.6% of fathers had monthly salary 68.1% of mothers were peasants, i.e. much less than at Ibara and Ijombe where few fathers 29% and 8% were salaried.

TABLE 7. DISTRIBUTION OF STUDY FATHERS BY OCCUPATION (N=402)

<table>
<thead>
<tr>
<th>Village</th>
<th>Number</th>
<th>Casual labour</th>
<th>Business</th>
<th>Monthly salary</th>
<th>Peasant</th>
<th>Nomadic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ibara</td>
<td>183</td>
<td>12.6%</td>
<td>16.9%</td>
<td>29.0%</td>
<td>41.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Mbarali</td>
<td>69</td>
<td>1.4%</td>
<td>0.0%</td>
<td>98.6%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Ijombe</td>
<td>150</td>
<td>1.3%</td>
<td>0.0%</td>
<td>8.0%</td>
<td>90.0%</td>
<td>0.7%</td>
</tr>
<tr>
<td>All</td>
<td>402</td>
<td>6.5%</td>
<td>7.7%</td>
<td>33.0%</td>
<td>52.5%</td>
<td>0.3%</td>
</tr>
</tbody>
</table>
### TABLE 8. DISTRIBUTION OF STUDY MOTHERS BY OCCUPATION (N=402).

<table>
<thead>
<tr>
<th>Village</th>
<th>Number</th>
<th>Housewife</th>
<th>Casual labour</th>
<th>Business</th>
<th>Peasant</th>
<th>Monthly salary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ibara</td>
<td>183</td>
<td>3.3%</td>
<td>1.1%</td>
<td>1.6%</td>
<td>87.4%</td>
<td>6.6%</td>
</tr>
<tr>
<td>Mbarali</td>
<td>69</td>
<td>1.4%</td>
<td>1.4%</td>
<td>1.4%</td>
<td>68.1%</td>
<td>27.5%</td>
</tr>
<tr>
<td>Ijombe</td>
<td>150</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>100.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>All</td>
<td>402</td>
<td>1.7%</td>
<td>0.8%</td>
<td>1.0%</td>
<td>88.8%</td>
<td>7.7%</td>
</tr>
</tbody>
</table>

#### 4.7 Prevalence of Helminthiasis in the total study population.

Six hundred and eight stool samples were examined for parasites. The overall prevalence of intestinal parasites in the population was 10.7%. About 10.2% (62) had single parasite infestation while 3 (0.5%) had multiple infestation. (Table 9).
### TABLE 9:
PREVALENCE OF PARASITES IN THE STUDY CHILDREN (N=608).

<table>
<thead>
<tr>
<th>Organism</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence of parasites</td>
<td>543</td>
<td>89.3</td>
</tr>
<tr>
<td>1 parasites</td>
<td>62</td>
<td>10.3</td>
</tr>
<tr>
<td>2 parasites</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>Total</td>
<td>608</td>
<td>100.0</td>
</tr>
</tbody>
</table>

4.8 The Commonest Parasites found in the study children

The parasites found in the stools were *Ascaris lumbricoides* hookworm, *Taenia saginata* and *Enterobius vermicularis*. The distribution of children by the parasites isolated is as in Table 10.
Table 10. Distribution of Children with Helminthiasis by Type of Parasite (N=65).

<table>
<thead>
<tr>
<th>Organism</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascaris lumbricoides</td>
<td>46</td>
<td>70.7</td>
</tr>
<tr>
<td>Hookworm</td>
<td>12</td>
<td>18.5</td>
</tr>
<tr>
<td>Taenia Saginata</td>
<td>3</td>
<td>4.6</td>
</tr>
<tr>
<td>E. Vermicularis</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td>Mixed infection</td>
<td>3</td>
<td>4.6</td>
</tr>
<tr>
<td>All</td>
<td>65</td>
<td>100.0</td>
</tr>
</tbody>
</table>

- Ascaris & Hookworm

4.9 Prevalence of intestinal parasite among children of different ages.

Prevalence of helminthiasis was lowest in the smaller children 2-4 years of age and highest in those 8.1-10 years as indicated in Table 11. Chi square test did not show a significant difference in prevalence between the different age groups (p>0.0600).
TABLE 11: PREVALENCE OF INTESTINAL PARASITE BY AGE OF HOST IN YEARS (N=608)

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Number</th>
<th>2 - 4</th>
<th>0 - 1</th>
<th>0.1 - 0</th>
<th>0.1 - 0**</th>
</tr>
</thead>
<tbody>
<tr>
<td>No parasite</td>
<td>544</td>
<td>91.1%</td>
<td>64.7%</td>
<td>90.6%</td>
<td>84.3%</td>
</tr>
<tr>
<td>Presence of parasite</td>
<td>64</td>
<td>8.9%</td>
<td>10.1%</td>
<td>10.0%</td>
<td>25.7%</td>
</tr>
<tr>
<td>All</td>
<td>608</td>
<td>17.0%</td>
<td>27.2%</td>
<td>10.1%</td>
<td>17.0%</td>
</tr>
</tbody>
</table>

χ² = 32.61083, df = 3, p = 0.0000

* Age group most infected with Ascaris
** Age group most infected with Hookworm.

Fig. 2 below shows the distribution of intestinal parasite prevalence by type of parasite and age of host. It is seen clearly here that Ascaris was the commonest infestation in all age groups.
Fig. 2. Prevalence of Intestinal parasite by age of host.
4.10 **Prevalence of Helminthiasis by Sex.**

There was a slightly higher prevalence of helminthiasis in girls (12.5%) as compared to the boys 8.8% (Table 12). This difference was however not statistically significant (p>0.05).

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Sex</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>No parasite</td>
<td>269</td>
<td>274</td>
</tr>
<tr>
<td>Presence of parasites</td>
<td>26</td>
<td>39</td>
</tr>
<tr>
<td>Total</td>
<td>295</td>
<td>313</td>
</tr>
</tbody>
</table>

\[ X^2 = 4.69117 \quad DF = 1 \quad P = 0.4547 \]

**Fig. 3** below depicts the prevalence of specific parasites and sex of host.
Fig. 3 Prevalence of the different intestinal parasites by sex of host.
4.11 Prevalence of Parasites in the different villages

The highest prevalence of helminthiasis was in Ijombe village (17.9%) and the lowest (4.4%) in Mbarali village. (See Table 13). The difference in prevalence was statistically significant ($p < 0.001$). This is important because the villages have different socio-economic as well as sanitation characteristics.

### Table 13. Prevalence of Parasites by Village

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Ibara</th>
<th>Mbarali</th>
<th>Ijombe</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of parasites</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>No parasites</td>
<td>230</td>
<td>92.4</td>
<td>130</td>
<td>95.6</td>
</tr>
<tr>
<td>Presence of parasites</td>
<td>7.6</td>
<td>6</td>
<td>4.4</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>249</td>
<td>100.0</td>
<td>136</td>
<td>100.0</td>
</tr>
</tbody>
</table>

$x^2 = 42.63825 \quad DF = 2 \quad p = 0.0001$
4.12 Distribution of parasites by type.

Of the three common parasites, namely: ascaris, T. saginata and hookworms, each was isolated from stool specimens in the three villages (Fig. 4). The prevalence of ascaris was highest in the typical rural village while that of hookworm was highest in the rural semi-urban village. The prevalence of these helminths was relatively low in rural estate village. There were 35 cases (15.8%) of ascaris in the typical rural village compared with eight cases (3.2%) and 3 cases (2.2%) from rural semi-urban and rural estate villages respectively.

Fig. 4 below depicts the different intestinal parasites by village.
Fig. 4. Distribution of parasites by village

![Graph showing distribution of parasites by village](image-url)
4.14 **Haemoglobin level.**

For purpose of analysis, the study children were grouped into 3 haemoglobin level categories: Severe anaemia $<7.99$ g/dl, mild/moderate anaemia $8.0-10.99$ g/dl and normal Ha with $Hb \geq 11.0$ g/dl. Of the 608 children examined 64 (10.5%) had severe anaemia, 412 (67.8%) had mild/moderate anaemia state while 132 (21.7%) had normal haemoglobin level. To try and explain the high prevalence of anaemia in the population, children with haemoglobin level below 11 g/dl were examined for prevalence of malaria. Four hundred seventy six of samples were examined for malaria. The prevalence was as in Table 14. There were only five cases with both malaria parasites and worms in the severe anaemia group and 11 in the mild to moderate group.
TABLE 14. DISTRIBUTION OF ANAEMIC CHILDREN BY PRESENCE OF MALARIA PARASITES.

<table>
<thead>
<tr>
<th>Hb g/dl</th>
<th>Malaria cases (♦ve)</th>
<th>Cases without malaria (-ve)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;7.99</td>
<td>5 (1.0%)</td>
<td>59 (12.3%)</td>
</tr>
<tr>
<td>8-10.99</td>
<td>11 (2.3%)</td>
<td>401 (84.4%)</td>
</tr>
<tr>
<td>Total</td>
<td>16 (3.4%)</td>
<td>460 (96.6%)</td>
</tr>
</tbody>
</table>

4.15 Worm burden of children of different haemoglobin status:

The prevalence of helminths was also expected to contribute to the anaemia. The worm burden was expected to be the main contribution to the severity and therefore the egg counts were grouped into three categories for purpose of analysis. Table 15 below shows the distribution of study children by worm burden.

Generally haemoglobin level was significantly, negatively correlated with worm load \( r = -0.1572, \ P < 0.001 \). The chi square test was also significant, \( P < 0.0001 \).

This means that an increase in worm load is associated with a
decrease in haemoglobin level.

TABLE 15. DISTRIBUTION OF CHILDREN OF DIFFERENT HAEMOGLOBIN STATUS.

<table>
<thead>
<tr>
<th>Hb g/dl</th>
<th>Mild/Moderate</th>
<th>Heavy</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤7.99</td>
<td>5 (7.7%)</td>
<td>5 (7.7%)</td>
<td>10 (15.4%)</td>
</tr>
<tr>
<td>8-10.99</td>
<td>44 (67.7%)</td>
<td>9 (13.9%)</td>
<td>53 (81.6%)</td>
</tr>
<tr>
<td>&gt;11</td>
<td>2 (3.0%)</td>
<td>0 (0.0%)</td>
<td>2 (3.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>51 (78.5%)</td>
<td>14 (21.5%)</td>
<td>65 (100.0%)</td>
</tr>
</tbody>
</table>

4.16 Level of Haemoglobin in children and Worm Burdens

Table 16 below depicts the distribution of study children by level of haemoglobin and worm burdens. It was noted here that 9.8% of children with mild to moderate worm load had severe anaemia, 86.3% of children with mild/moderate worm load had mild/moderate anaemia, while 3.9% of this group had normal haemoglobin (Table 16). Also in the group of children with heavy worm load, 35% of these had severe anaemia while 64.3% had mild/moderate anaemia. None of the children with heavy worm load had anaemia.
TABLE 16. DISTRIBUTION OF STUDY CHILDREN BY WORM LOAD AND HAEMOGLOBIN LEVEL (N=608).

<table>
<thead>
<tr>
<th>Paraste worm load</th>
<th>Number (N)</th>
<th>No worm load</th>
<th>8.0 - 10.99 g/dl</th>
<th>6.0 - 7.99 g/dl</th>
<th>&lt; 6.0 g/dl</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(Mild/moderate)</td>
<td>Mild/moderate</td>
<td>Mild/moderate</td>
<td>Mild/moderate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>No worm load</td>
<td>441</td>
<td>44.1</td>
<td>33.3</td>
<td>22.6</td>
<td></td>
</tr>
<tr>
<td>1400 epg</td>
<td>51</td>
<td>9.8</td>
<td>84.1</td>
<td>6.1</td>
<td></td>
</tr>
<tr>
<td>2401 epg</td>
<td>14</td>
<td>35.7</td>
<td>64.3</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>608</td>
<td>10.5</td>
<td>67.8</td>
<td>21.7</td>
<td></td>
</tr>
</tbody>
</table>

X' = 23.17788  DF = 2  P = 0.0001

Fig. 5 below depicts the distribution of study children by worm load and haemoglobin in g/dl.
Fig. 5 Distribution of study Children by worm load and Hb in g/dl
4.17 Worm load and nutritional status (wt/ht.).

The rate of wasting (weight for height <-2SD) studied population was 0.4%. These were three children with heavy worm load from typical rural village. Their environmental sanitation were poor.

4.18 Worm load and Socio-economic status of the parents:

Parental income was placed in three categories for purpose of analysis. Low (income ≤ 10,000.00 Tshs.), middle (income 10,001.00-15,999.00), higher (income ≥ 16,000.00).

Table 17 shows the distribution of children by worm load and parental monthly income. It is noted that 46 (11.4%) of the 402 children characterised with worms came from the low income group. 5 (1.2%) come from the middle income and 8 (2%) come from the high income group. Generally parent's socio-economic status was significantly, negatively correlated (Pearson's correlation test) with children's worm load, $r = -0.1002$, ($p<0.001$).
**TABLE 17. DISTRIBUTION OF STUDY CHILDREN BY WORM LOAD AND PARENTS MONTHLY INCOME IN TANZANIAN SHILLINGS (N=402).**

<table>
<thead>
<tr>
<th>Worm Load</th>
<th>Number</th>
<th>Parents Monthly Income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>No worm load</td>
<td>443</td>
<td>61.8%</td>
</tr>
<tr>
<td>1-400 epg</td>
<td></td>
<td>13.7%</td>
</tr>
<tr>
<td>401 epg</td>
<td></td>
<td>4.8%</td>
</tr>
<tr>
<td>Total</td>
<td>402</td>
<td>61.8%</td>
</tr>
</tbody>
</table>

*Monthly income = Salary of husband and wife + income from other sources
1 = 0-4 years = mild to moderate worm load
2 = 401 epg = heavy worm load.*

4.19 **Distribution of study children by worm load and parents level of education:**

From the total of 44 children with mild to moderate worm load (1-400 epg), 10.2% had parents with an education level of 0-4 years in school, 11.2% had parents received from 5-8 years and 10.3% had parents received from 9-17 years in school, while out of 13 children with heavy worm load (≥ 401 epg), 6.8%, 2.3% and 2.1% had parents with an education level of 0-4 years, 5-8 years and 9-17 years in school respectively. Chi squares didn't show any significant (p<0.3225), while parents education was significantly correlated with children worm load (r=-0.1002).
Table 18. DISTRIBUTION OF STUDY CHILDREN BY WORM LOAD AND PARENTS LEVEL OF EDUCATION (N=402).

<table>
<thead>
<tr>
<th>Worm load</th>
<th>Number</th>
<th>PARENTS LEVEL OF EDUCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0 - 4 years</td>
</tr>
<tr>
<td>No worm load</td>
<td>128</td>
<td>83.04%</td>
</tr>
<tr>
<td>1 - 400 spp</td>
<td>44</td>
<td>10.22%</td>
</tr>
<tr>
<td>≥401 spp</td>
<td>11</td>
<td>6.09%</td>
</tr>
<tr>
<td>All</td>
<td>183</td>
<td>31.99%</td>
</tr>
</tbody>
</table>

χ² = 4.6712  DF = 4  P = 0.3234

4.20 Summary.

In the studied children two statistical tools were used. Pearson's correlation test and Chi-square test. Pearson's correlation test was used mainly to see the association or relationship between children's worm load and the variables mentioned in the objectives, while Chi-square test was used to see if there was a significant difference in the average analysis between children's worm load and the above mentioned variables (Table 19 below).
### Table 19. Intestinal Worm Load with HB, SBS and Education Level

<table>
<thead>
<tr>
<th>Intestinal Worm Load</th>
<th>Variable</th>
<th>Chi-square Test</th>
<th>Pearson's Corr. Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worm load with positive Malaria parasites</td>
<td>(crosstabs) worm load by Haemoglobin</td>
<td>$p = 0.5100$</td>
<td>$r = -0.1430$</td>
</tr>
<tr>
<td>Hook worm load</td>
<td>H/Worm load by Haemoglobin</td>
<td>$p = 0.0001$</td>
<td>$r = -0.2070$</td>
</tr>
<tr>
<td>Ascaris worm load</td>
<td>A/Worm load by Haemoglobin</td>
<td>$p = 0.0063$</td>
<td>$r = -0.1200$</td>
</tr>
<tr>
<td>Intestinal worm load</td>
<td>Worm load by SBS</td>
<td>$p = 0.2270$</td>
<td>$r = -0.1002$</td>
</tr>
<tr>
<td>Intestinal worm load</td>
<td>Worm load by Education level</td>
<td>$p = 0.3225$</td>
<td>$r = -0.1010$</td>
</tr>
</tbody>
</table>

*Most significant Pearson's correlation test.*
5.0 DISCUSSION

5.1 Prevalence of intestinal parasites

The overall prevalence of helminthiasis (10.7%) was low as compared to that noted for other developing countries (WHO, 1987). Comparing to the villages of study, it was noted that the highest prevalence of helminthiasis was marked in Ijombe village with 17.9% and the lowest 4.4% in Mbarali village.

The prevalence of intestinal parasite tends to increase with age, reaching 15.7% in the highest age group studied (8.1-10) years old. This is similar to what is noted in literature where prevalence and intensity of intestinal parasites generally increase with age, but levels of infection decline in adulthood (Schad, et. al., 1975).

Ascaris was the most common parasite in the survey, showing a prevalence of 7.6% followed by hookworm, 2%. Cases of ascariasis were highest in the typical rural village. This could be explained by the fact that, that village is situated in mountainous area where the climate favours their existence as well as the presence of a low education level and low socioeconomic status plus slightly poorer environmental sanitation. This was also noted in a Kenyan study which showed a high prevalence in mountainous and highland regions (Chunge et. al., 1985).

The prevalence of hookworm was highest in the rural semi-
urban village (3.6%) compared to the other villages. This is not surprising because the area is situated in the lowlands of the Usangu plains where the weather favours more their existence and the completion of the life cycle of the parasite. Although the rural estate village is also situated in the lowlands of Usangu plains, the cases of hookworm was low. This being an estate village has better environmental sanitation and the inhabitants are of slightly better socioeconomic status compared to the rural semi-urban village. On other hand, studies carried out in other parts of Tanzania by Sturrock (1964, 1965 and 1966) showed a high prevalence of hookworm greater than 37%.

A low prevalence rate of *Taenia saginata* (0.5%) was noted. It is difficulty to explain why this study showed low level of infestation with this parasite since the climatic condition favours its existence. (But it is possible that within the years the conditions has actually improved). Sturrock (1966) at Holombo in the Dodoma Region Central Tanzania reported a 2.6% prevalence of taeniasis while Nhonoli (1974) found a 1.4% prevalence of taeniasis in Mbeya District.

There was also a low prevalence of *Enterobius vermicularis* at a rate of 0.2%. In this study the prevalence of *Enterobius vermicularis* was low. A theory that there may be some racial immunity towards *Enterobius* has been suggested (Chunge et. al., 1985). In most other studies where *Enterobius*
has been diagnosed in Kenya, prevalence rates were less than 2% (Chunge et al., 1985).

There was no case of *Schistosoma mansoni* found though Schistosomiasis is a most common disease in Tanzania (Eshuis et al., 1978). This can be explained by the fact that the sources of water are deep well river or piped water all which do not favour transmission of the parasite. Furthermore, there was no development of water projects for irrigation or electricity in the typical rural village and rural semi-urban village which provide the habitat for the snail vector. The irrigation project at the rural estate village is far away and out of reach of the children. Nevertheless prevalence in the rice areas needs to be determined among the adult population.

Other parasites such as Strongyloides *stercoralis*, *Giardia lamblia*, *Entamoeba histolytica*, *Trichuris trichura* and *Taenia solium* were not found in the study children. With the exception of Strongyloides *stercoralis*, *Giardia lamblia* and *Entamoeba histolytica* where other methods of diagnosis could be used, it is difficult to tell why the other parasites were absent since the climatic conditions favours their existence.

In another study carried out in Ifakara-Tanzania, Tanner et al. (1987) reported that the prevalence of trichuriasis schistosomiasis was less than 1% while the prevalence of giardiasis, amoebiasis and strongyloidiasis was 25%, 10% and 25% respectively.
The prevalence of intestinal parasites in boys and girls did not differ suggesting that the two sex groups had equal exposure to the contaminated environment. Similar findings were reported by (Wijers et. al., 1972, Tanner, et. al., 1987 and Shiro Kasuya et. al.; 1989).

5.2 Intestinal worm load infestation and haemoglobin level

The study findings indicated that with increase in worm load there was a corresponding decrease in haemoglobin level. Therefore worm load was the best predictor of anaemia in the study children. Other studies have shown that Intestinal parasites infections contribute significantly to iron deficiency anaemia (Mahu, et. al., 1988). Bohdal, (1968), in his research showed that 20-40% of the Kenyan population were anaemic. The prevalence was highest in pre-school children especially those who were heavily infested with intestinal parasites.

5.3 Hookworm and Ascaris’s worm load with their relationship to Haemoglobin.

A higher correlation was noted between anaemia and presence of hookworm in the study. This is not surprising as is noted in the literature that hookworm is an important contributor to anaemia Crompton (1984). Nhonoli et. al., (1974) states that, In less developed countries, "All children below the age of 10 are anaemic and only those without
parasitic infections reach levels which are recommended by the World Health Organization as the minimal acceptable levels for the appropriate age groups. The role of Ascaris in the causation of anaemia was less pronounced noting that its contribution to anaemia may be related to limitation to full utilization of nutrients from the diet (Stephen et. al., 1983), whereas that of hookworm is direct due to blood loss in the small intestine (Roche and Layrisse, 1966).

5.1 Malarial parasitaemia, helminthiasis and their relationship to anaemia.

Although there were five cases with both infections, intestinal worm load and malaria parasites in the severe anaemia group and 11 cases with both infection in the mild/moderate anaemia group, the total number of positive cases (with both hookworm and malaria parasites) was too small to make a significant correlation. In a similar study done in South Benin, Hercberg, et. al. (1986) showed no significant correlation between malarial parasite infection and haemoglobin level, while Nhonoli et. al., (1974) in health surveys conducted in rural communities in Tanzania showed that anaemia in rural children is due mainly to malaria infection.

5.5 Nutritional status and helminthiasis.

The prevalence of wasting in the population was low (0.4%). The analysis carried out did not show any relationship
between the worm burden and nutritional status. However it is noted that worms contribute to chronic under nutrition thus stunting rates would have been more important but it was difficult to obtain age as an indicator in this population. In Tanzania, Turner (1987) in a longitudinal study, revealed a higher wasting rate (3-20%) among children with parasites. Further studies looking at the diet of these children would have been necessary to explain their good nutritional status and the intestinal parasite worm load relationship.

In a study done in the Central high lands of Papua New Guinea on young children with different degrees of infestation with hookworm and Ascaris, no significant difference in anthropometric or biochemical tests of nutritional status was found between ascaris-free children and children with moderate infestations. Similarly, there were no difference in anthropometric and biochemical findings between children with mild hookworm infestations and those with moderate infestation (Ostwald et. al., 1984).

5.6 Worm load infestation and parents Socio-economic Status

Many intestinal parasites are found only in the tropical and subtropical regions but causes are mainly socio-economic rather than climatic (Spulvelda, et. al., 1984).

In this study Income was significantly negatively correlated with worm load, The higher the parents monthly income, the lower the children’s worm load. This is not
surprising since the factors associated with the transmission of intestinal parasites in high income families are very few. However in a study done in 1990 showed that the presence of more than three parasites per child affects his/her nutritional status independently of income level (Sawaya A.L. et al. 1990).

5.7 Worm load infestation and parents education level

In the studied children, the education level of parents was found to be negatively correlated with the children's worm load. Children from parents who had more education were less infested with intestinal parasite worm load. The more educated parents are generally conscious and are more likely to keep their children in better hygienic conditions compared to uneducated ones. Literate parents also tend to understand better the teaching of health and nutrition education (Aliling and Elequin 1970).

Conclusion.

Intestinal parasitic infestations exist among rural child communities of Mbeya District area, Tanzania with prevalence of 10.7% which is low compared to global prevalence.

Low haemoglobin level was found to be associated with intestinal parasite load infestation. The type of anaemia was however not elicited. The higher the worm load, the lower the
level of haemoglobin below normal. The higher the children's worm load also the lower the socio-economic status and education level of their parents. These findings suggest that parent's income and their education level are important factors influencing the intensity of children's intestinal worm load.

**Recommendations.**

1. It is important to promote health education on the transmission of intestinal parasites to rural population through schools and other forums. This coupled with better methods of treating helminths would reduce the prevalence of worms to even lower than the current level.

2. Policies that lead to improved education of rural communities and hence their social economic conditions should be promoted.

3. Environmental sanitation is a major contribution to worm prevalence and should be improved through promotion of primary health care strategies where communities are able to cater for their health needs.

4. More research should be carried out to determine a country wide prevalence and its load among rural child communities, slums and urban populations, to assist policy makers.
CHAPTER SIX

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Tropical Medicine and Parasitology.


Appendix 1

TABLE 20. HAEMOGLOBIN CONCENTRATIONS BELOW WHICH ANAEMIA IS LIKELY TO BE PRESENT AT SEA LEVEL.

<table>
<thead>
<tr>
<th>Age</th>
<th>Hb g/dl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td></td>
</tr>
<tr>
<td>Six months to six years</td>
<td>11</td>
</tr>
<tr>
<td>Six years to 14 years</td>
<td>12</td>
</tr>
<tr>
<td>Adults</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>13</td>
</tr>
<tr>
<td>Women</td>
<td>12</td>
</tr>
<tr>
<td>Pregnant women</td>
<td>11</td>
</tr>
</tbody>
</table>

Appendix 2

Map of United Republic of Tanzania
Appendix 3

Map of study area

LEGEND:

INTERNATIONAL BOUNDARIES

REGIONAL BOUNDARIES

DISTRICT BOUNDARIES

ROADS

RAILWAY

REGIONAL HEADQUARTERS
QUESTIONNAIRE FOR INTESTINAL PARASITE LOAD AND ASSOCIATED NUTRITIONAL AND ECONOMICAL STATUES, IN MBeya DISTRICT-TANZANIA.

Fill in the blanks or place a tick/ circle as appropriate.

A. HOUSEHOLD FORM

GENERAL
1. Serial No. ______
2. Date of Recording ______
3. Name of Head of HH ______________
4. Name of Village ______________
5. Name of Enumerator ______________
6. Village A, B, or C ______________
7. Name of the Ten cell leader __________
8. House Hold No. ______________

B. SOCIO - ECONOMIC VARIABLES

1. Father's Occupation (circle one)
   (1) Casual Labour
   (2) Business
   (3) Regular Monthly Salary
   (4) Peasant
   (5) Nomadic
   ( Tshs per month _______________

2. Mother's Occupation (circle one)
   (1) House wife
   (2) Casual labour
   (3) Business
   (4) Peasant
   (5) Regular Monthly salary
(Tshs per month ________________)

1. Average income of the HH per month (Tshs.______).

4. What type of Energy is normally used for cooking?
   (Circle one).
   (1) Wood
   (2) Paraffin
   (3) Gas
   (4) Electricity

5. What type of Energy is used for Lighting? (circle one)
   (1) Wood
   (2) Paraffin
   (3) Gas
   (4) Electricity

6. Ownership of durable (circle any concerned)
   (1) Refrigerator    (9) Sawing machine
   (2) Bicycle         (10) Car/lorry
   (3) Tractor         (11) Paraffin Stove
   (4) Radio           (12) Sofa set
   (5) Motor circle    (13) Plough
   (6) Cassette Player (14) Wheelbarrow
   (7) Gas cooker      (15) pressure lamp
   (8) Electric cooker (16) None of the above

Points awarded__________________

7. Farm possession and Production.
   (1) How much land do you own in acres?

_________________

(2) Is there any land hired from friends/relatives?    (1) yes    (2) no.

If yes, how many acres? __________

(3) How much money in a year do you earn from sale of crops? (i.e., from January 1990 to Dec. 1990,
8. Do you own livestock? (circle)
   (1) Yes __________ (2) No __________
   If yes, what livestock do you own?
   (circle any concerned).
   (1) Cow  (2) Sheep
   (3) Goat  (4) Donkey
   (5) Pig  (6) Others specify ______

9. How much money do you earn from sale of livestock and any of the livestock products? (i.e., From Jan. 1990 to Dec. 1990, Tshs. _______)

10. Do you own poultry? (circle) (1) Yes (2) No
    If yes, which of the following.
    1) Chicken
    2) Ducks

11. Level of economic status;
    a) Low
    b) Medium
    c) High

C: Environmental Factors:
1. Residence (circle one)
   (i) Own
   (ii) Hired

2. Type of house (circle one).
   Floor: (1) Brick
   (2) Bamboo
   (3) Earthen
   (4) Wooden
   (5) Cement
| Wall | (1) Brick  
|      | (2) Bamboo  
|      | (3) Earthen  
|      | (4) Wooden  
| Roof | (1) Thatched  
|      | (2) Corrugated iron sheets  
|      | (3) Earthen  
|      | (4) Flat tin  
|      | (5) Asbestos  

3. Type of Toilet (circle one)
   (1) Septic tank  
   (2) Pit latrine  
   (3) Surface latrine  
   (4) None  
   (5) Other (specify)

4. Main source of water (circle one)
   (1) Pipe water  
   (2) Deep well  
   (3) Shallow well  
   (4) River  
   (5) Pond  
   (6) Other (specify)

5. Is the kitchen located in the main house? Or in a separate structure been constructed for it? (circle one)
   (1) Kitchen in the main house  
   (2) Separate kitchen
D. **Level of Education:**

1. **Father's education**
   1) 0 (None) ____________
   2) 1-8 (Primary school) ________
   3) 9-12 (Secondary school) ________
   4) 13-14 (High school) ____________
   5) University (Graduate) ________
   6) Adult Education ____________
   7) Others specify ________________

2. **Mother's education**
   1) 0 None __________
   2) 1-8 (Primary School) ________
   3) 9-12 (Secondary School) ________
   4) 13-14 (High School) ____________
   5) University (Graduate) ________
   6) Adult Education ____________
   7) Others Specify ________________

3. **Highest level of education in the HH**

---

**E: Individual form**

**General**

1) Name of the child ______________________
2) Name of the school/Village ______________
3) Standard/class _________________________
4) Sex ________________________ Age __________

**F: Anthropometry:**

1) Weight (kg to the nearest 0.1) __________
2) Height (cm to the nearest 0.5) __________
   Haemoglobin (Hb g/l) ________________
G. **Stool examination results:**

The child was found to have the following intestinal parasite load. (100 for mild; 200 for moderate; ≥ 300 for heavy infestation worm/Egg count per gram; 0 for nil)

1) Ascaris
2) Strongyloides
3) Taenia Solium
4) Trichuris trichura
5) S. Mansoni
6) Hookworm
7) Taenia saginata
8) Enterobius vermicularis
9) Entamoeba Histolytica
10) Giardia Lamblia
11) Others (specify) __________ ___