

THE RELATIONSHIP BETWEEN INTESTINAL PARASITES
NUTRITIONAL STATUS AND HAEMOGLOBIN LEVELS AMONG
RURAL UNDERFIVES IN MARAGUA - MURANGA DISTRICT

BY

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DECLARATION

I hereby certify that this Dissertation is my own original work and has not been presented for a Degree in any other University.

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

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A C K N O W L E D G E M E N T S

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A B B R E V I A T I O N S

PCM - Protein Calorie Malnutrition

ART - Acute Respiratory Infection

NO - Number

WBC - White Blood Cells

MIN - Minimum

MAX - Maximum

SD - Standard Deviation

N - Number in the Group

The incidence of anaemia of 8% was low in this study. However even in this small proportion, Hookworm was found to be significantly associated with anaemia.

Introduction

Infestation with intestinal parasites is one of the major public health hazards in the tropics and in most developing countries. They are most abundant in areas of the world where there is poor environmental hygiene and defective disposal of human faeces. This infestation leads to a complex relationship between host, agent and environment in the causation of infection and its maintenance in the community especially in endemic areas. They may not necessarily produce serious disease in the human host, but indirectly rob the individual of his energy, interfere with his nutrition and ultimately make him susceptible to other diseases. Intestinal parasites consist of helminths and protozoa. The pathogenic intestinal helminths are Ascaris lumbricoides, the most abundant (1) Hookworm namely Ancylostoma duodenale and Necator americanus, Enterobius vermicularis, Strongyloides stercoralis, Trichuris trichiura, Taenia solium, Taenia saginata, and Hymenolepis nana. The pathogenic protozoa are Entamoeba histolytica, Giardia lamblia and Balantidium coli.

A considerable amount of work has been done locally and elsewhere on the prevalence of intestinal helminths. (3-18). In their review of intestinal parasites in Kenya, Chunge et al. 1985 (19) gave the most comprehensive account on the history of these diseases in Kenya. They noted that even by 1923 the colonial government had recognised that a great majority of the native population suffered from one or more helminth infection and that that without a revolution in the sanitary habits of population in the reserve, it was difficult to see how the incidence of helminthiasis could be reduced.

They also noticed that intestinal helminths were probably playing a very important part in reducing the physique of the Africans in the country. Prevalence rates of these infestations are fostered by poor economic status and environmental pollution with infected human faeces.

Ascaris lumbricoides, the human roundworm, is one of the commonest intestinal parasite in the world. It has been estimated to infect about one quarter of the world's population. (1) It is common in pre-school children and often co-exists with protein-calorie malnutrition (PCM) (2) throughout the tropics. Stephenson et al (20) in their study in two Machakos villages, on pre-school children demonstrated a close relationship between Ascaris infection and malnutrition. Later studies by the same authors (21) showed that Ascaris infected pre-school children grew significantly better after being dewormed compared to the non-dewormed counterparts. Similar studies by Gupta et. al (22) Willet et al (23) drew the same conclusion.

Hookworm is also quite common in our environment and has long been associated with iron deficiency anaemia (24, 25). Anaemia of any cause has definite morbidity and mortality especially in developing countries where the prevalence of a multiplicity of parasitic diseases aggravate the deficiency.

Heavy infections with Trichuris Trichiura, in children 1-4 years old, may be associated with prolonged diarrhoea which may be bloody, anaemia, abdominal pain, tenesmus and failure to thrive. Infection with Strongyloides

stercularis is common among tropical children (2) and in heavy infections may produce epigastric pain, nausea, vomiting, diarrhea and impaired absorption of nutrients due to mucosal inflammation (2, 27).

Infection with Giardia lamblia is quite common in the tropics (2, 17, 54, 55) and may be associated with failure to thrive by causing malabsorption. It attaches itself on the intestinal mucosa (54) and invades it (55).

Malnutrition is a major health problem in developing countries where intestinal parasites are also prevalent (2, 31) and intestinal parasites may affect nutrition adversely as stated above with various intestinal parasites. The effect of these parasites is likely to be felt more in the under fives (2, 20, 21, 22, 23, 27, 28, 29, 30, 26, 32). It is this realization that prompted the author to carry out this study in a rural community, to ascertain if the community was indeed infected with these intestinal parasites, their severity, whether they occurred in combinations or singly and how these factors were related to the nutritional status, haemoglobin levels and ages of the pre-school children affected.

AIMS AND OBJECTIVES

1. To determine the point prevalence, type and intensity of intestinal parasite infection in children under the age of five in this rural area.
2. To assess the nutritional status of the above children.
3. To determine the Haemoglobin of the same children.
4. To determine the relationship between these three parameters.

MATERIALS AND METHODS

The study was part of an on going study on Acute Respiratory infection (ARI) in Maragua - Muranga. The study area, Gakoigo, is part of Nginda location one of the locations of Muranga District, lying about 80 kilometres from Nairobi, and within 4 kilometres from Muranga Rural Health Centre. The study was carried out during the months of August to November 1987, which were quite dry, dusty and hot with a monthly rainfall of 20.0 mm and average temperature of 22.3°C. During this period almost all families were found to be obtaining most of their food from their cultivated pieces of land and there appeared to be no shortage of food. The households were often clustered in groups of two to five on basis of family ties. There was no running water or electricity. 364 children under the age of five years in the study area were selected by random sampling and included in the study, in the period of August to November 1987. During the four months of study the author made twice weekly visits i.e. every Monday and Wednesday to the area of study. Children were visited in their homes, where investigations and clinical examinations were done. An average of fifteen children were selected during each visit and visited per day. Informed consent was obtained for all study children.

Appropriate stool containers were supplied to parents the day before, with adequate instructions on stool collections on the morning of the examination. The stools were then transported to the Department of Medical Microbiology Section of the University of Nairobi and examined for the presence of ova and cysts.

The method used for stool examination was the Formal Ether Sedimentation Method, (33, 34) Riddley Modification. (see Appendix I)

Each child was examined and the nutritional status assessed by measuring weight, height, head circumference, chest circumference, mid upper arm circumference and triceps skin fold thickness (the anthropometric measurements) using the techniques described by Jelliffe (35) (Appendix II).

After examination of the children, appropriate data sheets containing relevant historical and clinical findings were filled (Appendix III). The children's nutritional state was classified according to Professor Waterlow's + Wellcome classification (Appendix IV).

The haemoglobin of each child was measured using the Spencer haemoglobinometer (Appendix V).

Results :

The study group comprised of a total of 364 children. Their age ranged from 0 - 5 years with a mean age of 31 months. There were 156 males and 208 females. (see Table 1).

Table 1

Age and Sex Distribution of the study population

	S E X			
Age in months	Male	Female	Total	%
0 - 11	28	39	67	18.4
12 - 23	24	27	51	14.0
24 - 35	25	45	70	19.2
36 - 60	79	97	176	48.4
Total	156	208	364	100.0

Out of the total of 364 children, 134 were infected with intestinal helminths, forming 36.8% of the study population. More children get infected as they grow older. (see Table 2).

Table 2

Prevalence of Intestinal Helminths by Age

Age in months	Number with Intestinal Helminths	Number without Intestinal Helminth	Total	% with Intestinal Helminth
0 - 11	4	63	67	1.1
12 - 23	13	38	51	3.5
24 - 35	29	41	70	8.0
36 - 60	88	88	176	24.2
Total	134	230	364	36.8

Intestinal parasites were found singly or in multiple infestation. Ascaris lumbricoides was the commonest intestinal helminth found forming 18.4%, with hookworm forming 8%, and Trichuris trichiura (1.1%) being the least finding. Multiple infestation were found in 9.3% of affected children. The most frequently occurring combination was Ascaris lumbricoides and Hookworm (3.8%). (see Table 3)

Table 3

Types of Intestinal Helminths

Types of Helminth	Number positive	% Positive
1. <u>Ascaris lumbricoides</u>	67	18.4
2. Hookworm	29	8.0
3. <u>Trichuris trichiura</u>	4	1.1
4. <u>Ascaris lumbricoides</u> + Hookworm	14	3.9
5. <u>Ascaris lumbricoides</u> + <u>Trichuris trichiura</u>	3	0.8
6. <u>Ascaris lumbricoides</u> + <u>Giardia lamblia</u>	9	2.5
7. <u>Hymenolypis nana</u>	2	0.5
8. <u>Ascaris lumbricoides</u> + <u>Trichuris trichiura</u> + Hookworm	1	0.3
9. <u>Trichuris trichiura</u> + Hookworm	2	0.5
10. <u>Ascaris lumbricoides</u> + <u>Trichuris trichiura</u> + <u>Hymenolypis nana</u>	1	0.3
11. <u>Ascaris lumbricoides</u> + <u>Hymenolypis nana</u>	2	0.5
Total	134	36.8

Eighteen percent of the study population were infected with pathogenic protozoa. Giardia lamblia was the commonest cyst found (12.9%). There was no significant association between infection with Giardia lamblia and Balantidium coli and the nutritional status. (see table 4)

Table 4

The Prevalence and type of cysts found
in the study population

Types of cyst	Number Positive	% Positive
1. Entamoeba Histolytica	5	1.4
2. Giardia lamblia	47	12.9
3. Balantidium coli	26	7.1
4. Combination of above cysts	24	6.7
Total	102	18.1

Twenty one percent of the study population was found to be infected with Ascaris lumbricoides. The highest prevalences was among 24 - 60 months(25.2%) and prevalences increases with increasing age. Children aged 0 to 11 months were least affected having only one child at one month of age and two children at 10 months of age. The one month old infant probably got infested by the mother, who handled the infant without proper washing of hands.

There was no significant difference in infection found between males and females. χ^2 - test of proportions ($P > 0.50$) ($Z = 0.629$) (see Table 5).

Table 5

The Prevalence of Ascaris lumbricoides in different age groups in the study population

Age in Months	Total No. in group	S E X		Tot.	% Prevalence per age group
		Male	Female		
0-11	67	1	2	3	4.4
12-23	51	5	6	11	21.6
24-35	70	6	12	18	25.7
36-60	176	18	26	44	25.0
Total	364	30	46	76	20.9

Intensity of infection of Ascaris lumbricoides

The concentration of 1gm of stool was done using modified Ritchie's Method as described in (Appendix I). The intensity of infection increases with increasing age. The children in 0 - 11 month had light infection. In ages 24 - 60 months more than 50% had moderate to heavy infection (Table 6)

Table 6

Intensity of infection by Ascaris lumbricoides according to age

Age in	Light	Moderate	Heavy	Total
0 - 11	3	-	-	3
12 - 23	8	1	2	11
24 - 35	7	8	3	18
36 - 60	20	8	16	44
Total	38	17	21	76

There is a progressive build up of egg count as age increases. In the 0 - 11 months eggcounts ranged from 2 to 34 with a mean of 12.6,

In the 12 - 23 months eggcounts ranged from 4 to 1000 with a mean of 20.8,

In the 24 - 35 months eggcounts ranged from 4 to 2834 with a mean of 30.9 and in the 36 - 60 months eggcounts ranged from 4 to 2920 with a mean of 35.7. (see Table 7). The child with the highest eggcount was male, aged 4 years old with an eggcount of 2,920.

Table 7

Actual egg counts of Ascaris lumbricoides in children studied according to the age groups

Age groups in	Actual egg counts
0 - 11 N = 3	2, 2, 34
12 - 23 N = 11	4, 18, 8, 24, 50, 54, 58, 72, 100, 900 1000.
24 - 35 N = 18	4, 6, 4, 26, 10, 22, 42, 200, 198, 368, 474, 160, 182, 542, 144, 104, 1000, 2834.
36 - 60 N = 44	16, 24, 100, 900, 56, 26, 78, 72, 1320, 20, 20, 50, 128, 2920, 4, 4, 88, 8, 90, 110, 930, 100, 62, 60, 100, 18, 8, 148, 98, 36, 55, 512, 62, 26, 172, 26, 2480, 1226, 556, 18, 900, 36, 80, 36.

Forty six out of 364 children were infected with Hookworm forming (12.6%). In the 0 - 11 months no child was found with Hookworm. Infection with hookworm also increases with age. There was no statistical difference in the infestation rate between males and females.

(Table 8)

Table 8

Prevalence of Hookworm by Age and Sex

Age in months	N	S E X		Total	% Prevalence per age group
		Male	Female		
0 - 11	67	-	-	-	-
12 - 23	51	3	-	3	5.9%
24 - 35	70	2	5	7	10.0%
36 - 60	176	24	12	36	20.5%
Total	364	29	17	46	12.6%

There is a progressive build up of eggcount as age increases. As the child gets older, rate and intensity of infection increases.

In the 0 to 11 months there was no child with hookworm, in the 12 to 23 months eggcounts ranged from 8 to 24 with a mean of 40, in the 24 to 35 months eggcounts ranged from 2 to 158 with a mean of 44, and in the 36-60 months eggcounts ranged from 2 to 418 with a mean of 50. (see Table 9).

Table 9

Actual egg counts of Hookworm infection

Age in months	Eggcount
0 - 11	0
12 - 23 (N = 3)	10, 8, 24
24 - 35 (N= 7)	10, 23, 2, 94, 20, 4
36 - 60 (N = 36)	44, 20, 100, 8, 80, 98, 44, 18, 36, 238, 4, 38, 8, 26, 6, 2, 24, 110, 26, 30, 4, 6, 36, 6, 16, 22, 30, 418, 16, 28, 70, 8, 20, 172, 20, 14.

Ninety six percent of all children infected with hookworms had light infection. (Table 10).

Table 10

Intensity of infection by Hookworm according to age

Age in months	Intensity of infection			Total
	Light	Moderate	Heavy	
0 - 11	-	-	-	-
12 - 23	3	-	-	3
24 - 35	7	-	-	7
26 - 60	34	2	-	36
Total	44	2	-	46

The prevalence of anaemia was only 8.2%. Hookworm does not contribute to the cause of anaemia in the 0 - 23 months. (Appendix VI) (see Table 11).

Table 11

The Prevalence of Anaemia in Association
with Hookworm

Age in months	Number in group	Range of Haemoglobin	Mean Haemoglobin	Anaemia	Hook worm Positive	Hook worm Negative
0-3	21	10-15	12.6	3	-	21
4-6	15	10.4-14.5	12.6	0	0	15
7-11	31	9.5-14.5	12.4	2	0	31
12-23	51	9.0-17	12.9	4	3	48
24-35	70	10-17	13.1	1	7	63
36-60	176	8-17	12.8	20	36	140
Total	364	9.5-17		30	46	318

Seventy three percent of the children who were anaemic had hookworm infection. There was significant association between anaemia and hookworm ($P < 0.001$). See table 12.

The children who had egg count of more than 25 had the lowest haemoglobin level. see figure I.

Figure I

Haemoglobin levels of children infestated with hookworm in the study population versus eggcount.

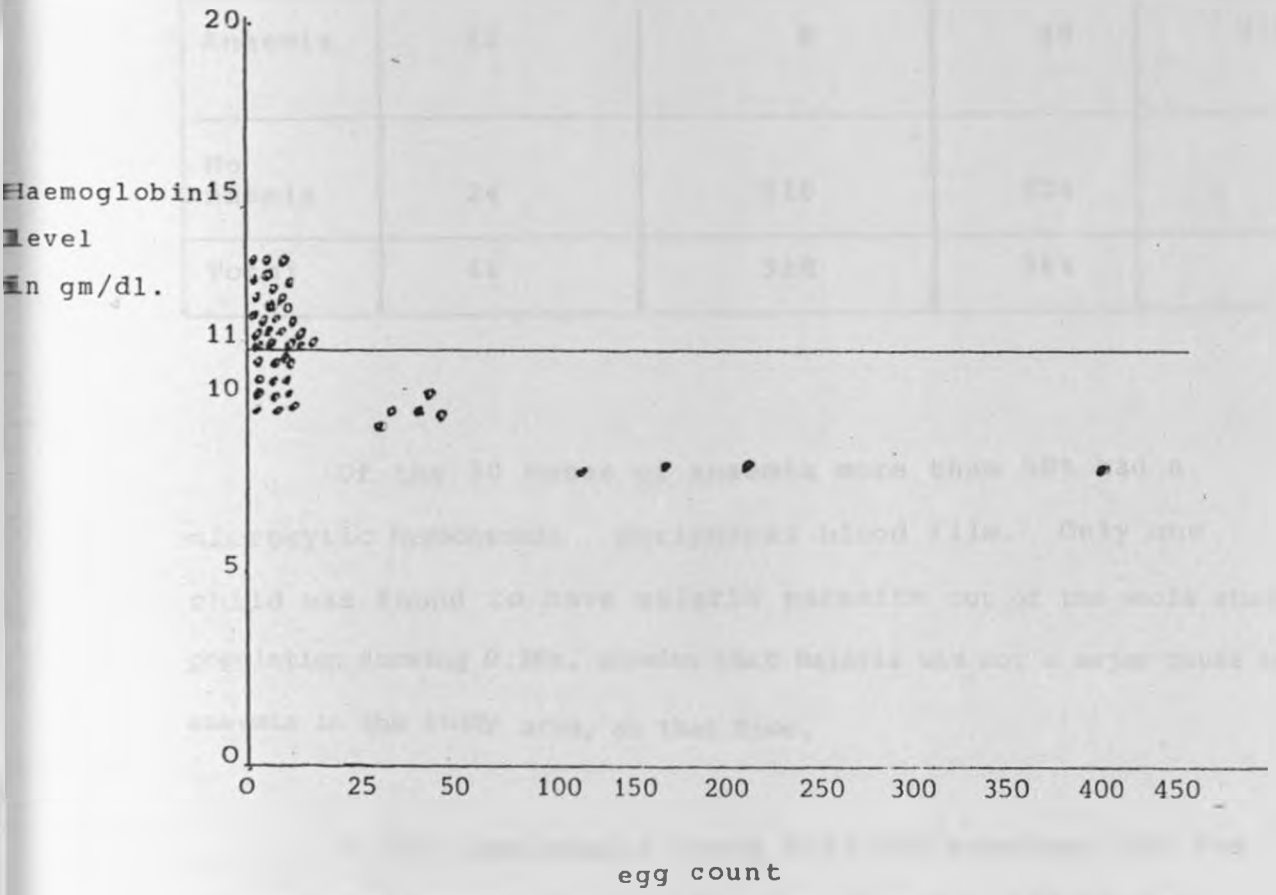


Table 12

The Relationship between Hookworm infection
and Anaemia

	HOOKWORM		Total	% with hookworm
	Positive	Negative		
Anaemia	22	8	30	73%
No Anaemia	24	310	334	
Total	46	318	364	

Of the 30 cases of anaemia more than 50% had a microcytic hypochromic peripheral blood film. Only one child was found to have malaria parasite out of the whole study population forming 0.28%, showing that Malaria was not a major cause of anaemia in the study area, at that time.

A thin peripheral blood film was examined for the presence of eosinophilia. (See Appendix V.) 38% of the children who had intestinal helminths had eosinophilia. There was a significant association between eosinophilia and presence of intestinal helminths. (see Table 13).

Table 13

The Relationship between intestinal parasite
and eosinophilia count

	Intestinal	Helminths
	Positive	Negative
eosinophilia	51	31
Normal	83	199
Total	134	230

$\chi^2 = 27.928, d.f = 1 (P < 0.001)$

Results of Clinical Examination

Clinical examinations of the children revealed no-one with Bitot's spots, corneal xerosis or visible goitre, but two had parotid enlargement and four kwashiorkor. Two of the children with kwashiorkor had heavy to moderate infestation with *Ascaris lumbricoides*, while the other two had been treated in the past after passing or vomiting worms. Seven children with marasmus had moderate to heavy infestation of Ascaris. Clinical features of malnutrition were noted in the study children; skin changes were noted in 17%, hair changes in 31%, puffiness of face in 8%, and apathy in 6%. These clinical features were, however, not severe.

Twenty eight children (7./%) were clinically anaemic.

The most common complaints among the study population were found to be cough (55%), running nose (46.4%) diarrhea (4.9%) and loss of appetite (2.2%).

There was evidence of past worm infestation in the study population . 26.6% had a history of vomiting worms, 39.9% of passing worms, 44.5% of treatment for worms and 50% of passing of worms by siblings in the family.

There was no association found between the symptoms of abdominal pain and diarrhea with any particular parasite.

Fifty six percent of children infected with intestinal helminth were found to have ARI. (see Appendix VI for definition). There was a significant association between symptoms of ARI and intestinal helminths. ($\chi^2 = 25.499$ ($P < 0.0001$)). This raises the possibility that some of their ARI symptoms may actually have been caused by *Ascaris lumbricoides* larva migrating through the lungs at the time of physical examination.

There was a general poor physical growth in the study population with only 23% well nourished while 74% were underweight and 20% were severely malnourished. Parasitic infection was more frequent among those who were malnourished as measured by weight for age than those who were well nourished. The degree of infestation was directly proportional to the severity of malnutrition. There was a statistically

significant association between intestinal parasitic infestation and malnutrition. ($P < 0.001$) (See Table 14 and 15).

Table 14

The relationship between intestinal parasites and level of nutrition - using weight for age in different age groups.

		Intestinal			
		Positive			
Age in months	Number with worms	> 80%	60-80%	< 60	
0-11	4	0	2		
12-23	13	0	13		
24-35	29	3	24	2	70
36-60	88	6	79	3	176
Total	134	9	118	7	364

Table 15

The Relationship between level of Nutrition and intensity of infection of Ascaris lumbricoides

Intensity of infection with Ascaris	Level of nutrition			Total
	> 80%	60-80%	< 60%	
Mild	10	-	-	10
Moderate	-	45	-	45
Heavy	-	14	7	21
	10	59	7	76

Although height for age measurements did not show any difference between various groups, weight for height for age revealed that children with intestinal helminths were more malnourished (32%) as compared to those who did not have intestinal helminths (56%) The difference was found to be significant $P < 0.01$. (see Table 16)

Table 16

The Relationship between intestinal Helminths and levels of nutrition as measured by weight-for-height in different age groups

		Intestinal Helminths					Total
		Positive			Negative		
		Level of nutrition					
Age group in months	>80%	60-80%	<60%	>80%	60-80%	<60%	
0-11	0	4	0	62	1	0	67
12-23	11	2	0	37	1	0	51
24-35	18	11	0	37	4	0	70
36-60	62	26	0	81	7	0	176
Total	91	43	0	217	13	0	364

There was no difference nutritionally between those with intestinal helminths and those without for children aged below eleven months, however there was a statistically significant difference in older age groups. ($P < 0.001$) as marked by ** (see Table 17.)

Table 17

Comparison of Mean weight by age groups between children with and those without Intestinal Helminths

Age Group in Months	POSITIVE INTESTINAL HELMINTHS			NEGATIVE INTESTINAL HELMINTHS		
	MIN	MAX	MEAN (SD)	MAX	MAX	MEAN (S. D)
0-11	4.50 N = 4	8.50	6.75 (1.85)	3.0	10.8 N = 63	6.9 (1.74)
12-23	6.60 N = 13	10.0	8.32 ** (0.98)	8.0	11.4 N = 38	9.54 ** (0.88)
24-35	8.00 N = 29	14	9.90 ** (1.53)	8.00	15.0	12.25 ** (1.7)
36-60	9.00 N = 83	16	12.4 ** (1.80)	9.00	20.0 N = 88	14.1 ** (2.2)

(P < 0.001 as marked by **)

Measurements of head circumference and chest circumference did not reveal any difference between children with intestinal helminths and those who did not.

Measurements of Mid upper arm circumference and triceps skinfold thickness showed statistically significant difference between children who had intestinal helminths and those who did not have, for those aged above eleven months. (P < 0.001)
(See Table 18 and 19.)

Table 18

Comparison of mean Mid Upper Arm circumference between children with and those without intestinal helminths

	I N T E S T I N A L			H E L M I N T H S		
	P O S I T I V E			N E G A T I V E		
Age Group in months	MIN	MAX	MEAN (SD)	MIN	MAX	MEAN (SD)
0-11	11.5	14	12.7 (1.2)	9	16	12.2 (1.6)
12-23	10	15	12.3 ^{**} (1.2)	11	16	13.5 ^{**} (1.5)
24-35	11	16	13.4 ^{**} (1.35)	11	18	13.6 ^{**} (1.4)
36-60	11.5	16.5	13.7 ^{**} (1.08)	11	18	14.2 ^{**} (1.3)

(** P < 0.001)

Table 19

Comparison of mean Triceps Skinfold thickness between children with and those without intestinal helminths

	I N T E S T I N A L			H E L M I N T H S		
	P O S I T I V E			N E G A T I V E		
Age Group in months	MIN	MAX	MEAN (SD)	MIN	MAX	MEAN (SD)
0-11	5	10	8.6 (3.9)	3	12	7.6 (2.0)
12-23	4	10	7.3 ^{**} (1.6)	5	12	8.3 ^{**} (1.8)
24-35	4	10	7.2 ^{**} (1.8)	5	10	8.3 ^{**} (2.0)
36-60	3	10	7.05 ^{**} (1.8)	3	10.4	7.9 ^{**} (1.7)

(** P < 0.001)

The Socioeconomic Survey

The socioeconomic survey revealed that 88% of mothers were married and are the primary figure in their household 16% of mothers were illiterate, 61.3% had some primary education, and only 16% went beyond primary education. 95% of mothers worked on family farms, and crops grown were legumes, vegetables and maize.

The father was monogamous in 83.5%, and educational achievements of fathers were found to be much higher than those of mothers, and they also have a wider range of job opportunities than the mothers.

Almost all families had access to a latrine of some type, though most of them were dirty, with uncovered holes, and a lot of flies.

Concerning water supply no house was found to have piped water. Most families got water from Maragua river (56.6%) and the rest from wells, streams, spring and rain water.

Breast feeding was almost universally present, and all children were immunised adequately for their age requirements.

DISCUSSION

The results in this study suggest strongly that there is a positive relationship between the prevalence of intestinal helminths especially Ascaris lumbricoides and malnutrition. All the severely malnourished children had Ascaris lumbricoides with heavy infection. Thirty two percent of children with intestinal helminths were found to be wasted compared to only 5.6% of those who did not have intestinal helminths. Ages 0-11 months were least affected as shown by the results. This is probably due to the almost universal practice of breast feeding in the study area, contributing valuable nutrients often into the second year of life.

The study also shows that there is an increase in the prevalence and severity of low weight for age with increasing age probably corresponding to increasing intensity of infection with intestinal helminths, that is, increased worm loads. With heavy worm loads there are more parasites competing for the child's food. From the age of two years onwards the child is more independent, running around the compound and fields and so easily gets infected.

It is evident that Ascaris lumbricoides does contribute to the cause of malnutrition in this area. The effect of Ascaris on growth was first recognised by pig farmers (1) who noted that pigs infected with Ascaris suum had less gain in weight than the controls and that deworming produced a marked increase in weight.

Although light infection has been thought to be symptomless, evidence is emerging that light and moderate infection may produce stunting of growth particularly in children living on suboptimal or frankly deficient diets. (40, 59). There is also malabsorption of fat, carbohydrates, proteins, Vit A, Vit C. (1, 2, 23, 28, 45, 46, 47, 48).

The Ascaris competes with the host for food. There is evidence of ingestion of food from the gut by Ascaris as shown by barium meal that often visualises the worms alimentary canal. Carbohydrates and protein splitting enzymes have been identified in the parasites intestinal tract (28). Monosaccharides are also absorbed from the surface of worms (22). In heavy infections the worm may form upto 10% of the child's body weight (29, 59). The Ascaris worm lay about 200,000 eggs/day representing a considerable amount of protein. Protein deficiency could be caused either by impediment of digestion and absorption or loss of protein through the round worm eggs. One million eggs which are produced daily by five females of Ascaris lumbricoides contain 4.25 mg of nitrogen, an amount that is not critical for the well-nourished but critical to the malnourished or borderline. (48, 59). There is mechanical interference with absorption at the brush border due to diffuse damage of mucosa and physical obstruction by the worms. The worm also produces an anti proteolytic substance, ascarase, which inhibits the succus entericus (59). There is also loss of appetite which also contributes to impedement of growth.

Complications due to migration of adult worms into the biliary and to intestinal obstructions are the major causes of acute morbidity and mortality in ascariasis. (2,29,31,32,49,50,51,52).

The association between ascariasis and stunting, and general under nutrition, avitaminosis decreased protein absorption, xerophthalmia, and ascorbic acid deficiency has been shown to be of possible nutritional importance. (23, 22, 20, 30, 45, 46).

There was significant association between Ascariasis and symptoms of ARI. This raises the possibility of Loeffler's Syndrome (2, 29) which is produced by *Ascaris* larva while migrating through the lungs. The extent of pulmonary symptoms depends on the number of larvae present, individual sensitivity to *Ascaris* and the production of *Ascaris* of a substance, whose nature is not clear, which impairs the B-adrenagic response (56). The pulmonary manifestations consists of fever, cough, dyspnea, and chest pain. These may be associated with occasional rales, ronchic, and moderate eosinophilia. Diagnosis of Loeffler's syndrome depends on demonstration of *ascaris* larva in the sputum (2, 31, 54). Features of pulmory infiltration may be seen on xrays.

There was a significant association between intestinal parasites and eosinophilia. A study by Okello and Mukibi (57) also found significant eosinophilia in people infected with intestinal worms.

In addition to pulmonary migration, other abnormal migrations may occur causing various symptoms and signs. Migration can occur spontaneously or follow disturbance in peristalsis or pyrexia above 39⁰c or ingested drugs. It is

usual for the worms to be passed with faeces or be vomited or passed through the nostrils. On rare occasions they might block the common bile duct leading to jaundice (49) or pancreatitis. Movement to the liver may cause multiple hepatic abscesses. Peritonitis may result from perforation of the intestinal wall. Deposition of ascaris ova into the peritoneum may result in subacute peritonitis (29) Asphyxia has been known to occur as a result of ascaris blocking the larynx but it is rare.

Ascaris larva may also migrate to the brain causing convulsions, meningism and epilepsy. Restlessness in sleep, teeth grinding are common during the night (2, 29).

Weight-for-age provides an indication of whether or not a child is or has been malnourished but tells very little about the duration of PCM. One can determine the child's present nutritional status better by simultaneously considering his weight-for-age, height or length-for-age, and weight for height. Using these three parameters it is possible to classify children as being

- 1) essentially normal in body size.
- 2) presently acutely malnourished, and
- 3) chronically malnourished in the past but presently of normal weight-for-height or
- 4) suffering from present acute PCM on top of chronic PCM (41)

These three categories of malnutrition can be explained more fully as follows:

(a) Current acute short duration malnutrition. This category includes children with low weight-for-age, normal height-for-age and low weight-for-height. Because height is normal but weight is low, the child has evidently had a recent short duration deficiency of calories and/or proteins but no evidence of long term deficiency. This was the commonest type of malnutrition seen in our study and can be explained by the close proximity to a Rural Health Training centre with their outreach programme and antihelminths usage on and off by the children. Antihelminths could be obtained by parents either from the clinic or village shop. It seems likely that most of the children in the study group have had intestinal helminths especially ascariasis at one stage or other in their lives.

Thirty seven point seven percent of the children had a weight-for-height below 80% using the WHO Harvard standards (Jelliffe 1966 (35)). Growth standards for Kenyan children have not yet been established. However Bodhal's study in 1966 (42) of nutritional status in healthy African and European children 4-5 years old in an elite Nairobi Kindergarten concluded that the various (anthropometric) measurements did not differ in comparison of African and European children. Several other studies done in Kenya like Korte and Simmons (43), including the National Rural Kenyan Nutrition Survey (44) have chosen the Harvard and other standards as quoted by Jelliffe. The use of this cut off point and the growth standard used (35) therefore seems justified.

(b) Past chronic malnutrition. This category includes children with low weight for age and low height-for-age but normal weight-for-height. The child presents evidence of a

presently adequate dietary intake of calories, but has the stigma of past long-duration deficiencies of calories or proteins or both. Recovered children and the so called nutritional dwarfs would fit into this category.

(c) Current long duration malnutrition (acute-on-chronic)

This category includes children with low weight-for-age, low height-for-age and a low weight for height. The child has evidence of both past and present deficiency of proteins and or calories.

Using only the weight for age (Wellcome classification) (29), 88% of children were underweight and 5% severely malnourished among the children who had intestinal parasites. It is the disadvantage of the Wellcome classification that it takes no account of retardation and hence the duration of malnutrition. Weight for age is sensitive to even small changes, therefore higher percentages. Weight for height seems to be a better method of assessing nutritional status as it is independent of age (43). In our study it was difficult to ascertain the exact age of the children as most mothers could not remember the exact dates of birth of their children.

One interesting observation is that the children found to be underweight (using the Wellcome classification (39) were significantly less retarded in height using the Waterlow classification (38), suggesting that malnutrition must be of more recent onset (41).

It seems that both head circumference, and chest circumference are not very sensitive indicators of mild and moderate malnutrition.

Hookworm is also quite common in the tropics. In our study there was a prevalence of 12.6%. Hookworm causes intestinal blood loss resulting in considerable loss of iron due to sucking of blood by the worms and bleeding from the raw areas left by the worms since they keep on migrating (2, 24, 31, 53). There is also loss of proteins due to bleeding and possibly some toxins produced by the worm. The presentation of a patient with hookworm depends on load of worms and the nutritional status of the individual. (24, 53). Severe infections produce hookworm disease characterised by iron deficiency anaemia (2, 29).

The prevalence of anaemia was quite low in our study area (8%) and hookworm infection did not have that significant effect on all age groups but only higher age groups especially 36-60 months where the prevalence and intensity was greatest, and also associated with evidence of reduction of the haemoglobin level, associated with hypochronic anaemia. However, although hookworm infection is prevalent, it is light and Hookworm has never been recognised as an important problem in this area of Kenya. Studies by Chege (6) also had similar findings.

There was a low prevalence of Malaria (0.2%) in the study area at the time of the survey, suggesting that transmission was low at the time of the survey, and that symptomatic cases were probably being treated with antimalarials at the Rural Health Training centre. Malaria transmission appears to be seasonal in nature.

In children 1-4 years old, Trichuris trichuira in heavy infections may be associated with prolonged diarrhea, blood stained stools, also abdominal pain, tenesmus and loss of weight.

Infection with strongyloides stercolaris is common among tropical children, (2) and in heavy infections may produce epiyastric pain, nausea, vomiting, diarrhea and impaired absorption from mucosal inflammation 2, 11.

There was a prevalence of 20% with infection with Giardia lamblia. Giardia lamblia may affect the nutritional status by causing malabsorption as it attaches itself to the intestinal mucosa, and invading it. (27, 54, 55).

The present field study of rural underfives showed that intestinal helminths especially Ascaris lumbricoides infections are associated with a statistically significant decrease in weight, Mid upper arm circumference, triceps skin fold thickness in children above one year of age . Recently a study by G.B. Bukonya (58) also found a statistically significant association between ascariasis, and reduced nutritional status . Children infected with ascariasis face a serious competition for protein among other food substance. In an area where protein intakes is inadequate loss to this helminthic parasites may have more serious results than is generally realized.

C O N C L U S I O N S

A cross sectional study was done on 364 children aged 0-5 years in a rural setup. The following were established :-

1. Intestinal helminths were found in 36.8% of the study population. *Ascaris lumbricoides* was found to be the commonest intestinal helminth forming 18.4%, the Hookworm 8%, *Trichuris trichiura* 1.1%, and Multiple infestation in 9.3%.
2. The intensity and prevalences of infection with intestinal helminth increases with age.
3. There was significant association between intestinal helminths especially *Ascaris lumbricoides* and malnutrition.
4. Pathogenic protozoa was found in 18% with, *Giardia lamblia* forming 12.9% and *Balantidium coli* 7.8% and there was no significant association between these protozoa and malnutrition.
5. There was an 8% prevalence of anaemia in the study area, which I consider to be low in a malaria infested area.
6. Hookworm infection was significantly associated with anaemia in older age groups i.e. 3-5 years of age.

R E C O M M E N D A T I O N

It is therefore recommended :

1. That routine treatment with a broad spectrum antihelminthic drug be offered to all children aged 2 years and above ; at 3 months interval.
2. That further study on the mechanism of how intestinal parasites affect nutrition be done.
3. That a community based health education programme for parents especially on environmental sanitation be carried out.

A P P E N D I X I

The method used for the examination was the Formal Ether Sedimentation Method-Ritchie's modified method (33, 34) i.e. Riddley modification which is as follows :

1. 1 gm of faeces was thoroughly emulsified with 7 mls of 10% formal saline and strained through a wire gauze (40 mesh per inch) into a centrifuge tube .
2. 3 mls of ether was added and mixture shaken vigourously for one minute.
3. The mixture was then centrifuged, accelerarating slowly and gradually over a period of 2 minutes to a speed of 2,000 r.p.m. and then allowed to come to rest.
4. The debris on the surface and at the interface between the two liquids was loosened from the wall of the tube with an applicator stick and the supernant was decanted, the last drop or two was allowed to run back.
5. The smallest deposit was shaken up and poured on to a clean glass slide and examined for larva and ova of helminths, (four cover slips per specimen) using a x 5 eye piece and x 10 objective lenses for ova and x 40 objective lenses for cysts.
6. A drop of iodine was added while looking for cysts.

Intensity of infection of Ascaris lumbricoides and Hookworm

The concentration of 1 gm of stool was done using the modified Ritchies Method (33, 34) as described above. Examination of 1 ml of one gm of stool was then done and number of ova of helminth counted by examining the entire smear based on 100 x 10 fields per 22 mm cover slip; egg count > 500 eggs per cover slip corresponded to heavy infection, egg count 100 - 500 eggs per cover slip corresponded to moderate infection, eggcount < 100 eggs per cover slip corresponded to light infection.

A P P E N D I X II

The methods for taking the various measurements are described below :-

1. Height

This was determined to the nearest 0.1 cm using a locally made calibrated length board with a stationary foot piece and movable head piece as described by Jellife (19).

2. Weight

Nude weight was measured to the nearest 0.1 kg on a portable salter spring balance (model 235) using a 25 kg capacity (salter Export Trading Co. West Bromwich Staffs England). Scale calibration was checked regularly each day.

3. Mid Upper Arm Circumference

This was measured to the nearest 0.1 cm on the left arm, half way between the tip of acromion process of the scapula and the olecranon process of the ulna. The tape measure used was the unstretchable fibre glass tape.

4. Triceps Skinfold thickness

This was measured with Herpenden calipers in triplicate to the nearest 0.1 mm on the left arm where the midpoint had been marked on the arm circumference measurement.

5. Head circumference

This was measured to the nearest 0.1 cm using a non-stretchable fibre glass tape by placing the tape firmly around the frontal bones just superior to the Supra orbital ridges, passing it round the head at the same level on each side, and laying it over the maximum occipital prominence at the back.

6. Chest circumference

This was measured with a flexible non stretchable fibre glass at the nipple line and measurements made to the nearest 0.1 cm.

General Data

A P P E N D I X III

1. Name	2. Study No.	<input type="text"/>	<input type="text"/>	<input type="text"/>	
2. Age (months)	<input type="text"/>	<input type="text"/>	4. Sex	<input type="checkbox"/>	Code M = 1
					F = 2
5. Weight in Kg	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
6. Height in CM	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
7. Head circumference in CM	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
8. Chest circumference in CM	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
9. Mid Upperarm Circumference in CM	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
10. Triceps skinfold thickness	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
11. Pedal pitting Oedema				<input type="checkbox"/>	
12. Skin changes				<input type="checkbox"/>	
13. Hair changes				<input type="checkbox"/>	
14. Clinical evidence of Anaemia				<input type="checkbox"/>	
15. Codes for 11 -14					
					None = 1, Slight = 2, Moderate =3, Severe =4
16. Puffiness of face or moon face				<input type="checkbox"/>	
17. Apathy				<input type="checkbox"/>	
18. Good apetite				<input type="checkbox"/>	
19. Respiratory rate above 50/min.				<input type="checkbox"/>	
20. Reduced Air entry				<input type="checkbox"/>	
21. Abnormal Chest sounds				<input type="checkbox"/>	
22. Running nose				<input type="checkbox"/>	
23. Cough				<input type="checkbox"/>	
24. Diarrhoea				<input type="checkbox"/>	
25. Bitots spot on the eye				<input type="checkbox"/>	
26. Conjunctival Kerosis				<input type="checkbox"/>	

27. Parotid Enlargement
28. Demostrable Goitre
29. Abdominal Distension
30. Presence of Protein energy malnutrition
- Codes for 15 - 29 Yes = 1, No = 2
31. Type of Malnutrition
- Code: Nil = 1, Kwashiokor =2, Marasmas =3
Marasmic Kwash =4
32. Marital Status of Mother
33. Level of education of mother
34. Level of education of father
35. Occupation of father
36. Occupation of mother
37. Sewerage disposal facility at home
- Flush toilet = 1, Pit latrine =2, Bucket latrine = 3
Sewerage type =4 None/surrounding Bush =5
38. Water supply
- Piped water in the House = 1. Piped communal = 2
Stream/well = 3 River = 4, bought at common area =5
Others = Borehole/storage tank/rain water =6

- 39. Vomited worms in the past
- 40. Passes/Passed worms in the past
- 41. Has been treated for worms
- 42. History of passing worms in another member of family
- 43. Breast feeding history. Codes for 40-45 Yes =1 No =2
- 44. Duration of Breast feeding (for infants)
- 45. Age of weaning (for infants)
- 46. Weaning diet (for infants).....
.....
- 47. Vaccination History Code, Yes = 1, No = 2, Don't know = 9
 - BCG
 - Polio No. 1 , Polio No. 2 , Polio No. 3
 - DPT No. 1 , DPT No. 2 , DPT No. 3
 - Measles

RESULTS

- 48. Haemoglobin level
- 49. Peripheral blood film.....
.....
- 50. Stool Ova and Cysts. (Negative = 1, Positive = 2)
- 51. Egg count.....
- 52. Types of worms.....
.....

A P P E N D I X IV

Nutritional Indices : -

Professor Waterlow - 1976 (38) classification of weight for height and height for age was used and thus Protein Energy Malnutrition was classified by following growth criteria:-

1. Stunting - children whose height for age fell below 90% of standard;
2. Wasting - children whose weight for height fell below 80% of standard. The findings of the anthropometric measurements were expressed as percentages of standard values for weight for age using the Wellcome standard (39) and the percentage of standard values for weight for height, height for age using the WHO Harvard Standards - Jelliffe 1966 (35).

Using the Wellcome classification for weight for age there were 3 categories of levels of nutrition :-

1. > 80% - well nourished
2. 60-80% - under weight (and are at risk of developing clinical malnutrition)
3. < 60% severely malnutrition.

Kwashiokor - weight for age below 80% with oedema

Marasmus - weight for age below 60% without oedema

The percentage weight-for-height was obtained by using the actual observed weight and height for each subject, and calculations made of the percentage of the standard, using the recommended Harvad standard tables as described by Jelliffe - WHO 1966 (35). The nutritional level was then assessed using weight for height for height and comparison made between those who had intestinal helminths and those who did not.

A P P E N D I X V

Blood was taken off to determine the Haemoglobin of each child, and a spencer Haemoglobinnometer was used as follows:- Samples were drawn from the capillary vessels and analysed on the spot for the haemoglobin content. This instrument compares the absorption of light by oxyhaemoglobin in a layer of haemolysed blood of a carefully derived depth with the absorption of a standard glass wedge.

Method

The chamber was loaded directly from the finger prick by introducing a drop of blood in the partially spaced chamber. Insert chamber into the instrument. Hold the instrument into the left hand, depress the switch at the base with left thumb and move the slide on the right handside with the right hand. Do this until the halves of the fields are same colour. An average of 2 or 3 quick reading gives a more accurate result than one prolonged observation. A thin peripheral blood film was also taken off, stained and examined for morphology of red

blood cells and presence of eosinophilia.

Giemsa staining for thin film

1. Smear was fixed with methanol for 1-2 minutes
2. Stain in Giemsa stain diluted 1:10 in buffer ph 7-72 for 40-50 minutes.
3. Wash in water and drip dry.

Eosinophilia was documented is there was > 10 eosinophils per 100 WBC, 0-10 eosinophils per 100 WBC was taken as normal. This method does not give absolute values of eosinophils but does show us the relative eosinophil count.

A P P E N D I X VI

Anaemia was documented when haemoglobin level fell below 9gm per dl in ages 0-6 months as per Nelson (26) and if below 11gm per dl as per WHO, 1972 (36) in other ages.

ARI was defined as acute cough and or rinorrhea with or without fever (37).

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