Special Report Series No. 6

INTESTINAL HELMINTHIC INFECTIONS IN BURMA

REPORT

OF THE

TECHNICAL COMMITTEE

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BURMA MEDICAL RESEARCH COUNCIL

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INTRODUCTION

It is common knowledge that intestinal infection with worms is prevalent in Burma, especially among children. The extent to which such infections cause disability and disease requires appraisal, in view of many health problems demanding attention in the country.

The Governnment has therefore appointed a technical committee for the study of intestinal helminthiasis in Burma which came into formal existence on 26 January, 1968. The terms of reference of this committee are :

1. Review current knowledge on the subject and consolidate available information on the subject as is pertinent to Burma.
2. Review the measures currently being employed to combat the problem in Burma.
3. Make definitive and practical recommendations on the actions required to solve the problem in Burma.
4. Chart the future course of research on the problem.
5. Specifically, to study the impact of intestinal helminthic infections on the health of the people of Burma, and to make suitable recommendations.
6. To report to the Burma Medical Research Council in 2 months.

In considering the scope of its study this committee included all intestinal helminthic infections of man, that is, infections with all those helminths which inhabit the lumen of the intestine of man during the fully developed or mature phase of their life cycle.

1. IMPACT OF INTESTINAL HELMINTHIASIS ON THE HEALTH OF THE PEOPLE OF BURMA

1.1. Method of study of the impact on health

In evaluating the impact on health of intestinal helminthic infections the Committee found it necessary to consider the concept of health as well as the practical measurement of levels of health.

WHO has broadly defined health as a condition of the human organism expressing the adequate functioning of the organism in given conditions. In a narrower sense and for working purposes health was also defined as conformity to accepted standards of given criteria in terms of basic conditions of age, sex, community and region (1). Health indicators are those related to persons and population, those related to physical environment, and those concerned with health services.

In the context of the present study it was deemed necessary to use only those health indicators related to persons or populations.

Also, such comprehensive indicators as crude death rate and expectation of life and even infant mortality rates were too general to be of use, and more specific indicators were sought.

The Committee arrived at the following conclusions regarding health indicators to be used in the assessment of the impact on health of intestinal helminthic infections.

1. Inasmuch as there is adequate *a priori* evidence that the helminthic infections under consideration do cause disease and disability at some time in some persons, the question of importance seems to be the extent of such disease and disability in the community.

The prevalence and intensity of intestinal helminthic infections in the community would generally indicate the extent of disease and disability attributable to the infection.

2. When measurable, the mortality and morbidity directly attributable to intestinal helminthic infection would be indicators as to the impact on the health of the community. Thus, cause-specific mortality and morbidity rates would have to be examined.
3. The relationship of nutrition to infection and more specifically to intestinal helminthic infection has been the subject of many authoritative studies. The Committee decided to include the nutritional

status of the community as among the possible indicators likely to reflect the impact of intestinal helminthic infection on health.

In addition to specific nutritional deficiencies, physical development and growth are of relevance to the present study.

1.2 The prevalence, distribution and intensity of intestinal helminthic infection in Burma

There are two sources of such data. Firstly, there are the laboratory records of various institutions ; secondly, there are the results of various special surveys of different communities. Other sources such as autopsy records are not available.

In all the studies performed up to now in Burma, the presence of eggs or larvae in stools is taken as evidence of intestinal infection with the worm. Intracutaneous and serological tests have not been used. Stool examination for eggs or larvae is the most practical test and is sufficient to detect most types of intestinal helminthic infections. The exceptions are Enterobiasis, Taeniasis and Trichiniasis.

The routine laboratories have used only the direct smear method of stool examination whilst the various surveys have also used standard methods of concentration and preservation, such as the brine floatation and formol-ether method. Egg counts and specification as to the fertility of the ova were not recorded in any of the studies.

1.2.1 *Prevalence rates from laboratory records*

The result of stool examination for helminth ova by the direct smear method in the laboratories of the various institutions in Burma are given in Table 1. Except for the National Health Laboratory other laboratories are attached to hospitals in the major towns of Burma. Most of the stool specimens are from inpatients and are either sent routinely or because of some gastrointestinal disorder. Except for the figures from the Children's Hospital where only children below ten years are treated, the data cannot be broken down according to age and sex. Since annual figures are given, seasonal variations, if any, have been averaged. It is difficult to be sure as to which population group the prevalence rates represent They represent prevalence rates in hospital patients, and although of some absolute value, may be more useful for comparative purposes.

TABLE 1.—*Results of stool examinations for intestinal helminths in different laboratories, Burma*

Laboratory and year			Number of specimens	Per cent positive with intestinal helminths						
				Ascaris lumbricoides	*Enterobius vermicularis*	Hookworm	*Hymenolepis nana*	*Strongyloides stercoralis*	*Taenia* spp.	*Trichuris trichiura*
1. National Health Laboratory,	1963	...	713	25.7	...	0.6	...	...	0.3	5.0
	1964	...	2,410	14.6	...	0.4	...	...	0.2	3.3
	1965	...	4,179	10.1	...	0.4	...	...	0.1	2.7
	1966	...	2,406	17.8	...	0.3	...	...	0.1	4.1
	1967	...	4,502	17.1	...	0.4	...	...	0.4	3.6
2. Children's Hospital	1966	...	517	21.3	...	...	...	...	...	5.0
	1967	...	2,440	21.0	...	...	...	...	...	3.9
3. Rangoon General Hospital	1967	...	6,302	19.4	0.1	0.7	0.1	1.4	0.1	4.3
4. Divisional Hospital, Magwe	1967	...	1,400	4.9	...	2.0	0.2	...	0.3	0.4
5. Divisional Hospital, Moulmein	1967	...	5,710	69.9	...	7.8	...	...	...	20.8
6. Sao San Htun Hospital, Taunggyi	1967	...	1,631	4.2	...	3.3	...	...	0.2	1.0

TABLE 2.—*Results of special stool surveys for intestinal helminths, Burma*

	Kachin State Arrom-dum village (Tarons) (1966)	Kachin State Arrom-dum village (Htalus) (1966)	Shan State Inle (1967)	Myin-gyan Tuywin-bo village (1968)	Chauk Peri-natal Out-patient (1968)	Insein Shan-tegyi village (1968)	Insein Sawbwa-gyigone village (1961)	Insein Kyaung-gone village (1963)	Insein Aung-sanmyo villages	Rangoon Univer-sity Hostels Menial staff (1959)	Rangoon Medical students (1959)	Rangoon Food Hand-lers (1966)	Bassein Town-ship (1968)
Number examined	55	24	107	55	135	125	238	426	3,882	114	99	671	393
Helminths	*Per cent Prevalence*												
Ascaris lumbricoides	70.9	62.5	3.6	5.5	8.0	72.0	...	60.1	23.0	23.9	10.1	15.6	68.4
Enterobius vermicularis	7.3	...	...	5.5	...	9.6	...	1.2	1.3	2.6	...	...	0.5
Hookworm ...	32.7	25.0	2.7	...	...	7.2	37.8	12.9	27.0	0.9	...	...	11.7
Hymenolepis nana ...	...	...	...	3.6	...	0.8	...	...	...	...	...	...	...
Strongyloides stercoralis	...	...	...	3.6	...	...	...	...	...	6.1	1.0	0.1	2.3
Taenia spp. ...	...	...	2.7	...	...	...	...	...	...	0.9	...	...	...
Trichuris trichiura ...	5.4	4.2	...	...	...	28.0	...	6.8	2.7	10.5	6.1	1.6	51.4

It will be seen from Table 1 that *Ascaris lumbricoides*, *Trichuris trichiura*, hookworm, *Enterobius vermicularis*, *Hymenolepis nana*, and *Taenia* are the helminths recorded as present. The hookworm and *Taenia* species were not identified. Depending upon the location of the laboratory, the prevalence rate of *Ascaris* infection ranges from 4.2 per cent to 69.9 per cent ; of *Trichuris* from 1 per cent to 20.8 per cent ; of hookworm from 0.3—7.8 per cent. Other helminthic infections are found only sporadically.

1.2.2 *Prevalence rates from results of special stool surveys*

These are specially planned surveys in which unselected samples of well defined population groups are tested. With the exception of one study all of them were carried out on apparently healthy subjects. In some of them the brine floatation method and formol-ether concentration methods were used. In addition to being performed in different regions of Burma there are also differences in the seasons in which the surveys were conducted. They are, so far, the best indications of the prevalence rates in the communities surveyed. The results of various surveys are summarized in Tables (2, 3, 4, 5, 6, 7, 8, 9, 10, 11).

The special surveys show that the rate of infection with *Ascaris* ranges from 3.6 per cent to 70.9 per cent ; with hookworm from 0—37.8 per cent ; with *Trichuris* from 0—28 per cent and with *Enterobius* from 0—9.6 per cent. *Strongyloides*, *Taenia* and *Hymenolepis* are also found to a much smaller extent.

1.2.3 *The age distribution*

The comparative prevalence rates of intestinal helminthic infection in adults versus children have been compiled from the data of Kyaunggon Village (7) and Bassein Township (11) surveys (Table 3) and from the laboratory records of the Children's Hospital and the Rangoon General Hospital. In all the comparisons, children show a higher rate of *Ascaris* infection and with one exception a lower hookworm infection rate. The differences are statistically significant except the hookworm rates for Kozu Village and the laboratory data for the Rangoon General Hospital and the Children's Hospital.

The higher *Ascaris* and lower hookworm infection rates in the younger age groups are in accordance with the observation of others, and is due to differences between

TABLE 3.—*Rates of intestinal helminthic infections by age*

Location	Age (years)	Intestinal helminths	
		Ascaris lumbricoides %	Hookworm %
Bassein Town	5—15	78.0	1.9
"	16—25	57.6	13.6
Kozu Village	5—15	71.0	21.5
"	16—25	45.6	15.8
Kyaunggon Village.	0—12	66.7	7.3
	31 +	55.4	16.9

adults and children in factors such as behavioural and occupational activities, superimposed upon natural age resistance and acquired resistance. The relative importance of each may only be measured under controlled conditions.

Data from Burma is not sufficient to be broken down into smaller age groups but it is noted by others that the prevalence of infection with *Ascaris* is higher among the pre-school age and in the lower primary grades. In the case of hookworm infection, the maximum incidence occurs somewhere between the ages of 15—25 (12).

1.2.4 *Urban versus rural distribution of intestinal worm infections*

The only comparable data on the relative rate of intestinal worm infection among urban and rural dwellers is that given by Bassein study. They found the *Ascaris* infection rate in Bassein Town to be 72 per cent versus 63 per cent in nearby Kozu Village. This is not significantly different ; but the hookworm infection rate was 5 per cent in Bassein Town in contrast to 19 per cent in Kozu Village, the difference being highly significant (11).

Although this is but one example, these figures suggest that hookworm infection seems to be more susceptible to the influence of urbanization whilst *Ascaris* is not appreciably so.

The WHO Technical Report on Ascariasis also notes that because of overcrowding in towns of non-industrialized countries, the prevalence of *Ascaris* infection may be higher in urban than in rural areas (13).

Where faeces are used as agricultural fertilizer, it might be expected to influence the urban versus rural distribution of *Ascaris* infection. But according to the information available, the use of faeces as fertilizer is neither widespread nor common in Burma (Dr. Kaung Zin, Agricultural Research Institute, Rangoon, personal communication).

1.2.5 *Distribution according to climate and region*

There is sufficient information available as to conditions of temperature, humidity and soil which are optimum for transmission of infection with the soil transmitted helminths and as to the limits within which transmission may occur. With the aid of climatographs it may be possible to predict the endemicity of infection with these worms in the various natural regions of Burma. But, then, the micro-environment to which the free living stages of the soil-transmitted helminths are exposed may be very different from the macro-environment. There are many examples of districts where certain helminths can survive whereas adjacent or surrounding areas are unsuitable for development. In Burma, although data are available for atmospheric temperature and rainfall there is yet little information on soil temperature and other soil conditions, which in addition to climate are influenced by factors such as vegetation. Thus only very broad generalizations may be made as to endemicity of the soil-transmitted helminths from the meteorological data available.

It may be expected that the prevalence of *Ascaris*, *Trichuris* and hookworm will be high in the warm, wet low lands such as the coastal strips and the delta, and to be low in the dry zone.

Actual measurements of the distribution of infection in the different regions of Burma have been carried out to a limited extent. In order to be able to compare the rate of infection in the different regions, a systematic collection of data would have to be done using comparable materials and methods and with due regard also to the seasonal variations.

The data available now, although imperfect, is capable of revealing large regional variations. The laboratory records of the various hospitals are comparable in the sense that they represent patient material, and that all use the direct smear technique. Seasonal variations have also been smoothed out because they are annual averages.

Admittedly, observer variations may be considerable. Yet the *Ascaris* infection rate of 4.9 per cent in Magwe Division Hospital, 4.2 per cent in the Sao San Htun Hospital contrasts markedly with the 69.9 per cent in the Moulmein Division Hospital and cannot be disregarded. In Rangoon there is a steady rate of about 20 per cent to 25 per cent. Similarly, the 7.8 per cent rate of hookworm infection in Moulmein may be compared to the 2-3 per cent and lesser rates in other hospitals.

Some of the materials and methods in the special surveys are not comparable. However, all the village surveys may be compared, and reveal that whereas all the Lower Burma and the Kachin State rates for *Ascaris*, *Trichuris* and hookworm infections are high, the dry zone village of Tuywinbo and Inle in the Shan States have remarkably low *Ascaris* and *Trichuris* infection rates. Such comparisons do not take seasonal variations into account but do confirm the previous laboratory variations. The inter-regional comparison of hospital proportional morbidity rates also provide additional corroborative evidence.

The conclusion seems justified that *Ascaris*, *Trichuris* and hookworm infection rates are low in the Dry Zone and in parts of the Shan States. They are high in the Delta, the coastal strips and parts of the Kachin State.

1.2.6 *The intensity of infection*

The intensity of infection may be measured by doing egg counts during stool examination or by enumeration of the number of worms found at autopsy or after anthelmintics. Only one such study is known to have been done in Burma. The number of *Ascaris* passed after a dose of piperazine was counted in children under ten years having suggestive symptoms of intestinal ascariasis. The mean number passed was 22 with a range of 1—140 (Dr. Khin Myo Win, personal communication). Variation of the intensity of infection with age, locality and season has not been studied in Burma. Neither have studies been done on the intensity of infection with other intestinal helminths.

There appears to be general agreement that the intensity of infection with soil-transmitted helminths is reflected in the overall prevalence rates. The higher prevalence of *Ascaris* infection in the younger age groups

and in certain regions may probably be taken as indication of higher intensity of infection, but in the absence of definitive studies more cannot be said regarding the worm burden.

11.2.7 *Conclusions*

It is obvious that more data are required to give a better picture of the prevalence and distribution of intestinal helminthic infection in Burma. But enough information is now available to show what helminths are present, and to reveal the most prevalent infections. A gross pattern of the distribution in terms of age and natural region may also be discerned. Unfortunately, almost no information is available on the intensity of infection with the various helminths.

The intestinal helminths prevalent in Burma are *Ascaris lumbricoides*, *Trichuris trichiura*, hookworm, *Enterobius vermicularis*, *Taenia*, *Strongyloides stercoralis*, and *Hymenolepis nana*. Others have not been recorded. Of these, the leading helminths from the view point of prevalence are the soil-transmitted helminths: *Ascaris*, *Trichuris* and hookworm.

Compared with the many published reports from other countries the prevalence rates of *Ascaris*, *Trichuris* and hookworm infection in certain regions of Burma may be regarded as high although not as extremely high as in some other countries.

Infection with *Ascaris* and *Trichuris* is widespread, with the highest prevalence in the wet delta and coastal strips and parts of the Kachin State. The prevalence is definitely lower in the Dry Zone and also appears to be low in the Shan States.

In children compared to adults, the *Ascaris* infection rate is higher and the hookworm rate lower. Urbanization seems to lessen the prevalence of hookworm infection but not that of *Ascaris*.

1.3 Morbidity and mortality due to intestinal helminthiasis in Burma

1.3.1 *General evaluation*

The morbidity and mortality due to intestinal helminthiasis is difficult to assess. With regard to ascariasis, a WHO Expert Committee stated that objective measurement of morbidity is very difficult and that there is relatively little factual information concerning it (13). A UNICEF-WHO Joint Committee states that mortality statistics are generally undependable in countries with high prevalence rates of ascariasis. Nevertheless, an attempt is made hereunder to glean some factual information regarding morbidity and mortality due to intestinal helminths from the data available in Burma.

The morbidity and mortality data available in Burma with respect to intestinal helminthiasis have been compiled. The hospital proportional morbidity rate due to intestinal helminths, the inter-regional comparison of hospital proportional morbidity rates due to intestinal helminths, the inter-regional comparison of hospital proportional morbidity rates due to specified types of intestinal helminths, and the mortality rates due to specified types of intestinal helminths are given in Tables 4 to 8. The proportional morbidity rates have been calculated from the Health Statistics Reports of Township and District hospitals which state the number of patients treated in hospitals for various specified categories of diseases (14).

In assessing the significance of the aforementioned morbidity data certain considerations will have to be kept in mind. Firstly the criteria for the clinical diagnosis of the various helminthiasis are ill defined. Secondly, the data are based on hospital patients only. It cannot be expected that all minor illnesses due to helminthiasis will be seen in hospital, even if assessable. Only the more ill patients not amenable to household remedies will seek medical aid and even then all such patients may not elect to come to hospital but may seek help elsewhere. Also, the size of the population drained by a given hospital is not possible to estimate. The township hospitals drain not only the towns in which they are situated but also a varying portion of the surrounding countryside, depending upon communications and the seriousness of the illness. Because

TABLE 4.—*Hospital Proportional Morbidity Rates due to intestinal helminths, Burma,* 1958—1961

Diseases	1958		1959		1960		1961	
	In-patients	Out-patients	In-patients	Out-patients	In-patients	Out-patients	In-patients	Out-patients
1. Ankylostomiasis ...	140	1,260	71	794	504	616	67	322
	(0.09)	(0.05)	(0.04)	(0.03)	(0.23)	(0.02)	(0.03)	(0.01)
2. Roundworm ...	1,044	76,095	828	74,579	1,082	95,187	1,100	95,027
	(0.66)	(2.92)	(0.48)	(3.03)	(0.50)	(3.13)	(0.54)	(3.0)
3. Tapeworm	73	1,347	68	1,206	89	1,550	67	1,141
	(0.05)	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.03)	(0.04)
Total ...	1,257	78,702	967	76,579	1,675	97,353	1,234	96,490
	(0.80)	(3.03)	(0.56)	(3.11)	(0.77)	(3.20)	(0.61)	(3.05)
Total of all hospital cases ...	157,201	2,601,648	173,329	2,459,339	218,341	3,039,565	202,631	3,159,920
Coverage (Towns) ...	214		210		245		303	

* Figure in parentheses denote the percentage of total cases. *Source* :-Directorate of Health Services (Annual Health Statistics Reports).

TABLE 5.—*Inter-Regiona comparison of Hospital Proportional Morbidity Rates due to intestinal helminths*, 1958—1961

Division/State	1958			1959			1960			1961		
	Helminths cases	All cases	Per cent	Helminths cases	All cases	Per cent	Helminths cases	All cases	Per cent	Helminths cases	All cases	Per cent
1. Arakan ...	1,910	95,982	2.0	2,610	113,522	2.3	4,800	154,846	3.1	2,728	115,889	2.4
2. Irrawaddy ...	10,309	288,510	3.6	12,375	327,139	3.8	17,751	357,918	5.0	16,273	379,307	4.3
3. Pegu ...	9,212	339,192	2.7	12,546	367,566	3.4	13,139	414,340	3.2	15,840	505,801	3.1
4. Tenasserim ...	12,657	129,956	9.7	16,032	225,088	7.1	15,518	222,089	7.0	17,328	217,187	8.0
5. Mandalay ...	4,090	303,045	1.3	3,602	199,794	1.8	6,248	378,290	1.7	3,986	295,269	1.3
6. Magwe ...	3,905	225,611	1.7	2,826	183,999	1.5	4,301	239,876	1.8	3,888	275,254	1.4
7. Sagaing ...	6,556	158,660	4.1	4,625	86,602	5.3	10,536	315,593	3.3	9,718	257,672	3.8
8. Chin Special ...	7,970	117,176	6.8	8,552	110,372	7.7	7,534	84,843	8.9	9,157	112,185	8.2
9. Shan ...	5,382	421,594	1.3	3,413	367,242	0.9	4,967	367,975	1.3	6,459	500,341	1.3
10. Kayah ...	1,714	28,743	6.0	283	20,155	1.4	680	16,341	4.2	727	18,676	3.9
11. Kachin ...	5,705	197,613	2.9	6,652	232,174	2.9	6,654	215,903	3.1	8,351	271,396	3.1
12. Kawthoolei ...	1,963	38,348	5.1	1,566	25,408	6.2	1,703	37,421	4.6	2,320	68,761	3.4
13. Rangoon ...	8,586	414,419	2.1	2,464	373,607	0.7	5,197	452,471	1.1	949	344,813	2.8
Total ...	79,959	2,758,849	2.9	77,546	2,632,668	2.9	99,028	3,257,906	3.0	97,724	3,362,551	2.9

Source : Directorate of Health Services (Annual Health Statistics Reports) Intestinal Helminths here is meant for ascariasis, Ankylostomiasis and tapeworm).

TABLE 6.—*Inter-Regional comparison of Hospital Proportional Morbidity Rates due to intestinal helminths specified, 1958—1961*

Division/State	1958						1959					
	Ankylostomiasis		Round Wrom		Tape Worm		Ankylostomiasis		Round Worm		Tape Worm	
	No.	Rate %	No.	Rate %	No.	Rate %	No.	Rate %	No.	Rate %	No.	Rate %
1. Arakan	...	...	1,910	2.0	...	...	...	...	2,435	2.1	175	0.1542
2. Irrawaddy	10	0.0035	9,900	3.4	399	0.1383	18	0.0062	12,270	3.8	87	0.0273
3. Pegu	11	0.0032	9,071	2.7	130	0.0383	5	0.0014	12,541	3.4	...	...
4. Tenasserim ...	759	0.5840	11,889	9.1	9	0.0069	750	0.3332	15,257	6.8	25	0.0111
5. Mandalay	31	0.0102	4,045	1.3	14	0.0046	2	0.0010	3,171	1.6	429	0.2147
6. Magwe	3	0.0013	3,796	1.7	106	0.0470	...	...	2,802	1.5	24	0.0130
7. Sagaing	...	...	6,556	4.1	...	...	...	...	4,625	5.3	...	...
8. Chin Special ...	120	0.1024	7,848	6.7	2	0.0017	...	...	8,552	7.7	...	...
9. Shan State ...	65	0.0154	4,744	1.1	573	0.1360	8	0.0022	2,997	0.8	408	0.1110
10. Kayah State ...	...	...	1,714	6.0	...	...	...	...	283	1.4	...	...
11. Kachin State ...	81	0.0410	5,596	2.8	28	0.0142	82	0.0353	6,556	2.8	14	0.0060
12. Kawthoolei State ...	...	...	1,958	5.1	5	0.0130	...	...	1,566	6.2	...	...
13. Rangoon	320	0.0772	8,112	2.0	154	0.0372	...	...	2,352	0.6	112	0.0300
Total ...	1,400	0.0507	77,139	2.8	1,420	0.0515	865	0.0329	75,407	2.9	1,274	0.0484

TABLE 7.—*Inter-Regional comparison of Hospital Proportional Morbidity Rates due to intestinal helminths specified,* 1958—1961—(concld.)

Division/State	1960						1961					
	Ankylostomiasis		Round Worm		Tape Worm		Ankylostomiasis		Round Worm		Tape Worm	
	No.	Rate %	No.	Rate %	No.	Rate %	No.	Rate %	No.	Rate %	No.	Rate %
1. Arakan	7	0.0045	4,791	2.9	2	0.0013	...	...	2,728	2.4	...	...
2. Irrawaddy	16	0.0045	17,578	4.9	157	0.0439	10	0.0026	16,047	4.2	216	0.0569
3. Pegu	119	0.0287	13,003	3.1	17	0.0041	4	0.0008	15,810	3.1	26	0.0051
4. Tenasserim	437	0.1968	15,074	6.8	7	0.0032	362	0.1667	16,772	7.7	194	0.0893
5. Mandalay	19	0.0050	6,181	1.6	48	0.0127	2	0.0007	3,910	1.3	74	0.0251
6. Magwe	...	...	3,574	1.5	727	0.3031	...	...	3,697	1.3	191	0.0694
7. Sagaing	1	0.0003	10,498	3.3	37	0.0117	...	...	9,718	3.8	...	...
8. Chin Special	1	0.0012	7,533	8.9	...	...	...	...	9,157	8.2	...	...
9. Shan State	497	0.1351	4,116	1.1	354	0.0962	...	...	6,044	1.3	415	0.0829
10. Kayah State	...	...	678	4.1	2	0.0122	...	...	727	3.9	...	...
11. Kachin State	18	0.0083	6,583	3.0	53	0.0245	11	0.0041	8,305	3.1	35	0.0129
12. Kawthoolei	...	...	1,703	4.6	...	...	...	...	2,315	3.4	5	0.0073
13. Rangoon	5	0.0011	4,957	1.1	235	0.0519	...	...	897	0.2601	52	0.0151
Total ...	1,120	0.0344	96,269	3.0	1,639	0.0503	389	0.0116	96,127	2.9	1,208	0.0359

Source : Directorate of Health Services (Annual Health Statistics Reports).

TABLE 8.—*Mortality Rates due to helminths specified during* 1958—1962

Diseases	1958		1959		1960		1961		1962	
	No.	* Rate	No.	* Rate	No.	* Rate	No.	* Rate	No.	* Rate
1. Ankylostomiasis ...	6	0.3	8	0.3	13	0.6	85	3.6	...	...
2. Other diseases due to helminths.	337	14.7	237	10.3	344	16.9	236	10.0	172	14.9
3. All other diseases classified as infective and parasitic.	45	2.0	153	6.7	104	5.1	19	0.8	54	4.7
Total ...	388	16.9	398	17.3	461	22.6	340	14.5	226	19.6
Deaths due to all causes	44,625	1,940.7	45,181	1,966.8	40,626	1,998.5	43,536	1,842.4	21,856	1,892.3

* Rate per 100,000 population.

Source : Directorate of Health Services (Annual Vital Statistics Reports).

of the foregoing considerations only hospital proportional morbidity rates have been considered. These rates will reflect, within the limits of the accuracy of the diagnosis, the proportion of hospital patients who are suffering from the more serious manifestations of intestinal helminthiasis. They will indicate the relative numerical importance of intestinal helminthiasis in hospital practice. It is impossible to be certain what relation such hospital proportional morbidity will have to conditions in the community. It is expected that the proportional morbidity due to intestinal helminthiasis will probably be much higher in the community than in hospitals.

The mortality rates are not only based on hospital deaths, but include all deaths due to helminthiasis within the municipal areas of towns. As such, the figures, though more representative in a sense have rendered diagnoses less dependable. Also, all helminthic diseases except ankylostomiasis have been grouped together, making them far less informative.

1.3.2 *Ascariasis*

As stated previously, objective measurement of morbidity due to ascariasis is very difficult and there is relatively little factual information concerning it. The prevalence of *Ascaris* infection might provide an index of the degree of morbidity due to this worm. In selected places it might also be possible to have some indication of the morbidity from the gross complication of ascariasis by detailed studies, frequently retrospective, of hospital admissions.

It is not known for certain what clinical manifestations are being diagnosed as ascariasis in Burma. It is generally acceded that gastro-intestinal symptoms such as intestinal colic or diarrhoea may lead to the diagnosis of ascariasis, especially if they occur in children. There may or may not be associated features of malnutrition. It is seldom that the pulmonary and skin manifestations of larva ascariasis are diagnosed as such, even when seen.

Mortality rates for ascariasis are not available. With regard to morbidity the Health Statistics Reports of the Directorate of Health Services, for the years 1958—61 show that out of a total of $2\frac{1}{2}$ to 3 million out-patients annually

treated at Township and District Hospitals in Burma, ascariasis accounts for approximately 75,000 to 100,000, being 3% of the total number. Among in-patients 800 to 1,100 patients or only 0.5% approximately are diagnosed as having ascariasis. These figures would have been more meaningful if expressed separately for adults and children. At least double the value of 3%, that is about 6% to 10%, would be a crude estimate of the hospital proportional morbidity in children.

Compared with reports from Ceylon where ascariasis is said to be the third-ranking cause of death in children, the above proportional morbidity rates do not seem to be high (15).

Definitive studies of morbidity due to ascariasis are very few in Burma. According to one study at the Children's Hospital, Rangoon, over 95% of about 200 children who had gastro-intestinal symptoms suggestive of ascariasis expelled the worms on being given piperazine (Dr. Khin Myo Win, personal communication). This appears significantly higher than the infection rate of 20% in the general patient population of that hospital In another study only 13% of children with diarrhoea had *Ascaris* ova in the stools on direct smear examination, in contrast to 88% in 25 controls (16). Even allowing for the dilution factor in diarrhoea stools, *Ascaris* infection does not seem to be a significant cause of these diarrhoeas.

As stated earlier, only gastro-intestinal symptoms tend to be taken as indicative of ascariasis. It is not known what the frequency is of pulmonary and skin manifestations due to larval ascariasis in Burma. Reports from other countries indicate that mortality due to pulmonary manifestation may be considerable in nyperendemic areas. Among aborigines in Queensland the mortality among children (3 months to 5 years), mostly attributed to "pneumonia" was high (29% to 54% of total deaths). After mass treatment of children for ascariasis, deaths fell to 8% (12).

With regard to the surgical complication of ascariasis in children 5, 6 and 11, children respectively underwent surgery at the Children's Hospital, Rangoon, during the years 1965-66-67 because of complications such as obstruction of the intestine or bile duct, appendicitis and intestinal

perforation (Dr. Pe Nyunt, personal communication). In comparison, 73 cases of intestinal obstruction due to ascariasis were seen in a single hospital in Ceylon in one year and 127 cases of biliary ascariasis alone were seen in a single Vietnamese clinic in a one year period (15).

In adults, surgical complications of *Ascaris* infection are a rarity in Burma, although not unknown. No studies of adult morbidity due to ascariasis have been made in Burma. The general impression is that the proportion of adults with gastro-intestinal symptoms due to ascariasis is much less than children.

It is probable that the quantity of anthelmintics in demand would bear a relation to the need and therefore to the morbidity due to ascariasis. The Burma Pharmaceutical Industry production of piperazine (BURAZINE) during the years 1962 through 1967 was 1,084,000, 598,000, 865,000, 1,645,000 and 1,529,000 oz. respectively; that is, about 1 to $1\frac{1}{2}$ million adult doses or more annually. In addition, the UNICEF imported into Burma during 1961 through 1967, 5,610,000 tablets of piperazine for distribution to the Rural Health Centres which is about 100,000 average adult doses per annum. Thus about 2 million adult doses of piperazine were consumed annually, the bulk of it by the approximately 10 million children in Burma. This figure would be an estimate of the minimum demand for piperazine and indicates the morbidity due to ascariasis among children.

Definitive data on morbidity and mortality due to ascariasis is meagre but after consideration of all the aforementioned facts and with due regard to the experiences in other countries this Committee is of the opinion that in children in Burma, the morbidity directly attributable to ascariasis is noteworthy, but that in relation to other causes of morbidity in this country, it cannot be considered as large. Death directly due to *Ascaris* infection is probably very small. In adults, definitive factual information is even less available, but in view of the smaller prevalence of infection and again drawing from the experiences of others, it is concluded that adult morbidity and mortality due to ascariasis is also insignificant in relation to other factors.

1.3.3 *Hookworm disease*

It is not clear on what basis the diagnosis of hookworm disease has been made in the cases reported from hospitals. Commonly, it is made when anaemia and general debility is associated with the presence of hookworm eggs in stool.

During the years 1958—61 the maximum number of patients annually treated for hookworm infection were 1,280 out-patients and 140 in-patients throughout the country. The highest proportional morbidity rates during the same period are 0.23% for in-patients and 0.05% for out-patients. These figures would have been more informative if separately available for the sexes and different age groups. The inter-regional comparison of hospital proportional morbidity rates show a constant pattern of high rates in the Tenasserim Division and low rates in Magwe, Mandalay and Sagaing Divisions. The hospital proportional morbidity rates are obviously very low even in the Tenasserim Division, the highest recorded being 0.5%.

The predominant symptom and cause of disability due to hookworm infection, at least in adults, is iron deficient anaemia. This aspect of morbidity is fully discussed under nutritional deficiencies due to intestinal helminths.

1.3.4 *Enterobiasis, Trichuriasis and other intestinal helminthiases*

In the Health Statistics Reports about 70 to 90 cases of Taeniasis were stated to have been treated annually as in-patients during the years 1958—61, and about 1,000 to 1,500 as out-patients. It is not known what the diagnostic criteria were and is presumably the passage of segments by the patients. These patients comprise about 0.04% of the total patient number.

A heavy, *Trichuris* infection may cause symptoms such as chronic diarrhoea and abdominal pain. Persistent and massive infection may produce rectal prolapse and in endemic areas trichuriasis may be the leading cause of rectal prolapse in children. *Strongyloides* infection may cause enteritis with severe abdominal pain and diarrhoea.

Trichuriasis has not been separately reported in the Annual Returns from hospitals and the morbidity from it in Burma is not known. Similarly, other intestinal helminths found in Burma—*Strongyloides*, *Hymenolepis* and *Enterobius* —have not been separately reported in the morbidity

returns from hospitals in Burma, and the extent of the morbidity they cause is not known. With regard to enterobiasis it is the impression of some that it causes a considerable degree of morbidity in children.

1.3.5 *Animal helminths*

Animal intestinal worms found in Burma and which are potential causes of human intestinal infections are: *Taenia taeniarfomis*, *Dipylidium caninum*, *Fasciolopsis buski*, and *Gastrodiscoides hominis* (U Tha Khin, Veterinary College, personal communication).

1.4 Effect of intestinal helminthiasis on the nutritional status of the people of Burma

The complexities of host-parasite nutritional relationships have been studied by many investigators. It is stated in the Report of the WHO Expert Committee on Nutrition and infection that social and cultural factors determine the ways in which infection can influence nutritional status, and that the clinical consequences depend on the state of nutritional inadequacy at the time the infection is acquired. An infection may have no serious consequences in a well nourished individual, but in persons already in a precarious nutritional state it can set off a fatal chain of events (17). Again it was observed by Smith (18) that "except in the case of a few individual nutrients, the better the host's diet, the poorer the state of the parasites. Conversely, again with a few exceptions, it is the host with the poor diet and in a low state of nutritional health who harbours the most prosperous parasites." The above observations are also relevant to intestinal helminthiasis, and their effect on nutrition requires to be viewed against the background of the nutritional status of the country, as may be assessed from the results of nutritional surveys and the physical development of the people.

1.4.1 *Results of Nutrition Surveys*

Maung Gale in 1939—41 (19), WHO/FAO/Govt. of Union of Burma in 1954—57 (20) and the Inter-departmental Committee on Nutrition for National Defence (ICNND) in 1961 (21) carried out countrywide clinical nutritional and

dietary surveys in Burma, most of which took place in the rural areas. The results show that the Burmese diet in general contains:

(*a*) sufficient calories, vegetable proteins and niacin,

(*b*) just sufficient amounts of fats, iron and ascorbic acid,

(*c*) insufficient quantities of animal proteins, vitamin A and thiamine,

(*d*) very low quantities of calcium and riboflavin.

The incidence of clinical signs of deficiency encountered are in agreement with the dietary data. The incidence of angular lesions is 18 to 28 per cent, of gingivitis 1 –8 per cent, and Bitot's spots were found only in 0.5 per cent or less of the population surveyed. Protein malnutrition in any form was not recognized. Goitre is highly prevalent in the mountainous areas of the Chin Hills and the Kachin State and the Shan States, the prevalence rate being 50 to 90 per cent. In other parts of Burma the ICNND survey noted up to 100 per cent of grade 1 and 2 goitres among civilians.

Biochemical tests were done only by the ICNND team. Urinary excretion of thiamine, riboflavin, nicotamide and serum determinations of vitamin C, vitamin A, carotene and proteins were carried out. Except for urinary thiamine and riboflavin the other tests were found to be within normal limits. It should be noted that although urinary thiamine levels were suboptimal no frank cases of thiamine deficiency were found during the survey. Hemoglobin surveys by the Anaemia Research Project using the cyanmethemoglobin method gives mean values of 14.4 g/100 ml for men and 12.5 g/100 ml for non-pregnant, non-lactating women. The percentage incidence of men with Hb. less than 14 g was 30 per cent and of women with Hb. less than 12 g was 35 per cent (22).

Nutritional deficiencies due to intestinal helminthiasis, especially ascariasis, are expected to be more evident in children particularly of the pre-school age group. Of the civilian sample of 2,003 on whom the ICNND did clinical examinations, 587 or 29 per cent were below 15 years. In

TABLE 9.—*Nutritional data on children*

	Maung Gale (school children) %	Postmus (school children) %	ICNND (less than 15 years) %
Bitot's spot	.07	.55	.45
Phrynoderma	.77	15.2	3.4
Gingivitis	8.1	1.0	1.7
Angular lesions	18.2	18.4	21.2
Urinary thiamine excretion (deficient).	...	...	4.8
Urinary riboflavin excretion (deficient).	...	...	8.6
Serum Vit. A (deficient)		...	28.6
Serum Vit. C (deficient)		...	0

their biochemical survey, only 8—35 subjects below 15 years were included for the various tests. The results in children are summarized in Table 9.

As in adults, frank cases of beriberi were not encountered in children. But, infantile beriberi is frequently seen in hospital. In 5 months, over 500 cases of infantile beriberi comprising 14% of the total Medical admissions were seen at the Children's Hospital, Rangoon (23).

Kwashiorkor was also not seen in the surveys conducted, but clinical cases were observed in various hospitals in Burma (Dr. Tin U, personal communication). During 1966, 421 out of a total of 10,134 admissions (4%) into the Children's Hospital, Rangoon, were cases of Kwashiorkor, with a case fatality rate of 38 per cent (Dr. Khin Myo Win, personal communication).

Although the extent of nutritional deficiency among the school-going age group may be estimated from the above data there is no factual basis even for a crude estimate with respect to the situation in pre-school age groups. The nutritional deficiencies found in the school-going age group are similar to those found in the general population surveyed.

1.4.2 *Measurement of physical development*

Anthropometric studies of the Burmese have been made by various investigators (19, 20, 21, 24). The mean adult height reported ranges from 63.1 inches to 66.1 inches in males and from 59.1 inches to 60.3 inches in females. The mean weights range from 108.5 lb. to 134.1 lb. in males and from 94.2 lb. to 105.2 lb. in females. These are manifestly lower than those from the developed countries.

In comparing the growth curves of Burmese school children from Aung San with those from Britain, Ko Ko observed that the Burmese children are already handicapped by the age of 5 years. At 5 years of age the British children are heavier than the Burmese by 2-3 years in terms of physical age and this difference even increases to the equivalent of 4-5 years of physical age in certain age groups. The difference in heights are not so marked but Burmese children were found to be shorter by 3-4 inches in corresponding age groups or by the equivalent of 1-2 years in terms of physical age. The gain in height of these Burmese children (5—15 years) runs parallel to that of the British but the curves for weight, by inspection alone, are slightly divergent suggesting a relative lag in growth of the Burmese (24).

During the ICNND survey, comparison was made between the growth curve of Burmese children (military dependents) and the State University of Iowa growth charts. In the pre-school age, growth appears to be adequate for the first year and then becomes retarded and remains so throughout the 18 years recorded. It was however noted that many of the babies, appear to be born small and remain below Western standards even in the first year of life. In the civilian sample which contained very few children below 5 years, the growth curves of the Burmese children were again outside those accepted as adequate for American children. However, the curves themselves follow the general pattern quite well and would seem only to indicate a "smaller stature" rather than growth retardation.

The anthropometric data indicate that the Burmese are smaller in stature when compared with the Western standards. There is uncertainty as to whether growth rates are retarded in the younger age groups. It is also questionable whether it is valid to use Western standards to assess Burmese growth rates.

1.4.3 *Ascariasis as a cause of nutritional deficiency in Burma*

A WHO Expert Committee on Soil-transmitted Helminths (12) states that malnutrition is more prone to occur in the *Ascaris* ridden child and that heavy infection with *Ascaris* has been related particularly to stunting and general sub-nutrition, avitaminosis A and Kwashiorkor. Again, a UNICEF-WHO Joint Committee on Health Policy (15) notes that malnutrition in children is inextricably bound up with helminthic infection and that *Ascaris* has been among the most widely incriminated in this respect.

Also it is commonly reported in the medical literature that heights, weights and mental performance of children with ascariasis are significantly less than those of unaffected children raised under "similar" conditions without ascariasis. While convincing controls for such studies have, almost of necessity, been lacking, well controlled experimental studies on dogs and swine infected with related worms do in fact show that weight gains of infected animals, even on adequate diets, are measurably reduced.

In Burma, no studies have been undertaken relating *Ascaris* infection to nutritional deficiencies or to physical development. But, in view of the fact that ascariasis has been incriminated as bound up with subnutrition and stunted growth in children, and because of its high prevalence in parts of Burma, this Committee is of the opinion that ascariasis is a significant factor contributing to malnutrition in children in endemic areas of Burma and that, at the least, it exists as a potential threat which, when complemented by other factors such as lowered dietary intake, may bring nutritional deficiencies out to the fore.

1.4.4 *Hookworm infection as a cause of nutritional deficiencies in Burma*

The predominant cause of morbidity due to hookworm infection is iron deficiency and iron deficient anaemia. The role of hookworm infection in the causation of anaemia in Burma is being studied by the Anaemia Research Project of the Burma Medical Research Institute.

Haemoglobin-surveys have been performed by various workers. Using the cyanmethaemoglobin method, mean values of 14.4 and 12.5 respectively for males and females were obtained by Aung-Than-Batu *et al.* (22).

TABLE 10.—*Iron deficiency anaemia in adult males*

	Shan-te-gyi village	Tuywinbo village	Insein Railway Workers
Number examined	259	262	860
Number anaemic (Hb. less than 11 g)	10	9	11
Iron deficient anaemia (serum iron less than 50/ug).	0.9%	1.1%	0.8

TABLE 11.—*Hookworm infection rates in anaemic subjects*
(2 Burmese villages)

	Males	Females
Number examined	521	648
Number anaemic (Hb. less than 11 g)	19	124
Anaemics whose stools were examined	13	89
Non-anaemic controls	23	69
Number in whom hookworm ova present ...	1 1	3 4
Per cent with hookworm ova	8 4	3 7

In females, anaemia and iron deficiency is to a large extent influenced by child-birth and pregnancy. The status of iron nutriture in males form a more reliable index of morbidity due to hookworm infection. In Table 10 is shown some of the results of investigation into the causes of anaemia in males. It was observed that only 5% of the males in the various surveys have deficient Hb. levels of less than 12.0 g/100 ml. Only 1% of the males in the various studies have iron deficient anaemia. In Table 11 is shown the hookworm infection rate among anaemic males, anaemic females and their controls. It may be seen that hookworm infection is definitely not associated with anaemia in the populations studied.

While these studies show that hookworm infection is not an important cause of anaemia and iron deficiency in the areas studied, the possibility exists that in the Tenasserim Division and other areas of high prevalence, hookworm may cause significant disease, at least in pockets, if not widespread.

Although the pathogenesis is not clear it is believed that hookworm infection may cause hypoproteinemia and oedema. Serum protein levels in Burmese measured by various investigators give mean values of 7.6 to 7.9 g/100 ml and are satisfactory. Serum protein measurement or other methods of assessing protein nutriture and metabolism in hookworm infected subjects have not been done in Burma. Children with Kwashiorkor are seen in hospitals but no reports are available as to the incidence and intensity of hookworm infection in such patients.

1.4.5 *Enterobius, Trichuriasis and other intestinal helminthiases*

Trichuris is the only other intestinal worm reported to be highly prevalent in Burma. There is little evidence that it produces nutritional deficiencies such as anaemia or oedama.

1.5 Assessment of the impact on health

The most prevalent intestinal helminths in Burma, according to results of stool examinations, are *Ascaris* (3.6 to 72.0%), *Trichuris* (1.6 to 28.0%), and hookworm (0.9 to 37.8%). Enterobius is expected to be more widespread than the stool survey results would indicate. The data available is sufficient only to give a gross picture of the prevalence and distribution according to age, urban versus rural residence and geography. The intensity of infection is not known.

Morbidity due to ascariasis is difficult to evaluate and only a few definitive studies have been done in Burma. The relationship between anaemia and hookworm infection has been the subject of special studies. Hospital proportional morbidity rates for the various helminths are the only factual basis for consideration of direct morbidity.

The nutritional status of the country has been assessed by several surveys. Limited data on physical development is also available. But information about the pre-school age group is meagre. Almost no studies have been done in Burma regarding the relationship between intestinal helminthic infections and nutrition.

The assessment of the Committee regarding the impact of intestinal helminthiasis on the health of the people will necessarily be circumscribed by the gaps in the available information, but the data at hand are deemed sufficient to reveal any significant effects that may be produced.