



SURVEILLANCE AND SURVEY METHODOLOGY FOR INTESTINAL PARASITIC INFECTIONS (IPI)¹

Intestinal diseases, Parasites - ECC

Data collection CONTENTS

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ANNEXES

1. Objectives of a survey on ascariasis
2. Objectives of a survey on hookworm infections
3. Survey methods for intestinal parasitic infections

¹ This document is one in a series of papers (PDP/85.1, 85.2, 85.3, 85.5) which have been prepared by the WHO Parasitic Diseases Programme and which are intended to provide up-to-date information on technical aspects of intestinal parasitic infections control. According to the advances in technology and as experience accumulates in national control programmes, these documents will be revised. Inquiries and comments may be directed to Director, Parasitic Diseases Programme, World Health Organization, 1211 Geneva 27, Switzerland.

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1. OBJECTIVES AND REQUIREMENTS OF SURVEILLANCE AND SURVEY

Surveillance is the continuous scrutiny of the factors that determine the occurrence and distribution of disease. It consists of the collection, analysis, interpretation and distribution of relevant data for purposeful action. The general requirements of surveillance for tropical diseases have been identified by WHO reports^(1,2):

A survey is an investigation in which necessary information is systematically collected and analysed for undertaking decisions. The generalization of results depends on the extent to which the surveyed population is representative of the general population. A field survey has a more narrow sense and is usually an investigation of a few variables in a sample of the population.

The specific requirements of surveillance programmes designed for intestinal parasitic infections will have to be adapted by national health authorities to fit local conditions. The following is a list of the general requirements with suggestions on how they fit programmes for intestinal parasitic infections:

1.1 Defined objectives.

Surveillance activity must be related to defined objectives. Some generally accepted objectives of surveillance that are common to intestinal parasitic infection programmes are to:

- (i) collect and analyze basic epidemiologic data (see below);
- (ii) assess public health importance (see PDP/85.1⁽⁷⁾);

This information is needed for:

- (iii) suggesting standard case management by PHC; and
- (iv) proposing community-oriented actions or interventions.

Examples of specific objectives for a survey on ascariasis are given in Annex 1 and similar examples of specific objectives for a survey on hookworm infections are given in Annex 2.

1.2. Data collection, processing and analysis.

All data collections should be designed to meet the specific objectives and needs of the intestinal parasite control programme. Collaboration should be established on a practical ongoing basis among epidemiologists, statisticians, laboratory workers, administrators and other people responsible for action. A schedule for the routine submission of data must be prepared and encouragement given for local, internal and regional dissemination of the information. Sampling techniques should be as simple as possible and relevant to the local cultural situation and the practical realities of the health services. Selected data should be presented regularly to all relevant levels of staff with varying levels of interpretation and with graphic presentations where possible.

1.3. Logistics.

The diagnostic laboratory facilities and materials required to support the intestinal parasite surveillance programme should be assessed. Particular care should be taken to set up appropriate channels for the ordering, supply and transport of reagents and supplies, and to assure adequate budgetary support.

1.4. Communications.

The surveillance system should be able to avail itself of all existing forms of communication to facilitate the exchange of information, increase understanding of the programme in the population, and implementation of the control programme.

1.5. Disease notification systems.

Most intestinal parasitic systems are not notifiable, however, the development of a surveillance system will require the creation of standard case definitions and notification methods (see Section 2).

1.6 Training.

Emphasis should be placed on training and leadership development for both national surveillance and peripheral units by involving all members of the surveillance team in continuing in-service training and regular feedback of information. The publication of a practical field manual on survey and census methods that is relevant to the local situation, could be useful.

2. ELEMENTS OF SURVEILLANCE

All surveillance programmes should contain the basic components of

- (i) a system for data collection,
- (ii) a system of data analysis, and
- (iii) a system of response.

Surveillance programmes should be suitable for a variety of situations, they should require a minimum of time and resources, and they should be sufficiently informative to guide decision-makers. Beyond these basic requirements, national surveillance programmes can assume any character and dimension. Because intestinal parasitic diseases are varied in their distribution prevalences and in their public health importance, it is not possible to lay down specific formulae for the conduct of surveillance that will fit all situations. The following brief review of the elements of surveillance (summarized in Table 1) will provide some guide to health administrators and show how one or more of these elements may be adapted for the national surveillance of intestinal parasitic infections.

2.1 Mortality registration

Although carried out in many countries, and especially useful for the surveillance of certain infectious diseases, mortality registration has limited value for most intestinal parasitic infections. It can be of considerable value for specific parasitic conditions, such as Taenia solium, cysticercosis, amoebic dysentery and liver abscess, hookworm anaemia and abdominal complications of ascariasis. Whenever possible, records of post-mortem examinations or hospital data should be used to obtain information.

2.2 Morbidity reporting

Most intestinal parasitic infections are not diagnosed, nor are they notifiable, nor even reported when recognized. Nevertheless, there are several intestinal parasitic syndromes that are commonly reported in hospital records. These include hookworm anaemia, intestinal obstruction from ascariasis, amoebic dysentery and liver abscess, neurocysticercosis, etc. whose presence or absence can provide useful national epidemiologic information. Other, less dramatic, parasitic conditions may require the establishment of special morbidity reporting systems based, for example, on the number of parasitoses diagnosed in a laboratory, on the number of outpatients or inpatients admitted because of intestinal parasitoses, or on the amount of anthelmintics used.

2.3 Individual case investigation

Individual case investigation has value as a possible indicator of a cluster, however, it is more useful in acute diseases than in chronic diseases. It can also be important in special circumstances where newly recognized pathogenic species, e.g. cryptosporidiosis, S. fuelleborni strongyloidiasis, or new epidemiologic patterns are suspected, e.g. opportunistic infections in the acquired immune deficiency syndrome (AIDS) patients.

2.4 Epidemic reporting

Any unanticipated increase in the occurrence of disease, or signs of infection such as diarrhoea in a group of people should be reported so that studies may be undertaken to determine the course and the factors which have contributed to the epidemic.

Intestinal parasitic infections that can cause epidemics are giardiasis, amoebiasis, hymenolepiasis, taeniasis/cysticercosis, S. fuelleborni strongyloidiasis.

2.5 Laboratory investigations

Laboratory investigations are well suited to the surveillance of intestinal parasites since the organisms are identifiable in the stool by conventional laboratory techniques. Laboratory support is also essential for validation of diagnoses based on clinical criteria used in surveys. Laboratory diagnostic support for surveillance is provided mainly by regional public health institutions, but may be supplemented at the first referral level by rural or district hospitals, and at the first health level by health centres and dispensaries.

2.6 Epidemic field investigations

Investigations of epidemics are necessary to determine the cause and mechanisms of transmission, both prerequisites to control. Epidemic field investigations of giardiasis in municipal water supplies and in day-care centers are examples of the application of this element of surveillance.

2.7 Epidemiologic surveys

Epidemiologic surveys are the principal means that have been used to study the prevalence of intestinal parasitic infections in communities. These surveys may be used to monitor changes in prevalence and intensity of infection during community-oriented control and prevention schemes.

2.8 Animal reservoir surveys

Animal reservoirs have an important role in certain intestinal parasites of man, e.g. Taenia solium cysticercosis in swine. Surveys of animal populations and carcasses in abattoirs are essential to gain a complete understanding of the actual spread of a zoonotic disease or to monitor the control programmes.

2.9 Drug utilization

A variety of drugs are available for the treatment of intestinal parasitic infections. The utilization rate of locally produced or imported drugs may be informative, e.g. number of niclosamide doses used annually in a country.

2.10 Demographic and environmental data

Demographic factors such as age, sex, ethnic group, rural vs. urban origin density of population, and literacy status, as well as economic (e.g. income rates) and environmental factors (e.g. ecological zones) must be recorded, and analyzed as they may be important determinants of disease.

TABLE 1: VALUE OF SOME ELEMENTS OF SURVEILLANCE IN INTESTINAL PARASITIC INFECTIONS (see Section 2)
(ranks from + to ++)

	Ascariasis	Hookworm infection	Trichuriasis	Strongyloidiasis	T. solium taeniasis/cysticercosis	Hymenolepsiasis	Amoebiasis	Giardiasis
2.1 Mortality registration	+	+	<u>+</u>	+	++		+	
2.2 Morbidity reporting	++	++	<u>+</u>	++	++		++	+
2.3 Individual case investigation				++	+	<u>+</u>	+	
2.4 Epidemic reporting				+	++	+	+	+
2.5 Laboratory investigations	+	+	+	+	<u>+</u>	+	<u>+</u>	+
2.6 Epidemic field investigations					+	+		+
2.7 Epidemiologic surveys	++	++	+	++	++	++	+	++
2.8 Animal reservoir surveys				<u>+</u>	++		+	+
2.9 Drug utilization	++	++	<u>+</u>		+		+	+
2.10 Demographic and environmental data	+	+	+	++	++	+	+	++

3. METHODS FOR CONDUCTING A SURVEY

At the national level the survey team should consist of a parasitologist, an epidemiologist, a clinician, a health services administrator and technicians. The team would be best located in a national reference centre such as the Ministry of Health or Institute of Public Health. It could also be situated in a Medical Faculty where it would benefit from interaction with other departments and the availability of students to help carry out field studies.

The selection of the population to be studied by national surveillance should be stratified to include all components of the society. It should include a representative selection of all ecological zones and economic sectors. Variables such as agricultural vs. industrial areas, ethnic groups, literacy rates, sanitary conditions, income level, etc. should be recorded since they are disease determinants, but, at the same time, the study design should be kept as simple as possible.

Sampling may be done either by a random sample method or by purposeful selection. Random sampling is preferred because it minimizes selection biases and facilitates generalization of the results. The sampling method may operate by either selecting individuals; or clusters, i.e. households, villages; or a stratified group, i.e. school-children, miners.

The minimum sample size for a prevalence study depends on the expected prevalence rate and the tolerable margin of error; for examples, see Annex 3. If a national survey is carried out by mobile teams it may be useful to calculate the sample size on the density and distribution of the population, e.g. one in every 200 households in urban areas or one in every 100 households in rural areas.

The collection and central analysis of surveillance data should lead to purposeful action. This may be short-term corrective action in the case of an epidemic, e.g. water-borne giardiasis, however, for most of the intestinal parasitic infections this means using the data for planning efficient long-term control and prevention programmes.

4. EXAMPLES OF A SURVEY IN IPI

Two practical examples of how surveillance programmes were organized by national health administrations with the assistance of the Parasitic Diseases Programme, WHO, are given. It should be emphasized that in most national situations where a surveillance programme is indicated, there will be gaps in essential resources such as the existence of previous data, skilled people, and a laboratory base. However, these gaps should not deter health administrators from innovating with the existing resources and requesting external assistance to fill these gaps and thereby create valuable surveillance programmes.

4.1 Field study in Peru.

A training course/seminar on the surveillance, prevention and control of intestinal parasitoses was organized by the Institute of Tropical Medicine "Alexander von Humboldt", Lima, Peru, the WHO Parasitic Diseases Programme and the WHO Regional Office for the Americas. The seminar was attended by 22 participants from 12 different regions of Peru. They included academicians, health service personnel, missionaries, a technician, and two visiting experts from Venezuela. A total of 40 instruction hours were devoted to laboratory diagnosis, epidemiology and control of intestinal parasitic infections.

A plan for a national survey of intestinal parasitic infections in Peru was discussed and created (see Annex 3). It was agreed that the sampling unit would be the family and the minimal sample size for each geographic area would be 250 people, i.e. about 50 families. Since a random selection of families was not possible, a purposeful selection was accepted. The areas were selected by each investigator in urban, suburban, and rural strata in each of 12 geographic regions of Peru. Standard methods and laboratory procedures were used. A total of 7,414 people were examined.

At the second seminar, organized one year after, the results were presented and future action was discussed. The survey showed that the distribution of intestinal parasitic infections in Peru varies greatly according to the ecologic zones. In dry coastal regions, giardiasis (7-12%) and hymenolepiasis (3-35%) predominate; in the Andes, ascariasis (1-53%), trichuriasis (3-37%), *E. histolytica*, amoebiasis (0-35%), giardiasis (0-30%) and hymenolepiasis (3-35%) are quite common and some zoonotic infections occur (fascioliasis, taeniasis, paragonimiasis); in the lower Amazonian jungle, ascariasis (25-100%), trichuriasis (40-94%), hookworm infections (20-77%) and strongyloidiasis (0-30%) are most common, but giardiasis (0-11%) and amoebiasis (2%) are also present. The survey also revealed some valuable information about the clinical importance of ascariasis (intestinal obstructions are common in the Amazonian region) and amoebiasis (dysentery and liver abscess are common in Arequipa and in the Amazonian regions).

The health centres are now positioned to continue and to extend their activities with more epidemiologic observations, evaluation of the public health importance of other intestinal parasites, i.e. hymenolepiasis, giardiasis, strongyloidiasis, taeniasis and fascioliasis, and further training and health education. Specific pilot studies and interventions are needed in the hyperendemic foci of ascariasis (Sepahua), hymenolepiasis (Lima, Trujillo), giardiasis and amoebiasis (Arequipa), strongyloidiasis (Santa Clara) and taeniasis/cysticercosis (Puno and Cajamarca). The efficacy of the control programmes will depend much on the availability of safe and cheap drugs for community-oriented chemotherapeutic intervention.

Major health programmes are expected to incorporate the problems of intestinal parasitoses more actively: diarrhoeal diseases control (giardiasis, amoebiasis and strongyloidiasis), water and sanitation (ascariasis as an indicator of sanitation), nutritional projects (deworming, malnutrition due to giardiasis and hymenolepiasis); occupational health (hookworm anaemia in miners and road construction workers), control of zoonoses (taeniasis/ cysticercosis), education in health, and finally, primary health care.

4.2 Field study in Lesotho.

A pilot survey of intestinal parasitoses was organized in Lesotho by the Ministry of Health, the Irish Medical Laboratory Project, the Clinical Laboratory of the Queen Elizabeth II Hospital in Maseru and the Parasitic Diseases Programme, World Health Organization, Geneva.

Information on intestinal parasitoses in Lesotho was very fragmentary. Limited manpower and transportation resources do not permit examination of more than 400 faecal samples. Therefore, it was decided to perform a survey among schoolchildren in 20 schools around the capital of Maseru.

A total of 381 faecal specimens were examined. Three hundred and eleven specimens came from randomly selected schoolchildren in the Maseru District: 157 samples were collected in eight rural schools, 62 samples in three periurban schools, 92 samples in five urban schools, and 70 samples from various groups of children. Each stool specimen was examined by direct smear stained with MIF and Kato-Katz technique.

In total, 54% of faecal specimens were found positive, 53.0% for intestinal protozoa and 4.5% for intestinal helminths. This pilot survey found that those intestinal parasitic infections that are transmitted from person-to-person, such as hymenolepiasis (3%), giardiasis (17%) and other protozoan infections are very common in schoolchildren in the Maseru District. This prevalence pattern is typical for dry, hot and crowded countries. This is also true of the finding of a high prevalence of giardiasis in day-care centres. On the other hand, soil-transmitted helminthiasis were rare in the Maseru District probably due to the dry climate, lack of vegetation around the houses, and a relatively good standard of sanitation. The parasitological survey could be extended to other areas of Lesotho and to other age groups in order to obtain a more complete picture of the prevalences of intestinal parasitic infections in the country. The pilot survey performed with assistance of WHO/PDP has offered a good start for these activities.

5. DECISIONS FOLLOWING A SURVEY

The process of taking decisions on an intestinal parasitic infections (IPI) programme should start with:

5.1 The analysis of available data on distribution, prevalence and public health significance of IPI (see Table 2).

5.2 In case the data are inadequate, a basic or additional survey should be considered as justified and necessary.

5.3 The next step of the process is an analysis of the feasibility of an IPI programme following a survey. The feasibility is a sum of different elements, each of which may be existing or not, adequate or inadequate. The major elements are: a national reference centre (a leading institution or person), medical and paramedical cadres in periphery of health services, funds, laboratory base (both manpower and equipment) and finally a communication system (including transportation) necessary for working contacts and coordination. In case some elements of an IPI programme are not adequate, the improvement of feasibility is necessary by creating a reference centre, training of cadres, search for funding, improvement of laboratory based and communication system.

5.4 In many areas only some IPI's are of a significant public health importance; therefore the decisions should be taken on each infection separately. The choices are:

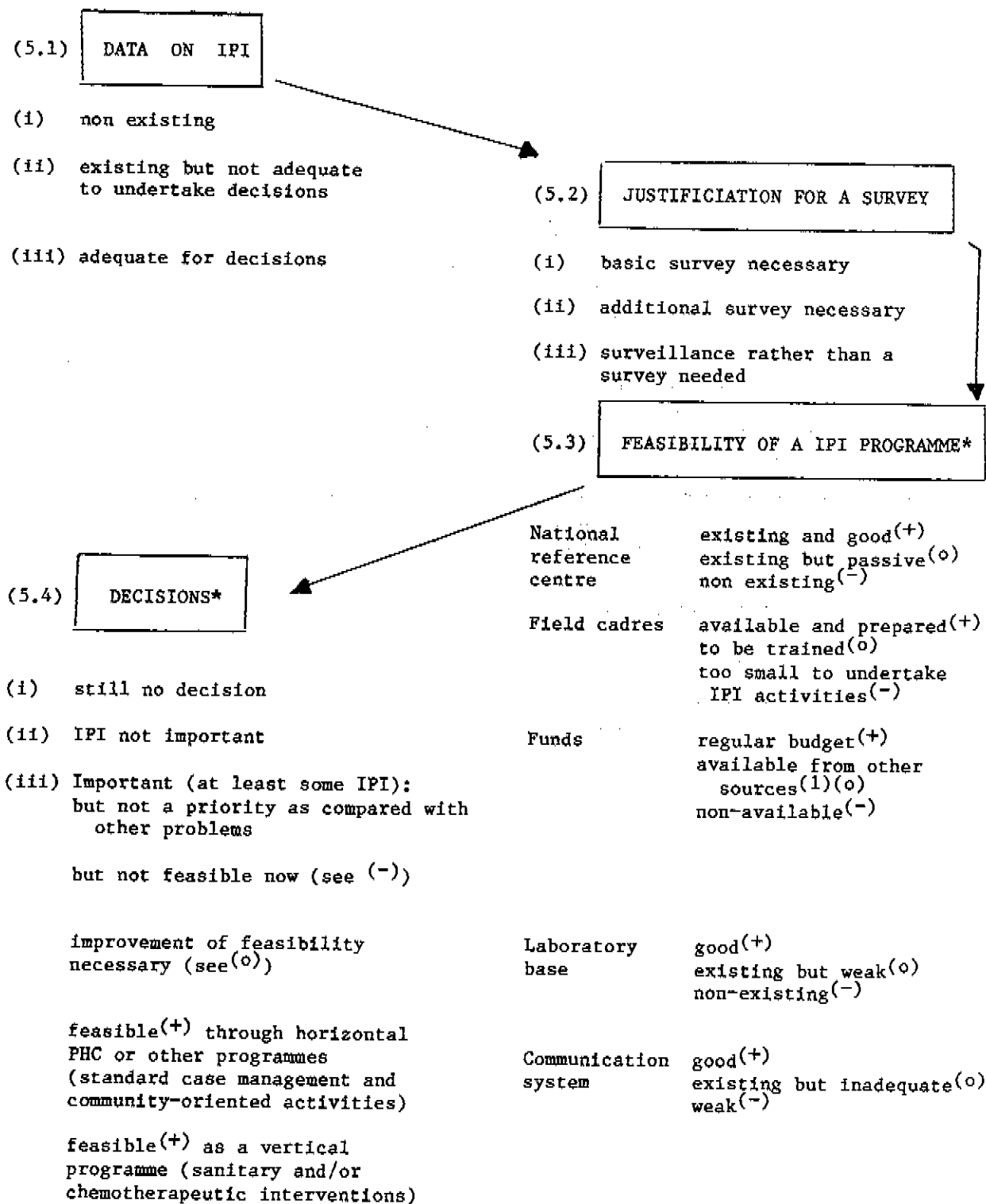
- (i) do nothing, if IPI's are not locally important;
- (ii) improve the feasibility of the future programme, if inadequate; or
- (iii) implement horizontal and/or vertical programmes.

For details see also the following documents:

Planning, implementation, monitoring and evaluation of the control of intestinal parasitic infections (IPI) programmes (PDP/85.3)⁽⁷⁾; and

Diagnostic techniques for intestinal parasitic infections applicable to primary health care (PHC) services (PDP/85.2)⁽⁸⁾.

TABLE 2: PROCESS OF TAKING DECISIONS ON AN IPI PROGRAMME (see Section 5)



*(Signs +, - and o refer to the signs in column 5.3)

REFERENCES

1. WORLD HEALTH ORGANIZATION: Report of a Study Group on surveillance of tropical diseases, Atlanta, Georgia, USA, 27-32 March 1978 (TDR/EPID-SWG(2)/78.4). Presented at Scientific Working Group on Epidemiology, Geneva 3-7 July 1978.
2. WORLD HEALTH ORGANIZATION. Intestinal protozoan and helminthic infections. Report of WHO Scientific Group. Technical Report Series, 666, Geneva, 1981.
3. PAWLOWSKI, Z.S. Strategies for the control of ascariasis. Annales de la Société Belge de Médecine Tropicale, 64, 125-134, 1984.
4. ANDERSON, R.M. The population dynamics and control of hookworm and roundworms infections. In: Population Dynamics of Infectious Diseases: Theory and Applications. Anderson, R.M. (ed), Chapman and Hall, London, 67-108, 1982.
5. HAYASHI, S. A model for the evaluation and assessment of the effect of control of the soil-transmitted helminthiases. In: Collected Papers on the Control of Soil-Transmitted Helminthiases, Vol. I, APCO, Tokyo, 265-273, 1980.
6. WORLD HEALTH ORGANIZATION. Field studies on the relation between intestinal parasitic infections and human nutrition. Report of an Informal WHO/UNICEF Consultation, Geneva, 5-8 May 1981 (NUT/81.3 and PDP/82.4)
7. WORLD HEALTH ORGANIZATION. Planning, implementation, monitoring and evaluation of the control of intestinal parasitic infections (IPI) programmes (PDP/85.3)
8. WORLD HEALTH ORGANIZATION. Diagnostic techniques for intestinal parasitic infections applicable to primary health care (PHC) services (PDP/85.2)

ANNEX I

OBJECTIVES OF A SURVEY ON ASCARIASIS⁽³⁾

The survey on ascariasis should concentrate on the following objectives:

1. To collect and analyse basic epidemiological data:

- prevalence and intensity of infection
- distribution : age, sex, profession,
country-wide or stratified or focal
- transmission : year-round or seasonal,
promiscuous defecation of children,
use of night-soil,
household type, food-borne, dust-borne,
reproduction rate⁽⁴⁾
reinfection rate⁽⁵⁾
- most heavily infected segment of population : children under 5-years, school-
children
- environmental reservoir : eggs survival time in soil
degree of soil contamination.

2. To assess public health importance

- interaction with nutrition⁽⁶⁾
- frequency of surgical complications due to ascariasis
- use of specific anthelmintics (amount of the drug and cost)
- frequency of seeking medical help or hospitalization because of "worms".

3. To suggest standard management by PHC:

- treatment of diagnosed cases: drug, dosage, contra-indications
- treatment of suspected cases: malnourished children
- improvement of local sanitation.

4. To propose community-oriented interventions:

- selection of the best drugs, dosage, timing
- proper monitoring and evaluation of results
- links with other programmes, health education, sanitation,
improvement of nutrition, maternal and child care, workers health.

OBJECTIVES OF A SURVEY ON HOOKWORM INFECTIONS

The survey on hookworm infections should concentrate on the following objectives:

1. To collect and analyse basic epidemiological data:

- prevalence and intensity of infection
- species : Ancylostoma, Necator
- distribution : age, sex, profession, widely distributed or focal
- transmission : year-round or seasonal, related to profession and/or sanitation, reproduction rate
- most heavily infected segments of population : adolescents, workers.

2. To assess public health importance:

- hookworm anaemia : prevalence, severity, mortality (critical intensity of infection), other endemic anaemias (malaria, hemoglobinopathies), iron in diet, iron store in individuals
- hookworm anaemia as a cause of seeking medical help or hospitalization (other anaemias?)
- use of specific anthelmintics or iron supplementation.

3. To suggest standard management by PHC:

- treatment of anaemic patients: anthelmintic (dosage, timing) and iron
- iron supplementation in pregnant women
- improvement of sanitation.

4. To propose a target chemotherapeutic programme (e.g. in mines or plantations):

- selection of target population
- selection of the best drug, dosage and timing
- iron supplementation programme
- coordination with other deworming actions
- links with health education and sanitation
- proper monitoring and evaluation of the programme

ANNEX 3

SURVEY METHODS FOR INTESTINAL PARASITIC INFECTIONS

1. Objectives

1.1 General objectives:

- to assist in the rational implementation of diagnosis, treatment, prevention and control of intestinal parasitic infections into health services (including primary health care services - PHC) or through specific interventions.

1.2 Specific objectives:

- (i) to collect basic data on prevalence, intensity and distribution of intestinal parasitic infections in local populations;
- (ii) to study the transmission;
- (iii) to study the pattern of major local intestinal parasitic infections and the public health impact of major local intestinal parasitic infections;
- (iv) to analyse the results (i, ii and iii);
- (v) to formulate action-oriented solution to health problems identified;
- (vi) to collaborate with local health services on rational diagnosis, treatment, prevention and control measures against major local intestinal parasitic infections.

2. Selection of population to be studied

For representative selection use stratification by:

- 2.1 ecological zones, if different;
- 2.2 demographic factors (rural, urban, suburban, age, sex, density of population, ethnic groups, literacy);
- 2.3 economic factors (agricultural v. industrial area, standard of living conditions, sanitary standards, income).

3. Sampling of population to be studied

3.1 Sampling methods are as follows:

- (i) random selection (by equal chance, important if generalization of results is intended);
- (ii) purposive selection (by deliberate choice of investigator who feels that the sample chosen is representative of the study population).

3.2 Sampling design may cover:

- (i) individuals selected from a population;
- (ii) cluster sampling by:
 - household (family) or village (an area in a town);
- (iii) stratification sampling by:
 - age (pre-school and/or school children)
 - profession (miners or plantation workers), or
 - health status (in-patients, out-patients).

4. Sampling size

The minimum sample size based on random sampling for estimating the prevalence of a condition in a population depends on:

- (i) the expected prevalence rate (%),
- (ii) the margin of error tolerated; and
- (iii) the degree of confidence that is required of the estimate, e.g. the estimate should fall within the stated interval with 95% confidence).

There are some tables to calculate the minimum sample size required. For major intestinal parasitoses (ascariasis, hookworm infections, giardiasis), for example, if the expected prevalence rate is 20% and it is necessary to be 95% confident that the true prevalence lies within 5 percentage points of that 20% (i.e. between 15 and 25% prevalence), then a minimal sample size of 246 people will be required. If the expected prevalence is 5%, and it is necessary to be 95% confident that the true prevalence is within a one percentage point (i.e. between 4 and 6% prevalence), then a sample of at least 1,825 people would be needed.

A useful alternative to random sampling in some situations is systematic sampling in which every 4th and 10th etc. person or household is sampled. Sample size requirements can be calculated on the same basis as random sampling above. One example of this approach is to examine:

- one in every 200 households in urban areas,
- one in every 100 households in rural areas, or
- one in every 50 households in rural areas with dispersed houses.

This sampling may be useful if a national survey is carried out by mobile teams.

5. Variables

Variables are the characteristics measurable either numerically (e.g. age) or in categories (absence or presence of infection or anaemia; light, moderate and heavy infection).

Variables should be as many as necessary, but as few as possible. They should be clearly defined and reproducible. For the latter purpose, only simple standardization techniques can be applied which will minimize the precision (individual, subject and observer's variations) and the accuracy of the technique (sensitivity and specificity of method).

Groups of variables in these studies are as follows:

5.1 Parasitological variables are quantified by:
(essential variables to be examined or observed are marked by*)

Ascariasis:

- (present, absent)* - direct smear, KATO or KATO-KATZ technique
- (unfertilized eggs present)* - as above
- (egg count)* - KATO-KATZ technique
- (number of parasites) - after deworming (in sub-samples)

Hookworm infections:

- (present, absent)* - KATO or KATO-KATZ technique
- (egg count)* - KATO-KATZ technique
- (differentiation between Necator and Ancylostoma) - HARADA-MORI technique
- (number of parasites) - (in 10% sub-samples)
- after deworming (in sub-samples)

Trichuriasis:

- (present, absent)* - KATO or KATO-KATZ technique
- (egg count)* - KATO-KATZ technique

Giardiasis:

- (cysts present, absent)* - direct smear

Amoebiasis:

- (haematophagous trophozoites present, absent) - direct smear with fresh faecal material
- (E. histolytica trophozoites present, absent) - TRICHROME technique (in sub-samples)
- (E. histolytica cysts present, absent) - direct smear or TRICHROME technique (in sub-samples)

Others, i.e. balantidiasis, isosporidiasis, cryptosporidiosis, strongyloidiasis, taeniasis*, hymenolepiasis*

(present or absent)

5.2 Individual variables

- Age (in years)* - by questioning or from documents
- Sex (male or female)* - by observation
- Weight (in kg - to the nearest)* - by weighing
- Height (in cm)* - by measurement
- Haemoglobin level - by measurement (using haemoglobinometer)
- Parasite-related diarrhoea (present, absent) - by questioning if more than 3 stools daily for 3 days or more in the last 2 weeks

5.3 Area variables:

- | | | |
|--|---|--|
| "Worms" as a major cause of seeking medical help* | - | number of out-patients with "worms" or hookworm anaemia as first diagnosis/per week in proportion to all diagnosed out-patients |
| Use of specific anthelmintics: | - | by surveying the annual sales to hospitals and pharmacy shops (amount of drugs, expressed in average dosage for an adult) |
| - in local hospitals | | |
| - in local pharmacy shops | | |
| Surgical complications of ascariasis (number of intestinal or bile duct obstructions diagnosed and/or requiring surgery) | - | by examination of hospital records during the last five years and calculating a percentage to other diagnoses or surgical interventions. |

6. Protocol for recording variables

The protocol should be prepared in a way which best fits the local resources and facilities. This can be done by hand tally of data, by the use of MacBee cards, or preferably by microcomputer.

7. Analysis of results

Analysis is a fundamental component of surveillance. It should not only summarize the continuous data but also try to understand the major ways of transmission. Analysis should lead to formulation of action-oriented solutions to the health problems shown by the data (see Annexes 1 and 2).

8. Final report

The final report should be concise, readable, contain sufficient information and suggestions for action-oriented solutions to permit informed decision-making by the appropriate health administration.