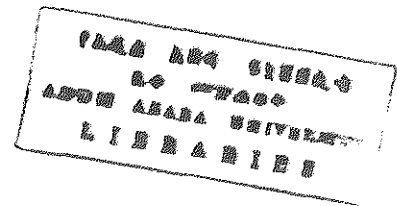


ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

ONCHOCERCIASIS: RELATIONSHIPS BETWEEN INFECTION
LOAD, SKIN MANIFESTATIONS AND SOCIO-ECONOMIC
INDICES IN PAWI AREA, NORTH WESTERN ETHIOPIA



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ONCHOCERCIASIS: RELATIONSHIPS BETWEEN INFECTION LOAD, SKIN
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NORTH WESTERN ETHIOPIA

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ABSTRACT

A study to determine a rapid screening method for onchocerciasis was conducted between April 10 and July 15 1996 in a populations of 5 villages, Manbuk area located in Pawi, North west Ethiopia. Out of the total 3,385 censused persons 766 (22.6%) residents of age five years and above, of whom 509 (66.4%) were heads of household, were included in the study. The 509 heads of household were interviewed to explore information on the socio-economic indices and about the populations knowledge of onchocerciasis. Parasitological and skin examination were conducted on the 766 individuals who showed up to participate in the study.

Results of the questionnaire survey indicated that the community actually knows about onchocerciasis, including its social and economic impacts. The parasitological examination by using skin snips revealed an overall prevalence of 43.7% and a geometric mean microfilarial density (MFD) of 13.62 mf/mg both reaching peak at the age of 25-34 years, especially among males. Farmers and those in the lower socio-economic strata appeared to be at more risk of infection. A relatively higher prevalence and MFD was found in the indigenous population than settlers. Skin examination revealed the presence of acute papular onchodermatitis (APOD), chronic papular onchodermatitis (CPOD), depigmentation (DPM) and palpable onchocercal nodules (PON) in a higher proportion of the population. The major skin manifestations were highly correlated with infection load, with correlation coefficients (r) of 0.81, 0.83, 0.82, 0.79, and 0.89 for APOD, CPOD, LOD, DPM AND PON, respectively. This indicated that any one of the major skin manifestations may be used to identify high risk communities for onchocerciasis. However, it is recommendable to use the PON since it showed the strongest correlation with both skin snip prevalence and microfilarial load. Furthermore, even lay men can be trained to quickly diagnose it because of its most obvious clinical presentation. Strong relationships also were detected between skin manifestations and socio-economic variables, with farmers and poorer persons in other occupation tending to have more severe skin manifestation. In conclusion, it is recommendable that: a) members of the lower economic strata in general, and the indigenous population and farmers in particular be given high priority in onchocerciasis control programs; b) the PON detection technique, in comparable ecogeographic regions of Ethiopia, for rapid screening of communities and mapping of onchocerciasis, be adopted; c) selection of 30% nodules which corresponds to a 90% skin snip prevalence in adult population can be used as the most appropriate local criteria for assigning a community as a high priority for control.

1. INTRODUCTION

1.1. Global magnitude

Onchocerciasis or river blindness, is a parasitic disease caused by a filarial worm known as *Onchocerca volvulus*. The prevalence and severity of onchocerciasis as well as the magnitude of the associated health, social and economic effects vary widely in different geographical areas where the disease occurs (WHO, 1987).

Although control of onchocerciasis in the Onchocerciasis Control Program in Volta river basin (OCP) has been highly successful, the disease remains endemic in 34 countries in the world of which 26 are in Africa Region, six in the Americas, and two in the Eastern Mediterranean Region. Current estimates show that about 18 million people are infected worldwide, of which 17.5 million are in Africa. Furthermore, it is estimated that 122.9 million people or more are at risk globally and of these some 118.1 million are in Africa alone. The remaining foci are distributed in Yemen and Latin America (WHO, 1995).

The disease is a major cause of public health and socio-economic problem of considerable magnitude in many tropical countries, particularly in Africa, the Arabian Peninsula and Latin America. In Africa, onchocerciasis has been associated with an

increased incidence of both epilepsy and hyposexual dwarfism, although no causative association has been clearly demonstrated (Nelson, 1970). These health, social and economic consequences of onchocerciasis affect families, communities and the nation at large in a number of ways. For instance, in hyper-endemic areas of West Africa, the effect of river blindness has led to the decline and desertion of villages; reduced viability of communities; limited population movement; increased disability and premature mortality (Nwoke, 1990; WHO, 1995).

The effects of onchocerciasis on the labor supply have presented a major concern especially in countries where it is endemic. There is adequate evidence to show that onchocerciasis affects the effective supply of labor in three ways: (1) as a cause of permanent disability through blindness and serious visual impairment; (2) partial visual impairment and or other disabling manifestations may also reduce the efficiency of labor days worked; and (3) onchocercal itching and skin disfigurement (Blanc, 1970; Thylefors, 1978).

It was observed that onchocercal blindness is concentrated in the working age groups and reaches very high levels in hyperendemic areas. In focal, often remote areas, devoid of access of roads and medical facilities, more than 10% of the population can be blind and up to 50% of the productive adult population can be visually disabled (Nelson, 1970;

Thylefors). Current estimates (WHO, 1995) show that of the 18 million people that are infected with onchocerciasis globally, some 270,000 are blind; in addition, a further 500,000 are severely visually disabled.

The low population densities and desertion of many fertile river valleys in the savannah zones of West Africa have become another example of the adverse effects of onchocerciasis on the availability of land in Africa (Nwoke, 1990).

In general, the socio-economic consequences of onchocerciasis are most marked in the hyper-endemic belt that extends across sub-Saharan Africa, excluding the West African countries in the original OCP area, where the burden of onchocerciasis has been greatly reduced as a result of the control. In the hypo- and meso-endemic areas in Africa, in the Arabian peninsula and in Latin America, where blinding onchocerciasis is less prevalent the socio-economic consequences of onchocerciasis are poorly known (WHO, 1995).

1.2. Onchocerciasis in Ethiopia

In Ethiopia the occurrence of Simulid vectors and onchocercal disease were first confirmed in Keffa and Illubabor regions, South-western Ethiopia, as early as 1939 by Italian workers (cited in Tatischeff *et al.*, S., 1993). Oomen (1969a) estimated the

number of microfilariae carriers in the endemic regions of Keffa, Wollega and Illubabor (area of 132,000 km²) to be about half a million.

Subsequent studies (Torrey, 1966; Oomen, 1967a, b; Oomen, 1968; Oomen, 1969a; Iwamoto *et al.*, 1973; TenEyck, 1973; Desole and Walton, 1976; Desole and Kloos, 1976; Woodruff *et al.*, 1977; Lester and Tsega, 1974; Mengesha and Jembere, 1975; Mengesha and Tiruneh, 1977; Abdella and Abubaker, 1975; Zein, 1986, 1988; Taticheff, 1987, 1993; Workeneh *et al.*, 1993; Yeneneh *et al.*, 1989; Aga *et al.*, 1995; Adugna *et al.*, 1996) have confirmed that the disease is endemic in a number of communities in southwestern, western and Northwestern parts of the country.

Recently, it is estimated to extend over about 300,875 square kilometers (Zein, 1988).

An overall estimate of one and half million infected people were reported by Zein (1988). WHO (1987) estimated the number of people at risk of onchocerciasis in endemic areas of Ethiopia to be about 7.3 million and those infected about 1.38 million. However, Zein estimated the population at risk of infection to be about 10 million (Zein, 1988).

The point prevalence determined by skin microfilariae detection ranges from a high of 82-84% in Western endemic zone (Gunderson *et al.*, 1988) through 56% in South-West (Iwamoto *et al.*, 1973; Desole and Walton, 1976; Desole and Kloos, 1976; Woodruff *et al.*, 1977) to a low of 19.5% in the North-West (Zein, 1986; Adugna *et al.*, 1996). In general, prevalence is greater in the low lands than in the high lands (Oomen, 1969a, b; Gunderson *et al.*, 1988).

In general, in view of increased emphasis on the development of large river basins and population resettlement programs in forest and/or savanna areas transacted by these rivers, onchocerciasis is expected to be one of the major public health problems in the future.

1.3. Parasite life cycle

The vector, which is principally *Simulium damnosum*, ingests microfilariae with human blood meal and larval development takes place in its thoracic muscles. Microfilariae develop over 6-12 days into third stage infective larvae (L₃) (Collins, 1979; Takaoka, 1981). When the vector takes a blood meal the L₃ larvae are injected into the human blood. The L₃ larvae travel in the circulation to the final site and molt into the adult form (L₄) during the process of feeding on blood. After maturing and mating in the host

skin, the adult female worms start producing microfilariae. Production of microfilariae continues throughout the productive life span of the female worm. After the end of productive life span, microfilariae can still be detected, but only for a limited period because their longevity of around 1-2 years (Duke *et al.*, 1990; Duke, 1993) is relatively short in comparison with the longevity of the adult worm. The first microfilariae produced by adult females may appear in the skin some 10-15 months after infection (Schulz-Key, 1990).

The adult worms live in fibrous nodules, some of which are subcutaneous and palpable while others lie deep in the connective and muscular tissues. The living worms are white and transparent, with distinct transverse striations of the cuticle. The male worms (3-5 cm) are relatively small and mobile, the females (30-80 cm) are long and thin and they have a life span of 9-14 years (Duke, 1993). The females produce abundant microfilariae (250-350 μ m in length), which migrate from the nodules to invade the skin, eyes, and some other organs and have a life span of about 6-24 months (WHO, 1987, 1995).

Onchocerca volvulus is believed to be the only species that develops to maturity and produces microfilariae in the skin of human beings (Duke, 1990a). However, *O. volvulus* is not a uniform species throughout its range and, several studies have revealed

distinct geographical strains with differences in their vector infectivity and in their pathogenicity (Anderson *et al.*, 1974; Cianchi *et al.*, 1985; Flockhart *et al.*, 1986; Vuong *et al.*, 1988; Botto *et al.*, 1988; Merdith *et al.*, 1991; Fischer *et al.*, 1995). These differences are thought to explain some of the major differences in the epidemiology of the disease in the rain-forest and savanna regions of Africa and Latin America.

1.4. Control measures

The two principal tools now available are vector control through larviciding, and chemotherapy with ivermectin. While it would be highly desirable to have a vaccine its development is still in infancy. Other possible interventions (such as nodulectomy and personal protection) are limited practical value for onchocerciasis control (WHO, 1995).

Vector control through larviciding has been effective in achieving the interruption of transmission and in the eventual elimination of the parasite reservoir. However, vector control has been very expensive, implying that, in endemic areas, interruption of transmission by means of vector control is feasible only through large-scale national or multinational activities such as those conducted by OCP, and is beyond the means of the endemic countries themselves (Remme *et al.*, 1986, 1990; Plaisier *et al.*, 1991; Cupp *et al.* 1992).

The main control strategies in current use are therefore, morbidity control by ivermectin treatment, elimination of the parasite reservoir, and prevention of recrudescence. The characteristic of ivermectin, single dose, prolonged microfilarial effect, and absence of harmful side-effects (Taylor and Green, 1989) make it highly suitable for controlling the disease effectively. By rapidly reducing or clearing the skin of *Onchocerca volvulus* microfilariae, ivermectin also decreases the ability of infected individuals to infect vector black flies (Guillet *et al.*, 1995). However, because of the limited effect of single dose ivermectin on transmission, treatment may have to be given repeatedly over a long period of time (Cupp *et al.*, 1992). The combined use of ivermectin and vector control has hence, opened new prospects for carrying out onchocerciasis control operations.

1.5. Clinical manifestations

The disease is mainly characterized by subcutaneous nodules, dermal, lymphatic and ocular manifestations. It causes severe itching, disfiguring skin lesions, and a variety of eye lesions that may lead to blindness. Besides, several other features of uncertain association, etiology or pathogenesis have also been described, including low body weight, general debility, diffuse musculoskeletal pain and, in Africa, epilepsy and hyposexual dwarfism (WHO, 1987, 1995).

Most of the signs and symptoms of onchocerciasis are attributable to the presence of microfilariae in the tissues. There may be 50-200 million microfilariae present in a heavily infected *O. volvulus* carrier and only a very small proportion of these are ingested by feeding *Simulium*. The majority of microfilariae are never ingested and they eventually die in the tissues causing scarring and disease (WHO, 1976). The main pathological changes that occur as a result of onchocerciasis appear to be directly or indirectly related to the local death of microfilariae (Otteson, 1995; Ward *et al.*, 1988). The mechanism through which infection leads to disease symptoms at specific locations is not completely understood, but a direct effect of the immune response against the microfilarial stage of the parasite, resulting in ADCC and/or the complement-mediated destruction of microfilariae, is assumed to be involved in the origin of the clinical symptoms of the skin and eyes (Elson *et al.*, 1995). However, several studies support the role of immune complex, autoimmunity, immunologic cross-reactivity and IgE-mediated immune response in the pathogenesis of onchocerciasis, particularly dermal and ocular onchocerciasis (Van-der-Lelij *et al.*, 1990; McKeehn *et al.*, 1993a, b; Meilof *et al.*, 1993; Cooper *et al.*, 1996). Onchocerciasis is generally viewed as an immune-mediated disease, in which the host response to the parasite, particularly microfilariae in the skin and eyes, leads to tissue damage.

In general, there is a wide spectrum of clinical manifestations associated with onchocerciasis and there are marked geographical variations. The possible explanations for these geographical variations are based on differences in intensity and duration of parasite transmission, biting behavior of the vectors, virulence and behavior of the local strain of parasite and by variations in host response due to race, nutrition, immunity or the presence of concomitant infections with other organism (Anderson *et al.*, 1974; Porter *et al.*, 1988; WHO, 1987).

In Ethiopia the commonest clinical manifestations of lowland and rain forest onchocerciasis are said to be severe, debilitating and disfiguring onchodermatitis, onchocercal nodules and depigmentation especially of the pretibial region (Oomen, 1967a, 1968, 1969a; Iwamoto *et al.*, 1973; Desole and Walton, 1976; Woodruff *et al.*, 1977) although adeno-lymphocel, cervical, femoral, and inguinal lymphadenopathy, and scrotal elephantiasis have also been reported (Mengesha and Jembere, 1975; Aga *et al.*, 1995).

Blindness as relates to onchocerciasis is reported to be low in Ethiopia (WHO, 1987, 1995; Tatchieff, *et al.*, 1993). However, since most of the previous studies were conducted in hypo-endemic areas, it has been suggested that more ophthalmological surveys are needed in areas where onchocerciasis transmission are very high (Aga, *et*

al., 1995)

1.6. Diagnosis

The diagnosis of onchocerciasis can be made by clinical examination for the presence of onchocercal skin and eye lesions, and onchocercomata, by the parasitological examination of skin snips, conjunctival snips, blood or urine for microfilariae, by immunodiagnostic methods and, in selected cases by provoking a Mazzotti reaction (or post-treatment clinical changes) with diethylcarbamazine (DEC) (WHO, 1987).

In endemic areas, clinical diagnosis of onchocerciasis can be performed by examining the skin and ocular manifestations. Although much has been published about signs and symptoms of onchocerciasis, and some investigators have suggested that signs such as depigmentation or leopard skin (Edungbula, et al., 1987) and subcutaneous nodules (Taylor et al., 1992) could be useful indicators of endemicity, no systematic studies have been undertaken in a defined population to compare these and other potential rapid assessment methods with skin snips as the reference standard. However, Kollo et al. (1995) evaluated the potential diagnostic indicators of onchocerciasis such as subcutaneous nodules, depigmentation or leopard skin, microfilaruria, DEC patch test positivity, excoriations, and pruritus in the rain forest region of southern Cameroon for

usefulness in rapid assessment of onchocerciasis endemicity in communities. Leopard skin and nodules showed the strongest correlation with both the skin snip prevalence and community microfilarial load, in the adult male study population. They selected $\geq 20\%$ nodules or $\geq 20\%$ leopard skin as the most appropriate local criteria for control, which corresponds to a $\geq 90\%$ skin snip prevalence in adult males (Kollo et al., 1995). However, since there is some variability in the characterization of leopard skin, the need for a simpler and readily recognizable skin onchocercal manifestation exists.

The clinical diagnosis of ocular onchocerciasis requires ophthalmological evaluation to determine visual function, the presence of intraocular microfilariae and pathological changes attributable to the infection. Visual function can be assessed by the measurement of visual acuity and pupillary reactions and by visual field examination. But ocular examination are time consuming and requires specialized techniques and an ophthalmologist (WHO, 1995).

The Mazzotti test is useful only when onchocerciasis is suspected but the parasite cannot be detected in the skin or eye. The test consists of giving a small dose of DEC usually 50 mg for an adult, and then observing the development of clinical reactions, such as itching, rash and lymphadenitis. False positivity in Mazzotti test may result in persons with gross sowda-like lesions of onchocerciasis, and/or in persons harboring microfilariae

of *Mansonella streptocerca* and *Dipetalonema* in the skin (WHO, 1976, 1987).

The detection of microfilariae in a bloodless skin snip is by far the most widely used diagnostic method for the diagnosis of onchocerciasis (Taylor *et al.*, 1989). The preferred sites for obtaining skin snips and the number of snips to be taken vary depending on the geographical strain of the parasite. In Africa two snips are required and the preferred site is below the iliac crest, whereas in South America the preferred site is behind the shoulder. However, in Yemen, the highest concentration of microfilariae occurs around the ankles (WHO, 1976). In detailed epidemiological studies, extra-skin snips should be taken from different parts of the body.

The skin snips can be taken with various instruments, including simple razor blades, sharp scissors, and the various types of scleral punches that produce relatively painless snips of fairly uniform size. Until recently, scleral punches were most commonly used because they are less painful and threatening to the patient than a razor blade and, in practiced hands, may give more uniform biopsies (WHO, 1987). However, with the advent of HIV, it has become less popular in prevalence surveys. Instead, a razor blade per person which shall be disposed after use is much safer and cheaper.

The snips are usually examined for living microfilariae either in water or in saline, and

the number of emerging microfilariae is usually counted after 10-30 minutes (Buck, 1974; Sowa and Sowa, 1975; Schulz-key, 1978). This method is however, highly modified and various compromises have been adopted, including the method used in the OCP area in West Africa of examining the skin snips after 30 minutes in water with the knowledge that at this stage only 50% of the microfilariae will have emerge (WHO, 1976).

A much more accurate method has been developed in Togo (Scheiber et al., 1976). This is an adaptation of the membrane filtration method used in filariasis surveys (WHO, 1974), in which case the skin snips are collected in saline in transparent plastic agglutination trays. A modification of this method has been developed and still used in the OCP area (WHO, 1987). Individual snips are placed in 0.3 ml of saline in the wells of the plate and incubated for 24-hours period at room temperature, and they are then preserved in the wells by adding one drop of 10% formal- saline to each specimen. The plates are then sealed with a transparent plastic sealer, and transported to a central laboratory for examination. The skin snips are then weighed and the microfilariae counted in the wet preparation.

For most epidemiological studies it is necessary to express the results quantitatively, either as the number of microfilariae per skin snip or, preferably, as the number of

microfilariae per milligram or per unit surface area or volume of skin (WHO, 1987). Further more, the result can also be expressed as the mean community microfilarial load (CMFL), i.e., the geometric mean microfilarial count per mg of skin snip (mf/mg) among persons aged greater than or equal to 20 years (Remme *et al.*, 1986). The disadvantages of skin snip method is that it often fails to detect early and light infections. However, the sensitivity is improved by taking additional snips. The more skin snips that are taken, the more accurate the diagnosis. Taylor et al (1989) has found that the overall sensitivity of 6 snips at various sites per person was estimated to be 92%.

Ultrasonography has also been used to distinguish an onchocercal nodule from lymph nodes, lipomas, fibromas and foreign body granulomas (WHO, 1995). Since the machine is non-invasive and can also detect impalpable nodules it appears to be a useful technique. However, the application of ultrasonography is limited to a few centers in endemic are because of the expensive equipment and the requirement of highly trained staff.

Species-specific and strain-specific DNA probe of *O. volvulus* has also been developed recently from a family of "Oncho-150" repeated base sequence and used in PCR to detect the parasite DNA in routine skin snips using specific primers. The probe has potential use in identifying *O. volvulus* in infected vectors; in distinguishing *O. volvulus* infective

larvae from non-human filarial larvae (such as *O. ochengi*); and could be used in differentiating between the forest and savanna formes of the parasite (Zimmerman *et al.* 1993).

The role of immunological tests utilized so far, for diagnosis of onchocerciasis were limited due to the lack of specific and characterized antigens, an ability to detect early infections, and due to frequent cross-reactivity which is pronounced in nematode infections (WHO, 1987). However, recently 37 recombinant antigens have been tested against coded serum samples from the WHO Filariasis Serum Bank (Ramachandran, 1993; Bradley *et al.*, 1993). After second and third screening, three recombinant antigens, namely Ov-7, Ov-11 and Ov-6, have been chosen for use in the immunodiagnosis of onchocerciasis. as a result of their high specificity (i.e., absence of cross-reactivity with sera from other filarial infections) and high sensitivity in detecting early infections.

2. STATEMENT OF THE PROBLEM

With the advent ivermectin, a new drug that has proved safe and effective, there is now global interest to assist endemic countries in the control of the disease through mass distribution of the drug. Now, there is a program called "African Program for Onchocerciasis Control (APOC). For Ethiopia to be part of APOC it must provide precise information on the distribution of the disease in the country. Since parasitological examination of the population is expensive and time consuming it is not a realistic way to use for mapping onchocerciasis in Ethiopia. To overcome this problem WHO (1995) recommends the use of rapid assessment methods which are based on determining the prevalence of skin manifestations particularly onchocercal nodules in a specific age/sex-group which has been found to correlate well with parasitological findings. The aim of this study was hence to find out which of the skin manifestations correlate(s) with the parasitological indices with view to recommending a rapid population screening method in Ethiopia. Extrapolation of results from other countries is not recommended due to possible variations in the skin manifestations due to differences in host and/or parasite factors and socioeconomic conditions.

3. OBJECTIVES

General Objective:-

Determination of a rapid screening procedure for onchocerciasis based on skin manifestations.

Specific Objectives:-

- a) To determine the prevalence and intensity of infection of onchocerciasis in the study population.
- b) To determine types and distribution of onchocercal skin manifestations in the infected individuals.
- c) To relate the prevalence/intensity to type and distribution of onchocercal skin manifestations.
- d) To see if onchocerciasis prevalence/intensity vary with the socio-economic status of population.

4. MATERIALS AND METHODS

4.1 Study area

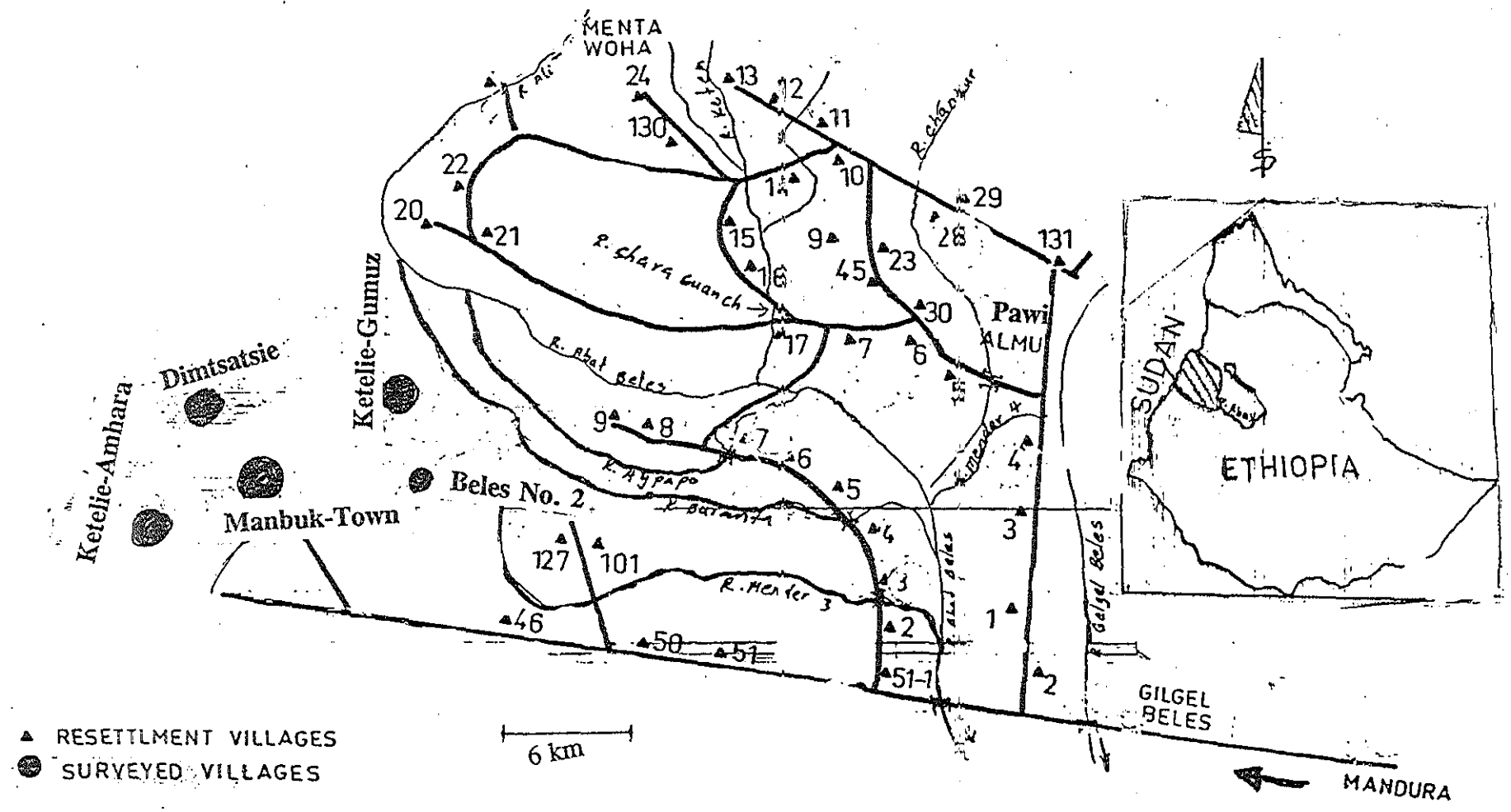
Our study area, comprising a small town called Mambuk and surrounding villages (Fig 1), is part of the Pawi Resettlement Scheme. The latter is one of the resettlement areas established in 1984/85 in response to the drought severely affected the country at the time. It is located in Metekel Administration Zone, Northwestern Ethiopia, at a distance of 600 Kms from Addis Ababa and at an altitude of 600 meters above sea level. There are about 45 villages under the Pawi resettlement scheme and more than 10 indigenous villages in the vicinity of the resettlement area.

The majority of the settlers came from drought-affected areas of Shoa (Central Ethiopia), Wollo, Tigray, Gondar and Gojjam regions (all northern Ethiopian regions). Since the villages are situated in the basins of Beles and Blue Nile rivers, both of which are within the onchocerciasis belt of Ethiopia (Gunderson et al., 1988; Raybould and White, 1979), the problem of onchocerciasis is expected to be high.

According to Nesibu Adugna (1994, unpublished data) the overall prevalence of onchocerciasis was 32.9%, while the rate in the indigenous populations was higher (38.3%) than in the resettled populations (27.4%). But the coverage of indigenous population in this study was very limited as previous studies dealt primly with the migrant population. Hence, the prevalence of the disease among indigenous population is little known.

Our specific study area, located at a distance of 35 km northwest of Pawi, was selected because of its endemicity for onchocerciasis and because it is also inhabited by both the indigenous Gumuz ethnic groups and settler populations. According to Adugna *et al.* (1994, unpublished data), the prevalence of onchocerciasis in Manbuk area was 55%. The four farming villages in the vicinity of Manbuk town were included on the basis of their accessibility and their location in relation to the main rivers.

Figure 1. A SKETCH MAP OF PAWE AREA SHOWING THE LOCATION OF THE VILLAGES SURVEYED IN RELATION TO THE MAIN RIVERS.



4.2. Population census and selection of study population

A house-to-house census was done in Mambuk and the 4 villages in order to register all residents by demographic characteristics and choose appropriate sample population for the study. In Mambuk town where the base population was big as revealed by the census heads of one-third of the household were selected for the interview while for the parasitological and skin examination it was decided to include all residents age 5 years and above from the selected households. For the remaining 4 villages because of the smaller population sizes revealed by the census it was decided to interview all heads of household and examine all residents aged 5 years and above.

4.3. Socio-economic study

For the socioeconomic study, interviews were conducted on heads of the selected household but only on those who showed up using pre-tested questionnaire (Annex 1). The questionnaire were designed to obtain information on knowledge (its local name, its cause (s), its signs and symptoms, mode(s) of transmission, treatment options and outcomes, in relation to onchocerciasis, income, education and occupation.

The questionnaire had 30 items, about half of which required yes, no or do not know responses while the remaining questions required the informant to select one or more items from several alternatives.

4.4. Skin and parasitological examination

Before the parasitological and skin examinations were conducted, the purpose of the study was explained to the chairman of the kebele/village and to influential persons in advance to obtain informed consent of the subjects.

All consenting individuals of aged 5 years and above were summoned to the nearest clinic for skin and parasitological examination. At the clinic each individual was taken to a private but well-lit room where he or she was asked to take clothes off. The skin of the individual is then thoroughly examined for onchocercal skin manifestations. This was performed by the investigator who had been trained in identification, classifying and grading of onchocercal skin diseases assisted by the resident nurse. The results were recorded in a pre-designed clinical examination protocol (Annex 2). For determining the presence/absence and distribution of onchocercal nodules particular attention was paid to examining the head, neck, scapula, elbows and forearms, wrist, ribs, coccyx, iliac crests, trochanter, knees, lower half of legs, feet and ankles. The numbers and locations

of the palpable onchocercal nodules (PON) were recorded to determine the cystic index (CI) i.e., the percentage of subjects presenting with an onchocercal cyst.

The presence or absence of other onchocercal dermal manifestations i.e., acute papular onchodermatitis (APOD), chronic papular onchodermatitis (CPOD), lichenified onchodermatitis (LOD), atrophy (ATR), depigmentation (DPM), lymphadenopathy, and lymphoedema (LYM) were noted and wherever present graded and appropriately recorded in accordance with the recommendations of WHO (1995) and Murdoch *et al.* (1993).

In addition, all consenting individuals who underwent skin examination were also parasitologically examined to determine prevalence and intensity of infection in the population. After cleaning with cotton pads pre-soaked in 70% alcohol, skin snips of about 2-3 mm in diameter were taken from both iliac crests of each individual using a disposable hypodermic needle and a razor blade. Each skin snip was separately placed in wells of flat-bottomed microtiter plate containing 0.1 ml normal saline solution. When all wells were full, the plates were numbered and covered with adhesive plaster to reduce evaporation or spillage and kept for 24 hours at room temperature.

After 24 hours the contents of each well was fixed with 10% formalin (WHO, 1976, 1987; Yeneneh *et al.*, 1989; Aga *et al.*, 1995), that is a drop (0.025 ml) of 10% formalin was added to each well and sealed with adhesive plaster then transported to laboratory. In the laboratory all the contents of each well was completely removed using Pasteur pipettes and transferred onto slides and examined under microscope at low power objective.

Each skin snip was weighed using an electronic balance (DOO30, A&D Company Limited) after blot-drying with filter paper to estimate the number of microfilariae (mf) per milligram of skin. For verification of the *O. volvulus* microfilariae, all the positive snips were stained with Giemsa (WHO, 1987) and re-examined for morphological conformation characteristics.

4.5 Data analysis

The data were coded and entered into computer using dbase 4 and analyzed using Epi-info and SPSS statistical packages as necessary. Microfilarial prevalence, geometric mean microfilarial densities (MFD) which was calculated as $MFD = \text{Sum of } \text{Log}(\text{mf}/\text{mg} + 1)/n$ (Collins *et al.*, 1992), community microfilarial load (CMFL) i.e., the geometric mean mf count per mg of skin snip among persons aged 20 years or greater (Remme

et al., 1986), cystic index (CI), and percentage of various onchocercal skin manifestations were calculated and compared by sex, age, occupation and other demographic variables. The relationships between prevalence, MFD, skin manifestations and socio-economic indices were tested using simple correlation analysis.

4.6 Ethical Issue

Attempts made to obtain ivermectin from donors and non-governmental organizations (NGOs) unfortunately were not successful. Hence, for those individuals found positive for microfilariae in the skin snips, other drugs such as mebendazole, phenegan, white petrolatum and anti-pain drugs were given free, upon prescription by the resident health worker.

5. RESULT

5.1 The Sample population

All villages combined only 509 heads of households (54% of the censused household) showed up and took the interview while for the skin and parasitological examinations only 766 individuals aged 5 years and above (22.6% of the censused population) were available (Table 1). The proportions participating by village varied from 33.2% to 92.5% for the interview and from 14.4% to 37.2% for the parasitological and skin examinations. Higher proportions of males participated in the study than females.

5.2. Community knowledge about onchocerciasis in the study villages

Out of the 509 heads of the household, 377 (74%) complained of health problems of one kind or another. Skin-related diseases were the commonest complaint (47.7%) followed by malaria (20.4) and severe cough (15.9%) (Table 2).

Table 1. Number of heads of household (HHH) and persons censused, interviewed and examined in the study villages, Pawi, 1996.

Village	Censused		Interviewed		Examined	
	No. persons	No. HHH	No. HHH	%	No. Persons	%
Beles No. 2						
Total	513	164	128	78	191	37.2
Males	258	87	82	94.3	131	50.8
Females	255	77	46	59.7	60	23.5
Dimtsatsie						
Total	591	131	97	74	147	24.9
Males	298	74	59	79.7	99	33.2
Females	293	57	38	66.7	48	16.4
Ketelie-Amhara						
Total	473	119	86	72.3	129	27.3
Males	222	65	64	98.5	100	45
Females	251	54	22	40.7	29	11.6
Ketelie-Gumuz						
Total	199	40	37	92.5	68	34.2
Males	108	38	37	97.4	58	53.7
Females	91	2	0	0.0	10	11.0
Manbuk-Town						
Total	1,609	485	161	33.2	231	14.4
Males	850	235	107	45.5	161	18.9
Females	759	250	54	21.6	70	9.2
Total	3,385	939	582	54.3	766	22.6
Males	1,736	499	349	69.9	549	31.6
Females	1,649	440	160	36.4	217	13.2

Table 2. Main health complaints of the interviewee among 509 heads of household, in the study villages, Pawi, 1996.

Complaints	Male		Female		Total	
	Number	%	Number	%	Number	%
Malaria	51	19.5	26	22.4	77	20.4
Severe Cough	46	17.6	14	12.1	60	15.9
Skin-related	127	48.7	53	45.7	180	47.7
Diarrhoea	23	8.8	12	10.3	35	9.3
Abdominal pain	6	2.3	9	7.8	15	4.0
Others*	8	3.1	2	1.7	10	2.7
Total complaints	261	69.2	116	30.8	377	74.1

* = 'Others' refers to mention of occasional headache, arthritis, non-specific generalized pain, etc.

The majority (>75%) of the respondents were aware of the signs and symptoms of the onchocercal skin-manifestations. In fact, close to 100% of the interviewee associated itching and skin rash with onchocerciasis (Fig.2). Because of the belief that it is caused by water or by living close to rivers, the term "Yewohabeshita" (disease caused by water) was recognized and routinely associated with the very unpleasant itching ("Foket") and skin rash ("Ekek").

5.3. Perceived socio-economic consequences of onchocerciasis by the interviewee.

The majority of respondents (75%) responded that onchocerciasis caused reduced labor supply and absenteeism from work. Of even more interest is the fact that over 80% said the disease causes social isolation and stigma. But very few (about 10%) mentioned that the disease causes desertion of villages (Fig. 3).

signs and symptoms

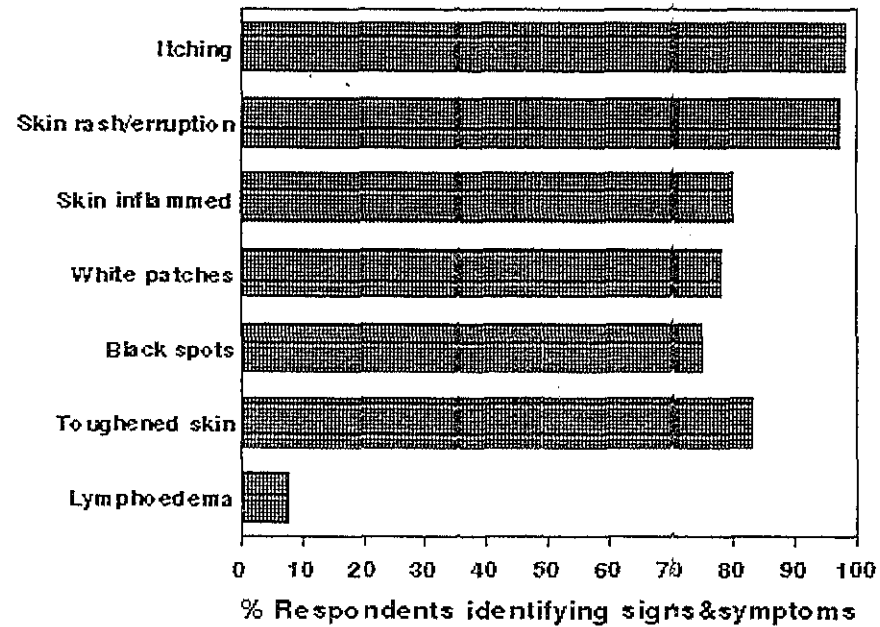


Figure 2. Knowledge about signs and symptoms of onchocerciasis among the study subjects, Pawi, 1996.

Socio-economic impact on

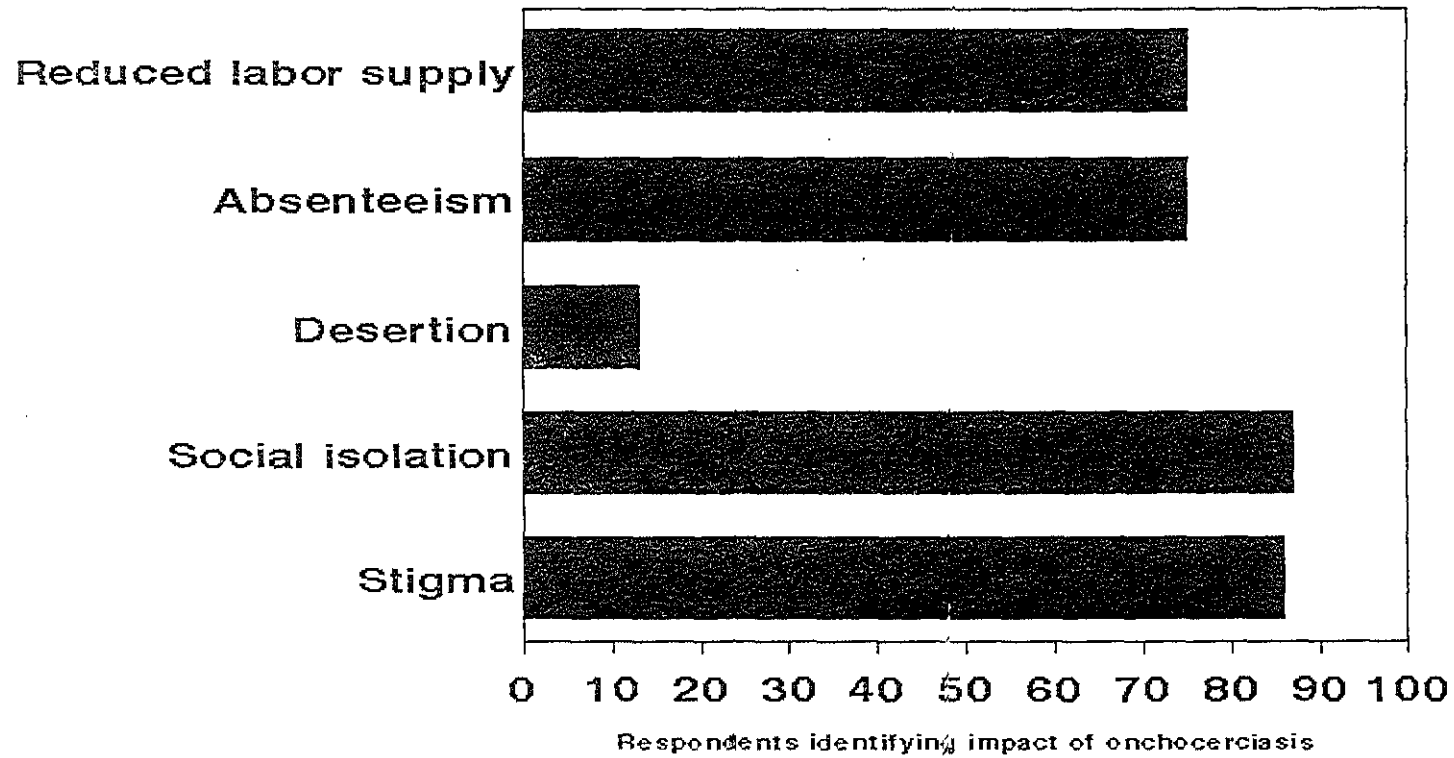


Fig. 3 Socio-economic impact of onchocerciasis identified by the 509 heads of household in the study villages, Pawi, 1996.

5.4 Prevalence of onchocerciasis in the study villages

The parasitological results are summarized in Table 3. All villages combined the overall prevalence rate of onchocerciasis determined by microscopic detection of skin microfilariae was 43.7% (335/766). The prevalence was in favour of males (50.8%) than females (25.8%) and the difference was statistically significant ($X^2 = 11.53$, $P < 0.01$). There was a steep rise in prevalence with age in both sexes until the age of 34 years with peak occurring in the 25-34 years age group in both sexes. The lowest infection rate was observed in the younger age group (5-14 years) followed by the older age group (45 years and above).

The prevalence rate by village was 59.7%, 42.2%, 29.5%, 47% and 38.5% for Beles No.2, Dimtsatsie, Ketelie-Amhara, Ketelie-Gmuz and Manbuk-town, respectively indicating that onchocerciasis prevalence is not uniform in the study villages (Table 4).

Table 3. Prevalence of onchocerciasis by age and sex, in the study villages, Pawi, 1996.

Age group years	Male		Female		Total	
	No. Exam	Skin snip Positive	No. Exam	Skin snip positive	No. Exam	Skin snip positive
5-14	109	29(26.6)	21	3(14.3)	130	32(24.6)
15-24	101	60(59.4)	72	17(23.6)	173	77(44.5)
25-34	100	79(79.0)	86	31(36.0)	186	110(59.1)
35-44	131	65(49.6)	28	4(14.3)	159	69(43.4)
45+	108	46(42.6)	10	1(10.0)	118	47(39.8)
Total	549	279(50.8)	217	56(25.8)	766	335(43.7)

() = Number in parenthesis show the percentage of positive skin snip.

Table 4. Prevalence of onchocerciasis by study villages, Pawi, 1996

	Beles No.2	Dimtsatsie	Ketelie-Amhara	Ketelie-Gumuz	Manbuk-Town
Number Examined	191	147	129	68	231
Number positive	114	62	38	32	89
Prevalence(%)	59.7	42.2	29.5	47	38.5

Prevalence of onchocerciasis by duration of residence in the villages are presented in Table 5. A higher rate of skin snip positivity (56.7%) was found in individuals who resided in the villages for more than 10 years than those with a residence period of 5-10 years (31.7%) and less than 5 years (21.7%). The prevalence of infection was highest (56.1%) among farmers, followed by civil servants (47.3%), house wives (20.4%), and dependants (16.4%) (Table 6).

For the purpose of this analysis the economic status of the surveyed heads of household was divided arbitrarily into three groups: poor (below average), medium (average) and rich (above average), based on their estimated income per month (in Birr). The properties used for estimating the income categories were cash income, number of livestock, beehives, hectares of land they owned and crop harvested in the previous years in quintals. All of the property was converted into cash equivalent based on the average local price for each item and the mean value calculated (Table 7).

A higher rate of infection (65.5%) was found in households with poor or very poor economic status than households with medium (32.5%) and relatively rich ones (31.7%) (Table 8). But the prevalence was almost the same between the illiterate and those who could just read and write whereas it was much lower among those that have elementary and above education (Table 9).

Table 5. Prevalence of onchocerciasis by duration of residence in the study villages, Pawi, 1996

	Duration of residence (years)		
	< 5 (N = 92)	5-10 (N = 268)	> 10 (N = 406)
Number positive	20	25	230
Prevalence(%)	21.7	31.7	56.7

Table 6. Prevalence of onchocerciasis by occupation, in the study population, Pawi, 1996.

Occupation	Number Examined	Number Positive(%)
Farmers	401	225(56.1)
Housewives	49	10(20.4)
Clivil servants	148	70(47.3)
Students	44	10(22.7)
Dependents	110	18(16.4)
Merchants	14	3(14.3)
Total	766	335(43.7)

Table 7. Annual income (in Kip) categories of the study population in Pawi, 1996

Economic status	Cash income	Cattle	Beehives	Crop	Total
Poor	≤ 600	≤ 200	≤ 80	≤ 250	≤ 1130
Medium	601-800	201-300	81-150	251-400	1131-1650
Rich	≥ 801	≥ 300	≥ 151	≥ 401	≥ 1651

Table 8. Prevalence of onchocerciasis by economic status of the households, in the study villages, Pawi, 1996.

Economic status	Number (%)	Number Positive(%)
Poor	351 (69)	230(65.5)
Medium	117 (23)	38(32.5)
Rich	41 (8.0)	13(31.7)
Total	509 (100)	281(55.2)

Table 9. Prevalence of onchocerciasis by levels of education, in the study population, Pawi, 1996.

Level of education	Number (%)	Number Positive(%)
Illiterate	398(52)	185(46.5)
Read and write	253(33)	112(44.3)
Elementary students	100(13)	37(37)
High school students	6(0.8)	0(0.0)
Others*	9(1.2)	1(0.13)
Total	766(100)	335(43.7)

"*" = High school graduates or above

5.5. Microfilarial density

The age-and sex-specific geometric mean counts of microfilariae per mg of skin snip (MFD) are presented in Table 10. All villages combined the overall MFD was 13.62 microfilariae per mg of skin snip. In both sexes the MFD increased with increasing age up to the age of 25-34, after which it showed a decreasing trend.

In all age groups, infected males had significantly higher microfilarial densities (24.72 mf/mg) than infected females (7.6 mf/mg) ($X^2 = 25.87$; $P < 0.01$). The highest geometric mean microfilarial count was observed in the age group 25-34 years in both sexes (males, 50.1 mf/mg and females 15.9 mf/mg). The geometric mean microfilarial counts ranged between 6 and 28.2 mf/mg and, the weight of skin snip ranged between 3.1 and 2.2 mg/mg.

The community microfilarial load (CMFL) i.e., the geometric mean mf count per mg of skin snip among persons aged 20 years and above by village varied from 7.4 to 31.6 mf/mg (Table 11). For all communities combined the overall CMFL was 13.2 mf/mg.

Table 10. Geometric mean microfilarial density (MFD) by age group and sex, in the study population, Pawi, 1996.

Age group years	Male	Female	Total
	MFD \pm SD	MFD \pm SD	MFD \pm SD
5-14	15.8 \pm 0.63	3.4 \pm 0.44	7.3 \pm 0.61
15-24	25.1 \pm 0.69	9.6 \pm 0.80	15.5 \pm 0.74
25-34	50.1 \pm 1.03	15.9 \pm 0.97	28.2 \pm 1.00
35-44	20.0 \pm 0.76	6.2 \pm 0.73	11.1 \pm 0.76
45+	12.6 \pm 0.71	2.8 \pm 0.42	6.0 \pm 0.70
All age groups	24.72 \pm 0.76	7.6 \pm 0.67	13.62 \pm 0.76

MFD = Geometric mean microfilarial density, SD = Standard deviation.

Table 11. Community microfilarial load (CMFL) by study villages, Pawi, 1996.

Village	CMFL (Mf/mg)
Beles No. 2	31.6
Dimtsatsie	7.8
Ketelie-Amhara	7.4
Ketelie-Gumuz	2.5
Manbuk-Town	8.5
Overall	13.2

5.6. Skin manifestations

Itching was reported in 53.8% of the population examined clinically (Table 12). Reactive skin lesion or acute papular onchodermatitis (APOD) was seen in 45.6% of the cases. Of these, the large majority (97%) reported to have itching. About 43% had chronic skin lesions or chronic papular onchodermatitis (CPOD) which ranged from mild to severe forms, and majority (87%) had excoriations around buttocks, waist area and shoulder. About 63% of the individuals with CPOD had also APOD, itching and other onchocercal dermal manifestations such as LOD, DPM and PON.

Texture related skin changes, such as lichenified onchodermatitis (LOD) and atrophy (ATR) were observed in 12.5% and 1.2% of the patients respectively. The majority (95%) of the patients with LOD had dark and toughened or thickened skin with itching and excoriations on one or both legs. However, all the ATR cases were seen in individuals aged less than 15 years, and were found on one or both buttocks. Onchocercal pigmentary changes or depigmentation (DPM) with white patches on one or both shins were observed in 14.1% of the patients.

Table 12. Findings of the skin manifestations in the study population, Patna - 1996.

Age group years	No. Exam	Proportion of persons with signs and symptoms							
		Itching	APOD	CPOD	LOD	DPM	ATR	PON	OSD
5-14	130	80(61.5)	55(42.3)	56(43.1)	17(13.1)	10(7.7)	2(1.5)	40(30.8)	41(31.5)
15-24	173	102(59.0)	82(47.4)	70(40.5)	21(12.1)	13(7.5)	2(1.2)	52(30)	56(32.4)
25-34	186	129(69.4)	86(46.2)	78(41.9)	27(14.5)	29(15.7)	4(2.2)	77(41.4)	82(52.7)
35-44	159	57(35.8)	68(42.8)	72(45.3)	16(10.1)	33(20.8)	1(0.6)	52(32.7)	48(30.2)
45+	118	44(37.3)	58(49.2)	50(42.4)	15(12.7)	23(19.5)	0(0.0)	33(30)	40(34)
Total	766	412(53.8)	349(45.6)	326(42.6)	96(12.5)	108(14.1)	9(1.2)	254(33)	267(35)

() = Number in parenthesis show the percentage of signs and symptoms.

APOD = acute papular onchodermatitis, CPOD = Chronic papular onchodermatitis, LOD = lichenified onchodermatitis, DPM = depigmentation, ATR = atrophy, PON = palpable onchocercal nodule, OSD = onchocercal severe dermatitis (itching + any manifestation + PON).

The prevalence of palpable onchocercal nodule (PON) was 33.2%, and it was higher in the age group 25-34 years. The cystic index (CI) i.e., percentage of subjects with PON, was significantly higher in males (76.9%) than in females (23.1%) ($X^2 = 12.7$, $P < 0.01$) (Fig 4). Of the 254 persons with PON, 42 (16.5%) had single nodule while 212 (83.5%) had multiple nodules. The range of count per person being 1-6 and mostly found in the pelvic area mainly close to coccyx and sacrum (Table 13). Onchocercal severe dermatitis (OSD) was observed in 35% of the population examined clinically.

As shown the result in Table 14 of the total of 485 persons positive by one or more signs and symptoms of onchocerciasis, 325 (67%) were also positive by skin microfilariae. Only 33% were negative for skin snip, giving a sensitivity of 97% using skin snip as a gold standard. Of 281 individuals who were negative clinically 271 (96.4%) were both parasitologically and clinically negative. Only 10 (3.6%) were skin snip positive but had no clinical sign and symptoms of onchocerciasis, indicating a specificity of 96.4%.

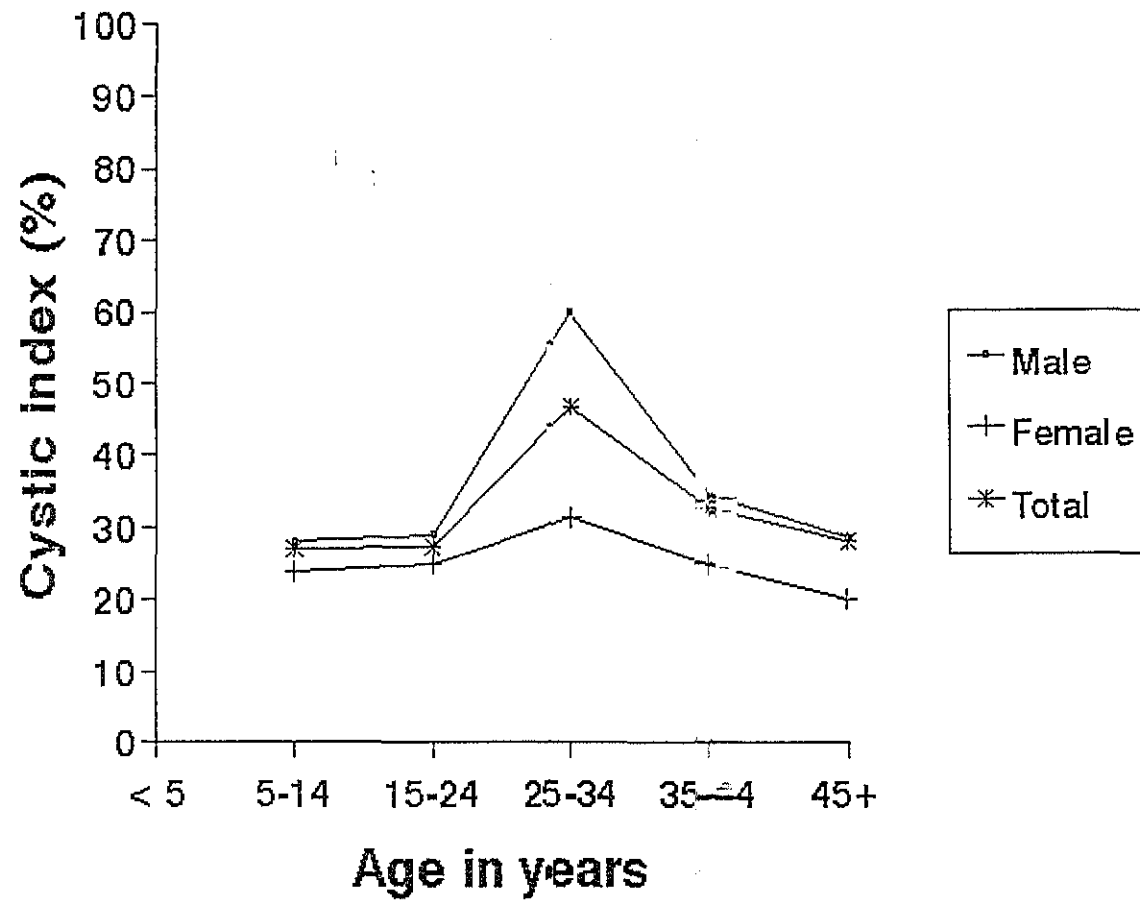


Fig. 4 The cystic index (CI) by age and sex, in the study villages, Pawi, 1996.

Table 13. Number of palpable onchocercal nodules (PON) and their anatomical distribution, in the study population, Pawi, 1996.

Anatomical site	Male		Female		Total	
	Frequency	%	Frequency	%	Frequency	%
Pelvis (Coccyx & sacrum)	156	62.4	54	72.0	210	69.3
Knee	30	13.2	13	13.3	43	14.2
Chest	20	8.8	5	6.7	25	8.3
Arms	9	3.9	3	4.0	12	4.0
Lower legs	7	3.1	0	0.0	7	2.3
Abdominal	6	2.6	0	0.0	6	2.0
Total	228	100.0	75	100.0	303	100.0

Table 14. Comparative results of skin snip positivity with skin manifestations in the study population, Pawi, 1996.

Skin snip	Skin manifestations					
	PON		OSD		Signs & symptoms	
	Pos (%)	Neg (%)	Pos (%)	Neg (%)	Pos (%)	Neg (%)
Pos	227(29.6)	108(14.1)	256(33.4)	79(10.3)	325(42.4)	10 (1.3)
Neg	27(3.5)	404 (52.7)	11 (1.4)	420(54.8)	160(20.9)	271(35.4)
Total	254(33.1)	512 (66.8)	267 (34.8)	449(65.1)	485(63.3)	281(37)

" * " = positive by one or more signs and symptoms.

When itching, one or more skin manifestations and PON is combined (defined as severe onchocercal dermatitis (OSD) 267 (35%) have severe form of the disease and of these 256 (95%) are also positive by skin snip indicating a strong relationship between severity and skin snip positivity. Out of 254 cases with PON, 227 (89.4) were positive by skin snip. Using the skin snip method as a gold standard the sensitivity and specificity of OSD are 76.4% and 84.2%, respectively while for PON these are 67.7% and 78.9%, respectively (Table 14). The sensitivity of PON would be much higher among the 25-34 years age group where peak PON was observed.

5.7. The relationship between prevalence, intensity of *O. volvulus* infections and signs and symptoms of onchocerciasis.

The correlations between prevalence, intensity of *O. volvulus* infections and signs and symptoms of onchocercal skin diseases are presented in Table 15. In general, the prevalence of positive skin snip, MFD and skin manifestations are all significantly correlated ($r=0.64 - 0.97$) with each other and with the prevalence and intensity of infections. It is of interest to note that PON is highly correlated with prevalence and MFD ($r= 0.89, 0.84$). There is also a strong association between OSD, prevalence and MFD ($r= 0.94, 0.95$).

Table 15. Correlation coefficients(r) between prevalence, intensity of *O. volvulus* infections and skin manifestations in the study population, Fawi, 1996.

	Skin snip pos.	MFD	APOD	CPOD	LOD	DPM
MFD	0.97	-	-	-	-	-
Itching	0.78	0.76	-	-	-	-
APOD	0.81	0.79	-	-	-	-
CPOD	0.83	0.73	0.84	-	-	-
LOD	0.82	0.80	0.75	0.78	-	-
DPM	0.79	0.75	0.72	0.75	0.64	-
OSD	0.94	0.95	0.85	0.89	0.90	0.86
PON	0.89	0.84	0.87	0.85	0.81	0.83

All are significant at $p < 0.01$

APOD = acute papular onchodermatitis, CPOD = Chronic papular onchodermatitis, LOD = lichenified onchodermatitis, DPM = depigmentation, ATR = atrophy, PON = palpable onchocercal nodule, OSD = onchocercal severe dermatitis (itching + any manifestation + PON).

5.8. The relationship between skin manifestations and socio-economic indices

Most of the skin manifestations were strongly associated ($r=0.88, 0.83, 0.80, 0.78, 0.75$ and 0.68) with farmers occupation (Table 16). A strong correlations ($r=0.71, 0.75, 0.68, 0.67, 0.77$ and 0.89) were also observed between skin manifestations and poorer persons. All of the skin manifestations were also significantly associated with education levels, with correlation coefficients, $r=0.62, 0.65, 0.67, 0.63, 0.66$ and 0.61 for illiterate and $r=0.53, 0.54, 0.56, 0.51, 0.55$ and 0.57 for literacy campaign educated.

Table 16. Correlation coefficients(r) between skin manifestations and socio-economic variables among 509 heads of household in the study villages, Pawi, 1996.

Socioeconomic variables	APOD	CPOD	LOI	DPM	PON	OSD
Income						
Poor	0.71*	0.75*	0.68*	0.67*	0.77*	0.89*
Medium	0.50	0.43	0.45	0.40	0.21	0.57
Rich	0.31	0.24	0.15	0.22	0.17	0.41
Occupation						
Farmers	0.83*	0.75*	0.68*	0.78*	0.80*	0.88*
Housewives	0.12	0.34	0.21	0.30	0.22	0.33
Civil servants	0.67	0.65	0.54	0.52	0.65	0.75
Students	0.14	0.35	0.20	0.13	0.18	0.25
Dependents	0.15	0.11	0.10	0.12	0.17	0.22
Education						
Illiterate	0.62*	0.65*	0.67*	0.63*	0.66*	0.61*
Read and write	0.53*	0.54*	0.56*	0.51*	0.55*	0.57*
High school	0.29	0.23	0.14	0.10	0.23	0.27

"*" = Significant at $p < 0.01$.

6. DISCUSSION

The present parasitological, skin manifestation and socio-economic investigation on *Onchocerca volvulus* infections among the inhabitants of villages close to Pawi Resettlement Area, North western Ethiopia, have revealed the public health importance and socio-economic consequences of onchocerciasis in the area. Onchocerciasis is obviously highly endemic in the study area with adverse health and social problems.

As revealed by the findings of the questionnaire interview the people know about onchocerciasis. The majority of the respondents were aware of the signs and symptoms of onchocerciasis. The disease is also perceived as a serious illness in these communities and their perceived knowledge about its impacts is very correct. They know that onchocerciasis causes reduced productivity, shortage of labor supply and absenteeism from work, social isolation and stigma. As indicated by various studies (Hwone, 1990, Workneh et al., 1993, WHO, 1993) onchocerciasis causes exactly these consequences. Local community knowledge about disease is important since it encourages community participation during disease control programs.

Judging from both parasitological and clinical findings, the area can be classified as medium (meso) endemic (WHO, 1966). Other studies carried out in the southwestern, western and northwestern parts of the country have reported hyper-, hypo- and meso-endemic levels of onchocerciasis (Taticheff *et al.*, 1988, 1993; Gundersen *et al.*, 1988; Yeneneh *et al.*, 1989; Aga *et al.*, 1995; Adugna *et al.*, 1996). Hence, onchocerciasis in this study area is less endemic than most reported results.

The prevalence rate of onchocerciasis recorded in this study was higher in males than in females, suggesting males to be at greater risk of infection. These findings are consistent with the findings of other investigators in Ethiopia (Oomen, 1969 a; Taticheff *et al.*, 1987; Yeneneh *et al.*, 1989; Aga *et al.*, 1995; Adugna *et al.*, 1996) and elsewhere (Wyatt, 1971; Anderson *et al.*, 1974; McMahon *et al.*, 1988; Brandling-Bennett, 1981). The higher rate of infection observed in males may be explained by occupation risk. Males are usually involved in activities like farming and fishing and as a result frequently visits the forest/river banks which brings them to a constant exposure to the bites of infected vectors. Unlike males, females spend a great deal of time in their houses and do not frequently visits the river banks, thus they are probably less exposed to *Simulium* bites than males. More over, the dressing habits of females, long skirts, may prevent them from *Simulium* bites hence explaining the lower rate of infection among them.

In both sexes a maximum infection rate was attained at the age of 25-34 years and the least infection was observed in the age group 5-14 and > 45 years. This probably reflects the fact that many young and old persons do not go out to work in the farm and are at less risk of the bites of infected *Simulium* flies. On the other hand, those in the 25-34 years of age are the most economically active members, a factor which exposes to the bites of blackflies. The observations that the prevalence of infection increases with age suggests that repeated exposure through years is required for onchocerciasis prevalence to rise. In any case any control program should give priority to males and to those in the 25-34 years age group.

It is of interest to note that onchocerciasis was more prevalent among the indigenous Gumuz population than among settler populations. This is consistent with the findings of previous investigators in Pawi (Adugna, *et al.*, 1994 unpublished data), in other parts of Ethiopia, in Bure, southwestern Ethiopia (Yeneneh, *et al.*, 1988) and more recently in Asossa (Adugna, *et al.*, 1996). All of the studies showed that the rate of infection is higher among the indigenous population than among the resettled population. This could probably be due to the longer duration of exposure of the indigenous population to the bites of the anthropophilic blackfly, *S. damnosum s.l.* than the settlers. But further studies are needed to cover more indigenous villages and to establish the differences in the immunological profiles between indigenous and resettled populations.

The fact that prevalence increased with duration of residence in our study population also supports the fact that prevalence rises with time. In any case, future control program should give top priority to the indigenous population.

By occupation the highest infection rate was observed among farmers and this is certainly due to their higher exposure to the bites of blackflies. Hence, future disease control programs should put emphasis on farmers as well. High prevalence rates were found in households with poor or very poor economic statuses. This could be due to occupational difference between richer and poorer persons.

It is of interest, however, that there were no much difference in the prevalence of onchocerciasis between illiterate and literacy campaign educated. Although this cannot be explained precisely, it may be due to the fact that both educated and uneducated work on lands bisected by rivers that contain the vectors, meaning both are equally exposed.

The geometric mean microfilarial load (MFD) per milligram of positive skin snip which is the measure of parasite burden, was higher in males (24.7) than in females (7.6), and increased with age up to 34 years and declined thereafter. Other investigator have also reported higher MFD in males and an increase with age (Wyatt, 1977; Brandling-Bennett *et al.*, 1981; McMahon *et al.*, 1988; Gunderson *et al.*, 1988; Moyou *et al.*, 1993). This

again supports the fact females are less exposed to infection due to a number of reasons ranging from occupation to wearing of protective clothes.

The community microfilarial load (CMFL) in the study population was 13.2 for an overall prevalence of 43.7%. Aga *et al* (1995) recorded a CMFL of 17.2 for a prevalence rate of 54.5% in southwest Ethiopia while Yeneneh *et al.* (1989) recorded a CMFL of 11.7 for a prevalence of 24.6% in western Ethiopia. In the Blue Nile Valley of western Ethiopia, Gunderson *et al.* (1988) recorded a CMFL of 12 for a prevalence of 38%. Workneh *et al.* (1993) recorded a CMFL of 34 for a prevalence of 82.7% among laborers in Teppi Coffee Plantation Project (southwestern Ethiopia). This indicates that CMFL is related to disease prevalence. However, differences could occur due to differences in levels of endemicity, differences in ecology, variations in host response and differences in intensity and duration of transmission (Anderson *et al.*, 1974; WHO, 1976, 1987, and 1995).

The findings on the type and severity of skin manifestations indicate that the population has a serious skin health problem. Some of the skin conditions have already led to bacterial superinfection. This calls for an urgent introduction of ivermectin for treatment of the skin diseases.

On the issue of establishing the relationships between parasitological, clinical and socioeconomic indices, a strong correlations was found between prevalence/MFD and clinical manifestations. The correlations between prevalence and APOD, CPOD, LOD, DPM and PON were 0.81, 0.83, 0.82, 0.79, and 0.89, respectively. Similarly, the correlations between MFD and APOD, CPOD, LOD, DPM and PON were 0.79, 0.73, 0.80, 0.75, and 0.84, respectively. This indicates that the major skin manifestations of onchocerciasis are related to prevalence and/or intensity of infection (MFD). Hence, use of any one of the major skin manifestations for estimating the prevalence of onchocerciasis in a community is quite acceptable and advantageous because skin snip surveys are invasive and expensive. However, classification of some of the skin manifestation requires experience and expertise. Identifying palpable nodules (PON), however, requires less expertise, is easy and fast. As indicated by the high correlations, especially among the 25-34 years age group and its sensitivity value compared to skin snip results, the PON can safely be used for rapid screening of the population and mapping of onchocerciasis which is required for planning of control programs.

Now that Ethiopia is a member of African Program for Onchocerciasis Control (APOC) it should immediately start training individuals for identification of PON in all Regions and undertake surveys using the PON detection approach to map high risk communities in the country in order to facilitate acquisition of ivermectin for repeated mass

chemotherapy. WHO (1995) recommends such an approach for rapid mapping of onchocerciasis in each country.

As regards the relationships between socioeconomic indices and onchocerciasis, we have observed that poorer people and farmers are more at risk of infection. It was also observed that strong associations existed between skin manifestations, occupation and economic levels of the households.

7. CONCLUSIONS AND RECOMMENDATIONS

In the Manbuk study area both prevalence and intensity of infection are highest among males than females, reaching peak in the 25-34 years age group. This is perhaps related to the occupational risk of the young male adults. By occupation, farmers are more infected supporting the role of occupational risk. By economic levels, poorer people had more infection probably due to differences in the capacity of buying and wearing long trousers that have protective effect against bites of the vector. There was also difference in onchocerciasis prevalence and intensity of infection that related to educational levels. However, indigenous population and settlers who have longer duration of residence appear to have more infection.

From the findings of the types and levels of skin manifestations it is evident that the population of Manbuk area in Pawi is suffering from serious onchocercal skin diseases. All onchocercal skin manifestations were significantly correlated with each other and with prevalence and microfilarial density. PON correlated quite well with both prevalence and skin microfilarial density. This is an important finding as it provides a strong support for use of PON for rapidly screening populations for onchocerciasis; a method that is easy, quick and safe compared to surveys based on skin snip examination.

According to WHO (1995) communities with a prevalence rate of 40% and above should be targeted for mass treatment with ivermectin . The 43.7% prevalence of onchocerciasis in the study area and the potential of disease propagation to cover the rest of potentially endemic areas is good reason that Manbuk area should be considered among the priority areas for treatment of onchocerciasis through mass administration of ivermectin. Males, especially those in the 25-34 years age group, in general and farmers and poorer sections of the community in particular, should be given higher priority during distribution of drugs.

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9. ANNEX I

QUESTIONNAIRE

I. Identification

1. Village code No. _____ 2. House No. _____ 3. I.D.No. _____
4. Name _____ 5. Sex _____ 6. Age (Years) _____
7. Marital status: married _____, divorced/widowed _____ 8. Educational status: a) Illiterate_ b) Literacy campagn _____ c) Elementary_ d) Hihg school___ e) Others (specify) _____
9. Occupation: a) Farmer _____ b) House wife _____ c) Civil servant _____ d) Dependant_ e) Merchant _____ g) Other (specify) _____ 10. Ethincity (specify) _____
11. Religion (specify) _____ 12. Duration of stay in present place/locality (years) _

II. Family Income

13. If working (daily laborer, privete business or employed) income (in Birr) per day per week _____ per month _____ 14. If not working, reason: a) No job found ___ b) Sick___ c) Too young___ d) Too old_ 15. If farmer (indicate numbers) how many of the following do you own? a) Livestock _____ b) Bee hives _____ c) Hector (s) of land d) Crop harvested last year in quintals _____.

III. Sanitation

16. Housing : a) Corrugated sheet-roofed _____, Grass-thatched _____

b) Kitchen available _____, Not available

c) Latrine available _____, Not available

d) Do domestic animals live in the same room with household members? Yes___, No

17. Source of water: a) Piped___ b) Unprotected spring/well _c) Protected spring/well

d) River/Pond _____ e) Other (specify)___

18. How often do you and members of your family wash cloths and the body? a) Irregularly_____ b) Regularly_____

IV. Nutrition 19. What is your common diet? Injera_____ Roasted/Bioled Grains____

Bread___ Porridge_____ Other (specify)_____

20. Feeding pattern (daily): Once___ Twice___ Three times___ As found available___

21. How frequently do you consume- a) Meat: weakly___, Monthly___, As found available b) Milk: Weakly___, Monthly___ As found available___

c) Vegetables & Fruits: Weakly___, Monthly___ As found available_____

V. Morbidity (general health status) and Knowledge about Onchocerciasis 22. Do you/any one else in your household have/has health problem? Yes___, No___

If yes, what are they? a) Malaria___, b) Severe Cough___ c) Skin related + Other illnesses___, d)Diharria___, e) Abdominal Pain___, f) Others (specify)_____

23. Which troubles you most_____ 24. If skin disease, a) How does it affects you? (specify)___ b) Symptoms of illnesses: Itching___, Skin rash/erruption___, Skin inflammed___, White patches___, Black spots___, Toughned skin ___

Others(Lymphoedema)_____.

25. Do you know onchocerciasis (local name)? Yes___, No___, If yes, how did you know it? a) I had /have it my self___, b) I know someone who had/have it_ c) I was told by health workers___, d) Some of my family members had/have it___, e) I read/heard about it ____, f) Other (specify)___

26. Do you or any one in your household have/has onchocerciasis? Yes_ No___ If yes, how was it acquired? a) Inherited from parents___ b) Acquired from neighbors___, c) Contracted by physical contact with onchocerciasis patients___ d) Couused by poor environmental conditions___ e) Transmitted by insects___ f) Don't know_ g) Other (specify)___

27. Action taken: a) Nothing___, b) Traditional medicine___, c) Pharmacy___, d) Health center/clinics___ e) Other (specify)

28. What was the out come of the treatment? a) Cured___ b) Improved_ c) No improvment ____, d) W orsened___

29. Do you think onchocerciasis is a serious matter of concern in your community? Yes___ , No___ . If yes why? a) Caouse serious illness_ b) Stigma attached to it ____, c) Affects many people___, e) Reduced labor efficiency__.

VI. Socio-economic impact

30. If skin disease does it affects your work? Yes___ , No___, If yes, how? a) Reduced work efficiency___ , b) Absenteesim from work___ , c) Desertions of villages_ d) Others (specify)___

31. Does it affects your social life? Yes___, No___, If yes, how a) Social isolation___ b) Stigma___.

10. ANNEX II

RECORD SHEET FOR INDIVIDUAL MEMBERS OF THE STUDY POPULATION

I. IDENTIFICATION

1. Village code No.____2. House No.____ 3. I.D.No.____4. Name____5.
Sex_6. Age (Years)____ 7. Marital status: married____,divorced/widowed_ 8.
Educational status: a) Illiterate___ b) Literacy campagn____ c) Elementary____d)
Hihg school___ e) Others (specify)___9. Occupation: a) Farmer____b) House wife
c) Civil servant_ d) Dependant__ e) Merchant____ g) Other (specify)____ 10. Ethincity
(specify) _11. Religion (specify) 12. Duration of stay in present place/locality (years)

II SKIN MANIFESTATIONS

	<u>Present</u>	<u>Absent</u>		<u>Present</u>	<u>Absent</u>
a) Itching	_____	_____	e) ATR	_____	_____
b) APOD	_____	_____	f) DPM	_____	_____
c) CPOD	_____	_____	g) PON	_____	_____
d) LOD	_____	_____	h) OSD	_____	_____

III. NUMBERS AND LOCATION OF PALPABLE ONCHOCERCAL NODULES

Pelvis(coccyx&sacrum) No.____ Arms No. _____ knee No.____

Lower legs No. _____ Chest No.____ Abdominal NO. _____

IV. SKIN SNIP (Weight and Numbers of Microfilariae (mf) from):

a) Buttocks Left __ mg No. mf __

Right __ mg No. mf _____