ONCHOCERCIASIS AND ITS SOCIOECONOMIC EFFECTS IN SOME PARTS OF IMO STATE, NIGERIA.

BY

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DECLARATION

I hereby declare that this thesis is a record of my original research work and that to the best of my knowledge, no part of it has been presented to any other institution for the award of any higher degree.

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CERTIFICATION

This is to certify that this thesis has been examined and approved for the award of the degree of DOCTOR OF PHILOSOPHY in ENTOMOLOGY AND PARASITOLOGY

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Abstract

Human infection with *Onchocerca volvulus* and its socioeconomic consequences were investigated in parts of the Imo River Basin of Nigeria between March 1996 and December 2000 using standard parasitological and socioeconomic methods. The knowledge, attitude and perception of the inhabitants to the disease and its treatment with ivermectin as well as the microbial agents associated with onchocercal skin lesions were also determined.

Of the 7,348 persons randomly examined by the skin snip method, 1,655(22.5%) were infected with microfilariae of *O. volvulus.* The prevalence of infection differed (P<0.05) between communities in the upper Imo River Basin (26.8%) and the middle Imo River Basin (19.0%). A mean microfilarial density, 20.1mf/ss was obtained. There was no significant difference (P>0.05) in sex-related infection, 22.9% in males and 22.1% in females. Classical symptoms of the disease were observed in varying rates.

Less than half of the villagers (48.2%) used to assess community knowledge knew about the disease and only about 5% attributed transmission of infection to the vector fly, *Simulium damnosum.* Persons afflicted with visible manifestations like dermatitis, lymphoedema (limb) and blindness were not considered good for marriages or hired as farm hands. The percentage drop in school attendance of pupils was higher in households where family heads had severe onchocercal skin disease (OSD) (4.9%) than in households with family heads of non-OSD status (2.1%). The total revenue loss due to direct costs of

treatment and man-days lost to incapacitation was remotely estimated at ₦92 million annually.

79.8% persons accepted ivermectin, while 68.8% complied with yearly treatment. This was attributed to several factors including effective grassroots mobilization, community participation in the planning and implementation of the programme and perceived efficacy of the drug. Microorganisms isolated from excoriated onchocercal skin lesions included *Staphylococcus aureus* (89.9%), *Streptococcus pyogenes* (50.8%), *Pseudomonas aeruginosa* (21.8%), *Escherichia coli* (60.7%), *Bacteroides* spp (11.5%) and *Clostridium* spp (3.3%). Majority of these organisms exhibited moderate to marked susceptibilities to broad spectrum antibiotics like Tarivid, Ciproxin and its derivative, Norfloxacin.

The results of the study have shown that despite the mesoendemic nature of onchocerciasis in the study area, it is still a serious problem considering the associated skin lesions, gross lymphatic pathologies and their negative impact on marriage, productivity and attendance to school. These findings underscore the need to sustain treatment with ivermectin and possibly on a semi-annual basis.

CHAPTER ONE

INTRODUCTION AND LITERATURE REVIEW

1.1 INTRODUCTION

Human onchocerciasis commonly called "River Blindness" is one of the most important chronic parasitic diseases afflicting millions of people in the tropical and sub-tropical zones. It is caused by a filarial nematode worm called *Onchocerca volvulus* (WHO, 1966) which is transmitted by blackflies of the genus *Simulium*. Onchocerciaisis constitutes a major public health problem and obstacle to socioeconomic development in endemic communities where an estimated 17.7 million people are currently infected with about 270,000 blind and 500,000 severely visually disabled (WHO, 1995a). The alternative name "River blindness" draws attention to the most serious and irreversible consequence of the disease, which is blindness.

Clinically, onchocerciasis is associated with a lot of changes in the body which involve mostly the skin giving rise to onchocercal skin lesions, the eye (ocular lesions) and the lymphatic system (lymphatic complications). Occasionally there are some associated systemic involvements. Furthermore, several other features of uncertain association, aetiology or pathogenesis have been described including low body weight, general debility, diffused muscloskeletal pain, epilepsy and hyposexual dwarfism (WHO, 1995a). The major clinical manifestations of onchocerciasis which have the most direct bearing on the burden of disease in terms of public health and socioeconomic importance are the ocular and skin lesions and troublesome itching

(Kale, 1998.) There are marked geographical variation in the prevalence and clinical manifestations of onchocerciasis (Anderson et al, 1974a, b; Buck, 1974) and these have direct bearing on the estimates of the burden of the disease in different parts of the world.

In Nigeria, although a lot of operational studies on onchocerciasis have been carried out since the disease was first reported by Parsons in 1909 (particularly in the northern bioecological savanna zone), yet there is still paucity of information on the real status of the disease in many unstudied endemic communities in the rainforest of south eastern Nigeria especially in the Imo river basin where a lot of breeding sites of the vector have been identified (Nwoke and Uwazie, 1991). This is especially with respect to the epidemiology, socioeconomic consequences, the attitude and perception of villagers towards treatment with Ivermectin (Mectizan) as well as the microbial agents associated with excoriated skin lesions.

These factors make it difficult for informed priorities to be identified in planning control strategies. The present work therefore has been designed to provide accurate and adequate data on the epidemiology, socioeconomic impacts of the disease in the Imo river basin, the attitudes and perception of villagers towards the treatment programme as well as the microbial agents associated with excoriated skin lesions. It is believed that data from this work will aid the National Onchocerciasis Control Programme (NOCP) and the African Programme on Onchocerciasis (APOC) in their control strategies. APOC control strategy is based on Community Directed Distribution (CDD).

The following are the objectives of the present study:

1. To determine the prevalence and distribution of onchocerciasis in communities in the Imo river basin area of Imo State.

2. To identify the local population's fundamental knowledge, and beliefs about onchocerciasis, in particular, the local perception of causes/transmission of disease; methods of treatment and prevention as well as those habits and customs of the people that contribute to predisposition, and maintenance of the disease.
3. To assess some of the socioeconomic consequences of onchocerciasis among the rural population with emphasis on marriage, productivity and other forms of social interaction in the community; attendance at school, and costs of treatment.
4. To evaluate the attitudes and perception of persons in the endemic communities to treatment with ivermectin (mectizan), in particular the degree of acceptance, compliance, perceived efficacy of the drug and identify the hindering and enabling factors in sustenance of the treatment.
5. To identify the microbial agents associated with excoriated skin lesions and determine their susceptibility to antimicrobial agents.

1.2 LITERATURE REVIEW

1.2.1 Historical Aspects of Onchocerciasis

The documented history of onchocerciasis dates back to about 124 years ago when John O'Neil, a young Irishman serving as a ship surgeon on HMS Decoy found microfilariae in the skin of six patients with 'craw-craw' in West Africa (O'Neil, 1875; Nelson, 1991). In his short communication to the Lancet, he illustrated the microfilariae which are now known to be the pathogenic stage of onchocerciasis and his illustrations and measurements clearly distinguish the parasite from *Mansonella streptocerca* which was later discovered in the skin of West Africans by Macfie and Corson (1922).

The German parasitologist Leuckart (1893) first described the adult worms from subcutaneous nodules which were sent to him by an unnamed medical missionary working in Ghana. In turn, Leuckart sent some of the materials to Patrick Manson who recognized that they were different from *Filaria nocturna (Wuchereria bancrofti) and Filaria diurna (Loa loa)* in not possessing a sheath (Nelson, 1991). It took several years before it was realized that the skin lesions and microfilariae described by O'Neil were related to the adult worms described by Leuckart.

The association between onchocercal skin lesions and eye disease was established by the pioneering work of Rodolfo Robles in 1917 in Guatemala (Nelson, 1991). Robles demonstrated clear association between the presence of nodules and the skin lesion known locally as 'Erysipelas de la Costa' and he gave a clear account of the anterior ocular lesions. Furthermore, he was the first to suggest that the disease was transmitted by simuliids and this was before Blacklock (1926) demonstrated that *Simulium damnosum* was the vector in West Africa. It is not suprising, therefore, that onchocerciasis in Latin America is known as 'Enfermedad de Robles'.

In addition to the foregoing, Robles noted also that the removal of nodules from the head region relieved the symptoms of the disease. This observation stimulated the creation of the nodulectomy brigades which are still the mainstay of the control campaigns in parts of Guatemala and Mexico. The perforation of the skull by subaponeurotic nodules which produced lesions which were likened to holes made by trephining was described by Robles. This was of interest since Diaz (1957) had used the presence of these holes in the skull as an argument in favour of the ancient origin of onchocerciasis in central America. According to Figueroa (1968), Robles noted that similar holes had been seen in the skulls of pre-Columbian Amerindians, and that the roughened skins and leonine faces depicted in ancient Mayan and Aztec sculptures were evidence of the ancient origin of onchocerciasis in the northern hemisphere.

The apparent absence of a reservoir host of onchocerciasis in the Americas and the relatively recent history of *Homo sapiens* in the western hemisphere would argue against the independent origin of onchocerciasis in man in this part of the world. It is more generally believed that the parasite was introduced from Africa at the time of the slave trade. However, the observations by De Leon and Duke (1966) and Duke (1970) on the differences between the parasites in Guatemala and Venezuela and Cameroon, and the more recent discovery of onchocerciasis in Amerindians in the Amazon region of Brazil and in Columbia and Eucador, suggest that a search should be made for a possible animal host in the region (Nelson, 1991).

In Nigeria, onchocerciasis was first reported in four patients in Lokoja by Parsons (1909). Later Sharp (1921) found microfilariae of *O. volvulus* in the skin of 55 out of 100 prisoners at Kaduna. He stated, however, that there was no evidence that the microfilariae was associated with any eye lesions. The first suggestion that ocular onchocerciasis occurred in this area was made in 1937 by Dr. J.L. McLetchie in a letter to Dr. D.J.M. Mackenzie, the Director of Medical Service, northern Region. Dr McLetchie stated that in Adamawa province (now Adamawa State), he saw a group of elderly people all of whom had onchocercal nodules and varying degrees of loss of vision up to total blindness. Ridley and Anderson (1950) also reported the case of a European Administrative officer on leave in the United Kingdom from northern Nigeria, suffering from ocular onchocerciasis.

The first detailed study on ocular onchocerciasis in Nigeria was initiated by Dr. F.H. Budden, the specialist opthalmologist, Overseas Civil Service, northern Nigeria in the 1950s when he established eye clinics at certain rural dispensaries (Budden, 1952). Additional studies by Budden (1955; 1956; 1958; 1963) confirmed that endemic onchocerciasis was widespread in many parts of the area. The pioneering work on the vectors and its bionomics by Blacklock (1926) were further advanced by several other studies by Crosskey (1955; 1956; 1957a, b). Further studies in the seventies especially by Bradley (1976) in the Hawal Valley, north eastern Nigeria which is reputed to contain some of the worst endemic foci comparable only to the Sudan savanna villages in Burkina Faso, Volta region showed that onchocerciasis was instrumental in the abandonment of the river valleys that are agriculturally fertile. After these initial studies, other investigations have been carried out in different parts of the country to determine the real status of onchocerciasis and its vectors.

The studies from the savanna region include Amuta (1982) in parts of Kaduna state; Dipeolu and Gemade (1983) and Gemade and Dipeolu (1983), Amuta and Onwuliri (1997,1998) in Benue State, Onwuliri et. al (1987), Nwoke *et. al* (1987), Ufomadu *et .al* (1988), Nwoke *et. al*, (1989) in the Jos Plateau; Akogun and Onwuliri (1995), Anosike (1996) in parts of Bauchi State. From the rainforest are reports by Nwokolo (1950) in Enugu State; Iwuala *et. al.* (1982) in Cross River State; Ogunba (1982) in Oyo State; Edungbola (1982), Edungbola *et. al.* (1983) in Kwara State; Udonsi (1986, 1988) in the Niger Delta; Amazigo (1994) in Anambra State; Nwoke *et. al.* (1994) in parts of Imo State. Results of these studies have shown that onchocerciasis and its vector species are widespread in the country.

1.2.2 The Worm

Onchocerca volvulus is predominantly a parasite of man maintained in nature by inter-human transmission. The adult worms (females 30-80cm, males 3-5cm) live in fibrous nodules, some of which are subcutaneous and palpable while others lie deep in the connective and muscular tissues. They have a life span of some 9-14 years. The females produce abundant microfilariae which migrate from the nodules to invade the skin, eyes and some other organs. They cause most of the disease manifestations of onchocerciasis and have a life span of about 6-24 months.

The filaria, *O. volvulus*, has no common animal reservoir. However, only one authentic record of the parasite occurring in an animal, *Gorilla gorilla* under natural conditions has been documented (Van den Berghe *et. al* 1964). Attempts have been made to transmit *O. volvulus* to a variety of monkeys and normal laboratory animals without success (Bianco, 1990). So far, the only animal which has produced adult worms and microfilariae has been the Chimpanzee (*Pan troglodites*) (Duke, 1962). Suprisingly, however, there are no records of natural infections in the Chimpanzee. There are numerous species of Onchocerca in cattle, horse and wild ungulates. Some of these closely resemble *O. volvulus*, so it seems likely that the human parasite was derived from parasite of ungulates and not phylogenetically through the anthropoid apes (Nelson, 1965; Muller, 1979).

O. volvulus, like all nematodes, has a developmental cycle involving four moults; three of the larval stages develop in the *Simulium* intermediate insect host and two stages develop in the definitive host or man. Like all filarial worms, the first larval stage is preceeded by the microfilaria, which is the stage ingested by *Simulium* and the L3 is the stage which is infective to man. Unlike other organisms (viruses, bacteria or protozoa), there is no multiplication of the larvae in either the intermediate host (*Simulium*) or multiplication of adult worms in the definitive host (man).

The life cycle begins with copulation and fertilization of the female by the male worm. Nothing is known about the pheromones or other stimuli that attract males to females in the nodules (WHO, 1995a). Despite the difficulty, parasites may have in finding one another, once united they may remain fertile and survive for as long as 16 years (Roberts *et. al.* 1967), although the mean duration of reproductive life has been estimated at 9-11 years and 95% of adults do not reproduce for longer than 13-14 years (Plaiser, *et .al.* 1991).

The number of microfilariae produced or released per day by the female worm is unknown. The use of embryograms which quantify the number of intrauterine stages cannot determine this. Observations however, on worms maintained *in vitro* suggest that 700-1500 microfilariae per females are released into the host on average per day, i.e. only a small proportion of this microfilariae developed *in utero* actually leave the female worms (Duke, 1993; WHO, 1995a). In contrast to other filarial species, microfilariae of *O. volvulus* are not expelled by the female worm, but leave it actively one by one. It has been estimated that it takes at least 5-10 seconds for a microflaria to leave the female worm when it has arrived at the vulva (WHO,1995a). This could obviously be a limiting factor. Microflariae that stay in the uteri gradually degenerate and are then reabsorbed (Schulz-key, 1990).

The uptake of microfilariae by the vector is easily accomplished since the positioning of the microflariae in the skin is an evolutionary adaptation for transmission (Nelson, 1970). The microfilariae lie at right depths in the subpapillary layer where they can be readily ingested by the short proboscis of the vector, and they are distributed in the surface of the skin in the anatomical region most likely to be bitten (Kershaw *et al.*, 1954). With *O. volvulus* in West Africa, where members of

S. damnosum complex are the vectors, the microfilariae are most abundant in the skin of the legs, whereas in Mexico, where the high-biting *S. ochraceum* is the vector, the microflariae are much more abundant in the upper parts of the body.

Several hundreds of microfilariae may be ingested when the female vector fly bites a highly infected individual. Not all the microfilariae survive because of the peritrophic membrane which traps and digests most of them. A few however, pass through the intestinal wall and reach the abdominal cavity and then migrate to the thoracic muscles where they undergo development through three stages. The microfilariae become fatter and shorter to become the first, short sausage L1 stage (150- 200um in length) with a well-defined gut and cuticle. The larvae then moult to produce the second long sausage L2 stage (300-400um in length), which is still inside the muscle cell. It is at this stage that the larvae become more active and undergo the second moult producing the L3 infective stage (500 – 600um in length) which escapes from the thorax and migrates towards the proboscis and thus may be transmitted to man during a subsequent blood meal. The development of *O. volvulus* is relatively rapid compared with other filarial parasites, and the infective larvae appear in the proboscis as early as the 6th day after the original ingestion of the microfilariae. As with other vector-borne diseases, temperature and humidity are important determinants for the successful development of the organisms in the vectors. Under natural conditions it is unusual to find more than one or two infective larvae in the vector, although Nelson and Pester (1962) recorded 72 infective larvae in a single *S. neavei* that had fed on a patient on Mount Elgon in Uganda.

The development in man is sequel to transmission which occurs when infected flies take a blood meal. When biting, blackflies use rasping actions leading to the appearance of a pool of blood to engorge from (as opposed to the piercing behaviour of biting mosquitoes) (Cheke, 1998). During the bite, the insect's saliva acts to enhance the likelihood of parasite transmission by the fly (if it possesses infective larvae) since it contains apyrase to inhibit platelet aggregation, anticoagulants and vasodilators to dull the host's immune responses (Cupp & Cupp, 1997). It is also likely that there is some factor which attracts the microfilariae from the patient's skin towards the site of the bite to facilitate parasite uptake by the vectors.

Very little is known about the subsequent development of *O. volvulus* in man , but is assumed that infective larvae probably moult to the L4 stage within 3-7 days following transmission . The moult from L4 to the juvenile adult stage probably occurs 4-6 weeks later (WHO,1995a; Cheke, 1998). Although the route followed by immature worms is unknown, they appear to be attracted to existing nodules and may settle on their surface to form satellite or composite nodules. The proportion of infective larvae inoculated that develop into adult worms is unknown. Microfilariae are rarely seen in the skin until 10-15 months after infection and can live in a patient for 6-24 months(Cheke, 1998).

1.2.3 The Blackfly – Vector of *O.volvulus*

The interhuman transmission of *O. volvulus* requires only a single vector in which the whole metamorphosis of the parasite from microfilariae (mf) to third stage infective larva occurs. The first indication that this vector was a day-biting insect and probably the anthropophilic blackfly (*Simulium*) was made after a preliminary epidemiological studies of the disease in Guatemala by Robles (1919). The mode of transmission of onchocerciasis was unknown until Blacklock (1926) demonstrated in Sierra Leone that the larval development of *O. volvulus* would take place efficiently in the blackfly *Simulium damnosum* Theobald, 1903.

There are several species of vector, but they are all small insects belonging to the genus *Simulium* in the family *Simuliidae* of the order Diptera in which the adult females largely feed on blood from warm – blooded vertebrates. This bloodsucking habit is the means by which the mf of *O. volvulus* found in the skin and not actually carried in the bloodstream, obtain entry to their vectors. About 1520 species of the simuliidae are currently recognized but only about 20 of these are involved as vectors of human onchocerciasis (Davies & Crosskey, 1991).

Aquatic or pre-imaginal stages

The life-cycle in all simuliids passes through the egg-larva-pupa-adult (imago) sequence of metamorphic stages. All stages except the adult are aquatic and eggs are laid into running water. The eggs are generally oval to sub-triangular in lateral view depending on the species. They are coated with a sticky, gelatinous substance which readily adheres to any substrate with which they come in contact, thus resisting the tendency to be swept down-stream. The egg is white when fresh, darkening to brown with advancing embryogensis.

Depending on the vector species involved and under normal conditions, the egg stage gives rise to the first instar larva. To allow for growth, the larval stage sheds its skin (cuticle), including the hardened head – capsule several times. Between each such moult, the larva is in a particular instar of its development. Simuliidae are almost unique amongst the Diptera for the high and variable number of larval instars, ranging from 6 to 9 in different species and sometimes varying within the same species (Davies & Crosskey, 1991). In *S. damnosum* s.l., however, seven larval instars occur but reliable data for other vector simuliids do not exist. The larvae, thriving in fast - flowing water, require an adequate current velocity to bring food particles to the head cephalic fans. Furthermore, in order to enhance their existence and survival, the larvae attach to the substrate on pads of silk spun from the silk glands, with anchorage being maintained by rows of hooks at the rear of the abdomen. Almost any fixed submerged surface may be used for larval attachment and typically include water plants, trailing roots and branches, fallen leaves, stones, inclined rock surfaces and lips of waterfalls. Clean surfaces are usually preferred, and larvae will readily attach to artificial substrates such as plastic ribbon used for experimental purposes (Davies & Crosskey, 1991).

After complete larval development, the metamorphosis to the pupal stage occurs within the larval body, the cocoon. The basic outline of development, however, is complicated by pharate (hidden) stage in which the fly has physiologically reached the pupal stage (pharate pupa), but for a time keeps the larval morphology, or has moulted to the adult fly (pharate adult) within the pupa cuticle, but remains for a time imprisoned under water in the pupal morphology (Davies & Crosskey, 1991). After a short pupal period, which ranges from 2-17 (usually 3 – 6) days, the adult fly emerges under water, floats on the surface and takes flight to mate, feed and continue the life cycle. The emergence to adult is predominantly diurnal, although this pattern may be influenced by temperature (Disney, 1969). The act of emergence takes about one minute and the process had been described by Wenk (1981).

According to Davies & Crosskey (1990) the reported development times in various vectors are as follows: *S. damnosum* complex (West Africa), egg 1 – 3 days, larva 4 – 18 (usually 7 – 12) days, pupa 2 – 5 days; *S. neavei* groups (East Africa), egg unknown in nature, larva between 26 and 72 days, pupa 8 – 10 days; *S. ochraceum* complex (Guatemala), egg 3 -10 days, larva 7 – 15 days, pupa 4 – 6 days; *S. metallicum* complex (Guatemala) egg 3 – 20 days, larva 6 – 20 days pupa 4 – 10 days. In the *S. damnosum* complex, differences in development times of the life cycle stages appear to be related to species identity and to temperature. They often complete the life-cycle from egg to adult fly in about two weeks, and under some circumstances in as little as one week.

The only vectors involved in phoretic relationships are members of the *S. neavei* group in which the larvae and pupae live on river crabs of the genus *Potamonautes*. Several species of crabs can act as carriers for the larvae and pupae. Eggs are not laid on the crabs and first instar larvae have not been found on them. The larvae of *S. neavei* group require to survive a range of circumstances not met by other tropical African simuliids, because the crab carriers may lie for long periods in still water or in the damp substratum beneath dried-out streams and the crabs sometimes travel overland between streams at night. Such crab behaviour poses special problems for vector control (Raybould & Mhiddin, 1978) as well as for simuliids survival.

Adult blackflies

The blackfly is one of the insect families of the sub-order Orthorrhapha and order, Diptera. The adults are usually small, dark flies with a stout body and a hump-backed appearance. The antennae are short and approximately cigar – shaped, with 11 segments and without whorls of long hairs. The mouthparts form a short, inconspicuous, downwardly – directed proboscis. The wings are broad, colourless and without scales. The legs are rather short and stout without scales.

Both sexes feed on plant juice, but females also suck the blood of warm blooded vertebrate animals which include man, monkeys, domestic animals (particularly cattle and horses) and small mammals such as rabbits; birds including domestic poultry, wild ducks, hawks, hornbills and many small birds (Davies & Crosskey, 1991).

Feeding behaviour

No simuliids feeds exclusively on man. Although vector species must be anthropophilic to be vectors at all, each is to a greater or lesser extent also zoophilic. Zoophiliy is an important aspect of vector behaviour, firstly because bloodmeals taken from animals lower the likelihood of infection of the vector with *O. volvulus* (which occurs only in man), and secondly because filariae of animal origin can occur in anthropophilic vector flies and can be confused with *O. volvulus* (Davies & Crosskey, 1991). A few vectors like *S. ochraceum* are strongly anthropotrophic even though about 15 alternative hosts have been recorded, including all common domestic animals (Dalmat, 1955). Some vector species like *S. damnosum* s.l. can be anthropophilic virtually, throughout its range, and very nearly anthropotrophic in many areas, but zoophilic populations occur where human settlement is lacking.

The complex factors involved in host location and selection of feeding site on the host have been reviewed by Thompson (1976) and Wenk (1981). Although both savanna and forest cytoforms responded to carbon dioxide exhalations, the savanna forms were less responsive and relied more on visual senses to detect the sources of their food whereas forest forms relied more on olfactory stimuli. These stimuli were shown to originate in sweat but have not been identified. The isolation of the chemical nature of these stimuli might be of value in the development of traps for catching flies, thus replacing the current reliance on human bait (Cheke, 1998).

Biting patterns

Simuliidae, like other biting flies, exhibit to some extent an endogenous rhythm of blood feeding activity, modified by physical factors.. Sunlight has been reported to be the major stimulus for blackflies (Wolfe & Peterson, 1960). Diurnal biting which begins at daybreak and continues until twilight has been documented for the Africa forest (Giudcelli, 1966), while Bellec (1974) noted that in the savanna zone, nulliparous females are more numerous in the evening especially in the wet season. Nocturnal biting is virtually non-existent. In some vector species, a midday lull often occurs that gives rise to a bimodal biting activity pattern that may be skewed towards either predominantly early morning or evening biting (Garms, 1973; Davies *et al.*, 1981). Evidence exist also to show that biting might be influenced by a lot of other variable factors like air temperature, relative humidity, strong winds and heavy rains (Hausermann, 1969; Lancey & Charlwood, 1980; Davies & Crosskey, 1991) as well as emergence rhythm (Marr, 1962).

Annual climate changes, especially well marked wet and dry seasons, have associated biting activity patterns and this has a strong correlation with seasonal larval density and incidence of pre-imaginal sites variation in both savanna and forest regions of Africa (Crosskey 1954, 1979; Le Berre *et. al.* 1964; Le Bere 1966; Duke 1968a; Hausermann 1969; WHO 1973; Davies & Crosskey, 1991). In West Africa savannas, with severe drought seasons the biting of *S. damnosum* s.l almost completely ceases for several months, resuming again with the coming of the rains and re-establishment of extensive breeding sites in the rivers. In the forested pre-coastal West Africa, where dry and wet season are less dramatically different, biting activity is spread more evenly through the year. Similarly in the Brazilian rainforest region, where breeding is perennially sustained in major rivers and annual conditions are relatively uniform, biting activity continues throughout the year. The reported exception to this established seasonal biting activity pattern, which is maximal with heavy rains, is *S. ochraceum*, the vector species of Guatemala and Mexico, which shows much higher biting density during the early dry season from September to January (Hashigushi *et. al.*, 1981). This is because of the multitudes of infant streamlets running over the ground and providing numerous breeding sites. In *S. damnosum* s.l. biting activity in mid – wet season can be temporarily depressed if excessive flooding destroys many breeding sites.

Dispersal

An important behaviour of most insects which ensures survival of the species is the dispersal of species away from parent individual or from the centre of the population. Blackfly dispersal may be understood as a displacement dominated by the flight capability of the insects; whereas migration may be considered as mainly wind – borne. Migration is active only in so far as the adults keep themselves air – borne by persistent wing beating (Magor *et. al.*, 1975). The linear and radial dispersal of *Simulium* blackflies as well as the seasonal/climatic factors affecting it has been reported by many workers (Crosskey, 1956, 1979; Davies, 1965, 1968; Garms *et. al.*, 1979; Wenk, 1981). Parity has been observed to cause differential dispersal in *Simulium* which is of great epidemiological significance. Studies on the *S. damnosum* complex in the Sudan and Guinea savanna zones have shown that parous flies tend to stay near to, or move along the rivers, whereas in forest regions, the proportion of parous flies are highest away from the rivers. As only parous flies can be infective, this has clear implication that man – fly contact at the riverside is potentially most dangerous for transmission in the savanna (Crosskey, 1957; Duke, 1967; Garms, 1973; Thylefors *et. al.* 1978; Davies *et. al.* 1981).

Flight range

Blackflies have been reported to travel long distances. Studies on the phenomenon of re-invasion of already controlled areas have shown that savanna forms of the flies travel as far as 300km (Garms *et. al.*, 1979), 400km and possibly

600km (Walsh *et. al.*, 1981). These findings are of epidemiological importance since the invading flies travel with infectious parasites, which they could transmit with in the treated zones. It has been assumed that the long distance migrants were mainly savanna cytospecies (*S. damnosum* s.s. and *S. sirbanum)* and that the forest species (*S. soubrense*, *S. sanctipauli*, *S. yahense* and *S. squamosum*) remained within their forestes habitats (Garms *et. al.*, 1979; Walsh *et. al.*, 1981; Zerbo, 1984). Recent findings, however, have shown that some forest species also migrate. *S. squamosum* restricted mainly to the mountainous area along the Togo/ Ghana border has been reported to migrate travelling as much as 125km into the Onchocerciasis Control Programme (OCP) region (Cheke & Garms, 1983). Furthermore, the Djodji form of *S. sanctipauli*, a forest variety hitherto considered to be almost sedentary gradually expanded its range and moved into the savanna habitats as the wet season progressed (Garms *et. al.*, 1989). This was the reversal of another worrying phenomenon, the migration of savanna species into previously forested zones in the wake of deforestation as reported in Liberia (Garms *et. al.*, 1991), Togo (Cheke, 1993), Sierra Leone (Baker *et. al.*, 1990; Thompson *et. al.*, 1996) and Cote d'Ivoire (Boatin *et. al.*, 1997). Where *S. neavei* s.l are the main vectors in Uganda for instance, deforestation may reduce onchocerciasis as *S. neavei* s.l and /or its host crabs, require good forest habitat to survive (Fischer *et. al.*, 1997). However, the new circumstances permit colonization by invading *S. damnosum* s.l. as reported in the Thyolo hills of Malawi and on the Muhoma River in Kabarole Districts of Uganda (Walsh *et. al.*, 1993) and so, eventually, the deforestation may lead to worse disease incidences than before in East Africa as well as in West Africa (Cheke, 1998).

Identification of simuliids

Onchocerciasis vector species seldom occur in isolation from other simuliids, and most onchocerciasis zones have a simuliids fauna consisting of many species of which the majority is completely harmless to man. There is thus a need for accurate differentiation of vector species (as larvae, pupae and adultflies) form innocuous species. Various techniques have been employed in the identification of simuliids vectors but so far larval cytotaxonomy and adult morphometry have been the most successful. Larval cytotaxonomy remains the most reliable method for the specific identification of species complex like members of the *Simulium damnosum* complex (Davies & Crosskey, 1991). In West Africa, however, problems still exist in interpreting the chromosomal variation of different population within the recognized species of the complex (WHO, 1995a).

The usefulness and problems of traditional morphotaxonomy have been discussed by various workers (Townson & Meredith, 1979; Meredith *et. al.*, 1983; Garms & Zillman, 1984; Garms & Cheke, 1985a; Cheke *et. al.*, 1987; Surtees *et. al.* 1988; Fisorgbor & Cheke, 1992; WHO, 1995a; Cheke, 1998). Five morphological characters have been observed to be taxonomic value, namely the colour of the abdominal setae, wing tuft colour, forecoxa colour, thorax length and the colour and length of the antennae. Although most flies can now be identified, at least to species sub-complex, by morphological means, numerous other techniques have been deployed with varying degress of success in identifying wild–caught female vector flies. These include enzyme electrophoresis (Meredith & Townson, 1981; Mebrahtu et. al, 1987), analyses of cuticular hydrocarbons (Carlson, 1982; Cheke *et. al.*, 1987; Millest, 1992), cytotaxonomy from adult material (Procunier & Post, 1986) and DNA probe. A more promising approach for species identification involves the polymerase chain reaction (PCR) which has been successfully used to identify *S.*

damnosum s.s, *S. sirbanum* and *S. squamosum* (Brockhouse *et. al.*, 1993) but attempts to apply the method to additional species such as *S. yahense*, *S. soubrense* and *S. sanctipauli* have so far met with only partial success (Cheke, 1998).

Vector complexes

The vectors of *Onchocerca volvulus* are members of the family Simuliidae in the genus *Simulium*. The main vectors *Simulium damnosum*, *S. neavei*, *S. ochraceum*, *S. metallicum* and *S. exiguum* are complexes of sibling species which do not otherwise form a taxonomically close group of species. In Africa and the Southern Arabian peninsula, onchocerciasis is associated mainly with members of the *S. damnosum* complex and to a lesser extent with the *S. neavei* group. The board distribution of both of these groups is well documented (Crosskey, 1987; WHO, 1987; Crosskey, 1990; WHO, 1995a). *S. albivirgulatum*, the vector in the "cuvette contrale" focus of Zarie, is the only vector species outside these two taxonomic groups.

S. damnosum was originally considered to be a fairly uniform species, differing biologically in different bioclimatic zones. However, since the mid – 1960s, it has become apparent that it is a complex of morphologically similar (sibling) species which can be distinguished by the banding patterns of the larval chromosomes (Davies & Crosskey, 1991; WHO, 1995a). At present, over 40 different cytological forms have been described. The species described in West Africa generally fall within three subcomplexes, namely the *S. damnosum*, *S. sanctipauli* and *S. squamosum* subcomplexes. The only cytospecies of the *S. damnosum* complex identified in the Arabian peninsula has been designated *S.* rasyani. In Nigeria, a lot of sibling species like *S . damnosum* s.s., *S. sirbanum*, *S.*

sudanese, S. soubrense, S. sanctipauli and *S. squamosum* have been reported (Vajime & Dunbar, 1975; Vajime, 1982b). The breeding habits and behaviour of the *Simulium damnosum* complex, in addition to the bionomics in relation to the transmission of *O . volvulus* have been reviewed by Lewis (1953, 1958, 1960, 1961), Crosskey (1954b., 1955, 1958, 1962, 1979); DeMeillon (1957); Duke (1966,1967); Jamnback (1976) and Vajime (1982b).

Blackfly of the *S. neavei* complex has been incriminated as the vectors of onchocerciasis in a number of endemic areas in East and Central Africa. This complex is made up of about 3 species; *S. neavei* s.s; *S. woodi* and *S. ethiopense* (WHO, 1995a). These flies breed mainly in small streams and rivers in highland areas of east and central Africa, and nearly all species have an obligate phoresy with fresh water crabs of the genus *Potamonautes*. The ecology and control of the *S. neavei* group have been documented by Jamnback (1976) and Sasa (1976).

The vectors of onchocerciasis in Central Africa and their distribution are well documented (Strong *et. al.*, 1934; Giaquiuto, 1937; De Leone, 1957; WHO, 1987). *S. ochraceum*, a species complex of at least three cytospecies is considered to be the primary vectors in Guatemala and Mexico, while *S. metallicum* s.l. and *S. callidum* play secondary roles. In South America, the potential vectors of onchocerciasis have been studied in much less depth than in other endemic areas. The situation is complicated by the presence of large numbers of human – biting forms in areas from which onchocerciasis is at present not reported. Most of the vectors undoubtedly belong to species complexes. The known vectors are *S. exiguum* s.l., *S. guianense*, *S. incrustatum*, *S. metallicum* s.l, *S. oyapockense* and *S. quadrvittatum* (WHO, 1995a).

1.2.4 Geographical Distribution and Epidemiological Patterns.

Geographical distribution

Onchocerciasis is prevalent in 3 regions of the world namely; Africa, Central and South America and the Eastern Mediterrannean regions. Current estimates suggest that about 17.7 million people are infected, of whom some 270,000 are blind; in addition, a further 500,000 are severely visually disabled. These figures however are certainly an underestimate as the quality of data varies considerably from country to country; in some surveys, for example, visual impairment was not assessed.

The Africa onchocercal belt, most of which is north of the Equator, lies mainly between the latitudes of 15°N and 14°S (WHO, 1976). The northern boundary extends from Senegal to about latitude 15°N in Mali, Niger and Chad and eastward to Sudan, where it stretches its most northern limit in the Abu Hamed area at 19° 15°N. From there it runs southward to Ethiopia. Further south, the disease foci exist in the Gambia, Guinea Bissau, Guinea, Sierra Leone, Liberia, Mali, Ivory Coast, (Cote d' Ivoire), Burkina Faso, Ghana, Togo, Benin, Nigeria, Cameroon, Equatorial Guinea, Central African Republic, Congo, Zaire, Rwanda, Burundi and Uganda. Furthermore, the Southern spread extends to latitude 14°S in Angola and runs north east, around the Zambian border to a point as far north as latitude 8°S in Zaire. According to Beaver *et. al.* (1983), more endemic foci in the Southern direction include the Cholo District of Malawi at latitude 17°S, in Tanzania at latitude 12°S and in the Macha District of Zambia at latitude 16° 26'S.

Onchocerciasis also occurs, to a much lesser extent and degree, in 6 Central and South America countries namely Brazil, Columbia, Ecuador, Guatemala, Mexico and Venezuela. In Mexico, there are 3 endemic foci in mountainous areas in the

South, namely one in the state of Oaxaca and two in Chiapas. The population at risk is 261,660 and three are over 25,000 reported cases (WHO, 1995a). In Guatemala active foci are concentrated on the western slope of the volcanic range. Almost 450,000 people live in the foci, the largest and most intensively infected being the central focus comprising the districts of Chimaltenango, Solola and Suchitepequez, where 30% of communities are hyperendemic (WHO 1995a). In addition there is a focus in the north – west near to the border with Mexico. In Venezuela, onchocerciasis occurs in the states of Mongas, Aragua, Miranda and Caraboba in the North and in the state of Amazonas in the south along the Brazilian border (Rassi *et.al.*, 1977).

Onchocercaisis is also prevalent in Brazil among Indians of the Amazonas state and Roraima state, which borders Venezuela. It is estimated that 200 communities scattered in the onchocercais area, including Auaris, Surucucu, Tootobi, Marari, Mucajai, Catrimani, Xidea, Paapiu and Hormoxi are infected (WHO, 1995a). In Colombia, the known focus is the Lopez de Micay area on the pacific coast, where 16,300 individuals are at risk of infection in 155 communities (Ewert *et.al*, 1979; WHO, 1995a). A few other communities on the border of Ecuador namely, Tumaco, Barbacoas and Ricaurte in Narimo are also suspected to be an onchocerciasis transmission zone. The onchocerciasis focus in Eucador is located in the north – western coastal province of Esmoraldas. The major focus involves blacks and Chachi Amerindians living in the Santiago River Basin. In 1993, there were 192 known infected communities and 20, 089 individuals at risk of infection (Arzube, 1982; Guderian *et.al*, 1982; WHO, 1995a)

Onchocerciasis is found in Yemen. Studies have revealed its existence along the wadis, between the Wadi Ghyl to the south and the Wadi surdud to the north (Fawdry, 1957; Buttner *et.al*, 1982; Connor *et. al.*, 1983, WHO, 1995a). However, the distribution may extend further south into the Wadi Aggan in Karish District and north around Al Mahwit on the reaches of Wadi Mawr.

Epidemiological Pattern

The epidemiological pattern of the disease shows considerable variations between and within geographical zones. These variations are due to factors relating to vector – parasites complexes, human and environmental (WHO, 1995a; Kale, 1998). The pattern of onchocerciasis in Africa can be divided into 4 broad categories (Anon, 1996): (1) the savanna woodland belt or the northern tropics, where the disease is of the blinding type; (2) the West and Equatorial Africa rainforest, where the disease is characterized as being of the "less blinding" type; (3) the Zaire basin, with a complex and mixed pattern of severe blinding and 'less blinding' onchocerciasis; and (4) the East Africa highlands extending from Ethiopia to Malawi, where the disease is generally of the 'less blinding' type.

The vector – parasite complexes and clinical characteristics of the disease differ in a number of respects between the American and the African infections and between different geoclimatic zones with in Africa and the Latin American foci (Duke, 1981). Some of these differences can be attributed to differences in the strains of the parasites and their pathogenicity, and some to differences in the species of *Simulium* vectors and their biting proclivities. The American simuliid vectors tend to bite mainly above waist level, whereas African simuliids bite the lower parts of the body most frequently (Duke and Beesley, 1958). Similarly, most onchocercal nodules develop above the waist in the Americas and below it in Africa (Duke, 1981).

Different epidemiological patterns have been described within the same zone. There are two fairly broad but distinct clinico – pathological patterns of onchocerciasis, particularly in West Africa, based on the diseases two predominant and major clinical complications: blindness and skin disease. In West Africa, blindness rates are significantly higher in hyperendemic communities in the savanna than in communities with similar levels of infection in the rainforest (Anderson *et al.*, 1976; Dadzie *et al.*, 1989, 1990). The situation is different in central and east Africa. In the Congo river basin, Central Africa, severe blinding and less blinding onchocerciasis are found in both the forest and savanna belts, whereas onchocercal blindness is rare in bothbelts in east Africa. By comparison, onchocercal skin diseases and related signs and symptoms are a greater cause of morbidity and debilitaiton in the rainforest zone where, until recently, the scale of their contribution to the burden of disease had been largely overlooked and unquantified, than in savanna areas (WHO, 1995b).

The different, albeit somewhat overlapping, epidemiological patterns which have been described generally fit into fairly discrete and recognizable vector – parasite complexes (Duke, 1966, 1981; WHO, 1987). Thus there is a recognized vector –parasite complex in the West Africa savanna belt which is associated with the most severe form of ocular disease. In this belt, communities located nearest the breeding sites of the vector (ie 'first-line' villages), which are therefore exposed to the most intense level of transmission, may suffer blindness rates in excess of 10% of the population (WHO, 1976). Onchocercal skin diseases (OSD) and troublesome itching have been reported in greater than 50% of the adult populations of some communities in the rainforest belt, where the prevalence of onchocercal blindness is relatively very low (WHO, 1995a).

Human factors include both biological and behavioural components. Those with the most direct bearing on the severity of onchocerciasis in the individual are age, sex and occupation. All three of these variables are directly related to intensity and duration of exposure to infection. Intensity of exposure is a factor of the number of infective bites sustained by the individual (Remme *et. al.*, 1986) and this, in turn depends as much on the transmission efficiency of the local vector (its vectorial capacity) as it does on the proximity of the residence or work place to the breeding sites of the vector (Duke, 1968). Mode of dressing, because it relates to exposure of the body to insect bites, is also a significant behavioural variable.

Prevalence of onchocercal infection is lowest in the first decade of life, after which it rises steeply to reach a peak, usually, in the third decade of life (Duke and Moore, 1968; WHO, 1976; Gemade and Dipeolu , 1983, Onwuliri *et. al.* 1987, Nwoke *et. al*, 1988; Anosike & Onwuliri, 1995).

Male/female differences in prevalence, intensity of infection and clinical manifestation of disease have all been observed (Brabin, 1990). Males are generally more affected than females though gender – related differences may not appear until a certain age and are more pronounced in areas of high transmission, particularly those in savanna. The observed differences, however, appear not only to be due to differences in exposure to infection between the sexes but probably also to relatively high, innate resistance to infection in females. Gender may therefore be considered to be a direct epidemiological risk factor.

Occupation is also clearly a risk factor in onchocerciasis. Thus fishermen, ferrymen and farmers, whose occupations bring them into close and intimate relationship with the vector, are at relatively high risk of infection. The intensity of infection in these groups is related to the annual transmission potential (ATP) and tends to be significantly higher than the mean value for their home village (WHO, 1976).

Another important biological factor is the nutritional status of the individual. In onchocerciasis as in other communicable diseases, the interaction between nutrition and infection tends to be bi–directional (Kale, 1998). Poor nutrition renders the victim more susceptible to, and less able to cope with the attendant biological and physiological stresses of infection, and the disease itself, especially in its more severe form, may tip the individual with borderline nutritional status into frank and overt malnutrition (WHO, 1976) . Cachexia has been reported to be a consequence of heavy and sustained infection with *O . volvulus* (Buck *et. al,* 1971; Ovuga et. al., 1992). The reports of weight loss in infected subjects reflect this aspect of the burden of onchocerciasis. .

Environmental factors with important socio-economic consequences include man-made changes to the environment. Most of these have direct impact on the breeding sites of the vectors of O. volvulus. Notable among these are the construction of large dams for hydroelectricity and other developmental project. This may reduce or alternatively as with spillways, increase the breeding sites of vectors and therefore affect the transmission of onchocerciasis (Kale, 1998). Pollution of rivers and streams which acts as breeding sites for *Simulium*, the result of discharge of human or industrial wastes, makes such water courses less suitable for the vector (WHO, 1976).

1.2.5 Clinico – Pathology of Onchocerciasis

Most of the tissue changes in onchocerciasis that contribute to the development of the various clinical manifestations appear to be associated with the death of microfilariae rather than related directly to the presence of adult worms (Nwoke and Dozie, 1997). In general the presence of microfilariae (living or dead) in a particular tissue appears to be necessary for pathology to develop in that tissue. Furthermore the interaction between *O. volvulus* and host's defence system is vital to an individual's tolerance of infection and differences in people's immune responses are probably central to the variations in the clinical pattern of onchocerciasis.

Generally the manifestations of onchocerciasis are predominantly dermal, ocular and lymphatic in character. Occasionally, there are some associated systemic manifestations. In addition too, there are several features of uncertain association, aetiology or pathogenesis which include low body weight, general debility, diffused musculoskeletal pain and in Africa, epilepsy and non – familial dwarfism (WHO, 1995a). The major clinical manifestation of onchocerciasis which have the most direct bearing on the burden of disease are the ocular and skin lesions and troublesome itching. Other clinical features of relatively less importance, from the disease – burden perspective are onchocercomata (nodules), involvement of the lymphatic system and some associated systemic manifestations (Kale, 1998). There are marked geographical variations in the prevalence and clinical manifestations of onchocerciasis (Anderson *et. al.*, 1974b; Buck,1974) and these have direct bearing on the estimates of the burden of the disease in different parts of the world. Some clinical manifestations occur in American onchocerciasis that are not seen in Africa or Yemen. Notable among these are the skin lesions referred to as'erysipelas de la costa' and 'mal morado' (WHO, 1966).

Dermal or skin lesions (onchocercal skin disease or onchodermatitis)

Onchocerciasis is often associated with changes in the skin (Wyatt, 1971; Anderson *et al.*, 1974b; Mackenzie *et. al.*, 1987a,b; Onwuliri *et. al.*, 1987; Hay *et al.*, 1989; Murdoch *et. al.*, 1993; Hagan, 1998). Itching and scratching are the most important, early manifestations of onchocercal dermatitis and may affect any part of the body. Alteration in skin pigmentation also occurs early in the disease and may also affect any area of the body. The itching may be mild and intermittent, or severe and continuous. Not all subjects with onchocercal dermatitis develop itching. Papular rash may also develop at any time on any part of the body. The papules may be small and closely packed or large and more widely separated and vesicular or pustular. Papular rash is usually associated with severe itching which leads to scratching, bleeding and ulceration with secondary infection (a condition known as 'craw – craw' in West Africa) (Hagan, 1998). The itching and skin papules in those with onchocerciasis reflect microfilarial death (Wyatt, 1971; Mackenzie et.al., 1985) and are non – specific responses (Wyatt, 1971; Murdoch *et. al.*, 1993).

Onchodermatitis has been classified by Golden and Oritz (1946) as **licheniform, pigmentation** and **exczematoid.** Oomen (1969) also recognizd two forms, **eruption** and **diffused onchocercal** skin changes. Recently, a clinical classifcation of onchocercal dermatitis has been developed by Murdoch et al. (1993) to facilitate and standardize the collection of data globally. The classification should permit meaningful comparision to be made of survey results from different geographical areas and help in the assessment of the effects of mass treatment with Mectizan (ivermectin, MSD). Mackenzie *et. al.* (1985) used a simplier, quantitative system in comparative clinico-pathological studies, dermatitis simply being classified as **reactive** or **long term**. The classification system of Murdoch and colleagues has a grading element to record clinical severity of lesions, clinical activity (in terms of itching and excoriation), and extent of the dermatitis. In the latter system, the categories of skin lesion are **acute papular onchodermatitis** (APOD), **chronic papular onchodermatitis** (CPOD), **lichenified onchodermatitis** (LOD), **atrophy** (ATR) and depigmentation (DPM). APOD, CPOD and LOD are the reactive forms. These categories are not mutually exclusive; one pattern may co-exist with or evolve into another. Other skin conditions that were included in the classification by

Murdoch *et.al.* (1993) include palpable onchocercal nodules (onchocercomata), hanging groin, lymphadenopathy and lymphoedema.

Acute papular onchodermatitis consist of small, widely scattered pruritic papules which progress to vesicles and pustules in more severe cases. Erythema and oedema of the skin may also be present, affecting a single limb or area of the trunk or face. APOD may develop in an individual from non-endemic area after visiting an endemic area.

In CPOD, the papules are flat topped and larger (3 – 5 cm) than those of APOD. Itching occurs in some lesions but it is not a constant feature. Post - inflammatory hyperpigmentation is characteristic. Individuals with this type of skin disease may also have acute lesions and other changes due to onchocerciasis.

The main characteristics of lichenified onchodermatitis are pruritus, raised, discrete papulo-nodules or plaques of thickened skin as well as hyperpigmented-skin noticeably darker than the surrounding skin. LOD is a common feature of onchocerciasis in certain geographical areas such as Sudan and Yemen, although it is seen less frequently elsewhere.

Atrophic skin adopts many of the characteristics of aging, such as loss of elasticity and contours and the skin appears excessively wrinkled. Atrophy is due to repeated episodes of acute inflammation associated with microfilarial death and destruction (Mackenzie *et. al.*, 1985). In other to avoid confusion with senile atrophy, ATR due to onchocerciasis is only scored as a significant abnormality in individuals less than 50 years. Laigret (1929) in Sudan, described atrophic skin as thus: "onchocerciasis makes young people look like old and old people look like lizards (lichenoid changes)". Hughes and Daly (1951) called it 'crocodile skin' and it is often impossible to distinguish the skin changes from those seen in vitamin A deficiency patients. Rodgers (1962) suggested that this skin change may be due to the fact that either the parasite competes for vitamin A in the skin or that Vitamin A deficiency may predispose the skin to heavier infection.

Alterations in the basal pigmental layer of the epidermis lead to the depigmentation associated with leopard skin. Patches of complete pigment loss are seen, with island or "spots" of normally pigmented skin centered around hair follicles. The surrounding areas of skin may be normal or hyperpigmented. Lesions are rarely itchy and are flat or slightly depressed. Sometimes the skin is not fully depigmented and is seen as yellow-brown areas on black skin. Such lesions may represent early or incomplete depigmentation. Although some studies have been carried out on the pathogenesis of leopard skin, its specific aetiology remains uncertain. Certain factors however have been postulated and these include: the dermatoxic components in the blackfly salvia (Craig, 1932; Nwokolo, 1950); the toxin of microfilariae or adult of *O. volvulus* and anaphylactic causes (Browne, 1960).

'Sowda' is a severe form of onchocercal dermatitis, first described in Yemen (Gasparini, 1962). Those affected have intensely itchy, dark and thickened skin with papular rash and enlarged, soft, non-tender, regional lymph nodes. Sowda is usually localized and typically involves one leg. A more generalized form may involve both legs or any part of the body. Some patients present with skin which is focally swollen and others present with a more diffuse lymphoedema. Microfilariae are usually absent in skin – snips from sowda patients (Hagan, 1988). Although sowda was first recognized in Yemen it has since been described in west Africa, Sudan, Ethiopia, Cameroon and Ecuador (Jopling, 1960; Anderson *et. al.* 1973; 1974; Wolfe *et. al.*, 1974; Mackenzie *et. al.*, 1985; Hay *et. al.*, 1989). In Latin America, onchodermatitis has been reported and is locally known as 'erysipelas de la costa and 'mal morado' (WHO, 1966, Buck, 1974; Nelson, 1991).

The nodules or onchocercomata are the main features of the clinical manifestation caused by the adult worms. During the early stages of infection, especially in children and in lightly infected persons, the adult worms usually do not produce any detectable symptoms – lying free in the subcutaneous tissue or enclosed in loose fatty tissue (Nnochiri, 1964). In later stages, however, chronic inflammations, without acute symptoms develop around the adult worms. These eventually become visible as palpable nodules of various sizes.

In Africa, the nodules are distributed around the pelvic especially over the iliac crest, greater trochanter of the femur, the coccyx, and sacrum; a few nodules are found around the knee and other common sites are over the lateral chest wall and spine (Browne, 1961; Nelson, 1970; Anderson *et. al.*, 1974; Dipeolu and Gemade, 1983; Nwoke *et. al.*, 1987; Amuta and Onwuliri, 1997, 1998; Kale, 1998). This is in contrast with the Latin American form of the disease where more nodules are located in the head region than other parts of the body (Lagraulet *et al.*, 1964; Mojusiau *et al.* 1965; Salazar, 1974; Duke, 1981).

The anatomical location of nodules is of clinical importance. Head nodules, which are particularly common in subjects of all ages in Guatemala and Mexico (Lagraulet *et al.*, 1964; Salazar, 1974), are associated with relatively high concentrations of microfilariae in the skin of the head and neck region (as determined by skin snips taken from the outer canthus). Infected individuals with head nodules run a higher risk of ocular complications than those without head nodules (Fuglsang *et al.*, 1976). Similarly, in Africa where the nodules are mainly in the lower part of the body, the density of microfilariae in the skin is highest in the lower extremities and in particular the pelvic region and buttocks (Kershaw *et al.*, 1954; Nelson, 1958; Edungbola, 1982; Nwoke *et al.*, 1989). Yemen onchocerciasis rarely present with onchocercomata (Somorin, 1983).

Ocular lesions

Ocular lesions or onchocercal ocular disease (OOD) are the most serious and feared consequences of onchocerciasis. The alternative name for onchocerciasis, river blindness, derives from the devastating effect of the disease on the eyes, ultimately leading to blindness in severely affected individuals. The natural history of OOD has been revealed by longitudinal studies carried out in areas of on–going transmission (Budden, 1955, 1976; Rolland, 1974; Anderson *et al.*, 1978; Rolland *et al.*, 1978). These have all shown that onchocerciasis is a progressive disease, its progress being related to repeated inoculation of infective larvae over many years, leading in turn to an increase in the intensity of microfilarial infection. The associated build- up of microfilarial concentration in the eyes may, after a period of some years, cause the severe eye lesions that may lead to blindness (Abiose, 1998). Although life microfilariae have been identified in all tissues of the eyes, the blinding lesions are most often seen in relation to dead microfilariae (Nwoke and Dozie, 1997).

The actual route of entry of microfilariae into the eye is not known. Several routes have been proposed which include entry through the sheaths of the posterior ciliary nerves and arteries (Neumann and Gunders, 1973), the blood circulation (Fuglsang and Anderson, 1974) or the cerebrospinal fluid (Duke, 1976) and along the orbital septum and the cheek ligaments (Tonjum and Thylefors, 1978).

Clinically, various structures of the eye may be affected but for ease of description, OOD may be considered as anterior – segment disease and posterior-segment disease, in addition to their associated irreversible consequences, blindness and visual – field loss. In the anterior – segment lesions, the cornea is frequently affected and the microfilariae in the cornea are considered to do little harm as long as they are alive, but when they die however, Buck (1974), noted that small infilteration form around them resulting in fluffy opacities similar to punctuate keratitis due to other causes. Other clinical conditions associated with anterior – segment disease include sclerosing keratitis and anterior uveitis (Kale, 1998).

A wide spectrum of disease may occur in the posterior segment of the eye. These diseases include chorioretinitis, optic neuritis and optic atrophy (Abiose, 1998; Kale, 1998). Early chorioretinitis, manifests as atrophy of the retinal pigment epithelium. This is typically located temporal to the macula area but may be nasal to the optic nerve. The atrophy later becomes coalescent and widespread (Abiose, 1998). Optic neuritis followed by post – neuritic optic atrophy associated with scarring and pigment disturbance at the disc margin may be seen even though primary optic atrophy may also occur. The associated vascular sheathing may extend for a considerable distance from the optic nerve head. Clinical experience has shown that the active optic neuritis may last at least several weeks and sometimes for a year or even longer. Prevalence of optic atrophy varies from 1% - 4% in hyperendemic, rainforest and savanna communities of Cameroon, to 6% - 9% in Sierra Leone, and 9% in the Guinea savanna of northern Nigeria (Anderson *et al.*, 1974b; Abiose *et. al.*, 1993).

Patients with OOD may present with mild problems (itching, redness, pain, photophobia, blurring of vision) or the more severe symptoms of night blindness and/or visual – fields loss, depending on which tissue of the eye is affected (Abiose, 1998). However, blindness remains the most serious consequence of onchocerciasis. There is a definite cut – off point for blindness as, by definition, an individual is blind when visual acuity is less than 3/60 in the better eye. However, the overall consequences of onchocerciasis can only be fully appreciated when the importance of uniocular blindness, visual impairment and constriction of the peripheral visual field is fully taken into consideration (Abiose *et. al.* 1994; Murdoch *et al.*, 1997). The severity of OOD generally depends on the intensity of infection (Anderson *et. al.*, 1976; Thylefors and Brinkman, 1977). This is in turn, related to the level of transmission. The disease pattern also appears to vary with sex and the local ecology. The prevalence of blindness rises with increasing subject age and males are more frequently affected than females because male-dominated occupations such as farming and fishing lead to greater exposure to infected vectors (Abiose, 1998). In addition to reduced exposure, Anderson *et.al.* (1974) noted that lower ocular incidence in females may be attributed to possible unexplained hormonal effects; especially in their reproductive years (Dipeolu & Gemade, 1983). With respect to local ecology, the prevalences of OOD and blindness in West Africa is much lower in the rainforest than in savanna (Budden, 1963; Anderson *et.al.*, 1974; Prost, 1980). In the northern savanna zone, the prevalence of onchocercal blinding lesions is high and has a direct, linear relationship with community microfilarial load (CMFL), ocular pathology and blindness increasing with increasing intensity of infection (Remme *et.al.*, 1989). In the Southern forest zone (except in Sierra Leone), the linear relationship between intensity of infection, ocular lesions and blindness is less steep.

Lymphatic complications

Involvement of the lymphatic system may cause lymphangitis and varying degrees of uni –or bilateral lymphadenopathy (Somorin, 1983; Connor and Palmieri, 1985; Kale, 1998). In the most severe form, lymphatic onchocerciasis may progress to lymphoedema (elephantiasis) of the affected part, limb, breast, face and including the genitalia (Buck, 1974). Skin that has thinned out and lost its elasticity (presbydermia) is not uncommon in chronic infections. When the skin affected is that of the groin, it presents as the classical "hanging groin", with or without enlarged, inguinal, lymph node. Those with onchocerciasis are also predisposed to hernias (Nelson, 1985a; Edungbola *et al.,* 1991). The association between these lymphatic complications and onchocerciasis particularly in Africa is well documented despite earlier controversies with respect to the role of *O. volvulus* in their aetiology. For instance, lymphoedema of the genitalia (scrotal elephantiasis) has been reported to be caused by *O. volvulus* in Chad (Buck *et al.,* 1971), in Sudan and Uganda (Kirk, 1947, 1957; Burkitt, 1966a, b), in Liberia (Gratama, 1966). Furthermore, high rates of genital elephantiasis have been observed in endemic foci of onchocerciasis and in particular on the Ulele River in northern Zaire, where bancroftian filariasis is absent (Ouzilleau, 1913; Dubois, 1916; Dubois and Forro, 1939; Connor *et. al.*, 1970). Although Oomen (1969); Price (1972), Heather and Price (1972) concluded that in Ethiopia onchocerciasis infection could not be the cause of elephantiasis, Wonde *et. al.* (1973) indicated that there could be casual relationship between onchoceriasis and elephantiasis in south-west Ethiopia, an endemic focus of the onchocercal disease. Elephantiasis of the face has been recorded by Piers and Fasal (1953) as a rare complication of onchocercaisis in Congo and in a female patient in Liberia by Nelson (1970).

The pathogenesis of these lymphatic involvements is poorly understood and perhaps controversial. Onchocercal lymphadenities and especially the alterations in the lymphoid tissue are believed to play a role in the inflammatory and immunological responses responsible for the development of hanging groin and elephantiasis (Connor *et.al.*, 1970, Gibson and Connor, 1978; Connor, George and Gibson, 1985). Acquired hernias on the other hand are believed to be caused by weight of hanging tissues which weaken the femoral and inguinal canals (Nelson, 1958a). Very strong reservations for the validity of this concept have been expressed. Acquired hernias have rather been suggested to be consequences of disorders of collagen metabolism caused by presence of *O. volvulus* in the groin of the infected individual which in turn results in the weakness of the transversalis fascia of the Hessenlback's triangle in the inguinofemoral region (Guderian and Kerrigan, 1990; Edungbola *et. al.*, 1991). This assertion was based on experimental results which attributed acquired groin hernias to a connective tissue abnormality, specific to disorders of collagen metabolism as well as to other established clinical and laboratory conditions which are related to higher prevalence of hernias such as Marfan's syndrome and Ehler Danlos syndrome (type V) (Guderian and Kerrigan, 1990) and Lathyrism (the experimental administration of beta amino proprionitrile to laboratory animals to induce a derangement of collagen metabolism) (Selye, 1957). Further studies are required to elucidate the actual mechanisms of pathogenesis of lymphatic involvements in onchocerciasis.

Although of relatively less importance from the disease burden perspective, these lymphatic involvements have been identified as important causes of disfigurement, embarrassment and severe morbidity in highly endemic areas in Africa (Edungbola *et. al.*, 1991). For instance, most patients have been reported to experience a lot of socio-cultural discomfort. This is especially reflected in the infected individual's unwillingness, fortified by shyness towards free social interaction within his or her locality (Nwoke, 1986). In patients with scrotal elephantiasis, sexual life is greatly affected if not completely hindered (Nwoke, 1986). Furthermore, in some endemic communities in Nigeria, women with complications are presumed to be promiscuous and at times undesirable as wives.

Systemic manifestations

According to WHO (1976), systemic manifestations of onchocerciasis include all the pathological manifestations caused by *O. volvulus* microfilariae in parts of the body other than the eye and the skin. Many aspects of these manifestations, however, are not fully known (Kale, 1998). Microfilariae of *O. volvulus* have been found in diverse organs and body fluids and tissues, including blood vessels, lymph nodes, the liver, kidney, lungs, spleen, nervous tissue, blood, urine, hydrocoele fluid, tears, sputum, vaginal washings, synovial fluid and cerebrospinal fluid (Price, 1961; Couzineau *et. al.*, 1973; Picq and Roux, 1973; Thomas *et al.*, 1973; Buck, 1974; Anderson *et al.*, 1975; Fazen *et al.*, 1975; WHO, 1976; Prost and Gorim de Ponsay, 1979; Prost and Vaugelauds, 1981). The frequency and concentration of microfilariae in some of these tissues (e.g the urine in cases of microfilaria) are directly related to the local level of endemicity and the density of microfilariae in the skin (Picq and Roux, 1973; Buck, 1974). The mobilisation of microfilariae into the various tissues is believed to be responsible for the severe reactions that sometimes accompany treatment, such as collapse, shortness of breath, coughing and vertigo (WHO, 1976).

Features of non-classical onchocerciasis (dwarfism, low body weight, musculoskeletal pain, epilepsy)

Onchocerciasis has been associated with non famililial dwarfism, the so-called Nakalanga syndrome seen in the Mabira forest in Uganda (Ovuga *et al.*, 1992). The pigmies were initially thought by Johnston (1902) and Pitman (1934) to be a relict group but detailed epidemiological, clinical and pathological studies on these dwarfs by Raper and Hadkin (1950) showed that they were infact offsprings of normal parents. Apart from the characteristic infantilism with associated signs of pituitary deficiency, there was one factor that distinguished them from children of similar age; they were all severely infected with onchocerciasis (Nwoke, 1986). Furthermore, this condition was reported by Nelson (1970) to be well known to the local Baganda, who attributed dwarfism in children to be due to bites by the "mbwa" fly, a local terminology for *S . damnosum.* Several studies have also reported similar dwarfs from other foci of onchocerciasis (Nelson, 1958b; Jellife *et al.*, 1962; Standfield, 1963; Bangenda *et.al.*, 1964).

Low body weight has been associated with onchocerciasis. The mean weight of residents of hyperendemic areas has been reported to be significantly less than that of residents of meso and hypo-endemic areas (Kale, 1998). The results of a 3 year, follow-up study by Buck *et. al.* (1971) indicated significant weight losses in heavily infected subjects.

Adequate evidence that musculosketetal pain (MSP) could be a likely sign of onchocerciasis was presented by Lamp (1967). He found that 63.7% of the 77 patients diagnosed as having onchocerciasis in Ile – Ife Nigeria presented with muscular or joint pain. After analyzing and comparing musculoskeletal pain with other symptoms, he concluded that "muscular and joint pain has much clinical significance in the diagnosis of onchocerciasis as do the classical dermotological symptoms". Earlier Dejou (1939) had described an acute arthritis with effusion in which the microfilariae of *O. volvulus* were demonstrated in the aspirated synovial fluid. Several other studies have shown increased prevalence of musculosketetal pain often enough to produce significant morbidity to be associated with onchocerciasis (Thompson, 1971; Pearson, 1985, 1988; Pearson *et.al*, 1985). Shell (1981) called musculoskeletal pain 'filarial rheumatism'. Pearson (1988) noted that rheumatic symptoms due to onchocerciasis could turn out to be the largest single cause of rheumatism in the tropics. Hence he advocated that onchocerciasis should not only be tagged with the established name of river blindness but also with the name "tropical rheumatism" or "tropical backache". MSP not only gives prolonged discomfort, but reduces the capacity to work, particularly manual work. It has also been suggested that MSP may lead to reduction of sexual activity in hyperendemic communities in Nigeria and possibly maternal mortality due to inability to 'bear down' during child labour because of associated pain (Ukaga, 1997). The potential use of MSP as a premonitory sign or symptom in a rapid, low cost diagnosis of onchocerciasis has been suggested (Nwoke, 1992).

Reports from hyperendemic areas of the Central African Republic, Guatemala, Mexico, Sudan and Cameroon have indicated a higher than normal frequency of epilepsy than in non – onchocercal and low endemicity areas (WHO, 1976; Kipp *et. al.*, 1993; Kaiser *et. al.*, 1996). Additional studies are required to clarify the actual relationship between these features of non-classical onchocerciasis and *O. volvulus*.

1.2.6 Prevalence Surveys

Since the demonstration of microfilariae in the skin of 6 patients with 'craw-craw' in West Africa (O'Neil, 1875), human onchocerciasis has been recognized as a disease of significant public health problem and obstacle to socioeconomic development in Africa. Almost all (96%) of the estimated 122.9 million at risk of the disease globally live in sub – Sahara Africa, and 17.5 million of the estimated 17.7 million who are infected live in Africa (WHO, 1995a). In Nigeria alone, there are believed to be about 3.3 million individuals infected with *O. volvulus* and > 100,000 cases of onchocercal blindness (WHO, 1987). Visual impairment due to onchocercal eye disease is demonstrable in about 3% of the children aged 5 years who live in hyperendemic communities in Nigeria and 35% of males and 26% of females in such communities are visually impaired by the age of 30 years (Gemade and Utsalo, 1990). In the face of these grim statistics, it is not surprising that the World Health Organization (WHO), the World Bank, the United Nations Development

Programme and other donor agencies with the WHO as executing agency, have attempted to control the disease in some West Africa countries, via the Onchocerciasis Control Programme (OCP) in West Africa.

From the inception of the project in 1974, the OCP, the largest single control programme on human onchocerciasis had to rely exclusively on vector control because no acceptable drug for mass treatment of this disease existed. The discovery of Mectizan in the late 1980s (Lindley 1987) was remarkable breakthrough in the fight against onchocerciasis. The unprecedented decision of Merck & CO. to donate the drug, in whatever quantities necessary to control onchocerciasis, provided endemic countries not only with incentive but also with formidable challenges (Gemade *et. al.*, 1998)

Endemic countries outside the OCP area such as Nigeria on realizing the enormous socio-economic and public health problems of this chronic disease have set up their own National Onchocerciasis Control Programmes (NOCP) with the support of non-governmnental development organizations (NGDO) and other donor agencies to control the disease through mass distribution of Mectizan. Although ivermectin has shown great promise and therefore, has revolutionized the treatment of onchocerciasis, its effective use is based on sound epidemiological, baseline data to rapidly identify river systems and communities eligible for mass delivery of the drug (Nwoke, 1990a).

<u>Need for rapid assessment method (RAM) for onchocerciasis in Nigeria</u>

The need for rapid assessment method for onchocerciasis in Nigeria became necessary because of the technical, logistic and public health limitations of the hitherto acceptable and conventional diagnostic procedure, the skin snip, for identifying communities eligible for treatment. Such limitations of the skin snip method include: being invasive and time consuming, requires expensive equipment, and highly technical as well as poor cooperation by the villagers because of discomfort and fear. The method may expose people to a higher risk of contracting other infectious diseases such as HIV/AIDS and infectious hepatitis (WHO, 1992). In addition, the use of skin snip in Nigeria is complicated by her extensive land mass and huge human population of over 100 million people – about twice the combined population of all the 11 participating countries of OCP (Edungbola, 1991). Furthermore, the widespread nature of onchocerciasis in the country makes it so cumbersome and very costly to use skin snip method to identify all the eligible endemic communities for the delivery of Mectizan to the estimated 40 million Nigerians living at the risk of infection (Nwoke, 1990a).

It was against this background that WHO (TDR) in collaboration with the Federal Ministry of Health and Social Services Nigeria organized a 5 multi-centre study in 1992 on rapid and low-cost method of identifying eligible communities for large – scale onchocerciasis treatment in Nigeria. The 5 multi – center study which was funded under the auspices of Onchocerciasis Operational Research Initiative was charged with the responsibility of developing a rapid assessment method that is simple and non-invasive, rapid and cheap, applicable and practicable over the wide range of ecological conditions, reliable and sensitive regardless of severity and duration of infection, non too technical, acceptable and tolerable in terms of sociocultural and religious considerations as well as absence of risk of infections or any other complications (Nwoke *et. al.*, 1994). In addition, the study was harmonized to cover all levels of endemicity including forest and savanna bioecological zones in the country. It was designed also, among other things to determine the relationships between the community microfilarial rate and onchocerciasis signs and symptoms which have earlier been suggested to have some association with prevalence rates (Nwoke, 1986; Edungbola et al., 1987). The results of the 5 multi – center study favoured the use of nodules and leopard skin as rapid low cost diagnostic indices for estimating the endemicity of onchocerciasis, as against the skin snip method.

Rapid epidemiological mapping of onchocerciasis (REMO) in Nigeria

The demonstration of a good correlation between the prevalence of onchocercal nodules and of skin microfilariae in a community (Taylor *et.al*, 1992; WHO 1992, 1995c) provided a major breakthrough in the rapid epidemiological mapping of onchocerciasis (REMO) (Ngoumou and Walsh, 1993). After developing and field – testing the concept of REMO in a nationwide survey in Cameroon, Ngoumou and Walsh (1993) developed a "Manual on Rapid Epidemiological Mapping of Onchocerciasis". This procedure was adopted by WHO/TDR as the standard protocol to be used to produce acceptable baseline epidemiological results for the control of onchocerciasis in endemic countries in Africa (including Nigeria).

The successful implementation of REMO required a good understanding of the ecology and behaviour of the vector, the epidemiology of onchocerciasis and the geography of the area under investigation. Prior to the Nigerian survey, WHO (TDR) and the Nigerian NOCP organized a one-day symposium with Drs J.H. Remme and P. Ngoumou as facilitators (Gemade *et. al*. 1998). All the key players involved in onchocerciasis control in Nigeria participated (NOCP staff, zonal consultants, NGDO, UN agencies, and entomologists and epidemiologists from each of the country's four primary health – care (PHC) Zones). At the end of this symposium, the country was divided into eight hydrological zones based on the distinct river systems (Gemade *et. al.*, 1998). With the NOCP consultants in place and the support of UNICEF, NOCP organized and implemented REMO exercise Nigeria in 1994, in accordance with the REMO manual of Ngoumou and Walsh (1993), using nodules palpations. Records were kept of the prevalences of leopard skin, onchocercal skin disease as useful indicators of disease burden (Vuong et al., 1988).

At the end of the REMO exercise, independent experts who did not participate in the primary exercise cross-validated the results using the supplemental guidelines for REMO (WHO, 1995c). Based on the results of the cross-validators, some results were consistent and therefore accepted, some were to be refined (by increasing the number of sample communities), some were re-defined, and additional surveys were carried out in areas where REMO some results proved unacceptable.

The REMO data, collated as an Excel (Microsoft) spreadsheet, were finally used to plot endemicity maps with the help of geographical – information system (GIS) software (Atlas version 3.0 for Windows; Strategic Mapping, Santa Clara, CA) (Gemade *et. al.*, 1998). The geographical co-ordinates of all the sampled communities were obtained from a gazetteer (Anon, 1988), read off the maps (at a scale of 1:250,000) used in their selection, or obtained by the use of global-positioning-system (GPS) receivers in the communities. The digitized co-ordinates and digitized information from the Africa Data Sampler (ADS) on the boundaries of the local government areas (LGA), states and on the positions of the major rivers were combined with the REMO data in the GIS. The multi - layer maps produced were then used, in conjunction with existing knowledge of the ecology and behaviour of blackflies and of the epidemiology of the disease, to split Nigeria into three categories: areas that require community directed treatment with Mectizan (based around river systems with communities in which nodule prevalence was ≥19%);

areas that do not require treatment; and areas that require further exploration by REMO. The map that emerged was reasonably detailed and was consistent with the known disease pattern, particularly across the international border with Cameroon in south-east Nigeria (WHO, 1995d).

1.2.7 Social and Economic Aspects

One aspect of the onchocerciasis disease process that has until recently received little attention is the social and economic aspects. Few studies have dealt with this aspect especially studies on the effects of onchocerciasis on social life, reduced labour supply and economic benefits of control programmes.

The need to understand the social and economic costs of onchocerciasis or conversely, the benefits to the individual and the societies whose health is improved by introducing control has been underscored by Popkin (1982). This is especially as a thorough picture of the socioeconomic aspects will provide planners and other policy makers with a basis for understanding the implications of the disease.

The effects of onchocerciasis on social life has been reviewed by a number of studies (Hughes & Daly, 1951; Fuglsand, 1983; Nwoke, 1986, 1991, Nwoke *et. al.*, 1987; Amazigo, 1994; Amazigo & Obikeze, 1991; Hagan, 1998). The symptoms and signs of onchocercal skin diseases (OSD) are linked, or are at least perceived to have causal connections with insomnia, skin appearance and fatigue. This is usually attributable to the degree of itching that accompanies OSD. In most endemic zones there is no difficulty in recognizing an infected community because the cross-section of the population seems to be busy scratching (Nwoke, 1991). In some rural villages in south – Eastern Nigeria, for instance, OSD has the striking characteristic feature of incessant itching described as "oko nyi mbo" meaning "itching that defies the nails" (Amazigo, 1994). In Ibadan in Western Nigeria, anyone that has constant itching is called 'narun' or 'ako kokoro'; in Ghana, 'ahokeka' (literally 'body itch') and in Uganda 'gwenyu' (Hagan, 1998). The itching is reported to be worse when it rained or threatened to rain, when patients perspired, or after a bath; all these may be related to the chemotactic tendency of microfilariae.

Furthermore, skin lesions of any origin have been identified by Goodman et al. (1963) and Porter and Beuf (1991) to be a handicap for girls because of the social significance of appearance and culturally acceptable standards of beauity. Such affected persons are likely victims of overt discrimination at school and other social gatherings (Goffman, 1963; Cash *et. al.*, 1977). In a recent multi-country study undertaken in Africa to determine the prevalence and clinical severity of OSD and the associated psychosocial importance, it was reported that at least 30% of those with OSD indicated low self-esteem because of their skin conditions (WHO, 1995b; Hagan, 1998). About 33% said they would find it difficult to marry and 1% - 2% would consider suicide because of their skin conditions. In Etteh Nigeria, Amazigo and Obikeze (1991) found that onchoceral dermatitis led to withdrawal behaviour, isolation and societal maladjustment in these affected. The victims often felt socially uprooted from their communities.

Similarly, the pan-African investigation on the public health and socio-economic impact of OSD (WHO, 1997) revealed that: (1) people who had OSD spend more on health – related expenditure than non-affected controls; (2) individuals with severe OSD spend more time and make significantly more visits to health-care facilities than controls; (3) subjects with OSD spend less time on productive activities than controls; and (4) children from homes where the head of the household had OSD attended school less regularly and were more likely to drop out of school than children of the same age-group in the same community whose head of household did not suffer from OSD.

Other skin conditions especially those that result in loss of skin elasticity have been noted to give young people a prematurely aged appearance, while the old people look like lizards. Hughes and Daly (1951) called this condition 'crocodile skin' and in some patients it is difficult to distinguish the skin changes from those seen in vitamin A deficiency patients. Depigmentation (DPM) elicited less psychosocial concerns than other skin diseases. In Awka and Calabar Nigeria, DPM is associated with wealth/ageing and beauty respectively (Hagan, 1998).

The socio-economic effects of onchocerciasis on the effective supply of labour have in the recent past presented a major concern especially in countries where this disease is endemic. Although not much has been done on this aspect, yet evidences have indicated that at least onchocerciasis affect the effective supply of labour in 3 ways (Nwoke, 1991); (1) as a cause of death, it removes the individual's supply of labour years in the future; (2) as a cause of permanent disability through blindness and serious visual impairment, onchocerciasis withdraws the affected individual's potential supply of labour years in activities requiring vision, and (3) partial visual impairment and/or other non-visual disabling complications like OSD reduce the efficiency of labour days worked.

At present, there exist no empirical evidence concerning the effect of onchocercal blindness on actual labour input. However studies by Rolland and Ballay (1969) and Nwoke (1986) in Upper Volta (Burkina Faso) and Nigeria respectively indicated that blindness is concentrated in the working age groups and with very high prevalence in hyperendemic communities. In the Onchocerciasis Control Programme (OCP) areas in West Africa, an estimated 33,800 men and 18,200 women were reported to suffer from onchocercal blindness (WHO, 1973). Estimates of the total potential working days lost due to blindness was put at 8,840,000 man days per year, taking an annual average of 170 working days as a basis for the estimation. As indicated earlier, the absence of empirical evidence on the effect of onchocercal blindness on actual labour input which might provide a basis for predicting the increment in aggregate income due to control is complicated by the fact that some blind patients continue to farm while majority engage in craft activities (Nwoke, 1991).

Fragmentary evidence exist to show that partial visual impairment and other non-visual disabling disease manifestations can reduce the efficiency of labour years worked. In a study on the recruitment of labour on a tea estate in Uganda, Prentice and McGrae (1966) showed that of the 23 cultivators tested, 20 (who presumably failed the test) were found to be infected by onchocerciasis. The extent however to which these groups differed in performance was not specified. This is especially important because working efficiency or productivity at work can logically be expected to depend on the severity of the disease (Nwoke, 1991).

Furthermore, this study did not control for other determinants of working efficiency, including other parasitic diseases. However, in a recent study, conducted by the World Bank in conjuction with the Institute of Pathobiology of the University of Addis Ababa on the impact of OSD on workers at the second – largest coffee plantation in Ethiopia, it was found that those payroll employees classified as having severe OSD earned 15% less in daily wages than those not infected (Kim *et al.*, 1997b).

The adverse effects of onchocerciasis on the effective supply of land in Africa have been documented by Waddy (1949), Rolland Ballay (1969), Hunter, (1972), Bradley (1976) and WHO (1987). These studies have shown that the low population densities and desertation of many fertile river valleys in the savannah zone of West Africa are mainly due to onchocerciasis. In Nangodi, Northern Ghana which is hyperendemic, Hunter (1972) reported that blindness prevalence increased rapidly as one moved towards the rivers until a point where the disease situation becomes incompatible with permanent human settlement. He noted from oral evidence that the frontier of settlement had extended to the bank of the river in the early part of the 20th century but receded steadily over the decades primarily as a result of onchocerciasis in the fertile riverine areas.

Additional studies by Rolland and Ballay (1969) in the Bisa region of Burkina Faso (formerly Upper Volta) showed that many factors including damage caused by wild animals, forced recruitment of labour in the Ivory Coast, illness, disagreement with traditional Chiefs, famine, lack of water supply in the dry season river and bush spirits were involved in the gradual abandonment of villages in this riverine area. However, he conceded that of all these factors, onchocerciasis was the most important recent cause of depopulation and the major obstacle to the repopulation of the deserted areas. Furthermore, in the Middle Hawal Valley Nigeria, Bradley (1972) observed that onchocerciasis was one of a complex of interrelated causes of abandonment, exerting a subtle catalytic effect on other factors already in operation in depopulating the fertile riverine areas.

The economic benefits of onchocerciasis control as determined in the various control programmes, particularly Onchocerciasis Control Programme (OCP) in West Africa and the African Programme for Onchocerciasis Control (APOC) have been reviewed by few studies. In part of the OCP area (Ghana) Williams (1970) attributed the economic benefits of 15 – years control programme to three factors namely: (1) an increase in the supply of land, (2) an increase in the supply of labour and (3) an increase in the cattle population. He estimated the output benefits of the new land based on the assumption that about 1600 hectares of land would come under cultivation progressively over the project's life; one quarter after 6 years, half after 8 years, three quarter after 10 years and the total after 12 years, a factor he attributed only to increased effective labour supply resulting from averted debility.

Furthermore, the extent of impairment of working efficiency was assumed by Williams (1970) to depend on the duration of infection in the following ways; a 5% reduction after 3 years, 15% after 4, 25% after 5 and further reductions of 5% in each later year, reaching 75% in the 15th year after the initial infection. Another element in the total output benefits was estimated on the assumption that intensive cultivation of fertile river valleys following onchocerciasis control would reduce transmission of animal trypanosomiasis and lead to sudden increase in the livestock population especially cattle by one per 1.2 hectares over an area in the 15th year of the project. Another study (Vajime,1982a) on the analysis of cost and benefits over a 35 – year period of the control programme noted that full development could be accomplished only after a period of years which contradicts the instantaneous output benefits projected by Williams (Nwoke, 1991).

The cost – benefit analysis of the APOC (which was put in place for 19 endemic countries which are outside the purview of the OCP), significantly understates the net benefits from APOC activities since it considers only reduction in onchocercal blindness (and the associated augmentation of the productive labour force) as the principal economic benefit resulting from the APOC (Kim *et al.*, 1997b; Benton 1998). The economic benefits of the cost-benefit analysis of the OSD are yet to be determined.

The cost – benefits analysis of the APOC conducted by the World Bank (Kim *et al.*, 1997a), contrasts expenditures of control activities over project horizon 1996-2007 with benefits accruing from reductions in onchocercal blindness. Projected expenditures of APOC activities to be financed from all sources (donors, beneficiary governments and non –governmental development organizations (NGDO), with the exception of Merck, the pharmaceutical producer, which is providing Mectizan free of charge, amount to U.S $131.2 million in 1996 constant dollars (U.S $160.7 million in nominal terms) (Benton, 1998).

APOC activities are projected to reach progressively large sections of the target population. It is assumed that once a certain proportion of the target population is reached, incidence levels blindness will decline subsequently over the course of 5 or 6 years (Kim *et.al.*, 1997a; Benton 1998). Based upon epidemiological information, there were an estimated 46,000 new cases of blindness resulting from onchocerciasis in APOC countries in 1996. In the absence of the APOC, the incidence of new cases of blindness is projected to grow at 2.5%, in tandem with the annual growth rate of the population in the region resulting in a total of 1,327,691 cases of blindness over the project horizon 1996 – 2017 (Benton, 1998). With APOC activities, a total of 338, 724 cases of blindness would occur within the same project period, resulting in about 988 967 cases of blindness being prevented.

In addition, about 10 million discounted healthy life-years would be added in the time horizon 1996 – 2017, which roughly represents 27 healthy life-days added/US $ invested in the APOC. This calculation is based on the premise that the number of healthy life – years added assumes that each case of blindness prevented, on average, adds 20 healthy years, discounted at a rate of 3% to reflect social time preference (Benton, 1998). This low discount rate, based on the report by Prost and Prescolt (1984), assumes that the future is valued almost as much as the present. Although a higher discount rate is typically applied to deferred consumption since resources not consumed today may be invested to yield higher returns in the future, this argument is not usually valid for human life years. A disability weight of 1 for blindness is assumed (ie 1 year of blindness is economically equivalent to 1 year of premature death). However, it has been argued that conditions such as blindness be accorded a disability weight greater than 1 since, in addition to foregoing the output of a blind worker, other members of society are responsible for his/her consumption requirements (Prost and Prescott, 1984).

Furthermore, assuming that each case of blindness prevented augments the productive labour force and yields addition agricultural output (the value of which approximates to US$150 in constant dollars), the analysis projects economic rates of return (ERR) from the APOC to range from 6% to 17%, depending almost entirely upon whether the APOC achieves its primary goal of long – term, sustainable treatment of onchocerciasis (Benton, 1998). The degree of achievement of sustainability is a major factor in determining the economic success of the APOC. Provided the APOC achieves sustainability beyond cessation of direct financing of the programme, the ERR approximates the mean rate of return of World-Bank-supported projects in the most productive sectors (such as industry, agriculture, energy, telecommunications and transport anywhere in the developing world.

Disability adjusted life years (DALY) have recently emerged as a similar quantitative measure of the burden of disease; allowing ease of comparison across diseases and enabling analysis of cost – effectiveness (in terms of cost per DALY averted). DALY are computed as the sum of years of life lost because of early mortality and years lived with disability because of a given disease (Benton, 1998). Years of life lost are computed as the difference between the actual age at death and the expectation of life at the age (World Bank, 1993). Estimates of the DALY lost annually because of onchocerciasis throughout Africa (OCP and APOC countries) have been put at about 884 000 (Remme, 1998). It is important to note that the estimate of DALY lost per year because of itching (522, 427) is greater than that from all ocular manifestations of the disease (Benton, 1998). These results

- underscore the recommendation that any net benefits from the APOC should where possible, consider the gains due to reductions in non-ocular, onchocercal morbidity in affected countries.

CHAPTER TWO

MATERIALS AND METHODS

2.1 STUDY AREA

2.1.1 Background

Imo State is located in the South eastern region of Nigeria (Fig. 1). It was created on February 3,1976 when the former East central state was divided into two states, the other being Anambra State. Following another state creation exercise by the then Military Government of General Ibrahim Badamosi Babangida in 1991, a new state (Abia) was carved out of the old Imo State. Imo State as presently constituted, lies between latitude 5^{O} 10' and 5^{O} 51' north, longitudes 6^{O} 35' and 7^{O} 28' east. It is bordered on the north by Anambra State, on the South and West by Rivers State and on the east by Abia State.

The state comprises an area of about 6,346 square kilometers, which is about 0.9% of the total land area of the Federation. The population by the provisional census figures of 1991 was about 2.5 million inhabitants, which is about 2.8% of the total population of the Federation. With a population density of 458 persons/km^2, Imo State has the third biggest density in the Federation after Lagos State (1,712 persons/ km^2) and Anambra State (534 persons/ km^2).

The majority of the population is broadly dispersed in a vast number of rural settlements. The largest towns are Owerri, the state capital with a population in 1991 estimated at about 289,721, Okigwe, Orlu and Oguta while population estimates of 133,699, 117,343 and 87,415 respectively.

For administrative purposes, the state is divided into 27 Local Government Areas namely: Aboh-Mbaise, Ahiazu-Mbaise, Ehime-Mbano, Ezinihitte, Ideato-North, Ideato-South, Ihitte/Uboma, Ikeduru, Isiala-Mbano, Isu, Mbaitoli, Ngor-Okpala, Njaba, Nkwerre, Nwangele, Obowo, Oguta, Ohaji/Egbema, Okigwe, Onuimo, Orlu, Orsu, Oru-East, Oru-West, Owerri Municipal, Owerri-North and Owerri South (Fig. 2).

2.1.2 Climate and Vegetation

The climate of Imo State, like that of Nigeria has two main regimes: a dry season and a wet season. These two regimes derive from the different air masses prevailing over the entire country at different times of the year: the dry northeasterly air mass of Saharan origin (Harmattan) and the humid maritime air mass originating over the Atlantic.

The wet season, in Imo state generally commences in March. Peaks of rainfall occur in July and September, with a short slightly drier spell called the "August break" occurring in the intervening period. The mean annual rainfall is between 1,800 and 2,500 millimetres per year. The maximum and minimum temperatures are 31.9^{O}C and 22.5^{O}C respectively while the daily sunshine rate is about 4.4 hours. Average relative humidity is about 74% occurring mostly during the wet season, while the rate of evaporation and evapotranspiration are 3.0mm/day and 136mm/month respectively The vegetation is typically rainforest.

2.1.3 Hydrology

Imo State has an extensive surface hydrological system characterized into main rivers, river basins and lakes. The main rivers are the Imo River and the Orashi River. There are two main river basins, the Niger River Basin and the Imo River Basin. The Niger River Basin drains only small part of the west of Imo State (some 80km^2). Its principal tributary in this area is the Orashi river, which flows parallel to

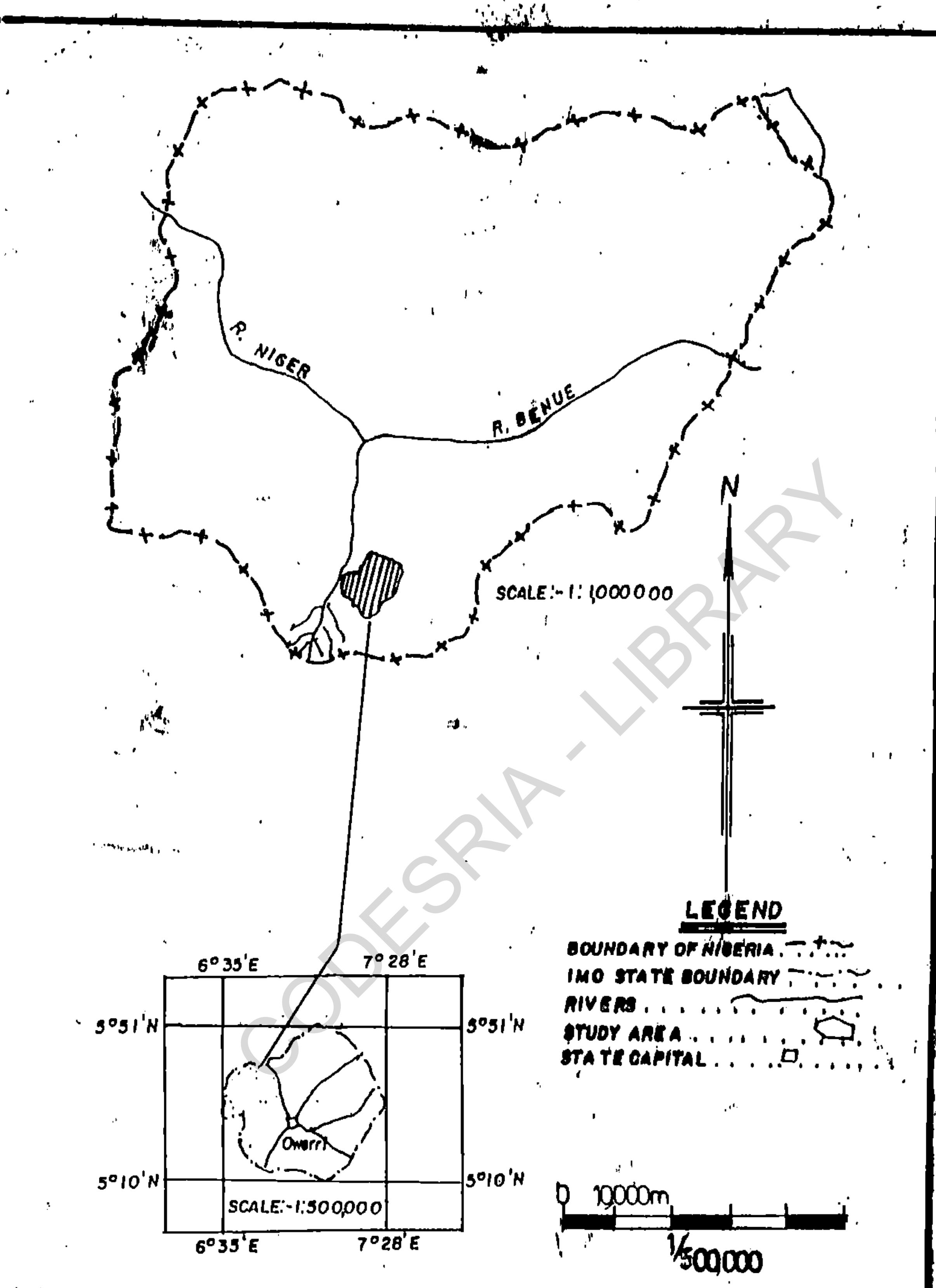
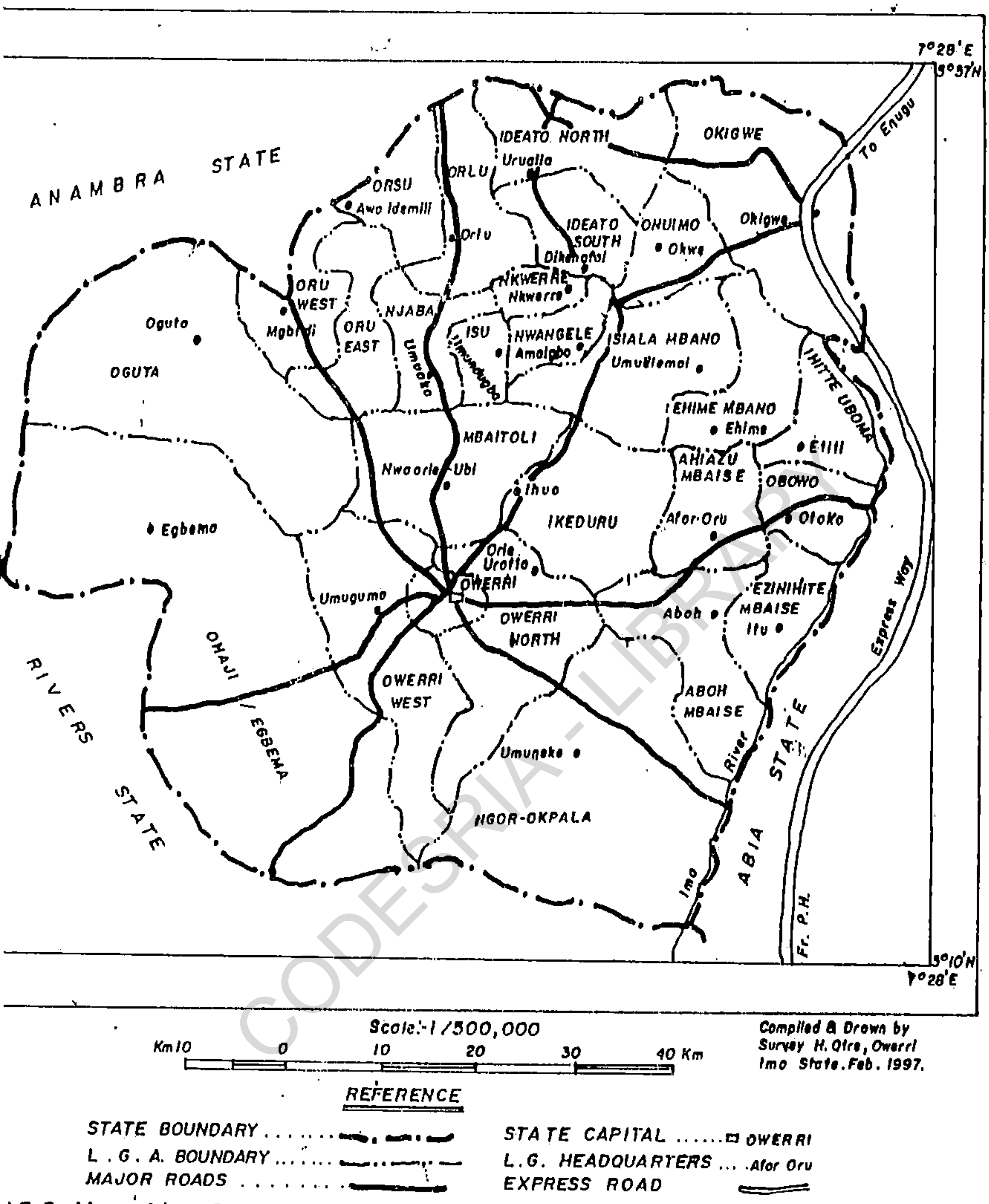


FIG. 1 Map of Nigeria Showing Imo State



IG.2 Map of Imo State Showing the 27 Local Government Areas

the Niger at the eastern edge of the flood plain. The Imo River Basin, covering the central part of the State, is the largest of the river basins within Imo State, draining an area of some 5,960 square km^2. For part of its length, the Imo River flows outside the state boundaries. It's total length within the state is about 225km. In its upper reaches (within the study communities), it receives many small tributaries, while the middle reach flows north – south for same 80km in a flat valley through the coastal plains lowland.

The main lakes in Imo state are the Oguta lake and the Abadaba lake. These lakes are exploited for fishing and as centres of recreation and tourism.

2.1.4 Administration and Settlement

The organization of government is articulated at 2 levels namely: the state government and the Local government/ Autonomous Communities. Under the current civilian administration, the State government is organized as follows: the Governor's Office, the Legislature, the Executive Council and the Judiciary.

The Local Government Law of 1976 set up 21 LGAs in Imo State, which has increased to 27 LGAs. Their main functions are the provision of social services, social welfare, and public utilities, issuance of licenses, supervision and regulation of economic activities, and responsibilities in respect of population registration and the Land Use Decree. The Autonomous Communities are the smallest territorial units of the local administration. There are about 300 autonomous communities in Imo State.

Settlement

The settlement pattern of most of Imo State is indigenous and, more specifically, Igbo in origin, consisting of a widely dispersal mix of residential compounds, farmlands, natural landscapes and commercial or industrial land use without any apparent "town" centres. In contrast, Owerri as well as Okigwe, Orlu and Oguta, all of which were originally established as provincial or divisional centres by the colonial authorities, are clearly recognizable as compact urban centres, with planned residential layouts located around a central business and commercial area. The size of these centres varied according to their rank within the administrative hierarchy and their commercial role within the regional economic network.

In the traditional organization of settlement, the basic social and political unit is the extended family, consisting of two or more families of different generations linked by blood ties and living in a common residential area under the leadership of a single head. The size of such a family may range from about 40 to 200 members. Two or more extended families recognizing a common ancestor and living in close proximity to another form a lineage. Two lineages may make a village, and a number of such villages make up the autonomous community. Under the traditional system each segment of the society acts as a corporate decision - making unit with its own hierarchies and councils.

2.1.5 Demography

The official population figure of Imo State derived from the 1991 National census exercise was 2,485,635 persons which was 2.8% of the overall population figure of the Federation. According to that exercise, Imo State had the third biggest population density of 458 persons/Km^2. Projected estimates by the year 2000 puts the population of Imo State at 3,219,446 persons. Age distribution showed that 44.3% of the 1991 census figure were 15 years and below; 51.0% were between 15-64 years and 4.7% were from 65 years and above. Furthermore the urban population constituted 32.6% of the total population.

Household size and composition

In its fullest sense, the household in Imo State is an extended household comprising a married couple (or a man with several wives) and their dependants, whether resident in the family compound or not. The average number of household members is 14.3, of whom 10.4 live permanently in the compound. The average household permanently resident within the compound comprises the head of the household, 1.32 wives, 5.4 children, and 2.63 relatives and other dependants. The average immediate family is about 7.7 people and there are 1.3 immediate families per compound .

Ethnic and educational characteristics

The entire population belong to the Igbo ethnic group. In terms of religious affiliation, 49% are Catholics and 32% are Anglicans. The remainder belong to other Christian churches or are those who worship ancestral gods. There is also a very small Muslim minority largely concentrated in Owerri capital city (Ama awusa) and at the Okigwe regional cattle market.

The statistics of educational attainment show that about 50% of the population do not have formal education. Furthermore, about 34% have benefited from education at the primary level, 16% at the secondary level, 2% vocational training and about 1% have been to a tertiary institution.

Occupation characteristics

The predominant occupational activities in the cities are civil service and trading. A lot of artisan workers are also found in the city. Majority of the rural dwellers are farmers, while others engage in trading, fishing, palm wine tapping, hunting activities etc.

2.1.6 Infrastructure

Imo state is linked to the rest of Nigeria by a well developed but poorly maintained road network, which gives access to all the neighbouring states. The Enugu – Port Harcourt express road facilitates vital trade links with Enugu and Anambra states and most of the states in the northern part of the country and Rivers state in the Niger Delta in the south. Another major road is the Federal Trunk A road linking Aba and Owerri with Onitsha and the states to the west of the River Niger. The state is not served by the Nigerian Railway System.

Postal services are okay in Imo State but telecommunication facilities are in a state of decay as Imo state still operates the analog telephone system. Most of the major towns are yet to be connected with telecommunication facilities. Majority of the LGAs are connected to National grid (NEPA) for supply of electricity which hardly functions.

In the Health sector, the state is served by a Federal Medical Center located at Owerri, a General Hospital also located at Owerri and many General and Specialist Hospitals in majority of the LGA Headquarters. In addition there are missionary hospitals and cottage hospitals, maternities, dispensaries and health clinics that dot various parts of the state. There are also Schools of Nursing and Midwifery as well as a School of Health Technology, which train staff and auxiliary manpower to run these health institutions under the auspices of the State Ministry of Health and the Health management.

The management of education in the state is under the Ministry of Education. Some of its functions include policy formulation, planning and co-ordination of all matters relating to education. With a community based approach, each local community makes financial contribution to the development of its schools and the education of its children. Being the primary enterprise of the people, many institutions are found in Imo State. The Federal institutions include the Federal University of Technology Owerri (F.U.T.O), the Federal Polytechnic Nekede (POLYNEK), the Alvan Ikoku College of Education (AICE) Owerri, the Federal School of Soil Conservation Mbaitoli, the Federal Government College Okigwe and the Federal Government Girls College Owerri, The state institutions include the Imo State University Owerri (IMSU), The Michael Okpara College of Agriculture (MOCA) and several other post-primary schools.

Imo State has good agricultural facilities, majority of which are in a total state of decay. These include the Rice mill at Acharaubo , the Imo Modern Poultry at Avutu, the Vegetable garden at Nekede, the Hatchery at Emekuku and a host of others. The state, in addition, has an oil rich parastatal ADAPALM which is a major income earner. The activities of these agricultural facilities are under the direct supervision of the State Ministry of Agriculture and Natural Resources. Over 80% of the rural population are farmers and engage in the cultivation of the root crops (cassava, yam, cocoyam, cereals (maize, rice), vegetables (melons, tomatoes, okra, spinach, water leaf) and legumes (groundnuts, beans).

2.1.7 Criteria for Selection

The study was conducted in some LGAs in the Imo River Basin (Fig 3). The LGAs include Okigwe, Onuimo, Ehime-Mbano, Ihitte-Uboma and Obowo. Okigwe and Onuimo LGAs are situated within the headwaters of the Imo River and thus are designated as the Upper Imo River Basin (Fig 4), while Ehime-Mbano, Ihitte-Uboma and Obowo are located around the middle part of the Imo River and thus are known as the Middle Imo River Basin (Fig.5). The LGAs were chosen principally because of their physical features and hydrogeology which are characterized by presence of fast flowing streams / rivulets which empty into the Imo River, the major river system in the state. The courses of most of these streams/rivulets run mainly over precambrian geological formations of various kinds. The exposure of rocks in the beds or side margins of these water bodies as well as the trailing vegetations at certain periods of the year create favourable breeding sites for vectors of the disease. Besides, earlier studies by Nwoke and Uwazie (1991) showed that the immature stages of *Simulium* abound in the area. In addition, the results of Rapid Assessment Methods for Community Diagnosis of Human Onchocerciasis (Nwoke *et al*, 1994) added another impetus for the choice of these LGAs.

2.2 EPIDEMIOLOGICAL TECHNIQUES

2.2.1 Pre- Disease Survey Logistics

The pre-disease survey logistics included visits to the LGC Chairmen, traditional rulers of the autonomous communities and the local village heads to explain the purpose of the survey and solicit for co-operation. Part of the pre-disease survey logistics included the mobilization of the communities/villages and the selection of village-based field assistants (VBFA) (males and females) by the villagers who assisted during the course of the study.

2.2.2 Clinical Examination

A specially designed individual clinical, parasitological and microbiological form was used to elicit information on the respondent's personal data, results of clinical, parasitological and microbiological examination as well as other comments and remarks (Appendix 1). The personal data information included the following: village, village code, community, LGA, name, household name/code, age, sex, martial status, educational status, occupation and number of years of residence.

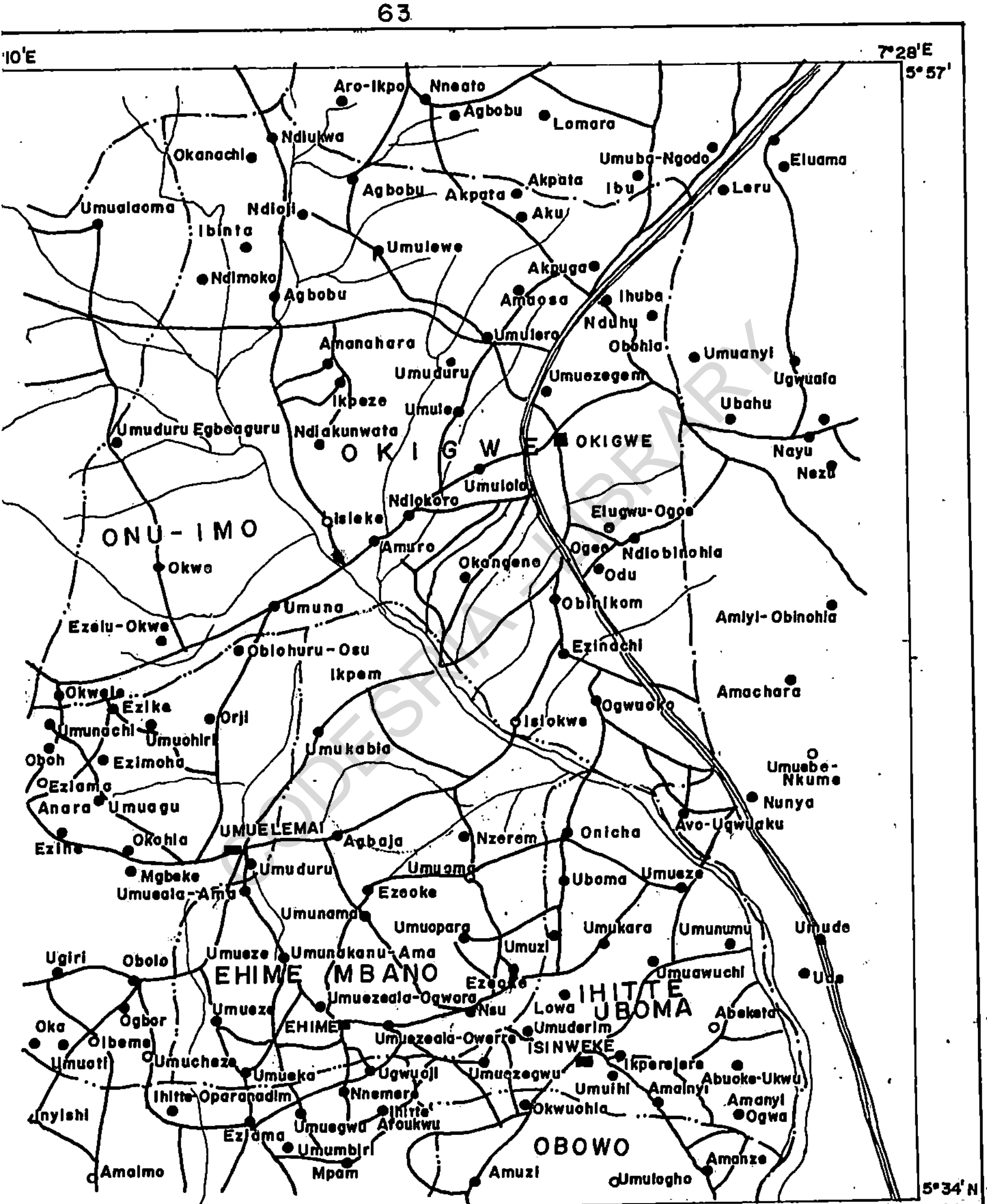
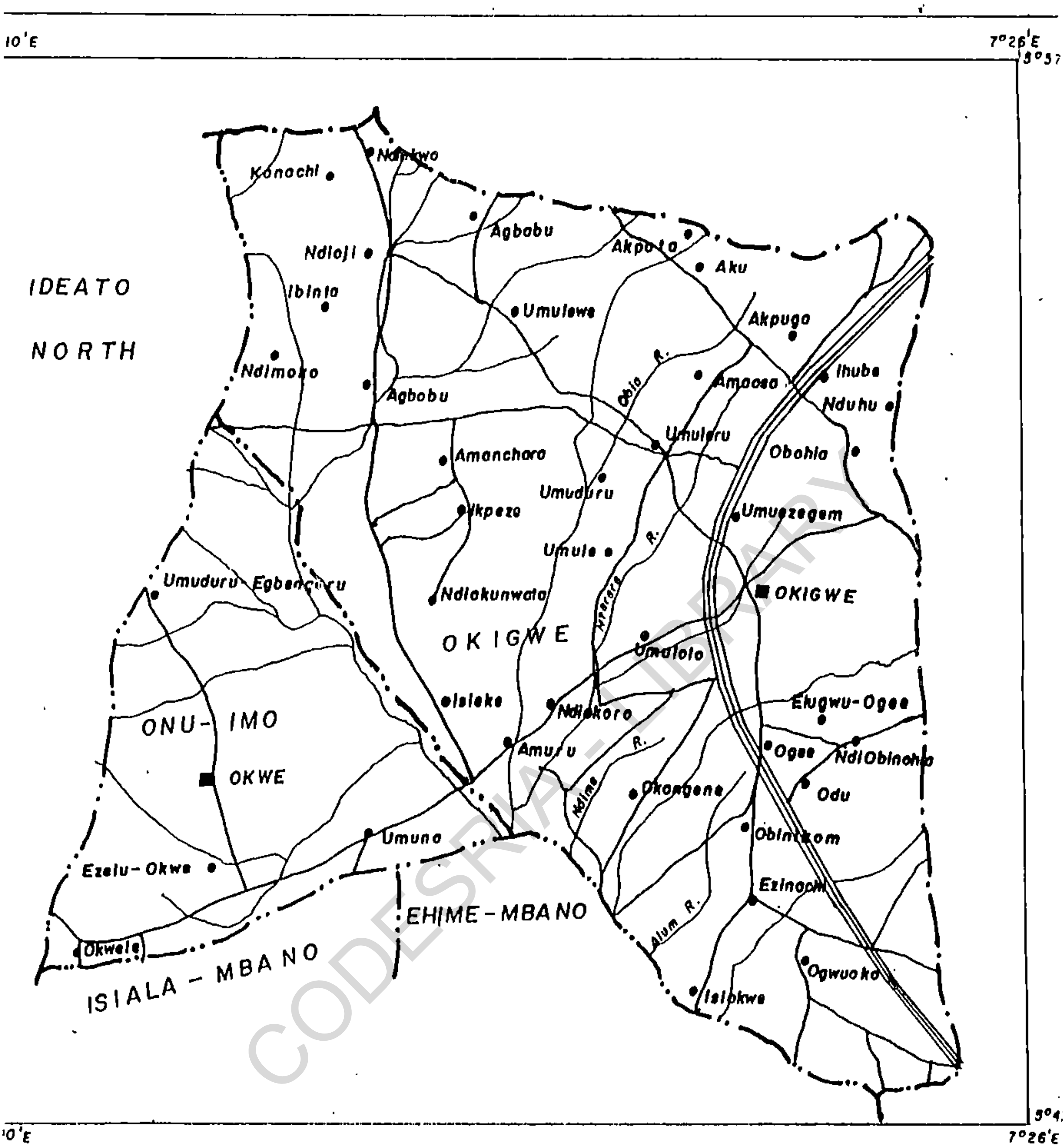


Fig.3: Map of Imo State showing study area (Imo River Basin)

Km.5 0 5 10Km.



Scale:- 1: 125,000 or 4cm to 5·00Km Approximately

Km 5 0 5 10Km

LEGEND

STATE BOUNDARY . . . .
LOCAL GOVT. BOUNDARY. . . . . .
ROADS . . . .
RIVERS / STREAMS . . . .
TOWNS. . . . .
LOCAL GOVT. HEADQUARTERS . . . . .

FIG. 4 : Map of the Study Area Showing the Upper Imo River Basin

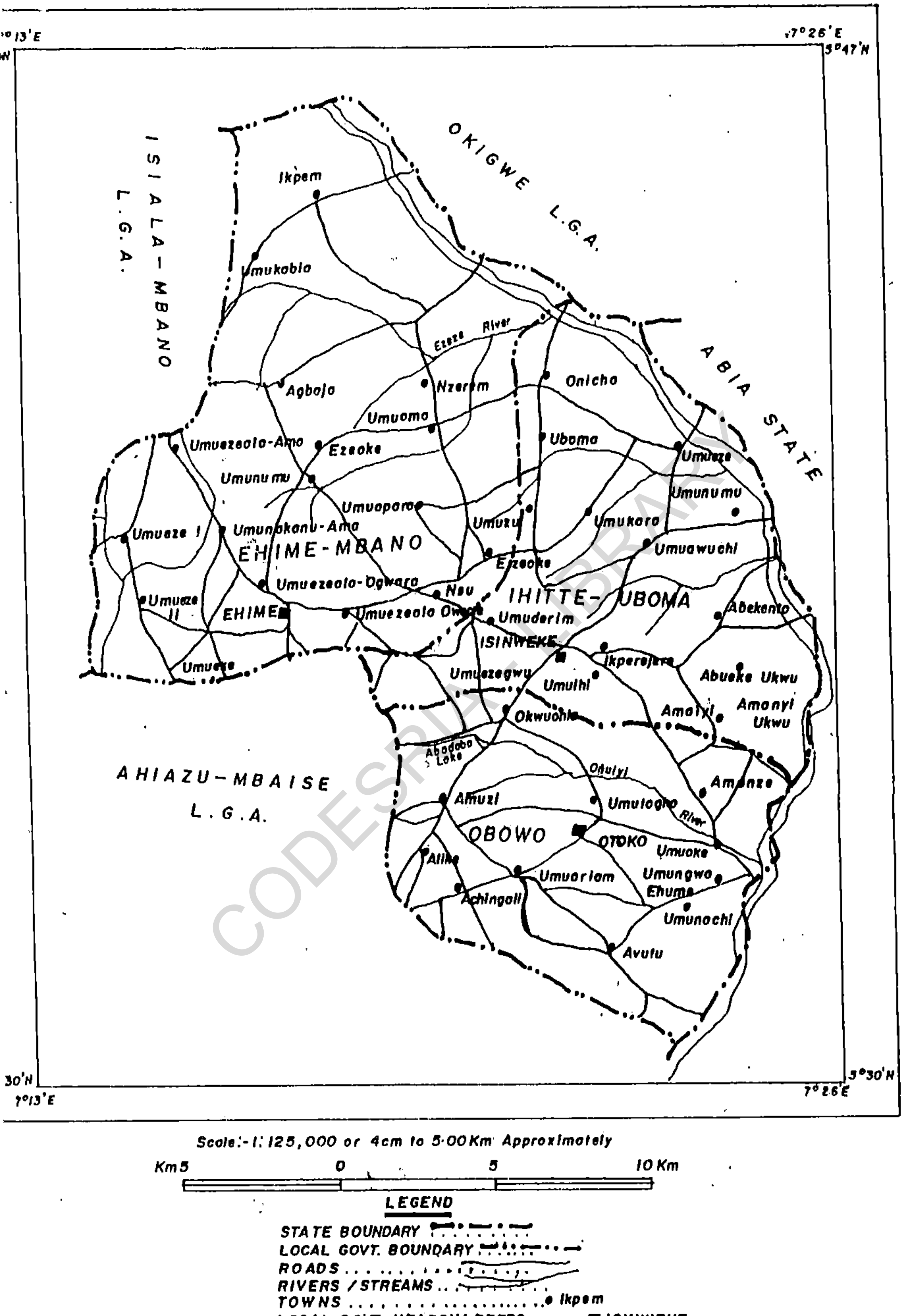


FIG. 5 Map of the Study Area Showing the Middle Imo River Basin

Since most of the villagers had no tradition of recording their ages, several major international /local events such as the First and Second world wars, Nigerian Independence and Civil war etc were used for age estimation.

Each of the respondents was examined in secrecy for clinical signs and symptoms of human onchocerciasis which included onchoceral skin lesions, lymphatic complications and ocular lesions. The onchocercal skin lesions are nodules, acute papular onchodermatitis (APOD), chronic papular onchodermatitis (CPOD), lichenified onchodermatitis (LOD), atrophy (ATR), depigmentation (DPM) and itching. Atrophy was only recorded as a significant abnormality in individuals 50 years and below in order to differentiate it from senile atrophy. The lymphatic complications included lymphoedema (limbs, genitalia and breast), lymphadenopathy, hernia and hanging groin. For ocular lesions, features such as itchy eye, impaired vision and blindness were identified using WHO (1996) recommendation of inability to count fingers at 3m or less. The results were recorded in the individual clinical and parasitological form. In addition, features of uncertain association, etiology and pathogenesis or (non–classical onchocerciasis) which include musculoskeletal pain, epilepsy, general debility and dwarfism were noted on the form. Clinical examination was carried out for all persons who reported at the predetermined examination centres. Under special circumstances, house to house survey was undertaken to examine some patients. For obvious cultural considerations, males and females were examined separately.

2.2.3 Parasitological Examination

Parasitological examination was carried out by two techniques namely skin snipping and microscopy. Prior to the skin snipping, the areas of the skin (left and right iliac crest were carefully swabbed with cotton wool soaked in 70% alcohol and allowed to dry. Two bloodless skin snips were taken from each site using the STORZ cornealscleral punch with 2mm bite. The skin biopsies were placed in microtitre plates (flat-bottom with 96 wells) containing 3 drops of 0.85% physiological saline solution. To prevent spillage of the contents especially during transportation to the laboratory, the plates were sealed with a Falcon 3073 pressure sensitive film plate sealer. The plates were incubated for 24 hours at room temperature, and emerged microfilariae from each anatomical sites were observed directly on the microtitre plates using inverted microscope and recorded in the individual clinical and parasitological form. The preservation of any specimens that could not be examined after 24 hours was carried out by addition of a drop of 10% formalin into each microtitre well. Furthermore, some of the positive skin biopsies were randomly selected and the emerging microfilariae were collected, fixed in methyl alcohol and finally stained with Giemsa. The prepared slides were observed under the oil – immersion lens to confirm the species of microfilariae morphologically. It should be noted that the scleral punch was sterilized with solutions of alcohol and bleach to prevent any possible transmission of blood –borne infections like Human Immunodeficiency virus (HIV) and Hepatitis B Virus.

2.3 COMMUNITY KNOWLEDGE AND BELIEFS ON ONCHOCERCIASIS

2.3.1 Methods of Data Collection

Two methods of data collection namely, the semi – structured interview utilizing a pre-tested multipurpose questionnaire and participant observation techniques were used to achieve this objective. An initial semi-structured questionnaire was developed and field tested through interview with 60 randomly chosen individuals aged ≥ 15 years. Based on the descriptive information from the preliminary interview, revised structured questionnaire (Appendix 2) was developed and administered by trained field assistants to 380 randomly chosen villagers ages ≥ 15 years (76 persons per study village). This was carried out to identify the local population's fundamental knowledge and beliefs about onchocerciasis.

In addition, observations of the domestic, social and occupational activities of the people were conducted. This was done to obtain factual information on those practices of the villagers which are related to exposure to the disease agent and its transmission. More so, this procedure was meant to provide validation and depth to the interview results.

2.3.2 Additional Instruments of Data Collection

Depth interviews were conducted with key informants to supplement and explain the questionnaire findings. This instrument was used on the strength of the suggestions by Lu *et. al,* (1988) that depth interviews yielded more accurate and comprehensive information on all aspects of filariasis when compared with other methods. Key informants were selected on the basis of a set of criteria namely: those with and without clinical signs and symptoms of onchocerciasis, representing various occupational groups in the community, age and length of stay in the community as well as degree of credibility.

Given the magnitude and sensitive nature of the work, as well as the need to generate adequate data, the field assistants were trained on the importance of approach/attitude and procedure of discussion with respondents and key informants. They were also trained on the importance and process of making relevant field observations, data collection and keeping accurate records. To realize the above, team members were reminded of the importance of their role in the whole research objectives and the procedure of achieving the goals.

2.4 SOCIOECONOMIC STUDIES

The socioeconomic impacts of onchocerciasis on the affected population was carried out using a combination of methods.

2.4.1 Social Costs

The social costs of human onchocerciasis was assessed during the study on the community knowledge and beliefs of onchocerciasis using sections of the same pre-tested multipurpose questionnaire (Appendix 2). The social costs investigated included the impact of the disease manifestations on marriage, productivity and other forms of socioeconomic activities as in the communities. Additional questions were designed for some afflicted villagers to ascertain the impact of the disease on their personal lives, activities as well as their coping strategies.

2.4.2 Economic Costs.

The economic costs of human onchocerciasis was carried out in the most endemic rural farming communities in the Upper Imo River Basin selected on the basis of the results of the clinical and parasitological studies. The criteria for selection included prevalence of palpable nodules in adults greater than 20% and community microfilarial load of 15mf per skin snip. The communities chosen were Aku, Umulolo, Amuro and Ihube. The economic parameters investigated included: the impact of onchocercal skin disease (OSD) in the household on school attendance of children aged 10-15 years; the extent to which OSD and other chronic lymphatic complications affect the direct costs of healthcare incurred amongst persons in endemic communities; the indirect costs of OSD and chronic lymphatic complications on activity patterns of afflicted individuals.

The impact of OSD in the household on school attendance.

A case – controlled methodology was used to examine the effects of OSD on the head of household on school attendance of children aged 10-15 years. The assessment was based on the premise that OSD infection might have a negative impact on income – generating capacity of household heads. This in turn might require intra- household labour substitution, where children were expected to pick up the slack in income generation or in household activities (WHO, 1995e) Cases were drawn from households in which the head had severe – OSD (ie those with palpable nodules, reactive skin lesions and unprompted self-reported troublesome itching) (Appendix 3) determined by clinical examination using the procedures and criteria developed by Murdoch *et.al.,* (1993). The controls were drawn from households where the head had no OSD (non – OSD status). One child per household was selected and in households with more than one child satisfying the age criteria, the eldest child in the household was selected for the study. The school register records of the cases and controls were examined and compared over a 3 – year period (Appendix 4). A total of 120 cases and 120 controls were enlisted in the study.

Direct costs of treatment

A matched – pair cohort design was used to determine the direct costs incurred by OSD – infected individuals as against non-OSD individuals using modifications of the methods described by Gyapong *et. al* (1996). One cohort consisted of individuals with severe-OSD and the control consisted of non- OSD individuals. Selection of the 2 cohorts was carried out after matching for age, sex, occupation and locality. The 2 cohorts were monitored over a 6-month period to determine their healthcare expenditure by trained field assistants who visited and interviewed them on a 2 – weekly basis. Open – ended questions were used initially to elicit healthcare seeking behaviour during the 2 weekly – recall visit. Subsequent questions dwelt on healthcare seeking costs (Appendix 5). Details of direct payments for treatment (consultation and medication) and of the costs, both in cash and kind of the transport, food and accommodation involved in seeking care were record as well as time spent in seeking health care. These were categorized as (a) cash expenditure, (b) expenditure – in – kind and (c) the time spent in seeking health care (Appendix 6). For analysis, payments in kind were converted to cash values using the prevailing local market prices. The value of time in seeking treatment was estimated using information derived from labour cost investigations undertaken during the preparatory field activities (ie local value of labour or wage rate in the area). All these were used to estimate the loss of revenue due to treatment. A total of 52 cases and 52 controls were enlisted in the study.

In addition, individuals with chronic lymphatic complications identified during the clinical examination preparatory for socioeconomic studies (Appendix 3) were monitored longitudinally every 2 months for one year to determine all healthcare sought for their conditions and the costs involved. Controls (ie those with no chronic conditions) were also selected after matching for age, sex, occupation and locality. A total of 28 cases and 28 controls were enlisted in the survey.

<u>Indirect costs: activity patterns</u>.

Indirect costs of OSD and other chronic lymphatic conditions as it relates to the subject activities during periods of ill health (including episodes of OSD) were investigated during the 2 weekly visits. Pre – testing indicated that attempts by the subjects to measure activities in terms of time would produce data of low quality because local concepts of time do not translate easily into hours and minutes especially for the predominantly illiterate population in the study area. The subjects were simply asked which activities (including farming) they were able to perform and those they could not manage during periods of ill-health.

In order to determine the man-days lost in the farm due to ill-health, it was assumed that the day was divided into 2 working periods, morning (7a.m.- 12 noon) and evening (3 p.m.- 7 p.m.) . A full day's work was taken as the 2 working periods in the day (morning and evening), while a half day's work was assumed to be any of the 2 working periods.

In addition to the above mode of data collection much qualitative information was collected using key person interviews, focus group discussions, participant-observation and network analysis (ie tracing the individuals on whom the subjects relied for support). The aim was to obtain information about impairment due to the burden of the disease on both afflicted and those providing help, in terms of time and resources devoted to affected individuals.

2.5 KNOWLEDGE, ATTITUDES AND PERCEPTIONS (KAP) ON IVERMECTIN (MECTIZAN) TREATMENT.

The knowledge, attitudes and perceptions of persons in endemic communities on treatment with ivermectin were assessed using a semi – structured questionnaire administered by field assistants. Two hundred and forty seven persons who had undergone 4 cycles of treatment drawn from participants in the studies on community knowledge and beliefs of onchocerciasis were enlisted in the study. The study was designed to investigate the villagers knowledge of the drug, the degree of acceptance, compliance, perceived efficacy and willingness to sustain the treatment programme. In addition, in-depth interviews were conducted with key persons to add quality and validation to the questionnaire findings.

2.6 MICROBIOLOGICAL STUDIES

2.6.1 Collection of Samples

During the clinical examination of villagers with onchocercal skin lesions, patients with excoriations in their lesions were identified for microbological studies (Apendix 3). A sterile swab stick was used to swab the surface of the excoriated lesions. For patients that had only superficial scaling with no excoriation, a sterile surgical blade was used to scrap portions of the lesions into sterile disposable petridishes. Each specimen was appropriately labelled with the patient's name, date and time of collection. For the purpose of this study, excoriations are defined as scratch marks with breach of the surface of the skin resulting in current or previous bleeding or loss of serous fluid.

2.6.2 Culturing of Samples

The collected samples were cultured in the laboratory unto different media namely: Nutrient Agar, Blood Agar, MacConkey Agar, and Sabouraud Dextrose Agar (Appendix 7). Apart from Sabouraud Dextrose Agar that was used for recovery of fungal organisms, all the other media were used for recovery of bacteria. The Sabouraud Dextrose Agar were supplanted with chloramphenicol (0.05mg/mg) and Cycloheximide (0.5mg/ml) to suppress the growths of contaminating bacteria and moulds respectively and incubated for 1 – 3 weeks at room temperature. The media for the recovery of bacteria were incubated at 37°C for 24 – 36 hours.

2.6.3 Identification of Microbial Isolates

The colour, nature and mode of development of the microbial colonies were noted to aid in the preliminary identification. For the suspected fungal isolates, the preliminary identification was based on a detailed study of their morphology as observed in lactophenol blue mounts from slide cultures on Sabouraud Dextrose Agar. Further identification was based on standard morphological description by McGinnis (1980) and Chabasse (1988).

The preliminary identification of the bacterial isolates was made by microscopic examination based on the following procedures/test namely: Gram staining, spore staining, capsule staining, motility test, germ tube test and India ink test.

Gram staining

Gram staining was performed according to the method described by Cowan and Steel (1974) with decolorizer modification Jawetz *et. al*, (1995). A colony of the organism was smeared on a grease free slide and allowed to dry. This was heat fixed by passing the slide over a flame 4 to 5 times. The heat-fixed smear was covered with crystal violet (primary stain) for 30 seconds and washed with water, without blotting. The smear was thereafter covered with Lugol's iodine (mordant) for about 30 seconds and washed with water without blotting. The stained slide was decolorized for 10-30 seconds with gentle agitation in acetone (30ml) and alcohol (70ml), and washed with water. The swear was finally covered with Safranin (counter stain) for 30 seconds, washed with water and air – dried. The stained slide was observed under the microscope with oil immersion.

Motility test

Motility test was carried out by culturing the organism in peptone water and incubating at 37^{o}C for about 4 hours. A loopful of the organism was then taken from the peptone water and placed on a coverslip in the middle of a plasticine ring. This was inverted carefully unto a clean slide and viewed under the microscope using 40

X magnification. A whip like movement in contrast to a darting movement indicated motility.

Spore staining

Spore staining was carried out by the Schaeffer-Fulton method as described in Benson (1978). A smear of the organism on a grease free slide was covered with 5% malachite green and steamed over boiling water for five minutes. After the slide had cooled sufficiently, it was rinsed with water for 30 seconds. This was counter stained with safranin for about 20 seconds, rinsed briefly with water to remove safranin, blotted dry and examined using oil immersion.

Capsular staining

A couple loopfuls of the organism was mixed in a small drop of India ink. The ink – organism mixture was spread over the slide and dried in air. The slide was gently heated to fix the organism unto the slide. The smear was then covered with crystal violet for one minute, washed gently to remove excess stain, blotted dry with paper and examined with oil immersion objective.

Germ tube test

Germ tube test is an important diagnostic test which differentiates *Candida albicans* from other candida species. *Candida albicans* forms germ tubes in serum at 37°C within 3 hours while others form germ tubes after 3 hours.

India ink test

India ink test was used as a further test for the year-like fungus *Cryptococcus neoformans*. Confirmation of the test was achieved by mixing a colony with a loopful of India ink on a slide. This was covered with a coverslip and examined microscopically for the typical encapsulated spherical budding yeast forms.

2.6.4 Biochemical Tests for the Bacteria and Fungi Isolates

Sugar metabolism

Following preliminary identification of the isolates, pure cultures of bacteria and yeast organisms were further subjected to biochemical reactions. One per cent solution of the following sugars: glucose, lactose, sucrose, mannitol and fructose were prepared in petone broth. Durham tubes were placed in the solution in such a way that no air space or void was created. The pH indicator, phenol red was added for acid detection. The solutions were autoclaved and the test organism stab – inoculated into each of the bottles containing sugar solutions. The bottles were incubated at 37^{O}C for 24 hours. The change of the indicator colour from red to yellow indicates acid production. Gas production is indicated by the formation of a void (air space) in the inverted Durham tube.

Catalase test

Catalase test was carried out to determine whether the bacterial isolates produce catalase enzyme which converts the antimetabolite hydrogen peroxide to water and oxygen. A drop of hydrogen peroxide (H_2O_2) was placed on a clean slide and a colony of the organism was emulsified in a drop of H_2O_2. The evolution of oxygen (effervescence) indicated the presence of catalase.

Oxidase test

Oxidase test depends on the ability of the test isolate to oxidise dimethyl-p-phenylenediamine hydrochloride in solution. Small pieces of filter paper were soaked in 1% solution of dimethyl-p-phenylenediamine hydrochloride. A little quantity of each bacterial colony was taken using a glass rod and rubbed on the filter paper. A purple colouration indicated a positive result ie the presence of oxidase.

Coagulase

A smear of the test organism was emulsified on the slide using saline water and a loopful of human plasma was added. A control without plasma was also set up. The slide was then rocked and kept for 2-3 minutes and then observed. Clumping of the of the cells indicated presence of coagulase.

Methyl red test (mixed acid fermentation)

Methyl red test was carried out in order to detect the production of sufficient mixed acid during fermentation of glucose in a medium where the pH is buffered with phosphate. Methyl red- Voges Proskauer (MR-VP) medium is essentially a glucose broth with buffered peptone and potassium diphosphate. MR-VP medium was inoculated with the young culture of the test organism and incubated at 37^{O}C for 48 hours. Three to four drops of methyl red indicator was added to the broth and mixed. A bright red coloration in the broth indicated a positive result.

Voges-Proskauer test (butanediol fermentation)

Voges – Proskauer test (Barritt's method) as described in Benson (1978) was carried out in MR – VP medium to determine the ability of bacteria species to ferment glucose with the production of acetoin (acetyl methyl carbinol), a precursor of 2,3 butanediol. To part of the broth culture used for the methyl red test, 1ml of 30% KOH and 3ml of 5% solution of alpha – naphthol in absolute ethanol was added. A positive reaction depended on the development of a pink colouration within a short time.

Citrate utilization

To determine whether the test organism can utilize citrate as a sole source of carbon, the isolate was inoculated unto Simmons citrate agar. The appearance of a Prussian blue colour from green was indication of a positive result.

Indole production

Indole production was carried out to determine if the test isolates can split the amino acid tryptophan into indole and pyruvic acid. The test organism was cultured in peptone broth for 24 hours. This was followed by addition of 10 to 12 drops of Kovac's reagent. The formation of a red colouration at the top the culture indicated a positive result.

2.6.5 Antimicrobial Sensitivity Testing

Antimicrobial sensitivity testing was carried out by a slight modification of the Stokes disc diffusion technique (Stokes and Ridgway, 1980) . About 25mls of the Mueller Hinton agar (prepared and sterilized according to the manufacturer's instruction) were poured into sterile petri dishes. Suspensions of bacteria were prepared in sterile peptone water. In order to obtain a semiconfluent growth, the turbidity of the suspension was matched against the turbidity standard (see Appendix 7 for preparation). Using a sterile loop of about 4mm diameter, a loopful of the test organism suspension was applied to the center of the sensitivity testing plate. A sterile dry cotton wool swab was used to spread the inoculum evenly across the plate. The inoculum was allowed to dry for a few minutes with the petri dish lid in place. Commercially prepared antibiotic discs (Optudisc) (previously warmed to room temperature) were applied to the sensitivity plates using sterile forceps and the plates incubated aerobically at 35-37°C overnight. The reaction of the test organism to each antibiotic was simply interpreted as sensitive or resistant. Tests with radius of the inhibition zone of at least 3mm and above were read as sensitive. Tests with no zone of inhibition or zone radius 3mm or less were read as resistant.

2.7 DATA ANALYSIS

All analyses were done using Statistical Analysis System (SAS) programme version 6.04 (SAS, 1990). The test statistics used were the Chi-square test, the paired t-test and correlation analysis. The Chi-square was used to determine the levels of significance of disease prevalence rates and other related data. We performed the t-test to compare mean values and group scores of data. The correlation analyses were used to examine the degree of relationships between variables. Bar charts were also used to allow for a quick appreciation of prevalence rates of skin microfilariae and clinical manifestations as well as other graphic data representations.

CHAPTER THREE

RESULTS

3.1 ONCHOCERCIASIS IN THE STUDY AREA (IMO RIVER BASIN)

3.1.1 Overall Prevalence, Intensity And Geographical Distribution

Prevalence and distribution

Of the 7348 persons randomly examined by the skin snip method, 1655 (22.5%) were infected with microfilariae (mf) of *Onchocerca volvulus* (Table 1). The prevalence of infection varied significantly ($P < 0.05$) among the study areas with communities in the Upper Imo River Basin scoring 26.8% while those in the Middle Imo River Basin had 19.0%. Table 2 reveals that the distribution of infection was similar in both sexes, 22.9% in males and 22.1% in females.

Fig. 6 shows the overall age-specific prevalence of onchocerciasis in the Imo River Basin. Infection increased with advancing age with the highest rates of 44.8% and 52.4% in persons in the 6th and 7th decades respectively. The lowest infection rate (7.4%) was recorded in persons in the 1st decade. A further breakdown of the results showed prevalence rates of 11.7%, 14.2%, 17.0% and 23.5% for persons in the 2nd, 3rd, 4th and 5th decades of life respectively.

The influence of occupation on the prevalence of onchocerciasis is presented on Table 3. Farmers had the highest prevalence (37.6%) followed by fishermen (26.2%), hunters (19.0%) and traders (18.8%). Pre-school pupils had the lowest infection rate (4.4%) while civil servants and pupils/student had 15.1% each. Indoor/sedentary workers scored 11.5% prevalence. Generally, occupation had a significant influence on the prevalence of onchocerciasis in the study area ($P < 0.05$).

Intensity of infection

The intensity of infection or microfilarial density (mfd) in skin snip of positive persons in the Imo River Basin is shown in Table 4. Out of the 1655 mf carriers, 77.7% had low skin mf count in the range of 1-25mf/skin snip (mf/ss); 18.7% had moderate skin mf count, 26 – 50mf/ss while 3.6% had high skin mf count with 51mf/ss and above. The community microfilarial density (CMFD) or community microfilarial load (CMFL) varied amongst the communities in the study areas with a mean cmfd of 22.1mf/ss in the Upper Imo River Basin and 18.1mf/ss in the Middle Imo River Basin. An overall mean CMFD of 20.1mf/ss was obtained in the study area.

Fig. 7 shows the age-relaxed mfd in skin snips of positive persons in the study area. Intensity of infection increased with advancing age from 4.9mf/ss in persons, 5 years of age and below to a peak of 34.3mf/ss in those in the 50-59 age bracket. The overall age-related prevalence of infection was directly proportional to the age-related mfd.

The influence of occupation on intensity of infection reveals that farmers had the highest score (48.8mf/ss) followed by fishermen (28.8 mf/ss), pupils/students (23.6 mf/ss) and hunters (21.5 mf/ss) (Table 5). The lowest intensity (4.9 mf/ss) was observed in pre-school pupils while scores of 16.0mf/ss, 15.8mf/ss and 13.1mf/ss were found in traders, indoor/sedentary workers and civil servants respectively. Generally, the prevalence of infection amongst the various occupational groups was strongly correlated with intensity of infection ($r = 0.94$; $P < 0.05$).

Table 1: Overall Prevalence Pattern of Onchocerciasis in the Imo River Basin

Study Area	No of Community sampled	Total No. examined	No. and (%) infected with *Onchocerca volvulus* microfilariae (mf)	No and (%) uninfected with *O. volvulus* microfilariae
Upper Imo River Basin	17	3311	889 (26.8)	2422 (73.2)
Middle Imo River Basin	21	4037	766 (19.0)	3271 (81.0)
Total	38	7348	1655 (22.5)	5693 (77.5)

Table 2: Overall Sex-Specific Prevalence of Onchocerciasis in the Imo River Basin

Study Area	Total no examined	No (%) infected	Male		Female	
			No examined	No (%) infected	No examined	No (%) infected
Upper Imo River Basin	3311	889 (26.8)	1526	409 (26.8)	1785	480 (26.9)
Middle Imo River Basin	4037	766 (19.0)	2230	453 (20.3)	1807	313 (17.3)
Total	7348	1655 (22.5)	3756	862 (22.9)	3592	793 (22.1)

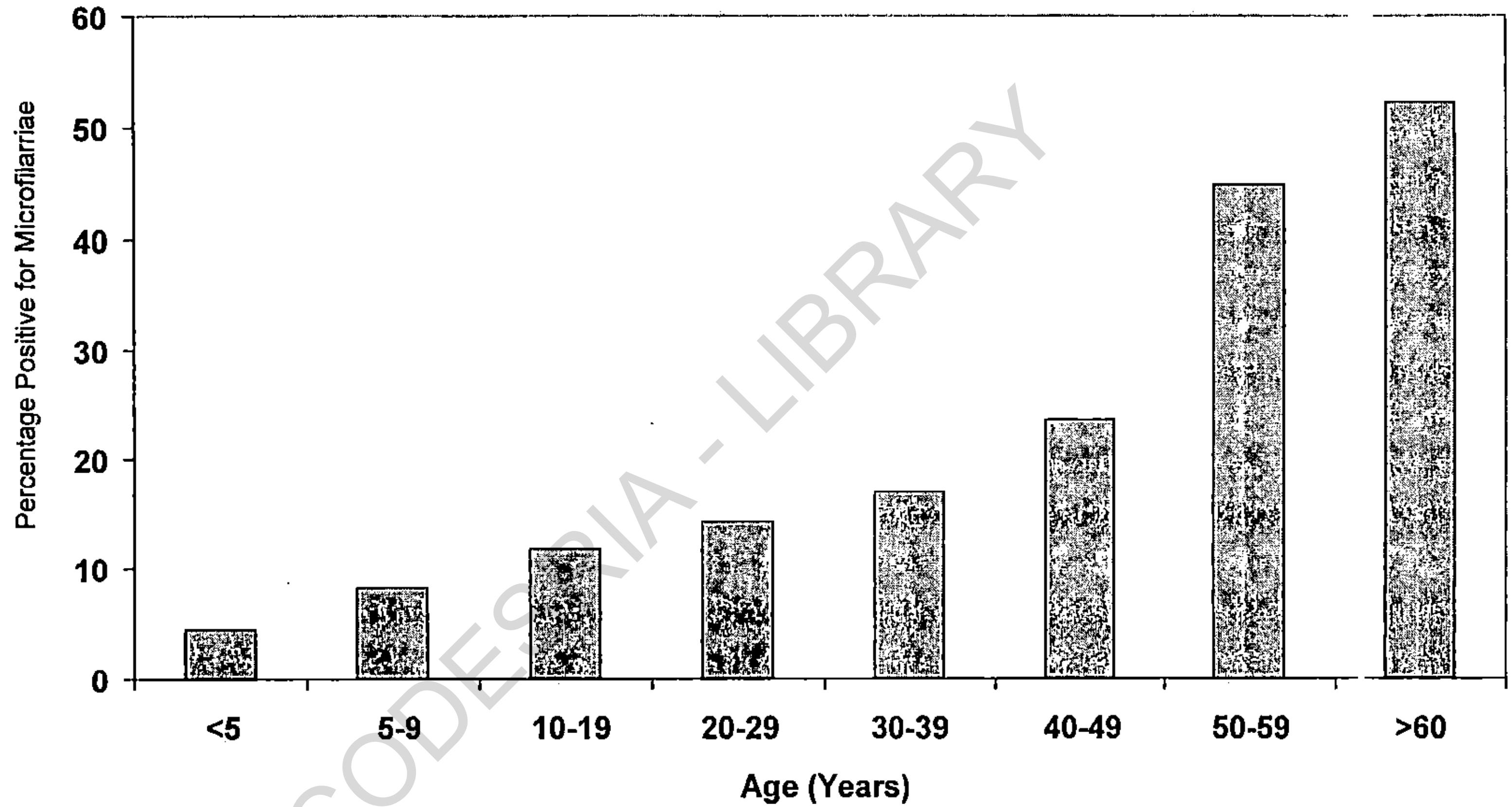


Fig. 6: Overall Age-specific Prevalence of Onchocerciasis in the Imo River Basin

Table 3: Overall Occupational-related Prevalence of Onchocerciasis in the Imo River Basin

Occupation	No examined	No and (%) infected	No and (%) uninfected
Trader	627	118 (18.8)	509 (81.2)
Farmer	2428	914 (37.6)	1514 (62.4)
Fisherman	141	37 (26.2)	104 (73.8)
Hunter	221	42 (19.0)	179 (81.0)
Civil Servant	776	117 (15.1)	659 (84.9)
Indoor/sedentary worker	783	90 (11.5)	693 (88.5)
Pupils Students	2168	328 (15.1)	1840 (84.9)
Pre-school pupils	204	9 (4.4)	195(95.6)
Total	7328	1655 (22.5)	5693(77.5)

Table 4: Density of *O. volvulus* Microfilariae in Skin Snips of Positive Persons in the Imo River Basin

Study Area	Total no examined	No and (%) infected with *O. volvulus* mf	No with following no of mf/skin snip and (mean mf density in skin snip)				Community microfilarial density (cmfd)
			1-25	25-50	51-100	>100	
Upper Imo River Basin	3311	889 (26.8)	750 (17.8)	110 (37.8)	28 (68.3)	1 (106.2)	22.1
Middle Imo River Basin	4037	766 (19.0)	536 (11.3)	200 (31.4)	30 (58.8)	0 (0.0)	18.1
Total	7348	1655 (22.5)	1286 (14.6)	310 (34.6)	58(63.6)	1 (106.2)	20.1

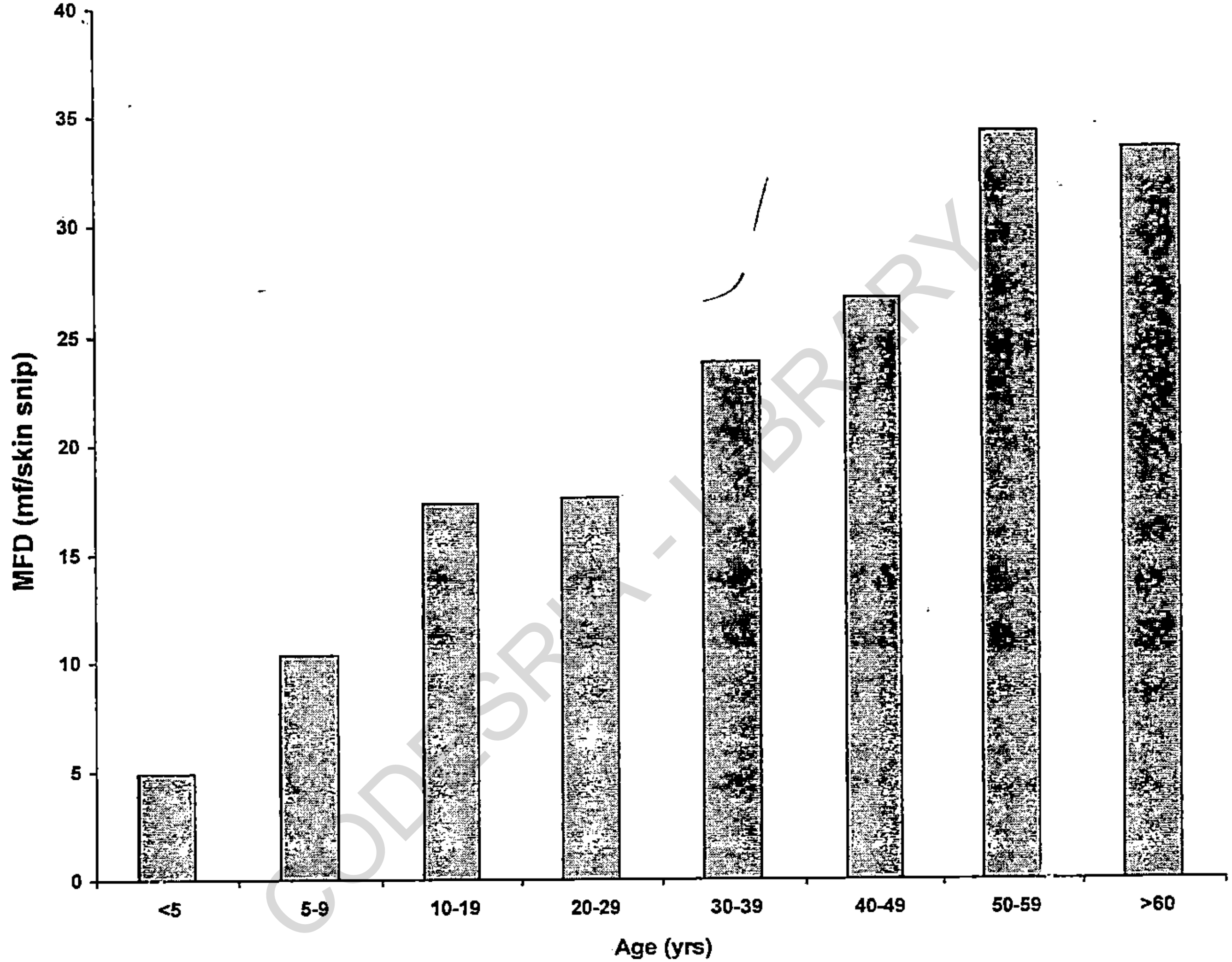


Fig. 7: **Age-related Density of *O. volvulus* Microfilariae in Skin Snips of Persons in the Imo River Basin**

Table 5: Occupational-related Density of *O. volvulus* Microfilariae in Skin Snips of Positive Persons in the Imo River Basin.

Occupation	No examined	No and (%) positive for *O. volvulus* mf	Mean microfilarial density (Mfd)
Trader	627	118 (18.8)	16.0
Farmer	2428	914 (37.6)	48.8
Fisherman	141	37 (26.2)	28.0
Hunter	221	42 (19.0)	21.5
Civil Servant	776	117 (15.1)	13.1
Indoor/sedentary worker	783	90 (11.5)	15.8
Pupils Students	2168	328 (15.1)	23.6
Pre-school pupils	204	9 (4.4)	4.9
Total	7348	1655 (22.5)	21.5

Clinical manifestations

Onchocercal lesions

Table 6 shows the distribution of onchocercal lesions in the study area. Overall, 4595 (62.5%) persons presented with various kinds of lesions. The prevalence in the Upper River Basin (72.6%) differed significantly from that in the Middle Imo River Basin (54.2%) (P < 0.05). The most common lesions encountered in the area were nodules (17.7%) and itching (15.2%) while the least common lesions were ATR (3.4%) and LOD (1.9%). Onchocercal skin disease (OSD) which include APOD, CPOD, LOD, ATR and DPM had an overall prevalence of 29.7% while the reactive forms (APOD, CPOD and LOD) had a prevalence of 16.8% (Plates 1,2,3,4).

The overall age – specific distribution of onchocercal lesions in the Imo River Basin is presented in Table 7. Generally the distribution of lesions increased with age. Specifically, the prevalence of itching and nodules increased with age up to the 5th decades and dropped in persons in the 6th and 7th decades. Most forms of OSD were encountered in persons in the 2nd decade of life and above. The sex distribution of lesions shows that more females (64.1%) than males (61.0%) presented with lesions in the area (Fig 8).

Lymphatic complications

The distribution of lymphatic complications of onchocerciasis shows that 607 (8.3%) persons presented with various complications (Table 8). The prevalence of complications in the Middle Imo River Basin (8.6%) was higher than that in the Upper Imo River Basin (7.9%). Hernia (3.4%) was the most encountered complication in the area, followed by lymphadenopathy (l,pathy) (2.4%) and hanging groin (1.0%). The least encountered complications were lymphoedema genital (lym genital) and lymphoedema limb (lym limb) with scores of 0.9% and 0.6% respectively (Plates 5,6,7,8). There were no cases of lymphoedema breast (lym breast) in the study area.

The age – specific distribution reveals that lymphatic complications were absent in persons in the 1st decade (Table 9). The overall prevalence however, increased with age from 2.2% in persons in the 2nd decade, and attained a peak of 20.9% in persons in the 6th decade. With the exception of Lym (genital) that was investigated only in males, all other complications were seen in both sexes, but with higher prevalence in males than in females (Fig. 9)

Ocular sign and symptoms

Table 10 summarises the distribution of ocular signs and symptoms suggestive of onchocerciasis in the study area. Overall 2304 (31.4%) persons had ocular signs and symptoms with the Upper Imo River Basin recording significantly higher rates (39.6%) than the Middle Imo River Basin (24.6%) ($P < 0.05$). Impaired vision (22.8%) was the most observed lesion followed by itchy eye (8.4%) while the least seen lesion was blindness (0.2%) (Plate 9).

The age distribution of ocular signs and symptoms is presented in Table 11. Overall, the prevalence of ocular signs and symptoms increased with age from 0.6% in persons in the 1st decade to a peak of 68.6% in those in the 6th decade. More specifically, blindness rates increased from 0.1% in persons aged 40 – 49 to 0.9% in those 60 years and above. The sex distribution showed an almost similar prevalence rate in males and females (Fig. 10).

Signs and symptoms of non- classical onchocerciasis

A total 2759 (37.5%) persons had signs and symptoms of non-classical onchocerciasis in the study area (Table 12). More persons (46.5%) in the Upper Imo River Basin had signs and symptoms than those in the Middle Imo River Basin (30.2%) (P < 0.05). The most observed sign and symptoms were general debility (19.5%) and musculoskeletal pain (17.6%), while the least was epilepsy (0.5%). No case of dwarfs presenting with onchocerciasis infections were observed in the study area.

The ages of persons examined had an influence on the distribution of sign and symptoms (Table 13). Musculoskeletal pain which was absent in persons in the 0-9 age group, showed an increase from 1.4% in the 10-19 age groups to a peak of 35.1% in persons aged 50-59. Similarly, epilepsy increased from 0.2% in the 10-19 age group reaching a peak of 1.4% in those age between 40 and 49 years. The sex distribution reveals that various signs and symptoms of non-classical onchocerciasis were more prevalent in females than males (Fig.11).

3.1.2 Prevalence, Intensity and Geographical Distribution in the Upper Imo River Basin

Prevalence and distribution

Of the 3311 persons examined by skin biopsies in 17 communities in the Upper Imo River Basin, 889 (26.8%) were infected with mf of *O. volvulus* (Table 14). The infection rates varied amongst the communities with the highest scores at Umulolo (36.0%), Amuro (34.3%) and Uhiowerre (30.9%), while the lowest scores were obtained in Amachara (6.2%), Okanachi (4.9%) and Umule (4.2%). Eight communities had infection rates of between 20 – 30% and these include Ajabo (28.3%), Aku (27.8%), Umulewe (25.6%), Isieke (25.2%), Ezelu – Okwe (23.9%),

Plate 1. Onchocercal Nodules on the Head and Waist Regions of a Male and Female Patient respectively

Plate 2. Acute Papular Onchodermatitis (APOD) on the Leg of a Young Female Patient

Plate 3. Chronic Papular Onchodermatitis (CPOD) on the Trunk and Legs of a Female Patient.

Plate 4. Depigmentation on the Legs and Hands of a Male and Female Patient respectively.

Table 6: Distribution of Onchocercal Lesions in the Imo River Basin

Study Area	Total no examined	No (%) infected	No(%) with onchocercal lesions							Total no (%) with Onchocercal lesions
			Itching	Nodules	APOD	CPOD	LOD	ATR	DPM	
Upper Imo River Basin	3311	889 (26.8)	574 (17.3)	675 (20.4)	273 (8.2)	349 (10.5)	73 (2.2)	104 (3.1)	357 (10.8)	2405 (72.6)
Middle Imo River Basin	4037	766 (19.0)	543 (13.5)	624 (15.5)	227 (5.6)	245 (6.1)	64 (1.6)	145 (3.6)	342 (8.5)	2190 (54.2)
Total	7348	1655 (22.5)	1117 (15.2)	1299 (17.7)	500 (6.8)	594 (8.1)	137 (1.9)	249 (3.4)	699 (9.5)	4595 (62.5)

Key
APOD = Acute Papular Onchodermatitis
CPOD = Chronic Papular Onchodermatitis
LOD = Lichenified Onchodermatitis
ATR = Atrophy
DPM = Depigmentation.

Table 7: Age-specific Distribution of Onchocercal Lesions in the Imo River Basin

Age (years)	Total no examined	No (%) infected	No(%) with onchocercal lesions							Total no (%) with Onchocercal Lesions
			Itching	Nodules	APOD	CPOD	LOD	ATR	DPM	
<5	204	9 (4.4)	7 (3.4)	5 (2.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	12 (5.9)
5-9	666	55 (8.3)	47 (7.1)	44 (6.6)	19 (2.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	110 (16.5)
10-19	985	115 (11.7)	152 (15.4)	166 (16.9)	79 (8.0)	39 (4.0)	0 (0.0)	2 (0.2)	0 (0.0)	438 (44.5)
20-29	1238	176 (14.2)	211 (17.0)	214 (17.3)	156 (12.6)	123 (9.9)	0 (0.0)	30 (2.4)	27 (2.2)	761 (61.5)
30-39	1321	225 (17.0)	228 (17.3)	275 (20.8)	109 (8.3)	161 (12.2)	11 (0.8)	67 (5.1)	99 (7.5)	950 (71.9)
40-49	1350	317 (23.5)	280 (48.2)	305 (22.6)	78 (5.8)	98 (7.3)	51 (3.8)	79 (5.9)	167 (12.4)	1058 (78.4)
50-59	950	426 (44.8)	106 (11.2)	173 (18.2)	39 (4.1)	97 (10.2)	44 (4.6)	71 (7.5)	229 (24.1)	759 (79.9)
≥60	634	332 (52.4)	86 (13.6)	117 (18.5)	20 (3.2)	76 (12.0)	31 (4.9)	0 (0.0)	177 (27.9)	507 (80.0)
Total	7348	1655 (22.5)	1117 (15.2)	1299 (17.7)	500 (6.8)	594 (8.1)	137 (1.9)	249 (3.4)	699 (9.5)	4595 (62.5)

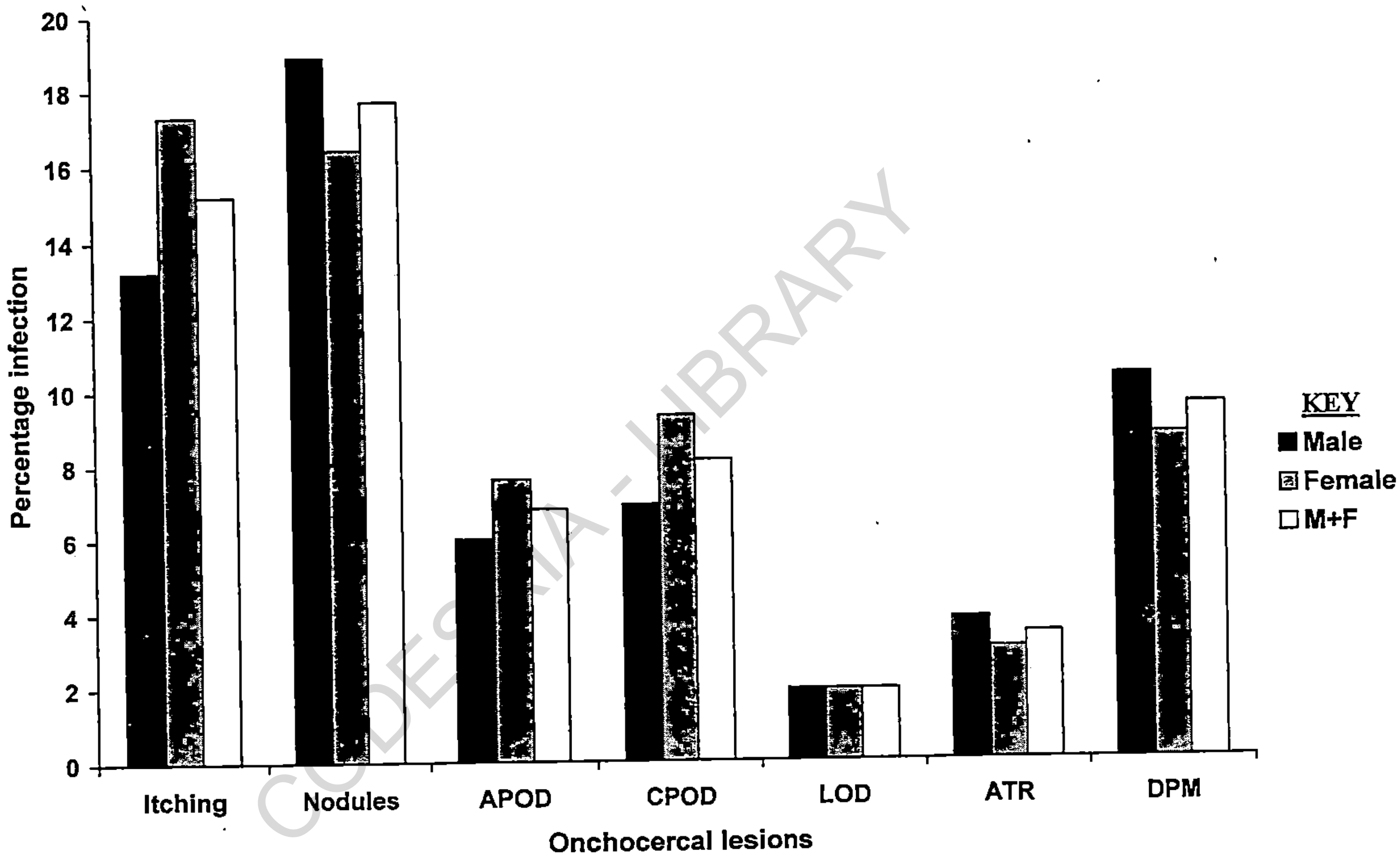


Fig. 8: Sex Distribution of Onchocercal Lesions in the Imo River Basin

Table 8: Distribution of Lymphatic Complications of Onchocerciasis in the Imo River Basin

Study Area	No examined	No (%) infected	No(%) with Lymphatic Complications						Total no (%) with Lymphatic Complications
			L, pathy	Hanging groin	Lym (Limb)	Lym (Genital)	Lym (Breast)	Hernia	
Upper Imo River Basin	3311	889 (26.8)	73 (2.2)	41 (1.2)	24 (0.7)	34 (1.0)	0 (0.0)	88 (2.7)	260 (7.9)
Middle Imo River Basin	4037	766 (19.0)	102 (2.5)	32 (0.8)	21 (0.5)	33 (0.8)	0 (0.0)	159 (3.9)	347 (8.6)
Total	7348	1655 (22.5)	175 (2.4)	73 (1.0)	45 (0.6)	67 (0.9)	0 (0.0)	247 (3.4)	607 (8.3)

Table 9: Age-specific Distribution of Lymphatic Complications of Onchocerciasis in the Imo River Basin

Age (years)	Total no examined	No (%) infected	No(%) with lymphatic complication						Total no (%) with Lymphatic Complications
			L, pathy	HG	Lym (Limb)	Lym (Genital)	Lym (Breast)	Hernia	
<5	204	9 (4.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0 0
5-9	666	55 (8.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0 0
10-19	985	115 (11.7)	9 (0.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	13 (1.3)	22 (2.2)
20-29	1238	176 (14.2)	22 (1.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	31 (2.5)	53 (4.3)
30-39	1321	225 (17.0)	34 (2.6)	7 (0.5)	3 (0.2)	4 (0.3)	0 (0.0)	34 (2.6)	82 (6.2)
40-49	1350	317 (23.5)	34 (2.5)	10 (0.7)	11 (0.8)	16 (1.2	0 (0.0)	61 (4.5)	132 (9.8)
50-59	950	426 (44.8)	45 (4.7)	33 (3.5)	21 (2.2)	29 (3.1)	0 (0.0)	71 (7.5)	199 (20.9)
≥60	634	332 (52.4)	31 (4.9)	23 (3.6)	10 (1.6)	18 (2.8)	0 (0.0)	37 (5.8)	119 (18.8)
Total	7348	1655 (22.5)	175 (2.4)	73 (1.0)	45 (0.6)	67 (0.9)	0 (0.0)	249 (3.4)	607 (8.3)

Plate 5. Bilateral Lymphadenopathy in a Male Patient

Plate 6. Lymphoedema of the Genitalia (Penile and Scrotal) in Two Male Patients

Plate 7. Lymphoedema of the Limb in a Female Patient

Plate 8. Hernia in a Male Patient

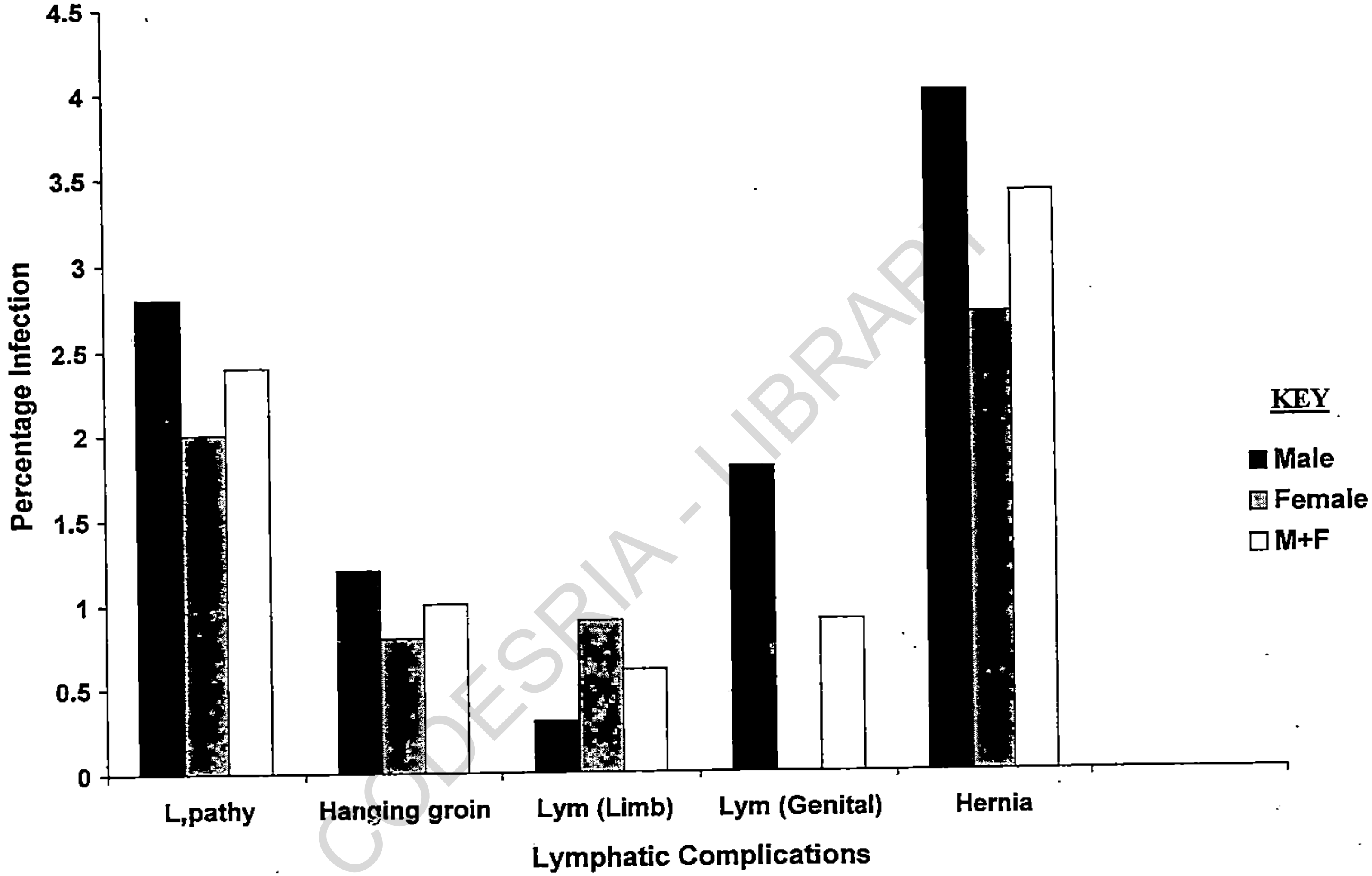


Fig. 9: Sex Distribution of Lymphatic Complications in the Imo River Basin

Table 10: Distribution of Ocular Signs and Symptoms of Onchocerciasis in the Imo River Basin

Study Area	No examined	No (%) infected	No(%) with Ocular Signs and Symptoms			Total no (%) with Ocular Signs and Symptoms
			Itchy eye	impaired Vision	Blindness	
Upper Imo River Basin	3311	889 (26.8)	297 (9.0)	1009 (30.5)	6 (0.2)	1312 (39.6)
Middle Imo River Basin	4037	766 (19.0)	320 (7.9)	666 (16.5)	6 (0.1)	992 (24.6)
Total	7348	1655 (22.5)	617 (8.4)	1675 (22.8)	12 (0.2)	2304 (31.4)

Plate 9. Onchocercal Blindness (Bi-ocular) in a Male Patient

Table 11: Age-specific Distribution of Ocular Signs and Symptoms of Onchocerciasis in the Imo River Basin

Age (years)	Total no examined	No (%) infected	No(%) with Ocular Signs and Symptoms			
			Itchy eye	Impaired Vision	Blindness	Total no (%) with Ocular Signs and Symptoms
<5	204	9 (4.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
5-9	666	55 (8.3)	5 (0.8)	0 (0.0)	0 (0.0)	5 (0.8)
10-19	985	115 (11.7)	39 (4.0)	0 (0.0)	0 (0.0)	39 (4.0)
20-29	1238	176 (14.2)	76 (6.1)	2 (0.2)	0 (0.0)	78 (6.3)
30-39	1321	225 (17.0)	112 (9.2)	300 (22.7)	0 (0.0)	412 (31.2)
40-49	1350	317 (23.5)	168 (12.4)	540 (40.0)	1 (0.1)	709 (52.5)
50-59	950	426 (44.8)	123 (12.9)	524 (55.2)	5 (0.5)	652 (68.6)
≥60	634	332 (52.4)	94 (14.8)	309 (48.7)	6 (0.9)	409 (64.5)
Total	7348	1655 (22.5)	617 (8.4)	1675 (22.8)	12 (0.2)	2304 (31.4)

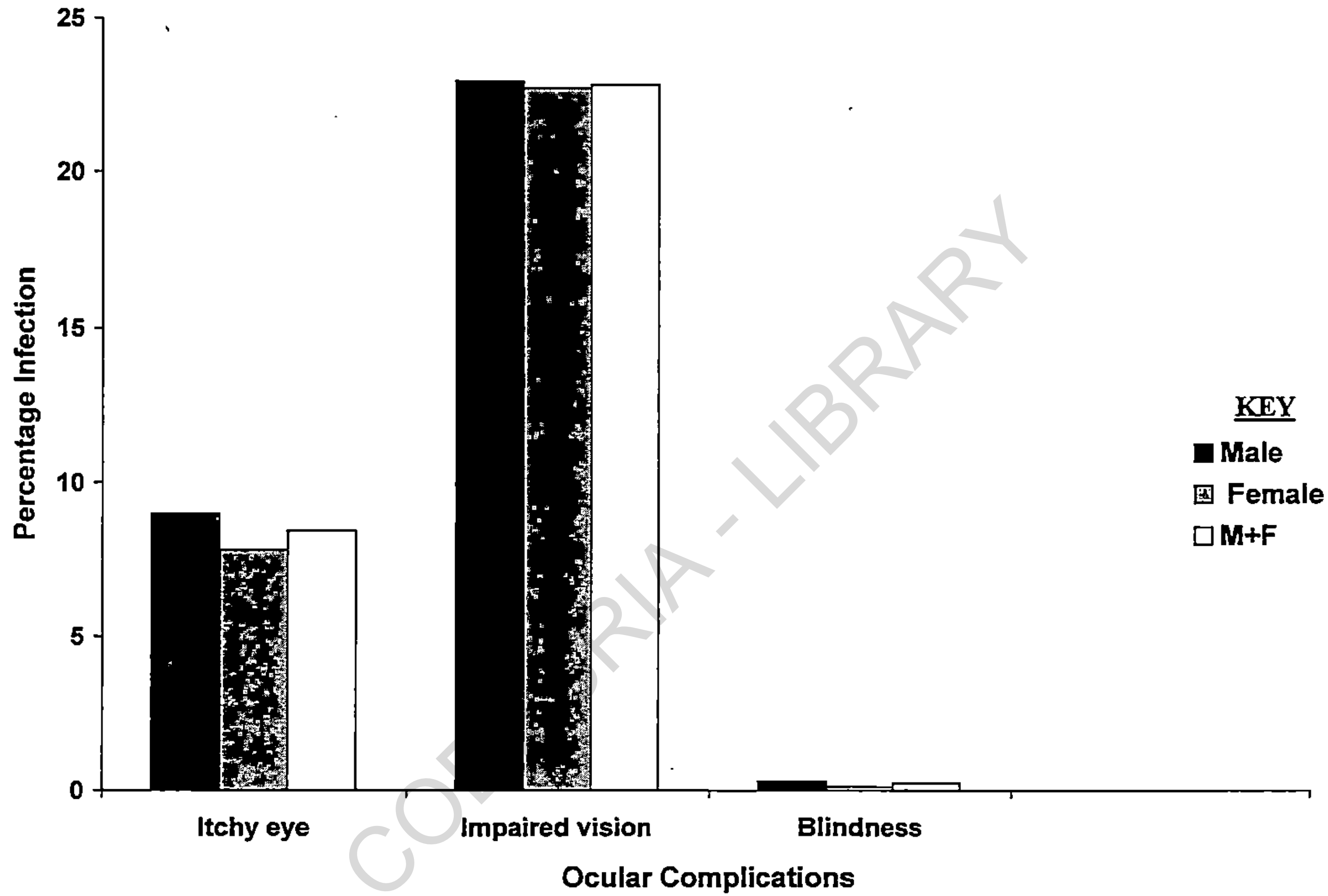


Fig. 10: Sex Distribution of Ocular Signs and Symptoms of Onchocerciasis in the Imo River Basin

Table 12: Distribution of Signs and Symptoms of Non-classical Onchocerciasis in the Imo River Basin.

Study Area	No examined	No (%) infected	No(%) with non-classical onchocerciasis				Total (%) with non-classical onchocerciasis
			Musculoskeletal pain	General debility	Epilepsy	Dwarfism	
Upper Imo River Basin	3311	889 (26.8)	808 (24.4)	706 (21.3)	24 (0.7)	0 (0.0)	1538 (46.5)
Middle Imo River Basin	4037	766 (19.0)	482 (11.9)	725 (18.0)	14 (0.3)	0 (0.0)	1221 (30.2)
Total	7348	1655 (22.5)	1290 (17.6)	1431 (19.5)	38 (0.5)	0 (0.0)	2759 (37.5)

Table 13: Age Distribution of Signs and Symptoms of Non-classical Onchocerciasis in the Imo River Basin

Age (years)	No examined	No (%) infected	No(%) with non-classical onchocerciasis				
			Musculoskeletal pain	General debility	Epilepsy	Dwarfism	Total no (%) with non-classical onchocerciasis
<5	204	9 (4.4)	0 (0.0)	3 (1.5)	0 (0. 0)	0 (0.0)	3 (1.5)
5-9	666	55 (8.3)	0 (0.0)	58 (8.7)	0 (0.0)	0 (0.0)	58 (8.7)
10-19	985	115 (11.7)	14 (1.4)	115 (11.7)	2 (0.2)	0 (0.0)	131 (13.3)
20-29	1238	176 (14.2)	143 (11.6)	190 (15.3)	8 (0.6)	0 (0.0)	341 (27.5)
30-39	1321	225 (17.0)	288 (21.8)	178 (13.5)	8 (0.6)	0 (0.0)	474 (35.9)
40-49	1350	317 (23.5)	365 (27.0)	404 (29.9)	19 (1.4)	0 (0.0)	788 (58.4)
50-59	950	426 (44.8)	333 (35.1)	275 (28.9)	1 (0.1)	0 (0.0)	609 (64.1)
≥60	634	332 (52.4)	147 (23.2)	208 (32.8)	0 (0.0)	0 (0.0)	355 (56.0)
Total	7348	1655 (22.5)	1290 (17.6)	1431 (19.5)	38 (0.5)	0 (0.0)	2759 (37.5)

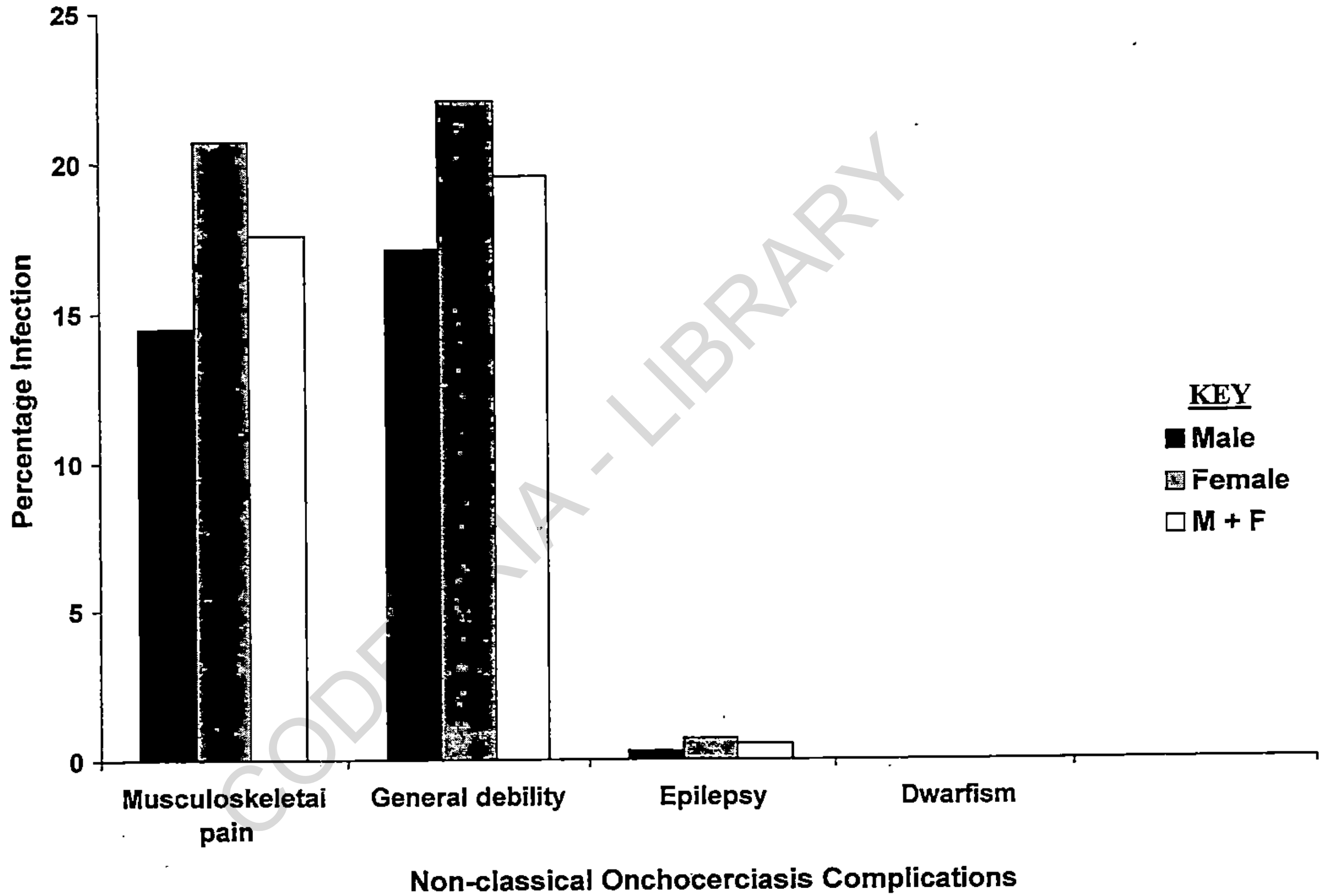


Fig. 11. Sex Distribution of Signs and Symptoms of Non-classical Onchocerciasis in the Imo River Basin

Okwelle (21.7%) and Ndiokoro (20.5%). Additionally, Ihube, Agbobu and Umuezegem communities had rates of 15.7%, 13.7% and 11.1% respectively.

Table 15 shows that the overall prevalence of infection was similar in both sexes, 26.9% in females and 26.8% in males. However infection rates in females were higher than those for males in the following communities: Amuro, Umulolo, Uhiowerre, Okwe, Ndiokoro, Agbobu and Umuezegem. On the other hand, male infection rates were higher than females in Aku, Isieke, Ajabo, Okwelle, Ezelu-Okwe, Umulewe, Ihube and Umule communities. In Amachara community, none of the females examined was infected with *O. volvulus* mf. With the exception of Aku, Okwelle and Okanachi commuities, the chi square analysis established a significant difference in sex infection rates in the other communities ($P < 0.05$).

Table 16 summarizes the distribution of onchocerciasis by age. The rate of infection increased with age from 2.7% in the 5-9 age group to 58.1% in persons aged 60 years and above.

The distribution of infection according to occupation is presented in Table 17. Infection was commonest amongst farmers (46.6%) and fishermen (28.4%) and least amongst pre-school pupils (2.7%). Hunters, pupils/students, traders, indoor/sedentary workers and civil servants had infection rates of 19.9%, 18.5%, 16.5%, 13.4% and 13.1% respectively.

Intensity of infection

The intensity of infection (microfilarial density) reveals that 750 (84.4%) persons had low skin mf count (1-25mf/ss), 110(12.4%) persons had moderate skin mf counts (26-50mf/ss) while 29 (3.3%) persons had high skin mf counts

(51mf/ss and above) (Table 18). The community microfilarial density (CMFD) varied amongst the communities with the highest score of 27.1mf/ss in Ajabo and the lowest (14,3mf/ss) in Umulewe. The overall CMFD in the area was 22.1mf/ss. Generally, the prevalence of onchocerciasis in the area showed a weak association with intensity of infection (r=0.38;p>0.130)(Fig.12.).

The intensity of infection increased with age from 2.4mf/ss in persons below 5 years of age to a peak of 33.2mf/ss in persons in the 50-59 group (Fig 13). A microfilarial density of 30.3mf/ss was obtained in persons 60 years and above. The prevalence of infection amongst the various age groups was proportional to the microfilarial density.

The influence of occupation on the intensity of infection is shown in Table 19. The intensity was highest in farmers (44.1mf/ss) and fishermen (33.8mf/.ss) and lowest in pre-school pupils (2.4mf/ss). In addition, hunters (29.7mf/ss) and pupils/students (27.6mf/ss) had higher intensities than indoor/sedentary workers (15.5 mf/ss), civil servant (14.3mf/ss) and traders (10.5mf/ss). A strong correlation was established between prevalence of onchocerciasis and intensity of infection amongst different occupational groups (r = 0.92; P < 0.001) (Fig. 14).

Clinical manifestations

Onchocercal lesions

The distribution of onchocercal lesions in the various communities in the Upper Imo River Basin is summarized in Table 20. A total of 2405 (72.6%) persons presented with various kinds of lesions. The prevalence of lesions varied amongst the communities investigated with highest score at Amuro (96.2%) and the lowest at Okanachi (24.6%). All the communities had prevalence rates of 50% and above, the only exceptions were Amanchara and Agbobu with rates of 44.4% and 41.2%

respectively. The commonest lesion obtained in the area was nodules (20.4%), followed by itching by (17.3%), DPM (10.8%) and CPOD (10.5%). The least common lesions were ATR (3.1%) and LOD (2.2%). Nodules however, were absent in Okanachi community. Generally, OSD gave a prevalence of 34.9% while the reactive forms were 21.0%. With the exception of LOD and ATR which were absent in some of the communities all the other forms of onchocercal lesions were seen in the area. The correlation coefficient established strong association (r = 0.73; P <0.001) between prevalence of infection and the presence of nodules (Fig 15a) and a weak association (r = 0.06; P>0.802) between prevalence of infection and depigmentation (Fig 15b).

The age-specific distribution of onchocercal lesions is presented in Table 21. The overall prevalence increased with advancing age from 14.9% in persons 5 years of age and below to a peak of 85.2% in persons aged 50-59 years old and dropped to 81.7% in persons 60 years and above. The distribution of lesions by sex reveals that more males presented with nodules, LOD, ATR, DPM than females while, the prevalences of itching, APOD, CPOD were higher in females than males (Fig 16).

Lymphatic complications

The distribution of lymphatic complications of onchocercaisis is presented in Table 22. Only 7.9% of persons examined had lymphatic complications, with Amuro recording the highest prevalence (19.0%) and Umule the lowest (2.8%). Four other communities had prevalences of 10% and above and these are Ajabo (16.5%), Agbobu (11.8%), Ihube (10.4%) and Ndiokoro (10.3%). The most common complications were hernia (2.7%) and L,pathy (2.2%) while the least common complications were Lym (genital) (1.0%) and Lym (limb) (0.7%). Hernia was seen in all the communities with the exception of Umulewe. Hanging groin with an overall prevalence of 1.2% was encountered in 11 out of 17 communities investigated. No case of Lym (breast) was obtained in the study area.

Table 23 summarizes the age-specific distribution of lymphatic complications. Overall lymphatic complications were recorded in all age groups, with the exception of the 0-9 groups. Specifically hanging groin, Lym (limb), Lym (genital) were absent in the 0-29 age groups but showed various rates in persons aged 30 years and above. Hernia and L,pathy on the other hand were encountered in persons 10 years of age and above.

With the exception of Lym(Limb), all the other lymphatic complications of onchocerciasis were seen more in males than females (Fig. 17).

Ocular signs and symptoms

Table 24 summarizes the distribution of ocular signs and symptoms of onchocerciasis. About 39.6% of persons examined were positive for ocular signs and symptoms. The community prevalence rates varied with the highest score of 74.3% in Ndiokoro to the lowest score of 14.0% in Umulewe. Communities with prevalence rates of 30% and above include Amuro (51.2%), Uhiowerre (49.6%), Okwelle (47.1%), Ajabo (42.2%), Umulolo (39.6%), Isieke (37.6%), Agbobu (35.3%), Umuezegem (35.1%), Okanachi (31.1%) and Ihube (31.0%). Impaired vision (30.5%) was the most common ocular sign and symptom and was recorded in the communities investigated while blindness (0.2%) was the least common and was encountered in only 5 out of the 17 communities in the study area. Itchy eye (9.0%) was the second most prevalent ocular lesion which was present in all the communities with the exception of Amuro, Amanchara and Umulewe. Statistically, the prevalence of the onchocerciasis was fairly strongly correlated with impaired

Table 14: Prevalence of Onchocerciasis in the Upper Imo River Basin

Community	No examined	No and (%) infected with *O.volvulus* mf	No and (%) uninfected with *O.volvulus* mf
Umulolo	945	340(36.0)	605(64.0)
Aku	342	95(27.8)	247(72.2)
Amuro	105	36(34.3)	69(65.7)
Ndiokoro	78	16(20.5)	62(79.5)
Umule	71	3(4.2)	68(95.8)
Ihube	134	21(15.7)	113(84.3)
Umuezegem	63	7(11.1)	56(88.9)
Amanchara	81	5(6.2)	76(93.8)
Umulewe	43	11(25.6)	32(74.4)
Okanachi	61	3(4.9)	58(95.1)
Agbobu	51	7(13.7)	44(86.3)
Ajabo	237	67 (28.3)	170 (71.7)
Uhiowerre	246	76 (30.9)	170 (69.1)
Okwe	178	42 (23.6)	136 (76.4)
Isieke	242	61 (25.2)	181 (74.8)
Okwelle	221	48 (21.7)	173 (78.8)
Ezelu-Okwe	213	51 (23.9)	162 (76.1)
Total	3311	889 (26.8)	2422 (73.2)

Table 15: Sex-specific Prevalence of Onchocerciasis in the Upper Imo River Basin

Community	Total no examined	No and (%) infected	Male		Female	
			No examined	No and (%) infected	No examined	No and (%) uninfected
Umulolo	945	340(36.0)	378	129(34.1)	567	211(37.2)
Aku	342	95(27.8)	132	37(28.0)	210	58(27.6)
Amuro	105	36(34.3)	53	15(28.3)	52	21(40.4)
Ndiokoro	78	16(20.5)	39	6(15.4)	39	10(25.6)
Umule	71	3(4.2)	20	2(10.0)	51	1(2.0)
Ihube	134	21(15.7)	57	14(24.6)	77	7(9.1)
Umuezegem	63	7(11.1)	30	2(6.7)	33	5(15.2)
Amanchara	81	5(6.2)	31	5(16.1)	50	0(0.0)
Umulewe	43	11(25.6)	17	8(47.1)	26	3(11.5)
Okanachi	61	3(4.9)	41	2(4.9)	20	1(5.0)
Agbobu	51	7(13.7)	27	1(3.7)	24	6(25.0)
Ajabo	237	67 (28.3)	122	41 (33.6)	115	26 (22.6)
Uhiowerre	246	76 (30.9)	137	41 (29.9)	109	35 (32.1)
Okwe	178	42 (23.6)	93	19 (20.4)	85	23 (27.1)
Isieke	242	61 (25.2)	110	29 (26.4)	132	32 (24.2)
Okwelle	221	48 (21.7)	118	26 (22.0)	103	22 (21.4)
Ezelu-Okwe	213	51 (23.9)	121	32 (26.4)	92	19 (20.7)
Total	3311	889 (26.8)	1526	409 (26.8)	1785	480 (26.9)

Table 16: Age-specific Prevalence of Onchocerciasis in the Upper Imo River Basin

Age (Years)	No examined	No and (%) infected	No and (%) uninfected
< 5	74	2 (2.7)	72 (97.3)
5 - 9	289	29 (10.0)	260 (90.0)
10 - 19	478	71 (14.9)	407 (85.1)
20 - 29	630	110 (17.5)	520 (82.5)
30 - 39	586	140 (23.9)	446 (76.1)
40 - 49	581	174 (29.9)	407 (70.1)
50 - 59	427	220 (51.5)	207 (48.5)
≥ 60	246	143 (58.1)	103 (41.9)
Total	3311	889 (26.8)	2422 (73.2)

Table 17: Occupation - related Prevalence of Onchocerciasis in the Upper Imo River Basin

Occupation	No examined	No and (%) infected	No and (%) uninfected
Trader	243	40 (16.5)	203 (83.5)
Farmer	1128	526 (46.6)	602 (53.4)
Fisherman	74	21 (28.4)	53 (71.6)
Hunter	136	27 (19.9)	109 (80.1)
Civil servants	320	42 (13.1)	278 (86.9)
Indoor/ sedentary worker	322	43 (13.4)	279 (86.6)
Pupils / Students	1014	188 (18.5)	826 (81.5)
Pre-school pupils	74	2 (2.7)	72 (97.3)
Total	3311	889 (26.8)	2422 (73.2)

Table 18: Density of O.volvulus Microfilariae in Skin Snips of Positive Persons in the Upper Imo River Basin

Community	No examined	No and % with *O volvulus* mf	No with following no. of mf/skin snip and (Mean of density found in skin snip) 1-25	25-50	51-100	>100	Community microfilarial density (CMFD)
Umulolo	945	340(36.0)	300 (18.4)	31 (45.8)	9 (84.3)	0 (0.0)	22.6
Aku	342	95(27.8)	85 (19.7)	7 (38.3)	2 (85.8)	1 (106.2)	23.4
Amuro	105	36(34.3)	21 (14.9)	12 (29.4)	3 (51.7)	0 (0.0)	22.8
Ndiokoro	78	16(20.5)	15 (17.4)	0 (0.0)	1 (60.1)	0 (0.0)	20.1
Umule	71	3(4.2)	3 (21.6)	0 (0.0)	0 (0.0)	0 (0.0)	21.6
Ihube	134	21(15.7)	18 (16.6)	1 (29.2)	2 (60.6)	0 (0.0)	21.4
Umuezegem	63	7(11.1)	6 (14.8)	1 (28.5)	0 (0.0)	0 (0.0)	16.8
Amanchara	81	5(6.2)	5 (18.4)	0 (0.0)	0 (0.0)	0 (0.0)	18.4
Umulewe	43	11(25.6)	9 (11.6)	2 (26.4)	0 (0.0)	0 (0.0)	14.3
Okanachi	61	3(4.9)	3 (18.6)	0 (0.0)	0 (0.0)	0 (0.0)	18.6
Agbobu	51	7(13.7)	6 (17.4)	1 (40.8)	0 (0.0)	0 (0.0)	20.7
Ajabo	237	67 (28.3)	50 (22.8)	16 (37.3)	1 (87.1)	0 (0.0)	27.1
Uhiowerre	246	76 (30.9)	68 (18.3)	5 (38.2)	3 (52.3)	0 (0.0)	21.0
Okwe	178	42 (23.6)	33 (14.8)	8 (29.8)	1 (74.2)	0 (0.0)	19.1
Isieke	242	61 (25.2)	54 (15.6)	5 (41.2)	2 (60.4)	0 (0.0)	19.2
Okwelle	221	48 (21.7)	35 (17.4)	13 (34.7)	0 (0.0)	0 (0.0)	22.1
Ezelu-Okwe	213	51 (23.9)	39 (14.3)	8 (34.2)	4 (60.8)	0 (0.0)	21.1
Total	3311	889 (26.8)	750 (17.8)	110 (37.8)	28 (68.3)	0 (0.0)	22.1

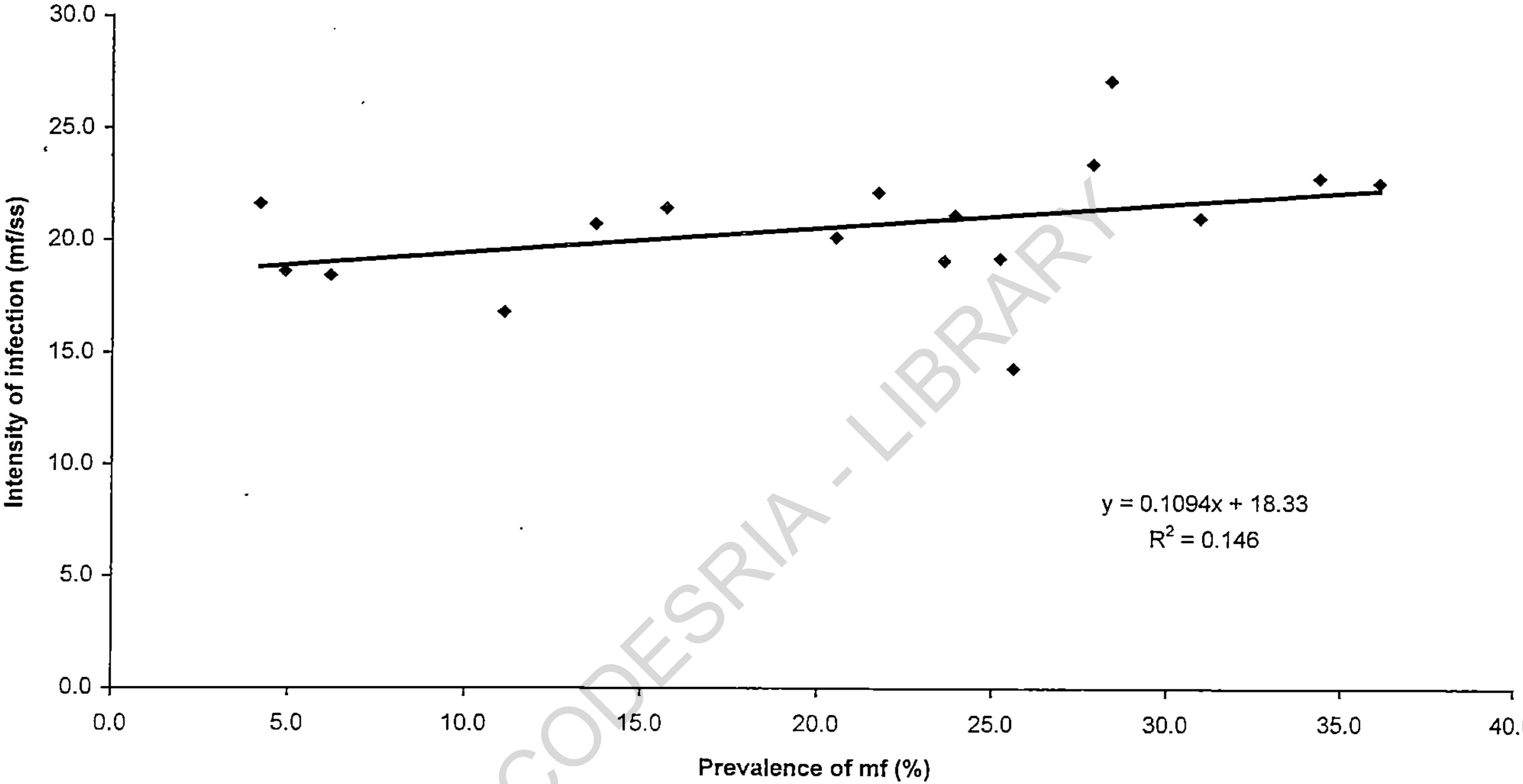


Fig. 12: **Relationship Between Prevalence of Onchocerciasis (Measured by Skin mf) and Intensity of Infection (Measured as Microfilarial Density) in Upper Imo River Basin**

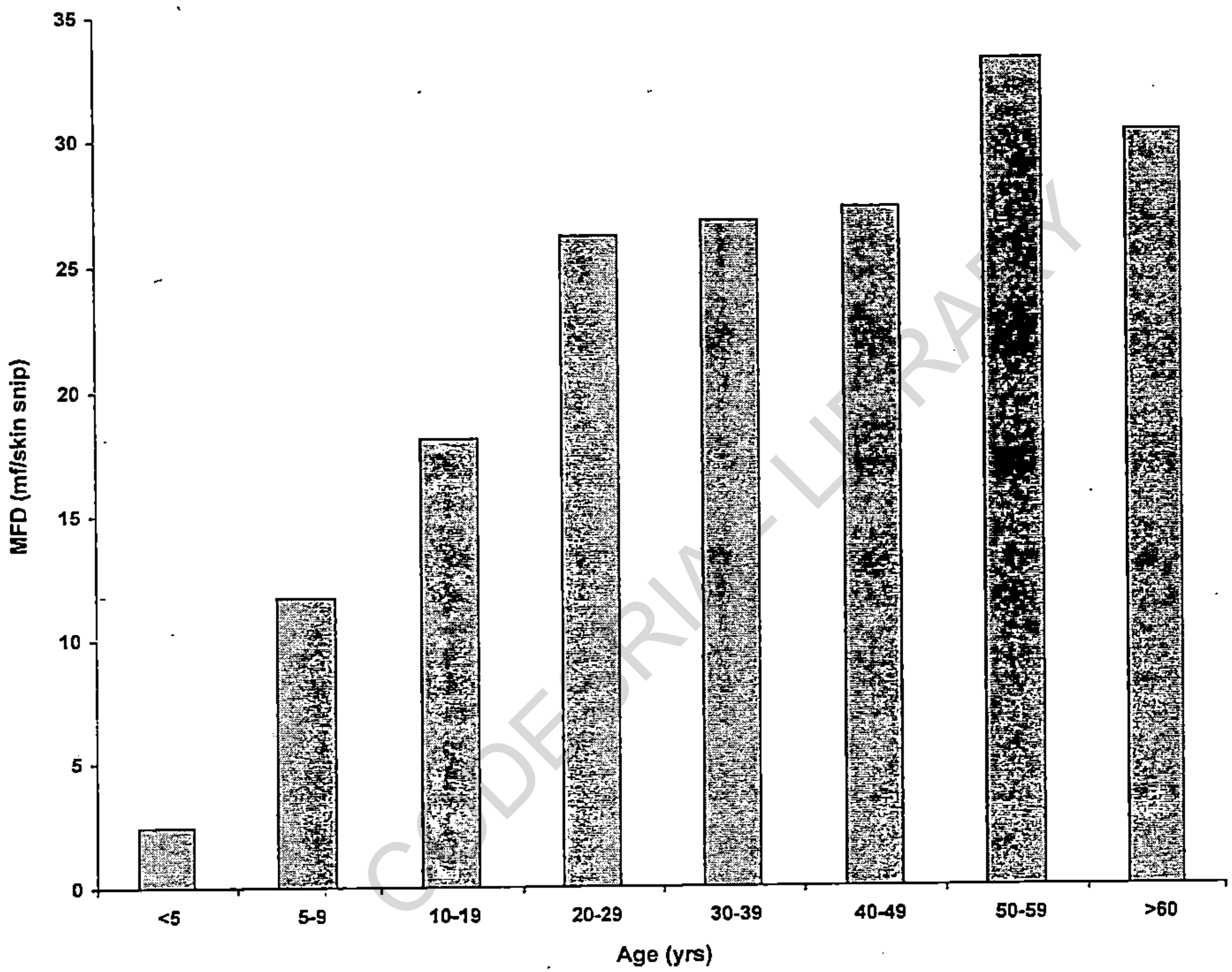


Fig. 13: Age-related Density of *O. volvulus* Microfilariae in Skin Snips of Persons in the Upper Imo River Basin

Table 19: Occupation-related Density of *O. volvulus* Microfilariae in Skin Snips of Positive Persons in the Upper Imo River Basin

Occupation	No examined	No and (%) positive for O. volvulus mf	Mean microfilarial density (mfd)
Trader	243	40 (16.5)	10 .5
Farmer	1128	526 (46.6)	44.1
Fisherman	74	21 (28.4)	33.8
Hunter	136	27 (19.9)	29.7
Civil servants	320	42 (13.1)	14.3
Indoor/ sedentary worker	322	43 (13.4)	15.5
Pupils / Students	1014	188 (18.5)	27.6
Pre-school pupils	74	2 (2.7)	2.4
Total	3311	889 (26.8)	22.2

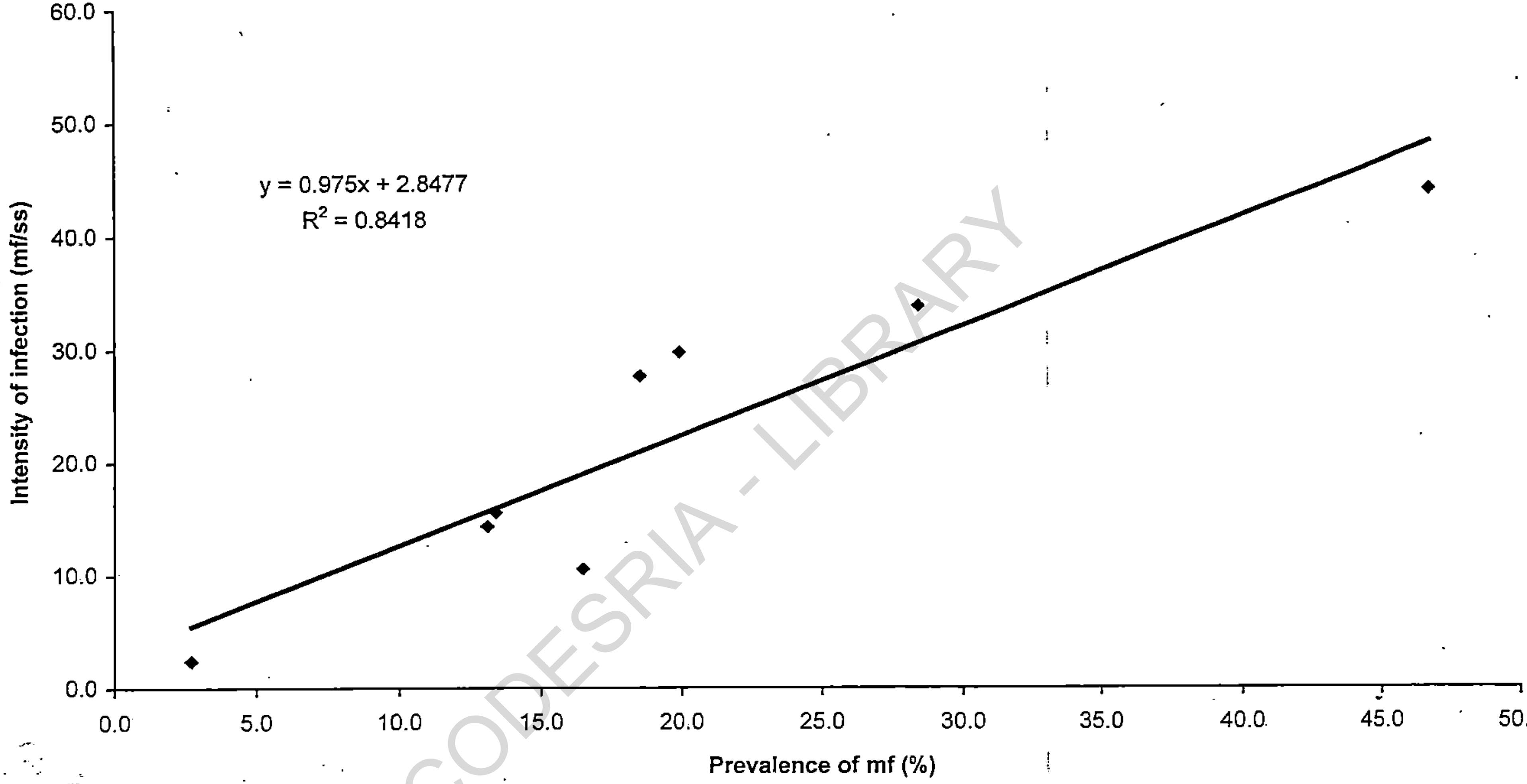


Fig. 14: Relationship Between Prevalence of Onchocerciasis and Intensity of Infection Amongst Different occupational groups

Table 20 : Distribution of Onchocercal Lesions in the Upper Imo River Basin

Community	No examined	No(%) infected	No (%) with onchocercal lesions: Itching	Nodules	APOD	CPOD	LOD	ATR	DPM	Total No (%) with onchocercal lesions
Umulolo	945	340(36.0)	192(20.3)	277(29.3)	79(8.4)	85(9.0)	25(2.6)	17(1.8)	92(9.7)	767(81.2)
Aku	342	95(27.8)	64(18.7)	93(27.2)	28(8.2)	47(13.7)	13(3.8)	11(3.2)	44(12.9)	300(87.7)
Amuro	105	36(34.3)	26(24.8)	27(25.7)	17(16.2)	12(11.4)	3(2.9)	3(2.9)	13(12.4)	101(96.2)
Ndiokoro	78	16(20.5)	21(26.9)	18(23.1)	7(9.0)	13 (16.7)	0(0.0)	1(1.3)	7(9.0)	67(85.9)
Umule	71	3(4.2)	14(19.7)	4(5.6)	5(7.0)	6 (8.5)	0(0.0)	4(5.6)	9(12.7)	42 (59.2)
Ihube	134	21(15.7)	3(2.2)	36(26.9)	19(14.1)	17(12.7)	1(0.7)	10(7.5)	27(20.1)	113(84.3)
Umuezegem	63	7(11.1)	17(27.0)	2(3.2)	3(4.8)	9(14.3)	0(0.0)	0(0.0)	9(14.3)	40(63.5)
Amanchara	81	5(6.2)	20(24.7)	2(2.5)	1(1.2)	5(6.2)	1(1.2)	0(0.0)	7(8.6)	36(44.4)
Umulewe	43	11(25.6)	7(16.3)	2(4.7)	2(4.7)	5(11.6)	0(0.0)	0(0.0)	7(16.3)	23(53.5)
Okanachi	61	3(4.9)	2(3.3)	0(0.0)	3(4.9)	7(11.5)	0(0.0)	0(0.0)	3(4.9)	15(24.6)
Agbobu	51	7 (13.7)	6 (11.8)	4 (7.8)	1 (2.0)	3 (5.9)	2 (3.9)	0 (0.0)	5 (9.8)	21 (41.2)
Ajabo	237	67 (28.3)	41 (17.3)	53 (22.4)	18 (7.6)	33 (13.9)	7 (3.0)	9 (3.8)	26 (11.0)	187 (78.9)
Uhiowerre	246	76 (30.9)	43 (17.5)	54 (22.0)	21 (8.5)	36 (14.6)	7 (2.8)	17 (6.9)	23 (9.3)	201 (80.7)
Okwe	178	42 (23.6)	18 (10.1)	21 (11.5)	17 (9.6)	19 (10.7)	4 (2.2)	5 (2.8)	15 (8.4)	99 (55.6)
Isieke	242	61 (25.2)	29 (12.0)	36 (14.9)	27 (11.2)	21 (8.7)	2 (0.8)	11 (4.5)	21 (8.7)	147 (60.7)
Okwelle	221	48 (21.7)	37 (16.0)	27 (12.2)	14 (6.3)	17 (7.7)	4 (1.8)	9 (4.1)	27 (12.2)	135 (61.1)
Ezelu-Okwe	213	51 (23.9)	34 (16.0)	19 (8.9)	11 (5.2)	14 (6.6)	4 (1.9)	7 (3.3)	22 (10.3)	111 (52.1)
Total	3311	889 (26.8)	574 (17.3)	675 (20.4)	273 (8.2)	349 (10.5)	73 (2.2)	104 (3.1)	357 (10.8)	2405 (72.6)

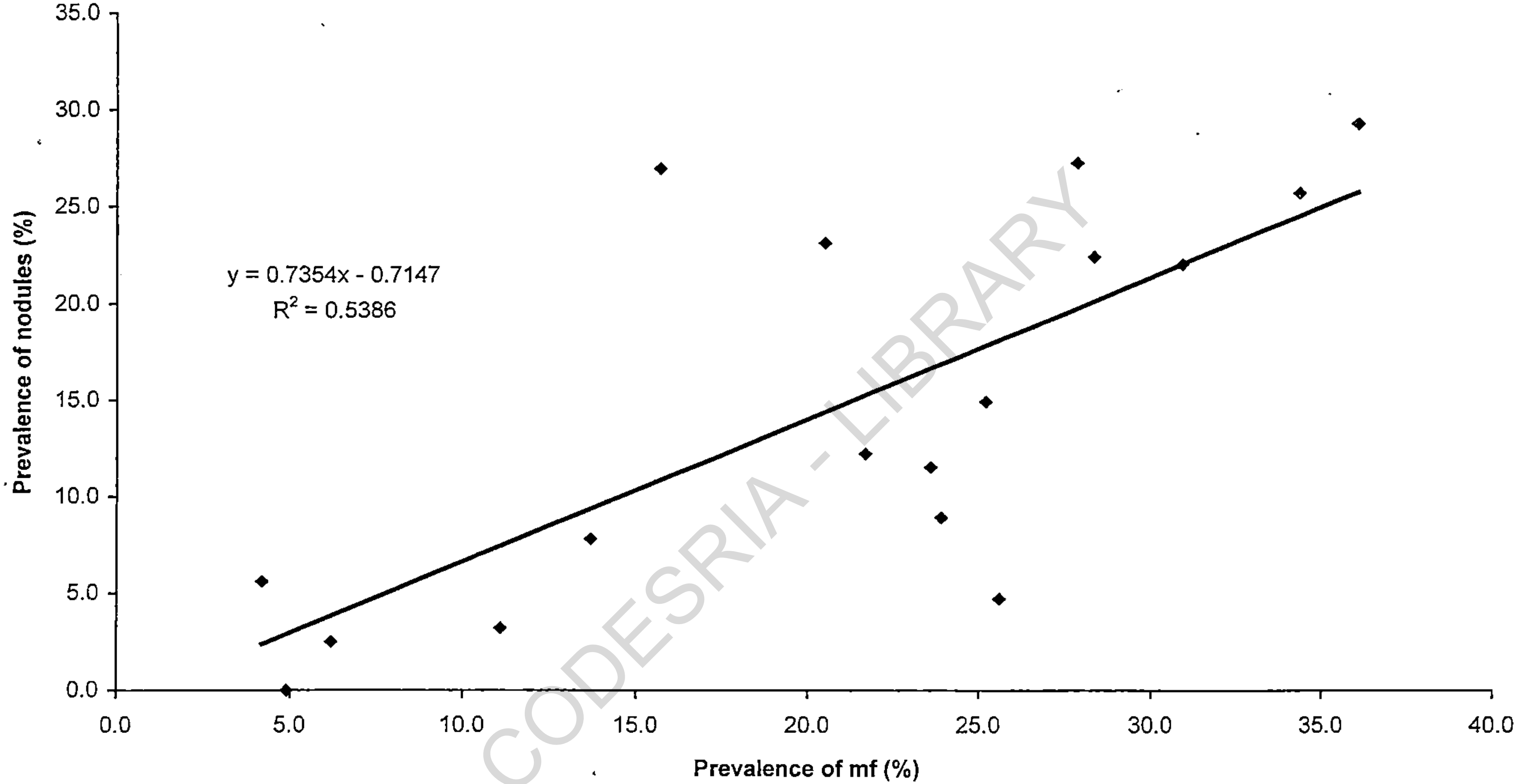


Fig. 15a: Relationship Between Prevalence of Onchocerciasis and Palpable Nodules in the Upper Imo River Basin

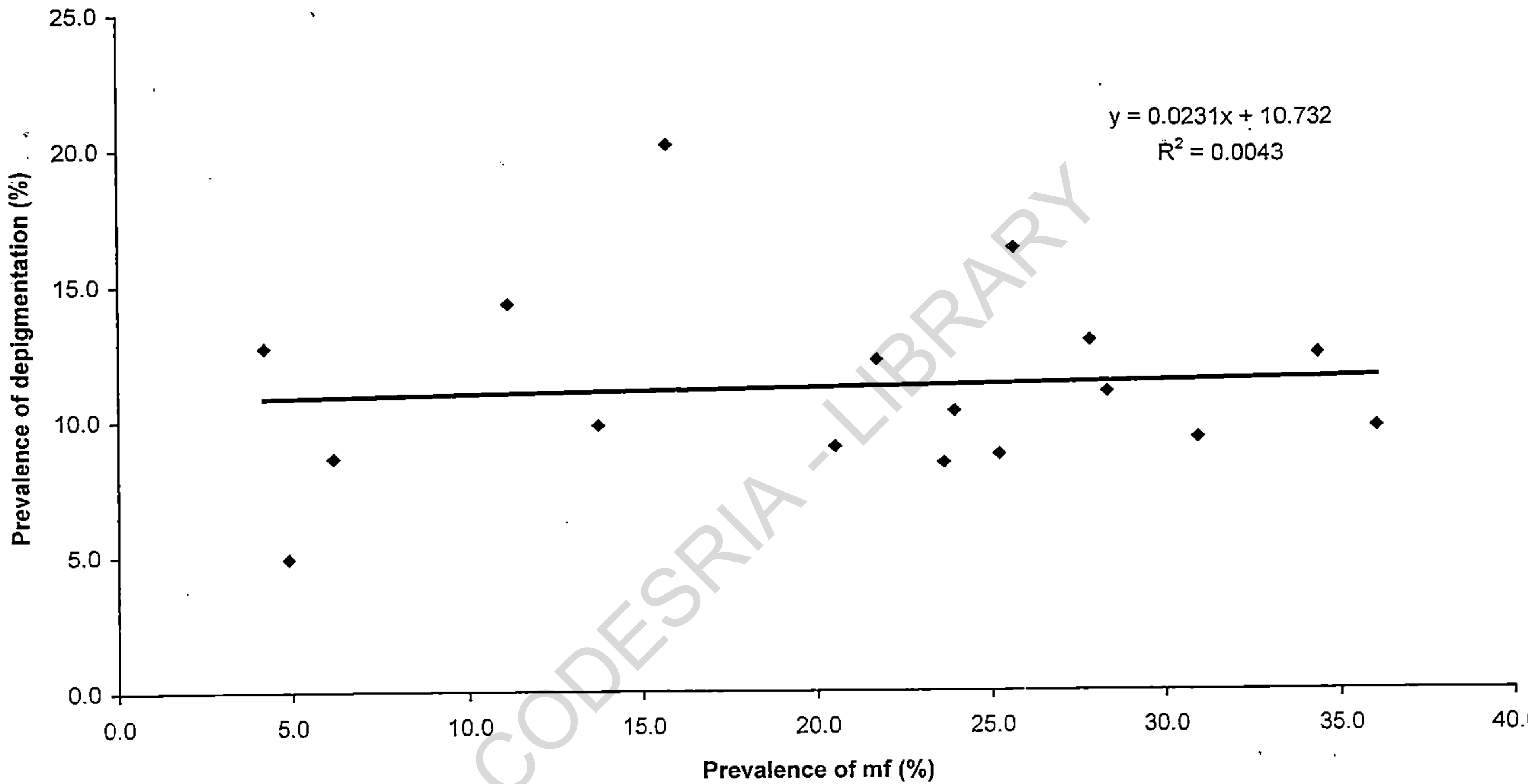


Fig. 15b: Relationship Between Prevalence of Onchocerciasis and Depigmentation in the Upper Imo River Basin

Table 21: Age-specific Distribution of Onchocercal Lesions in the Upper Imo River Basin

Community	No examined	No(%) infected	No (%) with onchocercal lesions							Total No (%) with onchocercal lesions
			Itching	Nodules	APOD	CPOD	LOD	ATR	DPM	
< 5	74	2 (2.7)	7 (9.5)	4 (5.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	11 (14.9)
5 - 9	289	29 (10.0)	28 (9.7)	37 (12.8)	19 (6.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	84 (29.1)
10 - 19	478	71 (14.9)	111 (23.2)	115 (24.1)	53 (11.1)	28 (5.9)	0 (0.0)	0 (0.0)	0 (0.0)	307 (64.2)
20 - 29	630	110 (17.5)	130 (20.6)	136 (21.6)	99 (15.7)	85 (13.5)	0 (0.0)	14 (2.2)	19 (3.0)	483 (76.7)
30 - 39	586	140 (23.9)	104 (17.7)	127 (21.7)	49 (8.4)	106 (18.1)	5 (0.9)	23 (3.9)	56 (9.6)	470 (80.2)
40 - 49	581	174 (29.9)	144 (24.8)	128 (22.0)	24 (4.1)	46 (7.9)	30 (5.2)	32 (5.5)	81 (13.9)	485 (83.5)
50 - 59	427	220 (51.5)	35 (8.2)	93 (21.8)	18 (4.2)	51 (11.9)	24 (5.6)	35 (8.2)	108 (25.3)	364 (85.2)
≥ 60	246	143 (58.1)	15 (6.1)	35 (14.2)	11 (4.5)	33 (13.4)	14 (5.7)	0 (0.0)	93 (37.8)	201 (81.7)
Total	3311	889 (26.8)	574 (17.3)	675 (20.4)	273 (8.2)	349 (10.5)	73 (2.2)	104 (3.1)	357 (10.8)	2405 (72.6)

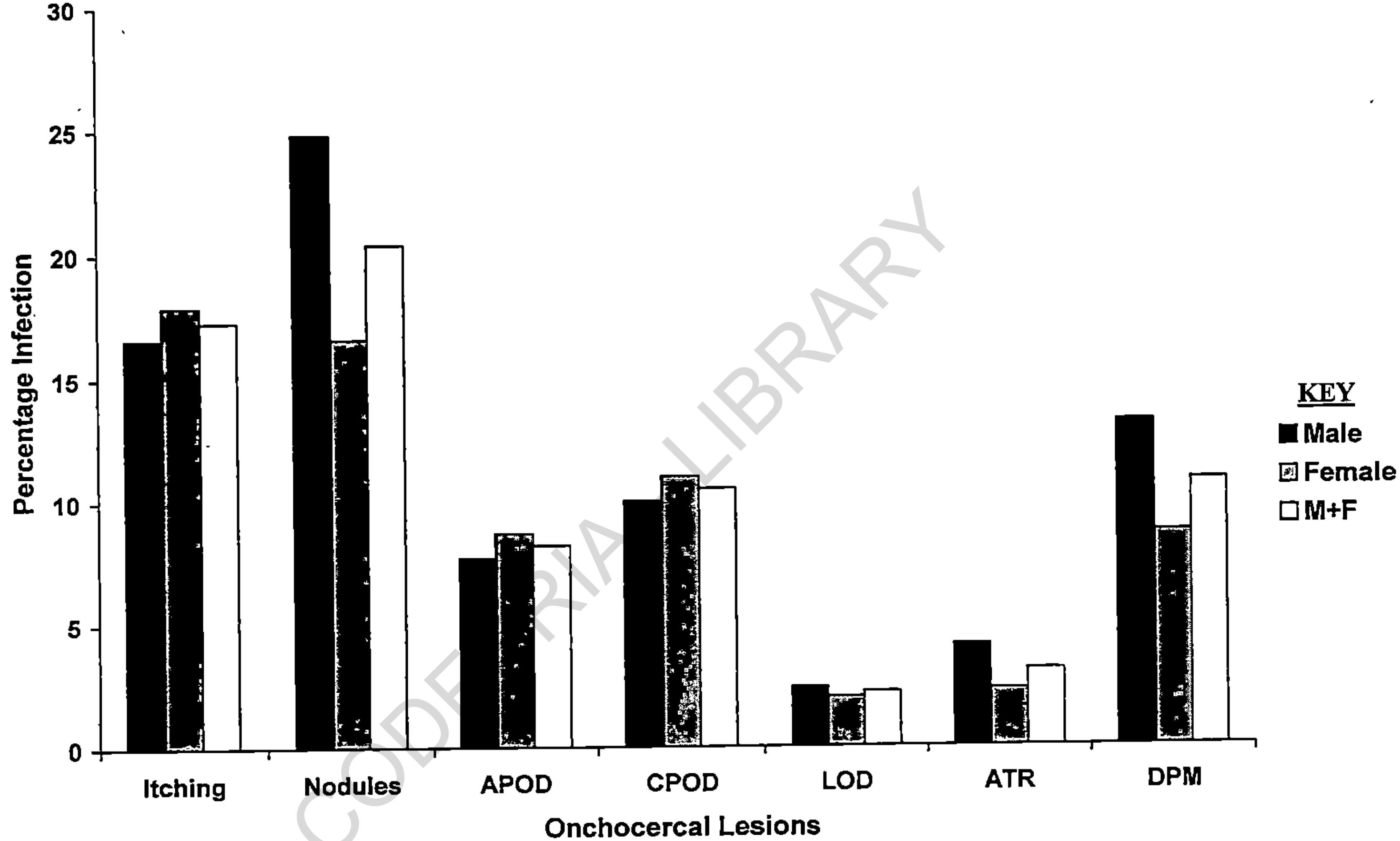


Fig. 16: Sex Distribution of Onchocercal Lesions in the Upper Imo River Basin

Table 22 : Distribution of Lymphatic Complications of Onchocerciasis in the Upper Imo River Basin

Community	No examined	No(%) infected	No (%) with Lymphatic Complications						Total No (%) with lymphatic complication
			L, pathy	Hanging groin	Lym (Limb)	Lym (Genital	Lym (Breast)	Hernia	
Umulolo	945	340(36.0)	13(1.4)	7(0.7)	7(0.7)	6(0.6)	0 (0.0)	17 (1.8)	50 (5.3)
Aku	342	95(27.8)	8(2.3)	7(2.0)	3(0.9)	8(2.3)	0 (0.0)	8 (2.3)	34 (9.9)
Amuro	105	36(34.3)	8(7.6)	4(3.8)	1(1.0)	2(1.9)	0 (0.0)	5 (4.8)	20 (19.0)
Ndiokoro	78	16(20.5)	2(2.6)	1(1.3)	0(0.0)	1(1.3)	0 (0.0)	4 (5.1)	8 (10.3)
Umule	71	3(4.2)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0 (0.0)	2 (2.8)	2 (2.8)
Ihube	134	21(15.7)	2(1.5)	3(2.2)	2(1.5)	2(1.5)	0 (0.0)	5 (3.7)	14 (10.4)
Umuezegem	63	7(11.1)	3(4.8)	0(0.0)	0(0.0)	1(1.6)	0 (0.0)	1 (1.6)	5 (7.9)
Amanchara	81	5(6.2)	0(0.0)	0(0.0)	1(1.2)	1(1.2)	0 (0.0)	2. (2.5)	4 (4.9)
Umulewe	43	11(25.6)	1(2.3)	2(4.7)	0(0.0)	0(0.0)	0 (0.0)	0 (0.0)	3 (7.0)
Okanachi	61	3(4.9)	0(0.0)	0(0.0)	1(1.6)	1(1.6)	0 (0.0)	4 (6.6)	6 (9.8)
Agbobu	51	7 (13.7)	0(0.0)	1(2.0)	1(2.0)	1(2.0)	0 (0.0)	3 (5.9)	6 (11.8)
Ajabo	237	67 (28.3)	11 (4.6)	9 (3.8)	3 (1.3)	7 (3.0)	0 (0.0)	9 (3.8)	39 (16.5)
Uhiowerre	246	76 (30.9)	7 (2.8)	3 (1.2)	1 (0.4)	2 (0.8)	0 (0.0)	6 (2.4)	19 (7.7)
Okwe	178	42 (23.6)	7 (3.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	7 (3.9)	14 (7.9)
Isieke	242	61 (25.2)	3 (1.2)	3 (1.2)	1 (0.4)	1 (0.4)	0 (0.0)	5 (2.1)	13 (5.4)
Okwelle	221	48 (21.7)	3 (1.4)	1 (0.5)	2 (0.9)	0 (0.0)	0 (0.0)	7 (3.2)	13 (5.9)
Ezelu-Okwe	213	51 (23.9)	5 (2.3)	0 (0.0)	1 (0.5)	1 (0.5)	0 (0.0)	3 (1.4)	10 (4.7)
Total	3311	889 (26.8)	73 (2.2)	41 (1.2)	24 (0.7)	34 (1.0)	0 (0.0)	88 (2.7)	260 (7.9)

Table 23 : Age-specific Distribution of Lymphatic Complications of Onchocerciasis in the Upper Imo River Basin

Age (years)	No examined	No(%) infected	No (%) with Lymphatic Complications						Total No (%) with lymphatic complication
			L, pathy	Hanging groin	Lym (Limb)	Lym (Genital	Lym (Breast)	Hemia	
< 5	74	2 (2.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
5 - 9	289	29 (10.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
10 - 19	478	71 (14.9)	5 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	10 (2.1)	15 (3.1)
20 - 29	630	110 (17.5)	11 (1.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	16 (14.5)	27 (4.3)
30 - 39	586	140 (23.9)	16 (2.7)	5 (0.9)	1 (0.2)	1 (0.2)	0 (0.0)	19 (3.2)	42 (7.2)
40 - 49	581	174 (29.9)	13 (2.2)	7 (1.2)	6 (1.0)	6 (1.0)	0 (0.0)	16 (2.8)	48 (8.3)
50 - 59	427	220 (51.5)	16 (3.7)	14 (3.3)	9 (2.1)	14 (3.3)	0 (0.0)	17 (4.0)	70 (16.4)
≥ 60	246	143 (58.1)	12 (4.9)	15 (6.1)	8 (3.3)	13 (5.3)	0 (0.0)	10 (4.1)	58 (23.6)
Total	3311	889 (26.8)	73 (2.2)	41 (1.2)	24 (0.7)	34 (1.0)	0 (0.0)	88 (2.7)	260 (7.9)

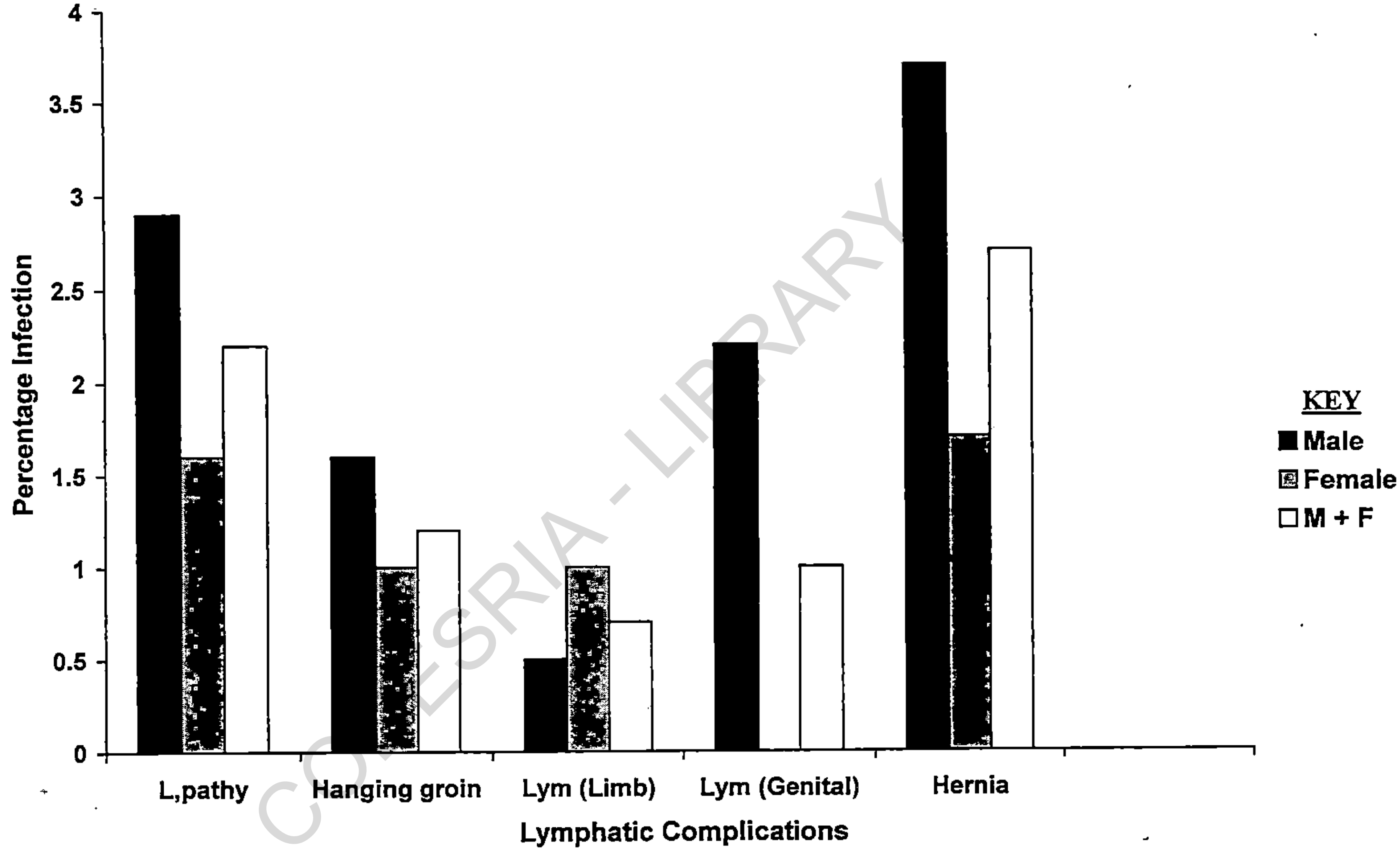


Fig. 17: Sex Distribution of Lymphatic Complications of Onchocerciasis in the Upper Imo River Basin

Table 24: Distribution of Ocular Signs and Symptoms of Onchocerciasis in the Upper Imo River Basin

			No (%) with Ocular Signs and Symptoms			
Community	No examined	No (%) infected	Itchy eye	Impaired vision	Blindness	Total no (%) with ocular signs and symptoms
Umulolo	945	340(36.0)	56 (5.6)	316 (33.4)	2 (0.2)	374 (39.6)
Aku	342	95(27.8)	21 (6.1)	153 (44.7)	1 (0.3)	175 (51.2)
Amuro	105	36(34.3)	27 (25.7)	51 (48.6)	0 (0.0)	78 (74.3)
Ndiokoro	78	16(20.5)	0 (0.0)	23 (29.5)	0 (0.0)	23 (29.5)
Umule	71	3(4.2)	5 (7.0)	17 (23.9)	0 (0.0)	22 (31.0)
Ihube	134	21(15.7)	19 (14.2)	28 (20.9)	0 (0.0)	47 (35.1)
Umuezegem	63	7(11.1)	0 (0.0)	9 (14.3)	0 (0.0)	9 (14.0)
Amanchara	81	5(6.2)	0 (0.0)	19 (23.5)	0 (0.0)	19 (14.3)
Umulewe	43	11(25.6)	0 (0.0)	5 (11.6)	1 (2.3)	6 (14.0)
Okanachi	61	3(4.9)	2 (3.3)	17 (27.9)	0 (0.0)	19 (31.1)
Agbobu	51	7(13.7)	7 (13.7)	11 (21.6)	0 (0.0)	18 (35.3)
Ajabo	237	67 (28.3)	32 (13.5)	67 (28.3)	1 (0.4)	100 (42.2)
Uhiowerre	246	76 (30.9)	38 (15.4)	83 (33.7)	1 (0.4)	122 (49.6)
Okwe	178	42 (23.6)	12 (6.7)	41 (23.0)	0 (0.0)	53 (29.8)
Isieke	242	61 (25.2)	27 (11.2)	64 (26.4)	0 (0.0)	91 (37.6)
Okwelle	221	48 (21.7)	33 (14.9)	71 (32.1)	0 (0.0)	104 (47.1)
Ezelu-Okwe	213	51 (23.9)	18 (8.5)	34 (16.0)	0 (0.0)	52 (24.4)
Total	3311	889 (26.8)	297 (9.0)	1009 (30.5)	6 (0.2)	1312 (39.6)

vision (r = 0.48; P < 0.049) (Fig. 18a) but weakly with blindness (r = 0.26; P < 0.312) (Fig. 18b).

No ocular signs and symptoms were recorded in the 0-9 age group. However, overall prevalence increased with age from 3.8% in persons in the 2nd decade to 74.8% in those in the 7th decade (Table 25). Blindness was encountered only in persons from the 6th decade of life and above. The sex distribution of ocular signs and symptoms of onchocerciasis shows that males had higher prevalences than females (P<0.05)(Fig.19).

Signs and symptoms of non – classical onchocerciasis

A total of 1538 (46.5%) persons presented with signs and symptoms of non – classical onchocerciasis in the area (Table 26). Aku had the highest prevalence (86.3%) while Okwelle had the lowest (27.1%). Besides Aku, 6 communities had prevalence rates of 50% and above namely Amuro (76.2%), Ihube (67.2%), Agbobu (58.8%), Umule (54.9%), Ndiokoro (53.8%) and Okanachi (52.5%). The most common signs and symptoms were musculoskeletal pain (24.4%) and general debility (21.3%) which were encountered in all the communities. The least common sign and symptom was epilepsy (0.7%) which was recorded in only 8 out of the 17 communities investigated. There was no case of dwarfs presenting with onchocerciasis in the area. The association between onchocerciasis and musculoskeletal pain was fairly strong (r = 0.40; P > 0.110) (Fig. 20a). On the other hand, the association between onchocerciasis and epilepsy, was weak (r = 0.05; P > 0.83) (Fig. 20b).

Table 27 summarizes the distribution of signs and symptoms of non-classical onchocerciasis by age. Generally, non-classical onchocerciasis was recorded in all age groups with peak prevalence (76.9%) in the 40-49 group. Similarly, general debility was encountered in all age groups while musculoskeletal pain showed prevalence beginning from the 10-19 age groups and above. Epilepsy on the other hand was only associated with persons in the 10 – 49 age bracket. The sex distribution shows that more females than males had signs and symptoms of non-classical onchocerciasis (Fig. 21). Epilepsy, however had a slightly higher prevalence in the females (0.9%) than in the males (0.5%).

3.1.3 Prevalence, Intensity and Geographical Distribution in the Middle Imo River Basin

Prevalence and distribution

A total of 4037 persons from 21 communities were screened, out of which 766 (19.0%) were infected with *O. volvulus* mf (Table 28). Infection was recorded in all the communities with Ikpem scoring the highest 32.1%, followed by Nzerem (30.5%) while Umuopara had the lowest score of 7.9%. Five communities had rates of between 20 – 30% and these include Umuawuchi (29.8%), Umueze (28.6%), Ezeoke (27.1%), Umungwa (21.4%) and Umunumu (20.2%). In addition, infection rates of between 10-19% were obtained in 12 communities namely, Umuzi (18.8%), Amanyi Ukwu (18.3%), Amanze (17.8%), Ikperejere (17.4%), Umuoma (16.7%), Umunachi (15.7%), Umuoke (15.6%), Umuduru (15.2%), Umukara (15.0%), Ehume (12.8%), Amuzi (12.7%) and Umukabia (12.4%). Okwuohia on the other hand had an infection rate of 9.6%.

The distribution of onchocerciasis by sex is summarized in Table 29. Overall, males (20.3%) had higher infections than females (17.3%). Similarly, males infections were higher than females in 14 communities, while the reverse was the case in 6 communities. The only exceptions was Umuoma where the pattern of infection was similar in both sexes.

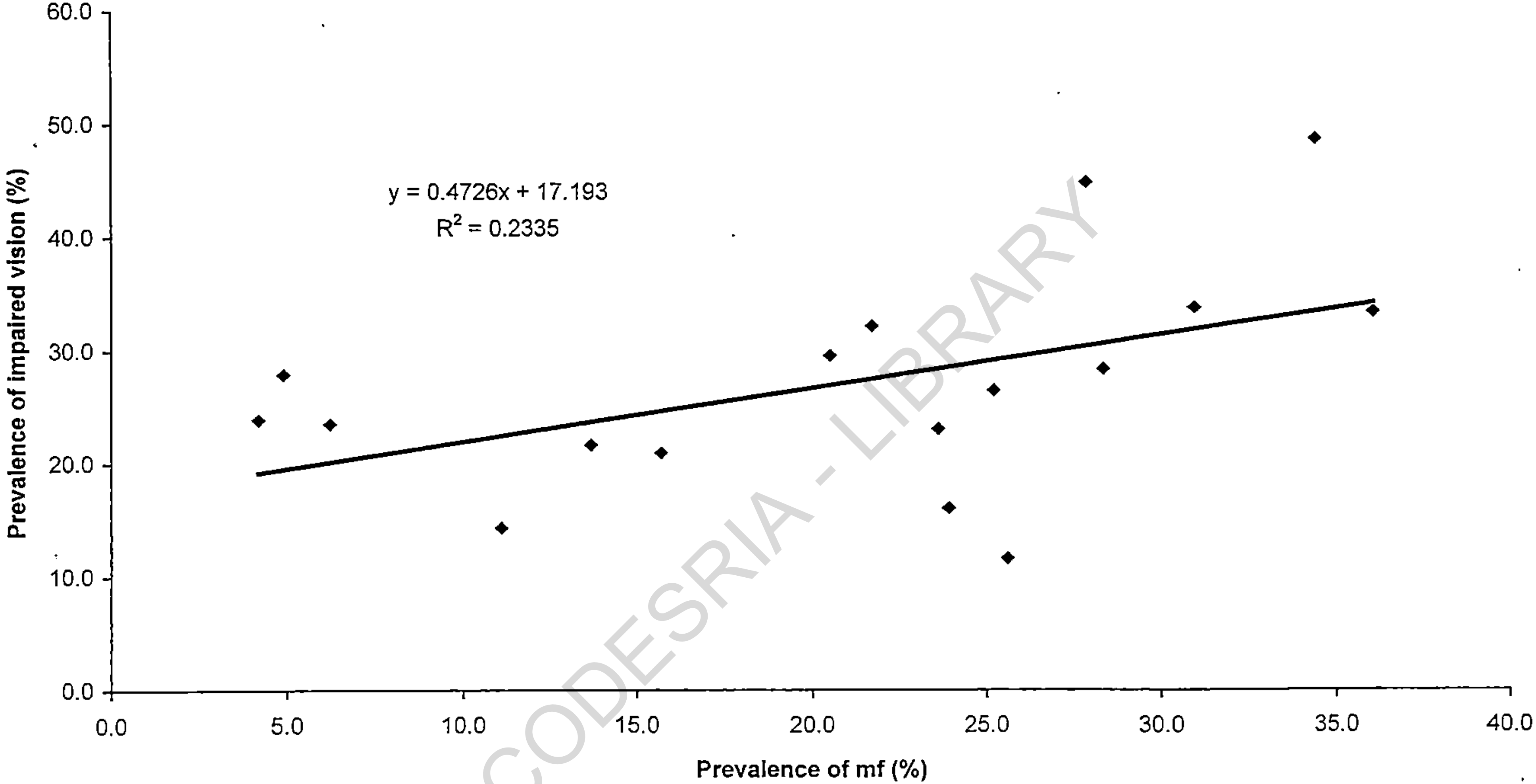


Fig. 18a: Relationship Between Prevalence of Onchocerciasis and Impaired Vision in the Upper Imo River Basin

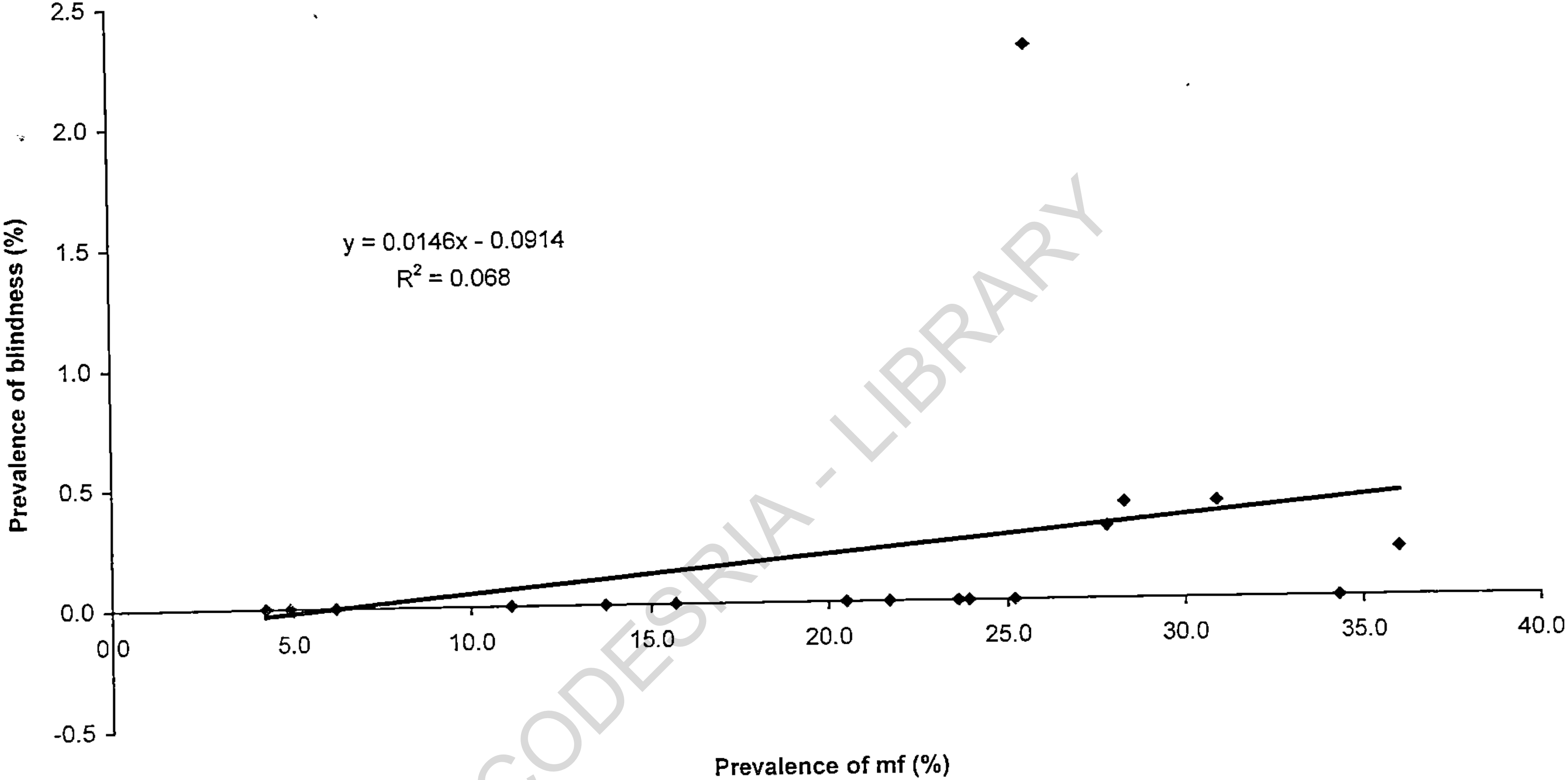


Fig. 18b: Relationship Between Prevalence of Onchocerciasis and Blindness in the Upper Imo River Basin

Table 25: Age-specific Distribution of Ocular Signs and Symptoms of Onchocerciasis in the Upper Imo River Basin

Age (years)	No examined	No (%) infected	No (%) with ocular Signs and Symptoms			Total no (%) with oculars signs and symptoms
			Itchy eye	Impaired vision	Blindness	
< 5	74	2 (2.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
5 - 9	289	29 (10.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
10 - 19	478	71 (14.9)	18 (3.8)	0 (0.0)	0 (0.0)	18 (3.8)
20 - 29	630	110 (17.5)	39 (6.2)	2 (0.3)	0 (0.0)	41 (6.5)
30 - 39	586	140 (23.9)	68 (11.6)	173 (29.5)	0 (0.0)	241 (41.1)
40 - 49	581	174 (29.9)	92 (15.8)	382 (65.7)	0 (0.0)	474 (81.6)
50 - 59	427	220 (51.5)	45 (10.5)	306 (71.7)	3(0.7)	354 (82.9)
≥ 60	246	143 (58.1)	35 (14.2)	146 (59.3)	3 (1.2)	184 (74.8)
Total	3311	889 (26.8)	297 (9.0)	1009 (30.5)	6 (0.2)	1312 (74.8)

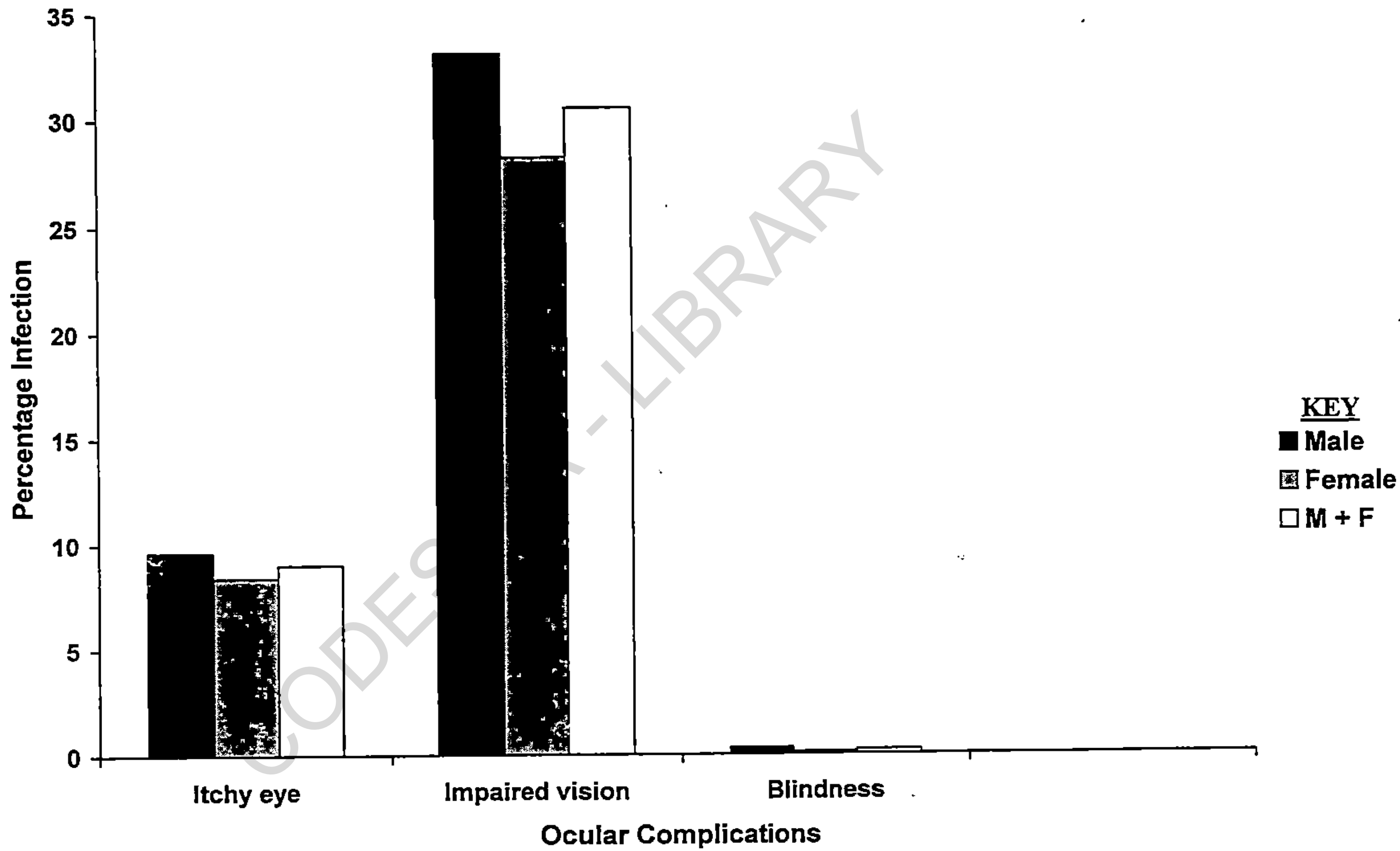


Fig. 19: Sex Distribution of Ocular Signs and Symptons of Onchocerciasis in the Upper Imo River Basin

Table 26: Distribution of Signs and Symptoms of Non-classical Onchocerciasis in the Upper Imo River Basin

Community	No examined	No(%) infected	No (%) with Non-classical Onchocerciasis: Musculoskeletal pain	General debility	Epilepsy	Dwarfism	Total no (%) with Non-classical onchocersiasis
Umulolo	945	340(36.0)	254(26.9)	137(14.5)	11(1.2)	0(0.0)	402(42.5)
Aku	342	95(27.8)	179(52.3)	113(33.0)	3(0.9)	0(0.0)	295(86.3)
Amuro	105	36(34.3)	43(40.9)	37(35.2)	0(0.0)	0(0.0)	80(76.2)
Ndiokoro	78	16(20.5)	24(30.8)	18(23.1)	0(0.0)	0(0.0)	42(53.8)
Umule	71	3(4.2)	5(7.0)	34(47.9)	0(0.0)	0(0.0)	39(54.9)
Ihube	134	21(15.7)	34(25.4)	54(40.3)	2(1.5)	0(0.0)	90(67.2)
Umuezegem	63	7(11.1)	13(20.6)	17(27.0)	0(0.0)	0(0.0)	30(47.6)
Amanchara	81	5(6.2)	18(22.2)	11(13.6)	0(0.0)	0(0.0)	29(35.8)
Umulewe	43	11(25.6)	11(25.6)	7(16.3)	0(0.0)	0(0.0)	18(41.9)
Okanachi	61	3(4.9)	12(19.7)	19(31.1)	1(1.6)	0(0.0)	32(52.5)
Agbobu	51	7(13.7)	9(17.6)	21(14.2)	0(0.0)	0(0.0)	30 (58.8)
Ajabo	237	67 (28.3)	43 (18.1)	51 (21.5)	3 (1.3)	0 (0.0)	97 (40.9)
Uhiowerre	246	76 (30.9)	41 (16.7)	38 (15.4)	0 (0.0)	0 (0.0)	79 (32.1)
Okwe	178	42 (23.6)	32 (18.0)	36 (20.2)	1 (0.0)	0 (0.0)	69 (38.8)
Isieke	232	61 (25.2)	45 (18.6)	29 (12.0)	0 (0.9)	0 (0.0)	74 (30.6)
Okwelle	221	48 (21.7)	17 (7.7)	41 (18.6)	2 (0.9)	0 (0.0)	60 (27.1)
Ezelu-Okwe	213	51 (23.9)	28 (13.3)	43 (20.2)	1 (0.5)	0 (0.0)	72 (33.8)
Total	3311	889 (26.8)	808 (24.4)	706 (21.3)	24 (0.7)	0 (0.0)	1538 (46.5)

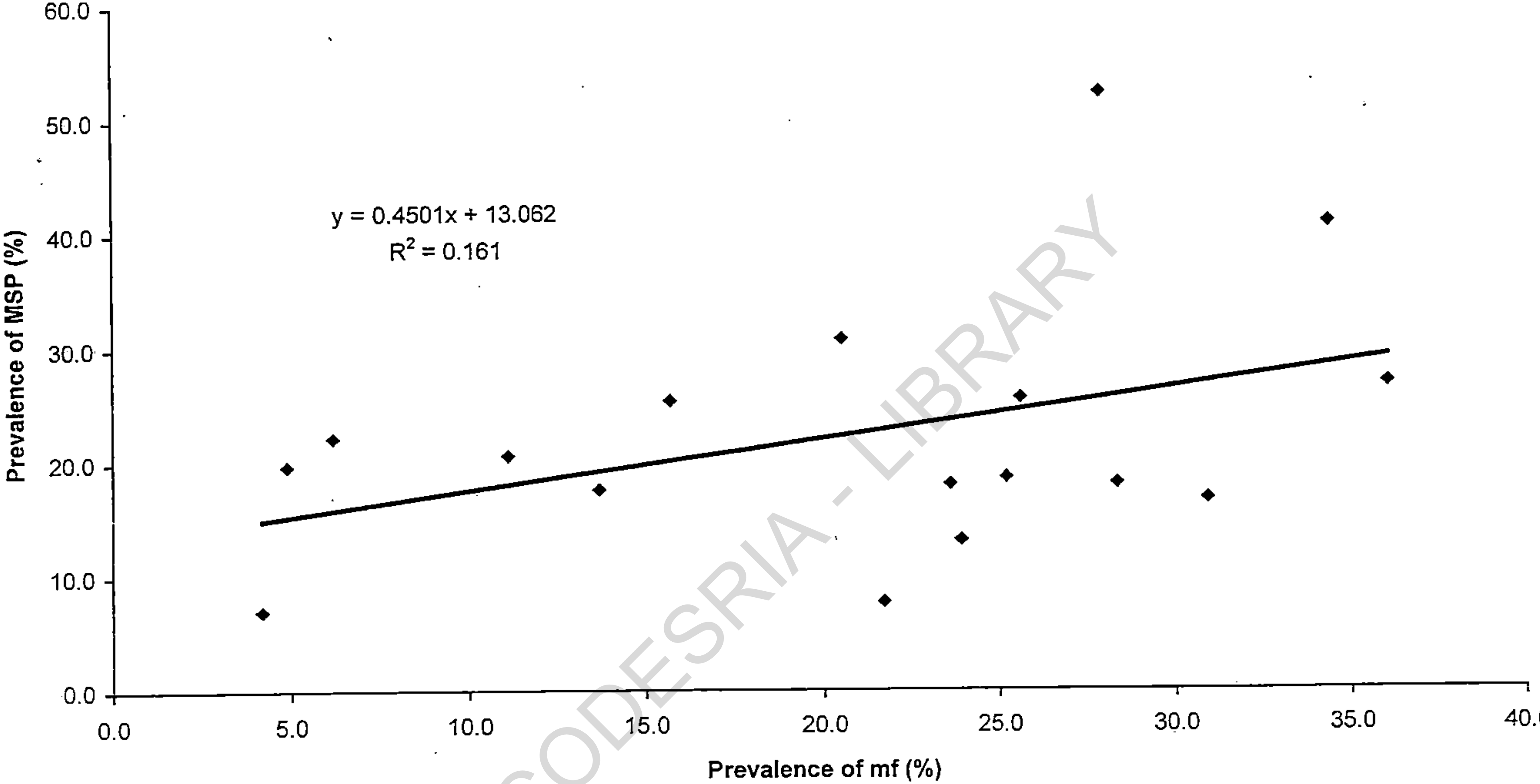


Fig. 20a: Relationship Between Prevalence of Onchocerciasis and Musculoskeletal Pain (MSP) in the Upper Imo River Basin

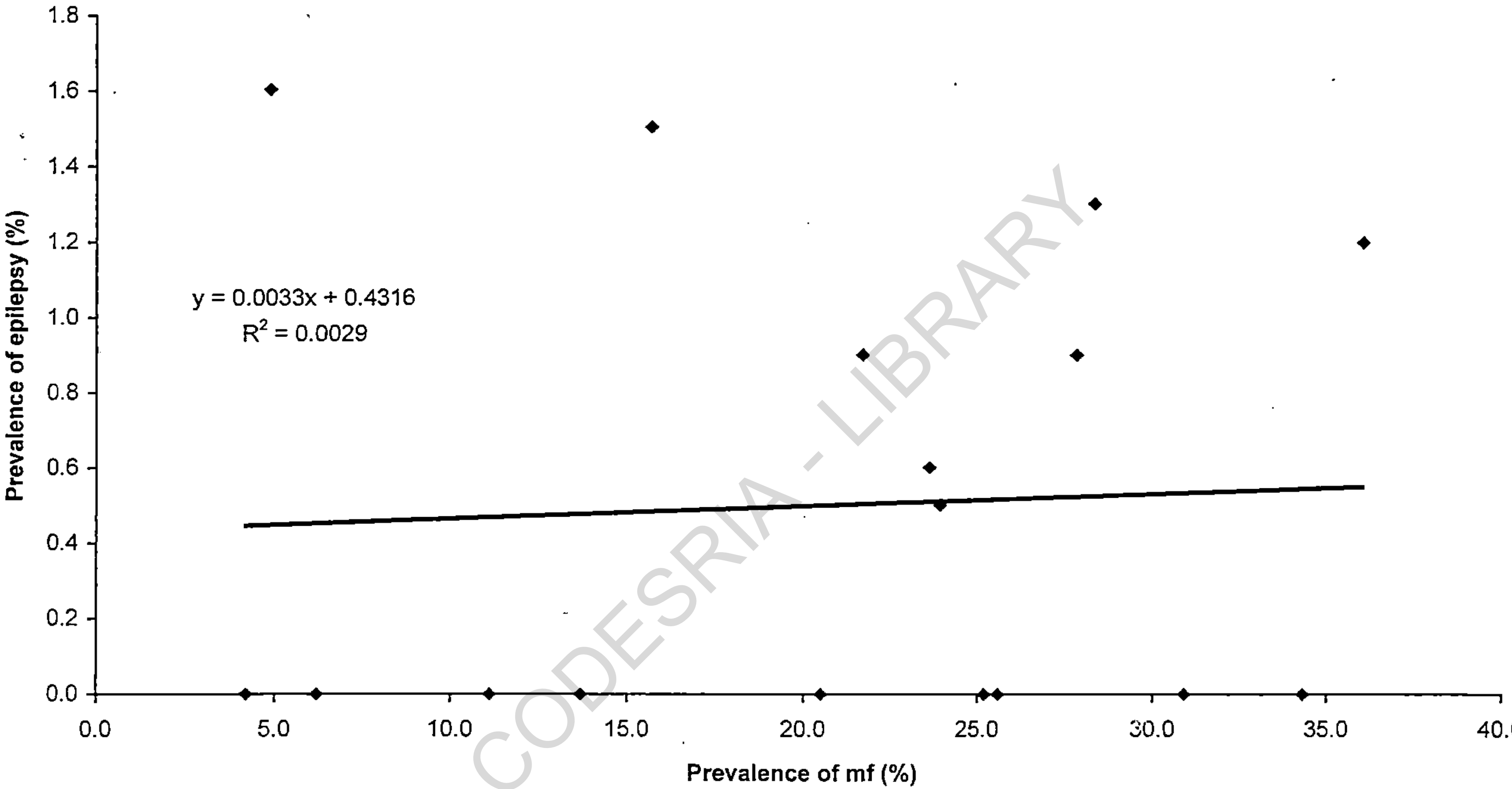


Fig. 20b: Relationship Between Prevalence of Onchocerciasis and Epilepsy in the Upper Imo River Basin

Table 27: Age-specific Distribution of Signs and Symptoms of Non-classical Onchocerciasis in the Upper Imo River Basin

Age (years)	No examined	No(%) infected	No (%) with Non-classical Onchocerciasis				
			Musculoskeletal pain	General debility	Epilepsy	Dwarfism	Total no (%) with Non-classical Onchocerciasis
< 5	74	2 (2.7)	0 (0.0)	3 (4.1)	0 (0.0)	0 (0.0)	3 (4.1)
5 - 9	289	29 (10.0)	0 (0.0)	30 (10.4)	0 (0.0)	0 (0.0)	30 (10.4)
10 - 19	478	71 (14.9)	14 (2.9)	48 (10.0)	2 (0.4)	0 (0.0)	64 (13.4)
20 - 29	630	110 (17.5)	95 (15.1)	97 (15.4)	6 (1.0)	0 (0.0)	198 (31.4)
30 - 39	586	140 (23.9)	186 (31.7)	52 (8.9)	4 (0.7)	0 (0.0)	242 (41.3)
40 - 49	581	174 (29.9)	263 (45.3)	172 (29.6)	12 (2.1)	0 (0.0)	447 (76.9)
50 - 59	427	220 (51.5)	191 (44.7)	126 (29.5)	0 (0.0)	0 (0.0)	317 (74.2)
≥ 60	246	143 (58.1)	59 (24.0)	78 (31.7)	0 (0.0)	0 (0.0)	137 (55.7)
Total	3311	889 (26.8)	808 (24.4)	706 (21.3)	24 (0.7)	0 (0 .0)	1538 (46.5)

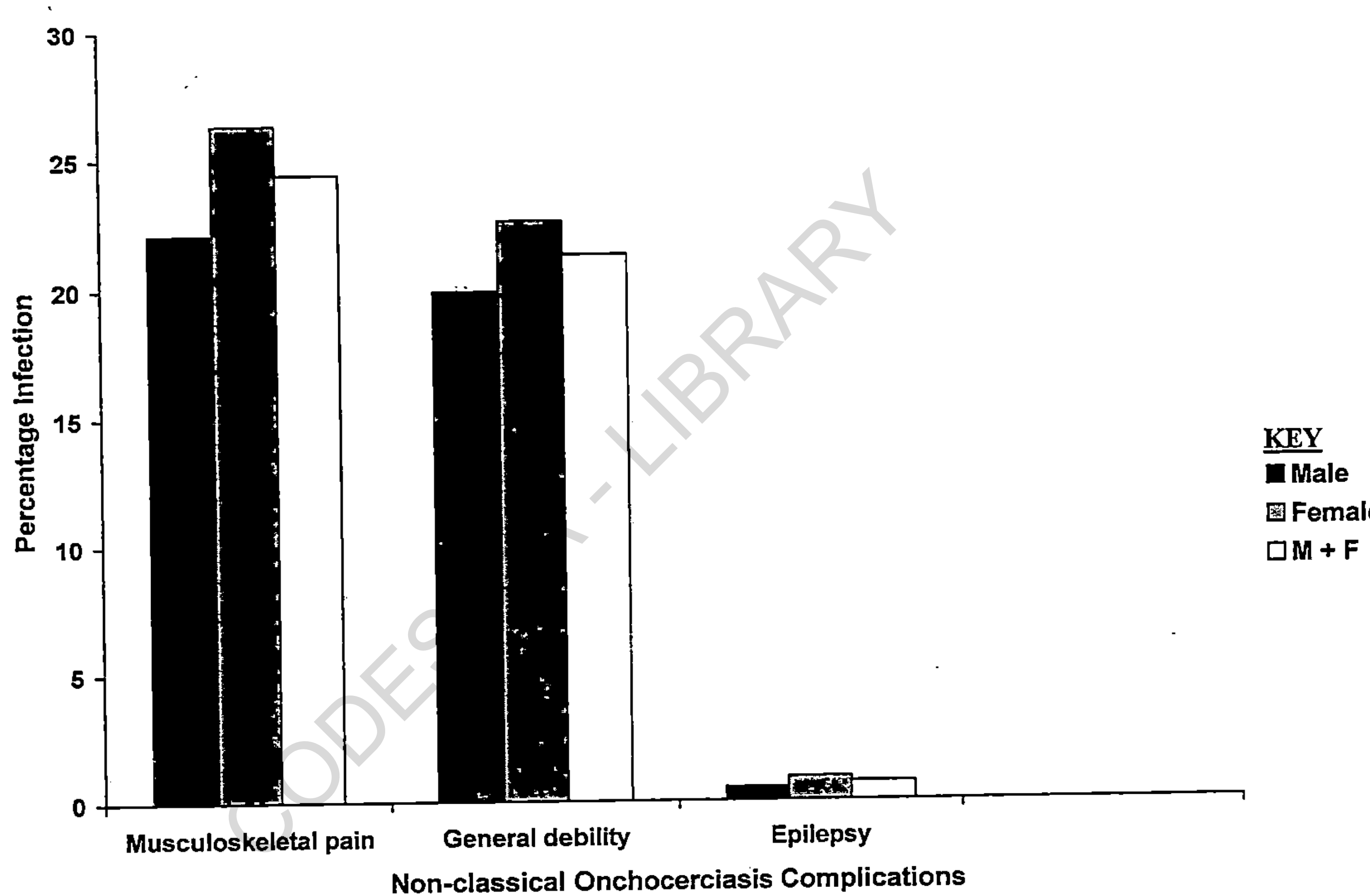


Fig. 21: Sex Distribution of Signs and Symptoms of Non-classical Onchocerciasis in the Imo River Basin

Table 28: Prevalence of Onchocerciasis in the Middle Imo River Basin.

Community	No examined	No and (%) infected with *O. volvulus* mf	No and (%) uninfected with *O. volvulus* mf
Umukabia	186	23 (12.4)	163 (87.6)
Nzerem	174	53 (30.5)	121 (69.5)
Ezeoke	181	49 (27.1)	132 (72.9)
Umuoma	198	33 (16.7)	165 (83.3)
Ikpem	221	71 (32.1)	150 (67.9)
Umuopara	216	17 (7.9)	199 (92.1)
Umuduru	164	25 (15.2)	139 (84.8)
Ikperejere	247	43 (17.4)	204 (82.6)
Umuzi	213	40 (18.8)	173 (81.2)
Umueze	189	54 (28.6)	135 (71.4)
Umunumu	193	39 (20.2)	154 (79.8)
Umukara	180	27 (15.0)	153 (85.0)
Umuawuchi	228	68 (29.8)	160 (70.2)
Amanyi Ukwu	169	31 (18.3)	138 (81.7)
Umumgwa	192	41 (21.4)	151 (78.6)
Amanze	185	33 (17.8)	152 (82.2)
Okwuohia	197	19 (9.6)	178 (90.4)
Umuoke	173	27 (15.6)	146 (84.4)
Ehume	164	21 (12.8)	143 (87.2)
Amuzi	189	24 (12.7)	165 (87.3
Umunachi	178	28 (15.7)	150 (84.3)
Total	4037	766 (19.0)	3271 (81.0)

Table 29: Sex-specific Prevalence of Onchocerciasis in the Middle Imo River Basin

Community	No examined	No and (%) infected	Male		Female	
			No examined	No and (%) infected	No examined	No and (%) infected
Umukabia	186	23 (12.4)	97	17 (17.5)	89	6 (6.7)
Nzerem	174	53 (30.5)	83	32 (38.6)	91	21 (23.1)
Ezeoke	181	49 (27.1	108	31 (28.7)	73	18 (24.7)
Umuoma	198	33 (16.7)	113	19 (16.8)	85	14 (16.5)
Ikpem	221	71 (32.1)	125	38 (30.4)	96	33 (34.4)
Umuopara	216	17 (7.9)	119	13 (10.9)	97	4 (4.1)
Umuduru	164	25 (15.2)	88	14 (15.9)	76	11 (14.5)
Ikperejere	247	43 (17.4)	143	27 (18.9)	104	16 (15.4)
Umuzi	213	40 (18.8)	129	23 (17.8)	84	17 (20.2)
Umueze	189	54 (28.6)	117	31 (26.8)	72	23 (31.9)
Umunumu	193	39 (20.2)	106	26 (24.5)	87	13 (14.9)
Umukara	180	27 (15.0)	97	14 (14.4)	83	13 (15.7)
Umuawuchi	228	68 (29.8)	123	42 (34.1)	105	26 (24.8)
Amanyi Ukwu	169	31 (18.3)	83	17 (20.5)	86	14 (16.3)
Umungwa	192	41 (21.4)	105	25 (23.8)	87	16 (18.4)
Amanze	185	33 (17.8)	113	21 (18.6)	72	12 (16.7)
Okwuohia	197	19 (9.6)	99	11 (11.1)	98	8 (8.2)
Umuoke	173	27 (15.6)	93	15 (16.1)	80	12 (15.0)
Ehume	164	21 (12.8)	80	8 (10.0)	84	13 (15.5)
Amuzi	189	24 (12.7)	118	13 (11.0)	71	11 (15.5)
Umunachi	178	28 (15.7)	91	16 (17.6)	87	12 (13.8)
Total	4037	766 (19.0)	2230	453 (20.3)	1807	313 (17.3)

Table 30 shows the age-specific prevalence of onchocerciasis. The pattern of infection increased with age from 5.4% in persons below 5 years of age to 48.7% in those aged 60 years and above.

The distribution of onchocerciasis in relation to occupation is presented in Table 31. Infection varied amongst the various groups with farmers (29.8%), fishermen (23.9%) and traders (20.3%) scoring the highest, followed by hunters (17.6%), civil servants (16.4%), pupils/students (12.1%), indoor/sedentary workers (10.2%) while pre-school pupils scored the lowest (5.4%).

Intensity Of infection

Table 32 shows the intensity of infection in skin snip positive persons in the Middle Imo River Basin. Seventy percent of the persons examined had low skin mf count (1-25mf/ss), 26.1% had moderate skin mf count (26-50mf/ss) while 3.9% had high skin mf count (51 – 100mf/ss). No count of 100mf/ss and more was recorded in the area. The community microfilarial density varied amongst the communities with the highest 32.2mf/ss and 32.1mf/ss at Umueze and Umuawuchi respectively and the lowest 6.6mf/ss at Amuzi. Five communities had CMFD of between 20-29mf/ss. An overall CMFD of 18.1mf/ss was obtained in the area. The intensity of infection showed a good relationship with the distribution of onchocerciasis in the area ($r = 0.45$; $P < 0.043$) (Fig.22). Fig 23 reveals that the intensity of infection increased with age from 7.4mf/ss in persons below 5 years of age to 36.7mf/ss in those 60 years and above.

Table 33 shows that farmers amongst other occupational groups had the most intense infection (48.8mf/ss), followed by fishermen (28.0mf/ss), pupils/students (23.6mf/ss) and hunters (21.5mf/ss). The least intense infection was recorded in pre-school pupils (4.9mf/ss). Traders, indoor/sedentary workers and civil servants had infection intensities of 16.0mf/ss, 15.8mf/ss and 13.1mf/ss respectively. Generally, the prevalence of onchocerciasis was strongly correlated with the intensity of infections amongst the different occupation groups ($r = 0.84$; $P < 0.009$) (Fig. 24).

Clinical manifestations

Onchocercal lesions

Table 34 summarizes the distribution of onchocercal lesions in communities in the Middle Imo River Basin. Overall, onchocercal lesion was obtained in all the communities investigated with a total of 2190 (54.2%) persons being positive. Ikpem had the highest prevalence (93. 2%) while Umuzi and Umukara had the lowest prevalence each scoring 27.2%. Besides Ikpem, 10 other communities had prevalence rates of 50% and above. The most encountered lesions was nodules (15.5%), followed by itching (13.5%) and DPM (8.5%) while the least was LOD (1.6%). A total prevalence of 25.3% was obtained for all forms of OSD while the reactive ones gave a prevalences of 13.3%. Generally, the prevalences of onchocerciasis in the area were strongly correlated with presence of nodules ($r = 0.66$; $P < 0.001$) (Fig. 25a) and depigmention ($r = 0.54$; $P < 0.001$) Fig. 25b).

Table 35 shows the age – specific distribution of onchocercal lesions in the area. The prevalence of lesions was associated with different age groups and increased with advancing age from 5.3% in persons in the 1st decade to a peak 78.9% in persons in the 7th decade. The sex distribution reveals that all the various forms of onchocercal lesions as encountered in the study area were more prevalent in females than in males (Fig. 26).

Lymphatic complications

The distribution of lymphatic complications of onchocerciasis is presented in Table 36. Three hundred and forty seven (8.6%) persons had lymphatic complications. Ikpem and Umuawuchi recorded the highest prevalences, 22.2% and 21.9% respectively, while the lowest prevalence was obtained in Ehume (1.8%). Four communities had prevalence rates of between 10 – 19% and these include Nzerem (13.8%), Umungwa (13.5%), Umuoke (12.1%) and Umueze (11.1%). The most common complications were hernia (3.9%) and L,pathy (2.5%), while the least common was Lym (limb) (0.5%). Overall, hernia was the only complication recorded in all the communities investigated. There was no case of Lym (breast) associated with onchocerciasis in the area.

The age-specific distribution of lymphatic complication is summarized in Table 37. Overall, lymphatic complications were observed starting from persons in the 2nd decade 1.4% and increased to a peak 24.7% in persons in the 6th decade and dropped to 15.7% in others in the 7th decade and above. Specifically, some complications, hanging groin, Lym (limb) and Lym (genital) were associated with individuals in the 4th decade and above. The various lymphatic complications of onchocerciasis were observed more in males than females, the only exception being Lym (limb) that had a higher prevalence in females (0.8%) than in males 0.3% (Fig 27).

Ocular signs and symptoms

Table 38 summarizes the distributions of ocular signs and symptoms of onchocerciasis. Nine hundred and ninety two (24.6%) persons had ocular signs and symptoms with rates varying in the commuities from the highest in Amanze (45.4%) to the lowest in Amanyi Ukwu (8.3%). Nzerem had a prevalence of 40.2% while rates of between 30-39% were obtained in 5 communities namely Umungwa (39.6%), Ikpem (36.7%), Umunachi (36.0%), Okwuohia (34.0%) and Umuoke (31.2%). Impaired vision (16.5%) and itchy eye (7.9%) were the most prevalent ocular signs and symptoms seen in all the communities. Blindness (0.1%) was the least prevalent ocular lesion observed in only 4 of the 21 communities investigated; namely Ikpem (0.9%), Umueze (0.5%), Umungwa (0.5%) and Amanze (0.5%). The prevalence of *O. volvulus* mf was weakly associated with impaired vision ($r = 0.21$; $P > 0.340$) in the area (Fig 28a) but fairly strongly associated with blindness ($r = 0.49$; $P < 0.022$) (Fig. 28b).

The age-specific distribution of ocular signs and symptoms is presented in Table 39. Overall, no ocular signs and symptoms were recorded in persons 5 years of age and below. The prevalence however, increased from 1.3% in persons between 5-9 years to a peak of 58.0% in persons aged 60 years and above. Specifically, while itchy eye showed a similar pattern of prevalence with the overall age distribution, impaired vision and blindness were more associated with persons in the 4^{th} and 5^{th} decades respectively. The distribution of ocular signs and symptoms by sex reveals a similar prevalence pattern in males and females in the study area. (Fig. 29).

Signs and symptoms of non-classical onchocerciasis

Table 40 shows the distribution of signs and symptoms of non-classical onchocerciasis in the Middle Imo River basin. A total of 1221 (30.2%) persons presented with signs and symptoms of non-classical onchocerciasis. Nzerem (67.8%) had the highest prevalence followed by Ikpem (54.3%), while the lowest prevalence was in Umunumu (9.8%). Communities with prevalence rates of between 40-49% include Umunachi (46.1%), Umungwa (43.8%), Umuawuchi (42.5%) and

Umuoke (42.2%). The commonest signs and symptoms of non-classical onchocerciasis in the area were general debility (18.0%) and musculoskeletal pain (11.9%) while the least common sign was epilepsy (0.3%). There were no dwarfs presenting with onchocercal infection in the area. There was a good association between onchocerciasis and musculoskeletal pain ($r = 0.49$; $P < 0.026$) (Fig. 30a) on one hand and onchocerciasis and epilepsy ($r = 0.47$; $P < 0.029$) (Fig. 30b) on the other. The age-specific distribution of signs and symptoms of non-classical onchocerciasis is summarized in Table 41. Overall persons in all age groups presented with non-classical onchocerciasis with the exceptions of those 5 years of age and below. Similarly, general debility was recorded in all age groups, except in persons 5 years of age and below. Musculoskeletal pain and epilepsy on the other hand were observed in persons from the 20 – 29 year group and above. Generally females presented more with signs and symptoms of non-classical onchocerciasis than males (Fig. 31).

3.2 COMMUNITY KNOWLEDGE AND BELIEFS ON ONCHOCERCIASIS

3.2.1 Characteristic of Respondents

A total of 380 persons made up of 197 males and 183 females (76 persons per study community), aged ≥ 15 years were interviewed with structured questionnaire (Appendix 2) administered by trained field assistants. Of the total respondents, 24.5% were fathers and 23.4% were mothers. Sons and daughters constituted 20.5% and 21.3% respectively. Other respondents interviewed classified as other males and females represented 6.8% and 3.4% respectively (Table 42). The great majority of respondents were farmers (41.8%), followed by artisans and traders (22.6%), while the least respondents were health workers (5.5%). Students and civil servants constituted 18.2% and 11.8% respectively. In terms of

Table 30: Age-specific Prevalence of Onchocerciasis in Imo River Basin

Age (years)	No examined	No and (%) infected	No and (%) uninfected
< 5	130	7 (5.4)	123 (94.6)
5-9	377	26 (6.9)	351 (93.1)
10-19	507	44 (8.7)	463 (91.3)
20-29	608	66 (10.9)	542 (89.1)
30-39	735	85 (11.6)	659 (88.4)
40-49	769	143 (18.6)	626 (81.4)
50-59	523	206 (39.4)	317 (60.6)
≥ 60	388	189 (48.7)	199 (51.3)
Total	4037	766 (19.0)	3271 (81.0)

Table 31: Occupation-related Prevalence of Onchocerciasis in the Middle Imo River Basin

Occupation	No examined	No and (%) infected	No and (%) uninfected
Trader	384	78 (20.3)	306 (79.7)
Farmer	1300	388 (29.8)	912 (70.2)
Fisherman	67	16 (23.9)	51 (76.1)
Hunter	85	15 (17.6)	70 (82.4)
Civil servants	456	75 (16.4)	381 (83.6)
Indoor/sedentary worker	461	47 (10.2)	414 (89.8)
Pupils/students	1154	140 (12.1)	1014 (87.9)
Pre-school pupils	130	7 (5.4)	123 (94.6)
Total	4037	766 (19.0)	3271 (81.0)

Table 32: Density of *O. volvulus* Microfilariae in Skin Snips of Positive Persons in the Middle Imo River Basin

Community	No examined	No and (%) infected with *O. volvulus* mf	No with following no. of mf/skin snip and (mean count)				Community microfilarial density (cmfd)
			1-25	25-50	51-100	>100	
Umukabia	186	23 (12.4)	12 (7.4)	7 (26.2)	4 (58.9)	0 (0.0)	22.1
Nzerem	174	53 (30.5)	38 (10.5)	12 (27.2)	3 (54.8)	0 (0.0)	16.8
Ezeoke	181	49 (27.1)	42 (12.7)	6 (36.4)	1 (70.2)	0 (0.0)	16.8
Umuoma	198	33 (16.7)	21 (15.6)	9 (38.8)	3 (52.1)	0 (0.0)	25.2
Ikpem	221	71 (32.1)	45 (18.4)	24 (28.6)	2 (64.7)	0 (0.0)	23.2
Umuopara	216	17 (7.9)	9 (14.4)	8 (34.1)	0 (0.0)	0 (0.0)	23.7
Umuduru	164	25 (15.2)	17 (16.2)	7 (30.8)	1 (68.6)	0 (0.0)	22.4
Ikperejere	247	43 (17.4)	27 (9.3)	14 (31.8)	2 (62.6)	0 (0.0)	19.1
Umuzi	213	40 (18.8)	33 (12.4)	7 (36.3)	0 (0.0)	0 (0.0)	16.6
Umueze	189	54 (28.6)	21 (17.6)	29 (38.2)	4 (65.6)	0 (0.0)	32.2
Umunumu	193	39 (20.2)	25 (14.2)	13 (28.4)	1 (51.9)	0 (0.0)	19.9
Umukara	180	27 (15.0)	24 (16.3)	3 (34.8)	0 (0.0)	0 (0.0)	18.4
Umuawuchi	228	68 (29.8)	37 (19.9)	26 (42.6)	5 (68.3)	0 (0.0)	32.1
Amanyi Ukwu	169	31 (18.3)	25 (10.2)	5 (27.6)	1 (50.8)	0 (0.0)	14.2
Umumgwa	192	41 (21.4)	27 (6.9)	12 (26.3)	2 (53.2)	0 (0.0)	14.8
Amanze	185	33 (17.8)	31 (5.4)	2 (28.7)	0 (0.0)	0 (0.0)	6.8
Okwuohia	197	19 (9.6)	14 (5.7)	5 (28.4)	0 (0.0)	0 (0.0)	11.7
Umuoke	173	27 (15.6)	24 (4.8)	2 (26.4)	1 (54.5)	0 (0.0)	8.2
Ehume	164	21 (12.8)	19 (5.6)	2 (25.2)	0 (0.0)	0 (0.0)	7.5
Amuzi	189	24 (12.7)	24 (6.6)	0 (0.0)	0 (0.0)	0 (0.0)	6.6
Umunachi	178	28 (15.7)	21 (4.3)	7 (27.4)	0 (0.0)	0 (0.0)	10.1
Total	4037	766 (19.0)	536 (11.3)	300 (31.4)	30 (58.8)	0 (0.0)	18.1

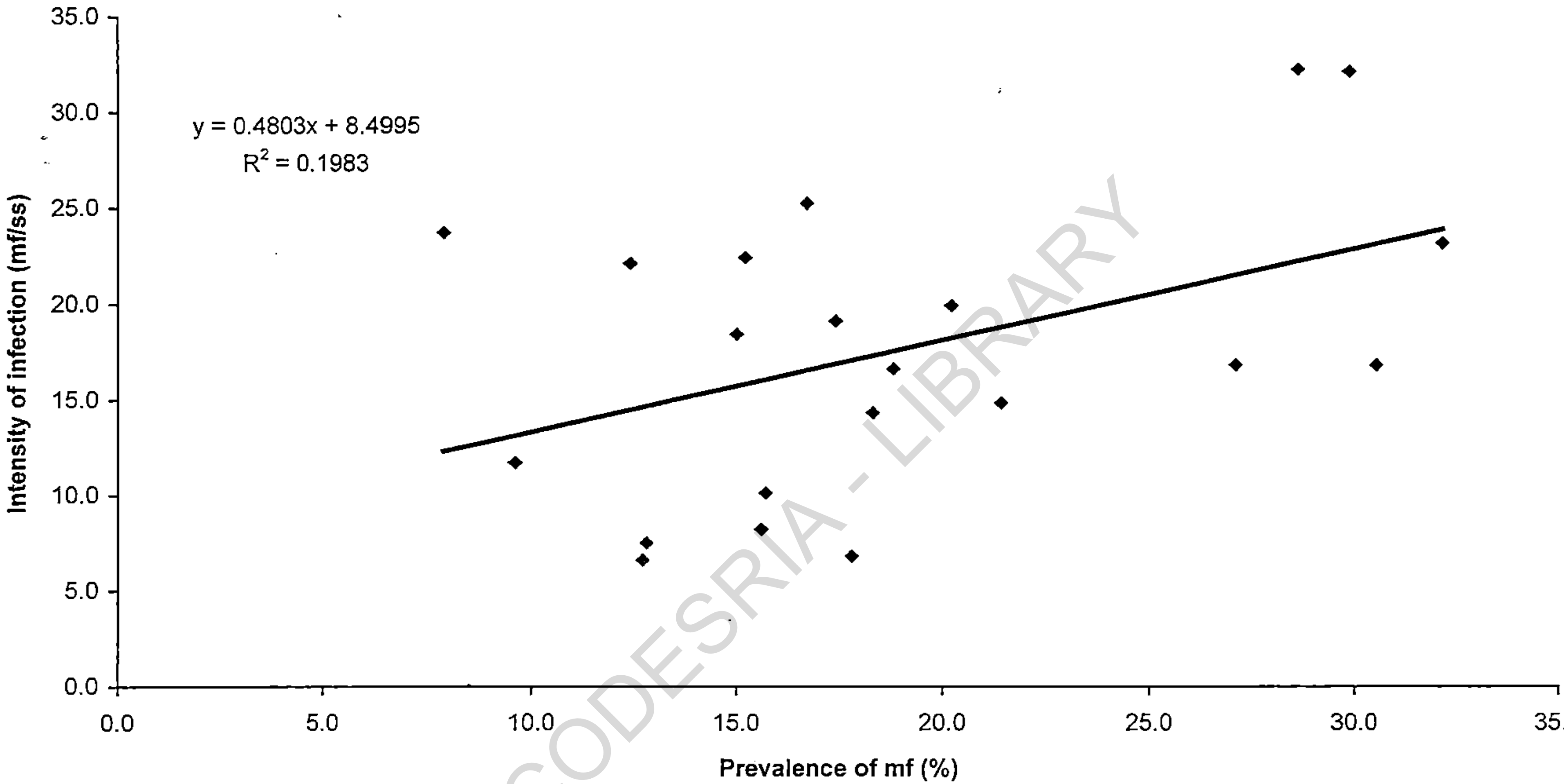


Fig. 22: Relationship Between Prevalence of Onchocerciasis (Measured by Skin mf) and Intensify of Infection (Measured as Microfilarial Density) in the Middle Imo River Basin

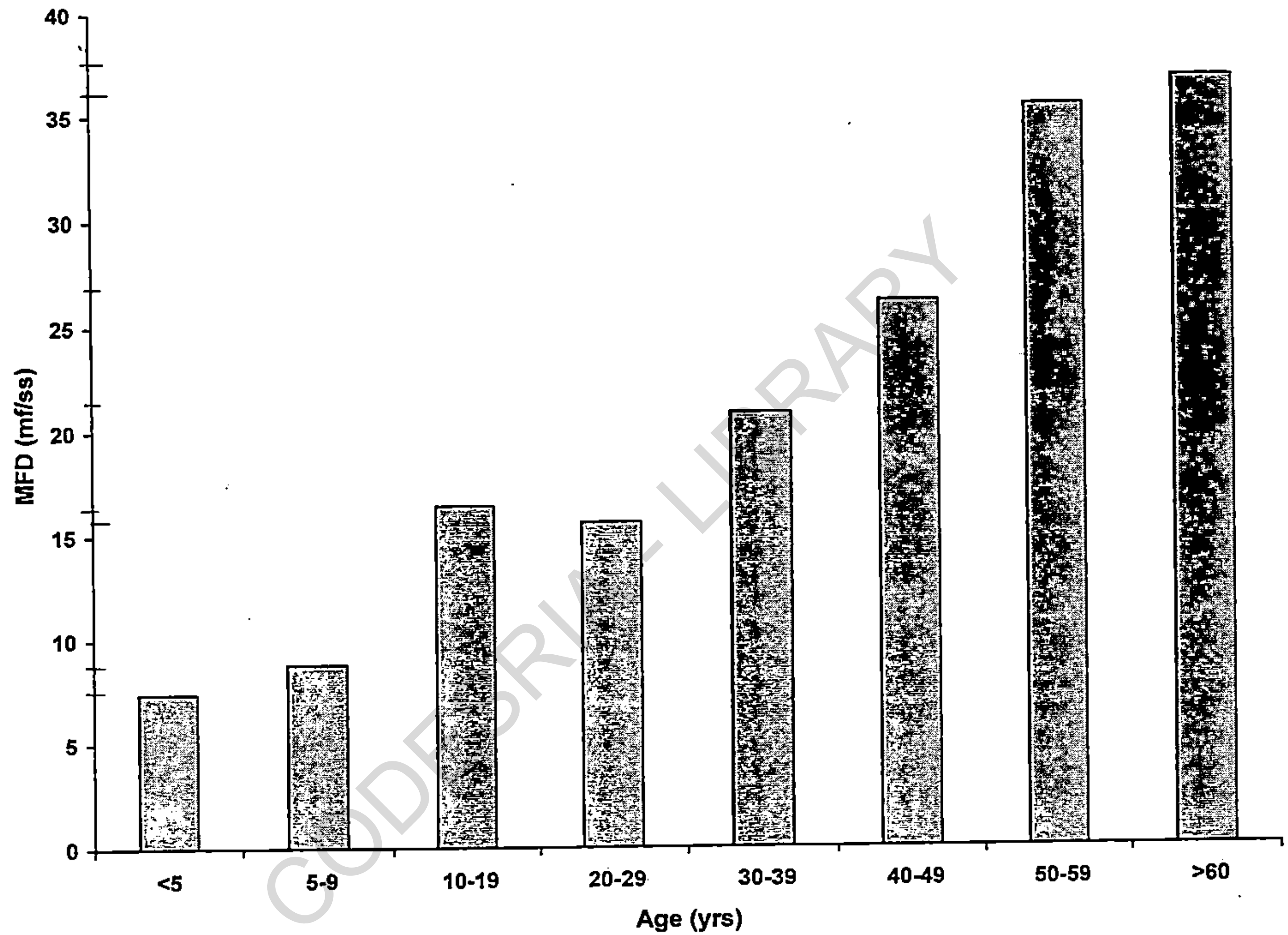


Fig. 23: Age-related Density of *O. volvulus* Microfilariae in Skin Snips of Persons in the Middle Imo River Basin

Table 33: Occupation-related Density of *O. vovulus* Microfilariae in Skin Snips of Positive Person in the Middle Imo River Basin

Occupation	No examined	No and (%) positive for *O. volvulus* mf	Mean microfilatial density (MFD)
Trader	384	78 (20.3)	16.0
Farmer	1300	388 (29.8)	48.8
Fisherman	67	16 (23.9)	28.0
Hunter	85	15 (17.6)	21.5
Civil servants	456	75 (16.4)	13.1
Indoor/sedentary worker	461	47 (10.2)	15.8
Pupils students	1154	140 (12.1)	23.6
Pre-school pupils	130	7 (5.4)	4.6
Total	4037	766 (19.0)	21.5

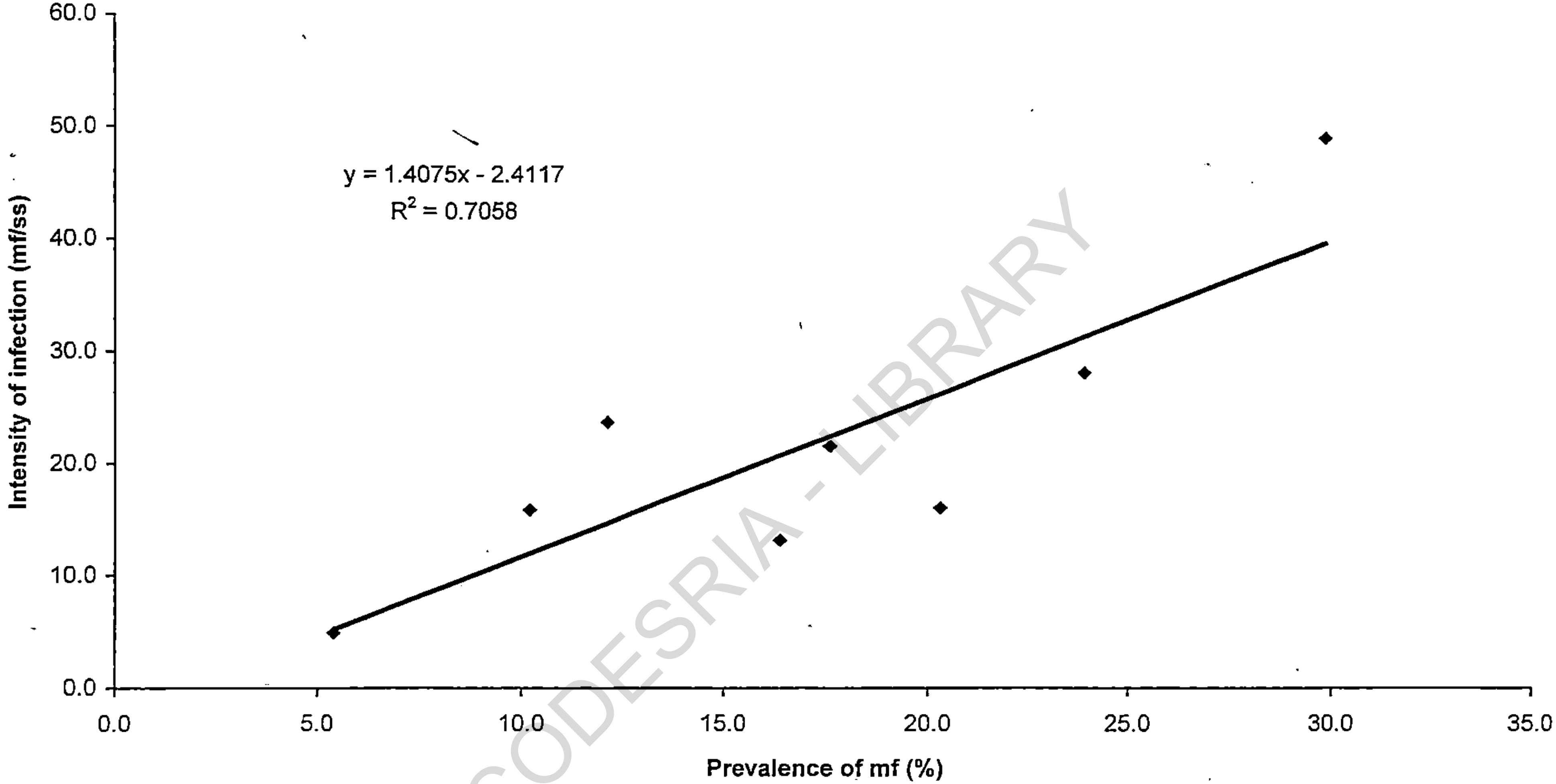


Fig. 24: Relationship Between Prevalence of Onchocerciasis and Intensity of Infection Amongst Different Occupational Groups

Table 34: Distribution of Onchocercal Lesions in the Middle Imo River Basin

Community	No examined	No (%) infected	No (%) with Onchocercal Lesions							Total No (%) with Onchocercal lesions
			Itching	Nodules	APOD	CPOD	LOD	ATR	DPM	
Umukabia	186	23 (12.4)	34 (18.3)	21 (11.3)	9 (4.8)	13 (7.0)	5 (2.7)	9 (4.8)	12 (6.5)	103 (55.4)
Nzerem	174	53 (30.5)	37 (21.3)	45 (25.9)	19 (10.9)	16 (9.2)	9 (5.2)	5 (2.9)	24 (13.8)	155 (89.1)
Ezeoke	181	49 (27.1)	25 (13.8)	29 (16.0)	11 (6.1)	17 (9.4)	3 (1.7)	6 (3.3)	17 (9.4)	108 (59.7)
Umuoma	198	33 (16.7)	18 (9.1)	23 (11.6)	7 (3.5)	9 (4.5)	5 (2.5)	3 (1.5)	9 (4.5)	74 (37.4)
Ikpem	221	71 (32.1)	54 (24.4)	47 (21.3)	34 (15.4)	29 (13.1)	7 (3.2)	14 (6.3)	21 (9.5)	206 (93.2)
Umuopara	216	17 (7.9)	34 (15.7)	34 (15.7)	18 (8.3)	23 (10.6)	5 (2.3)	3 (1.4)	16 (7.4)	133 (61.6)
Umuduru	164	25 (15.2)	28(17.1)	18 (11.0)	8 (4.9)	11 (6.7)	3 (1.8)	7 (4.3)	15 (9.1)	90 (54.9)
Ikperejere	247	43 (17.4)	21 (8.5)	29 (11.7)	7 (2.8)	5 (2.0)	2 (0.8)	9 (3.6)	19 (7.7)	92 (37.2)
Umuzi	213	40 (18.8)	13 (6.1)	22 (10.3)	3 (1.4)	3 (1.4)	0 (0.0)	7 (3.3)	10 (4.7)	58 (27.2)
Umueze	189	54 (28.6)	24 (12.7)	31 (16.4)	9 (1.4)	7 (3.7)	3 (1.6)	7 (3.7)	25 (13.2)	106 (56.1)
Umunumu	193	39 (20.2)	49 (25.4)	27 (14.0)	0 (0.0)	3 (1.6)	1 (0.5)	5 (3.6)	8 (4.1)	93 (48.2)
Umukara	180	27 (15.0)	9 (5.0)	17 (9.4)	0 (0.0)	5 (2.8)	3 (1.7)	3 (1.7)	12 (6.7)	49 (27.2)
Umuawuchi	228	68 (29.8)	18 (7.9)	69 (30.3)	15 (6.6)	12 (5.3)	3 (1.3)	14 (6.1)	47 (20.6)	178 (78.1)
Amanyi Ukwu	169	31 (18.3)	13 (7.7)	25 (14.8)	8 (4.7)	3 (1.8)	2 (1.2)	5 (3.0)	22 (13.0)	78 (46.2)
Umungwa	192	41 (21.4)	44 (22.9)	38 (19.8)	14 (7.3)	17 (8.9)	4 (2.1)	16 (8.3)	18 (9.4)	151 (78.6)
Amanze	185	33 (17.8)	11 (5.6)	23 (11.7)	8 (4.1)	13 (6.6)	0 (0.0)	4 (2.0)	7 (3.6)	66 (33.5)
Okwuohia	197	19 (9.6)	25 (13.5)	31 (16.8)	11 (5.9)	15 (8.1)	4 (2.2)	8 (4.3)	24 (13.0)	118 (63.8)
Umuoke	173	27 (15.6)	27 (15.6)	34 (19.7)	19 (11.0)	11 (6.4)	4 (2.3)	9 (5.2)	13 (7.5)	117 (67.6)
Ehume	164	21 (12.8)	13 (7.9)	17 (10.4)	10 (6.1)	8 (4.9)	0 (0.0)	3 (1.8)	4 (2.4)	55 (33.5)
Amuzi	189	24 (12.7)	27 (14.3)	23 (12.2)	8 (4.2)	11 (5.8)	0 (0.0)	4 (2.1)	8 (4.2)	81 (42.9)
Umunachi	178	28 (15.7)	19 (10.7)	21 (11.8)	9 (5.1)	14 (7.9)	1 (0.6)	4 (2.2)	11 (6.2)	79 (44.4)
Total	4037	766 (19.0)	543 (13.5)	624 (15.5)	227 (5.6)	245 (6.1)	64 (1.6)	145 (3.6)	342 (8.5)	2190 (54.2)

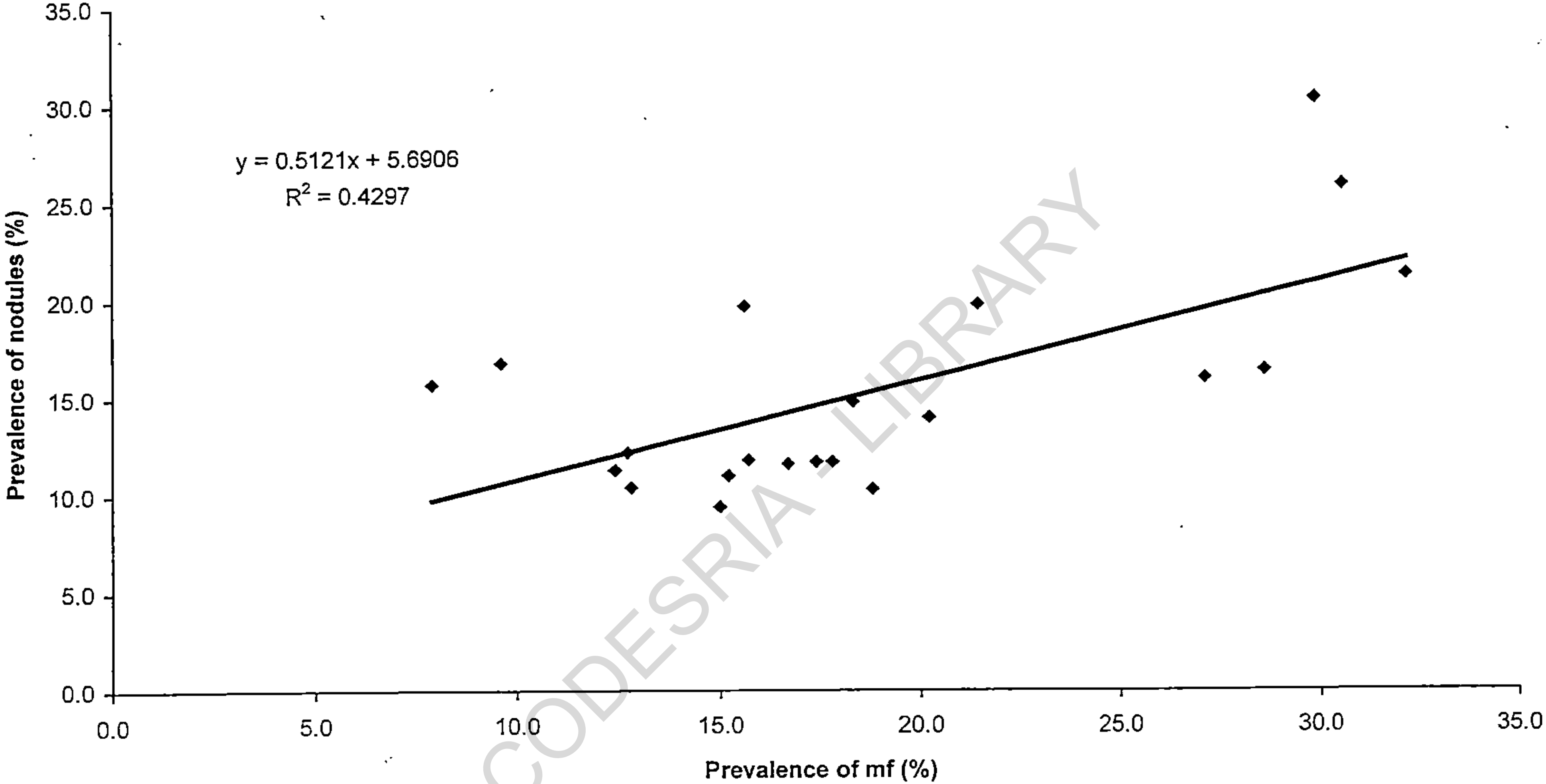


Fig. 25a: Relationship Between Prevalence of Onchocerciasis and Palpable Nodules in the Middle Imo River Basin

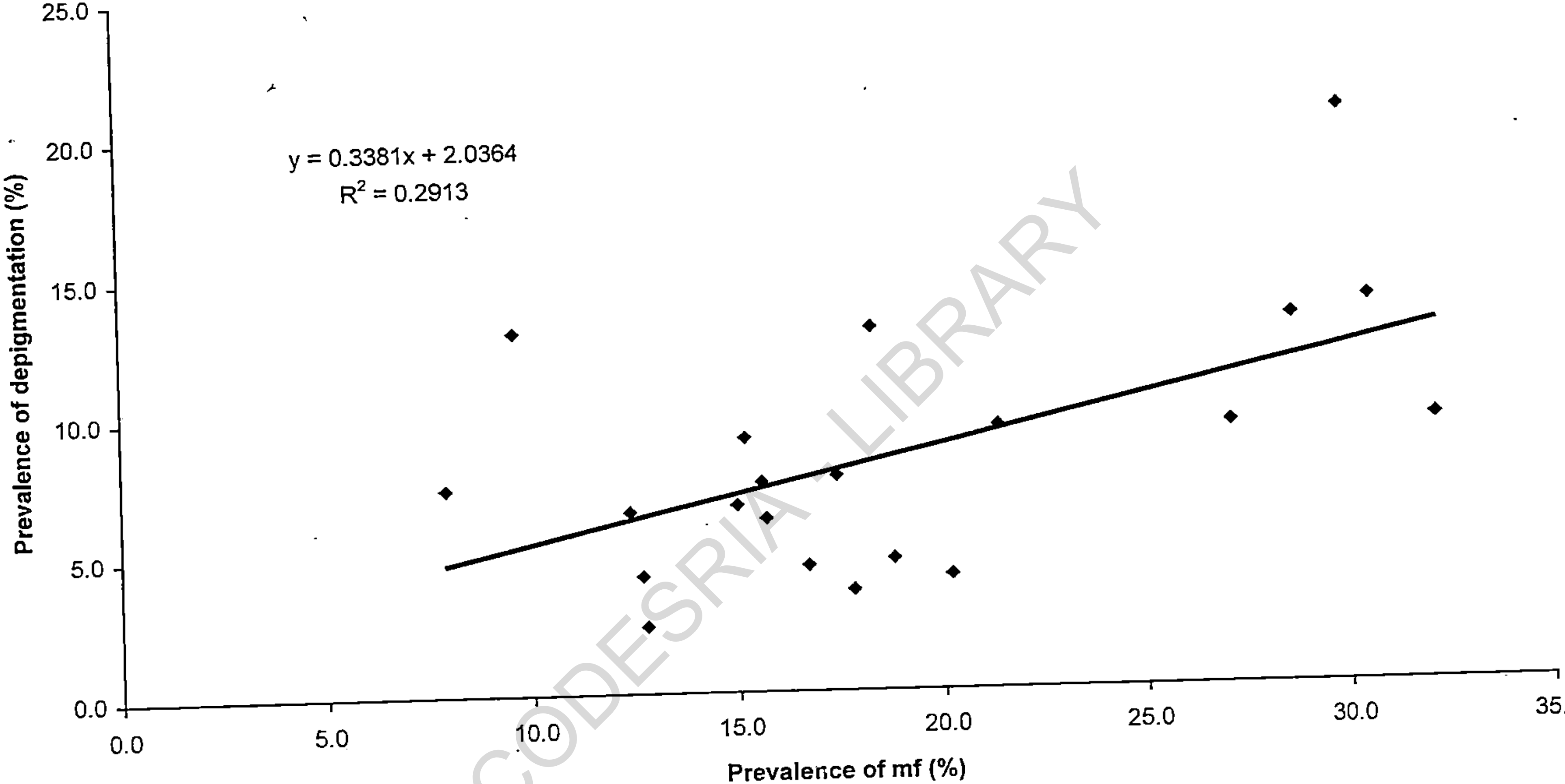


Fig. 25b: Relationship Between Prevalence of Onchocerciasis and Depigmentation in the Upper Imo River Basin

Table 35: Age-specific Distribution of Onchocercal Lesions in the Middle Imo River Basin

Age (years)	No examined	No (%) infected	No (%) with Onchocercal Lesions							Total No (%) with Onchocercal lesions
			Itching	Nodules	APOD	CPOD	LOD	ATR	DPM	
< 5	130	7 (5.4)	0 (0.0)	1 (0.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.8)
5-9	377	26 (6.9)	19 (5.0)	7 (1.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	26 (6.9)
10-19	507	44 (8.7)	41 (8.1)	51 (10.1)	26 (5.1)	11 (2.2)	0 (0.0)	2 (0.4)	0 (0.0)	131 (25.8)
20-29	608	66 (10.9)	81 (13.3)	78 (12.8)	57 (9.4)	38 (6.3)	0 (0.0)	16 (2.6)	8 (1.3)	278 (45.7)
30-39	735	85 (11.6)	124 (16.9)	148 (20.1)	60 (8.2)	55 (7.5)	6 (0.8)	44 (6.0)	43 (5.9)	480 (65.3)
40-49	769	143 (18.6)	136 (17.7)	177 (23.0)	54 (7.0)	52 (6.8)	21 (2.7)	47 (6.1)	86 (11.2)	573 (74.5)
50-59	523	206 (39.4)	71 (13.6)	80 (15.3)	21 (4.0)	46 (8.8)	20 (3.8)	36 (6.9)	121 (23.1)	395 (75.5)
≥ 60	388	189 (48.7)	71 (18.3)	82 (21.1)	9 (23.)	43 (11.1)	17 (4.4)	0 (0.0)	84 (21.6)	306 (78.9)
Total	4037	766 (19.0)	543 (13.5)	624 (15.5)	227 (5.6)	245 (6.1)	64 (1.6)	145 (1.6)	342 (8.5)	2190 (54.2)

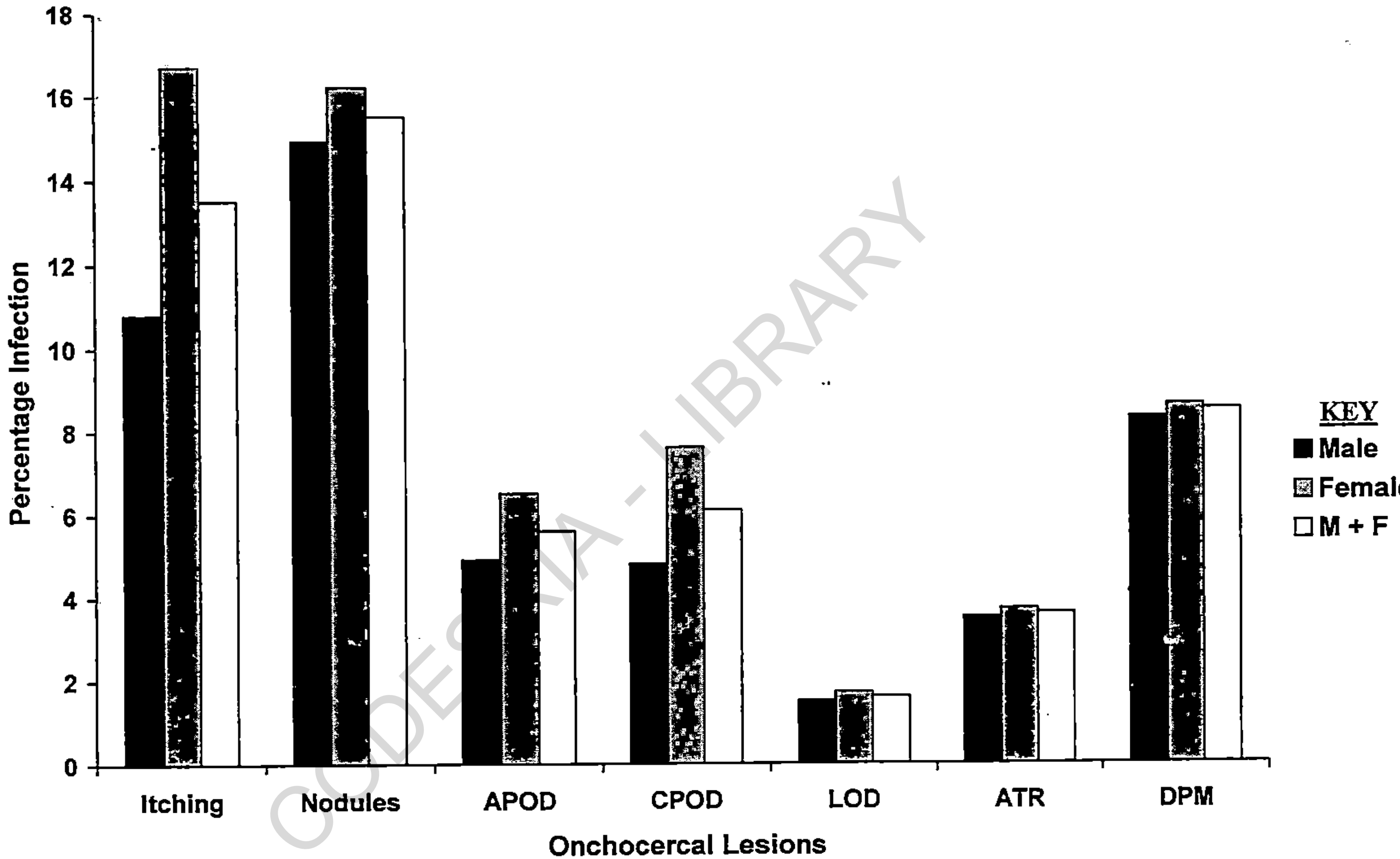


Fig. 26: Sex Distribution of Onchocercal Lesions in the Middle Imo River Basin

Table 36: Distribution of Lymphatic Complications of Onchocerciasis in the Middle Imo River Basin

Community	No examined	No (%) infected	No (%) with Lymphatic complications						Total No. (%) with Lymphatic complications
			L, pathy	Hanging groin	Lym (Limb)	Lym (Genital)	Lym (Breast)	Hernia	
Umukabia	186	23 (12.4)	2 (1.1)	0 (0.0)	0 (0.0)	2 (1.1)	0 (0.0)	12 (6.5)	16 (8.6)
Nzerem	174	53 (30.5)	8 (4.6)	5 (2.9)	3 (1.7)	4 (2.3)	0 (0.0)	4 (2.3)	24 (13.8)
Ezeoke	181	49 (27.1)	4 (2.2)	1 (0.6)	1 (0.6)	0 (0.0)	0 (0.0)	7 (3.9)	13 (7.2)
Umuoma	198	33 (16.7)	4 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	7 (3.5)	11 (5.6)
Ikpem	221	71 (32.1)	11 (5.0)	9 (4.1)	5 (2.3)	9 (4.1)	0 (0.0)	15 (6.8)	49 (22.2)
Umuopara	216	17 (7.9)	2 (0.9)	0 (0.0)	0 (0.0)	1 (0.5)	0 (0.0)	6 (2.8)	9 (4.2)
Umuduru	164	25 (15.2)	0 (0.0)	1 (0.6)	1 (0.6)	0 (0.0)	0 (0.0)	8 (4.9)	10 (6.1)
Ikperejere	247	43 (17.4)	11 (4.5)	1 (0.4)	0 (0.0)	2 (0.8)	0 (0.0)	8 (3.2)	22 (8.9)
Umuzi	213	40 (18.8)	7 (3.3)	0 (0.0)	0 (0.0)	1 (0.5)	0 (0.0)	2 (0.9)	10 (4.7)
Umueze	189	54 (28.6)	9 (4.8)	3 (1.6)	1 (0.5)	2 (1.1)	0 (0.0)	6 (3.2)	21 (11.1)
Umunumu	193	39 (20.2)	1 (0.5)	1 (0.5)	0 (0.0)	1 (0.5)	0 (0.0)	7 (3.6)	10 (5.2)
Umukara	180	27 (15.0)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	4 (2.2)	5 (2.8)
Umuawuchi	228	68 (29.8)	14 (6.1)	7 (3.1)	3 (1.3)	5 (2.2)	0 (0.0)	21 (9.2)	50 (21.9)
Amanyi Ukwu	169	31 (18.3)	4 (2.4)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	4 (2.4)	9 (5.3)
Umungwa	192	41 (21.4)	7 (3.6)	2 (1.0)	3 (1.6)	2 (1.0)	0 (0.0)	12 (6.3)	26 (13.5)
Amanze	185	33 (17.8)	4 (2.2)	0 (0.0)	1 (0.5)	2 (1.1)	0 (0.0)	8 (4.3)	15 (8.1)
Okwuohia	197	19 (9.6)	1 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (2.0)	5 (2.5)
Umuoke	173	27 (15.6)	8 (4.6)	1 (0.6)	1 (0.6)	1 (0.6)	0 (0.0)	10 (5.8)	21 (12.1)
Ehume	164	21 (12.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (1.8)	3 (1.8)
Amuzi	189	24 (12.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	7 (3.7)	7 (3.7)
Umunachi	178	28 (15.7)	5 (2.8)	1 (0.6)	1 (0.6)	0 (0.0)	0 (0.0)	4 (2.2)	11 (6.2)
Total	4037	766 (19.0)	102 (2.5)	32 (0.8)	21 (0.5)	33 (0.8)	0 (0.0	159 (3.9)	347 (8.6)

Table 37: Age-specific Distribution of Lymphatic Complications of Onchocerciasis in the Middle Imo River Basin

Community	No examined	No (%) infected	No (%) with Lymphatic complications						Total No. (%) with Lymphatic complications
			L,pathy	Hanging groin	Lym (Limb)	Lym (Genital)	Lym (Breast)	Hernia	
< 5	130	7 (5.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
5-9	377	26 (6.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
10-19	507	44 (8.7)	4 (0.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (0.6)	7 (1.4)
20-29	608	66 (10.9)	11 (1.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	15 (2.5)	26 (4.3)
30-39	735	85 (11.6)	18 (2.4)	2 (0.3)	2 (0.1)	3 (0.4)	0 (0.0)	15 (2.0)	40 (5.4)
40-49	769	143 (18.6)	21 (2.7)	3 (0.4)	5 (0.7)	10 (1.3)	0 (0.0)	45 (5.9)	84 (10.9)
50-59	523	206 (39.4)	29 (5.5)	19 (3.6)	12 (2.3)	15 (2.9)	0 (0.0)	54 (10.3)	129 (24.7)
≥ 60	388	189 (48.7)	19 (4.9)	8 (2.1)	2 (0.5)	5 (1.3)	0 (0.0)	27 (7.0)	61 (15.7)
Total	4037	766 (19.0)	102 (2.5)	32 (0.8)	21 (0.5)	33 (0.8)	0 (0.0)	159 (3.9)	347 (8.6)

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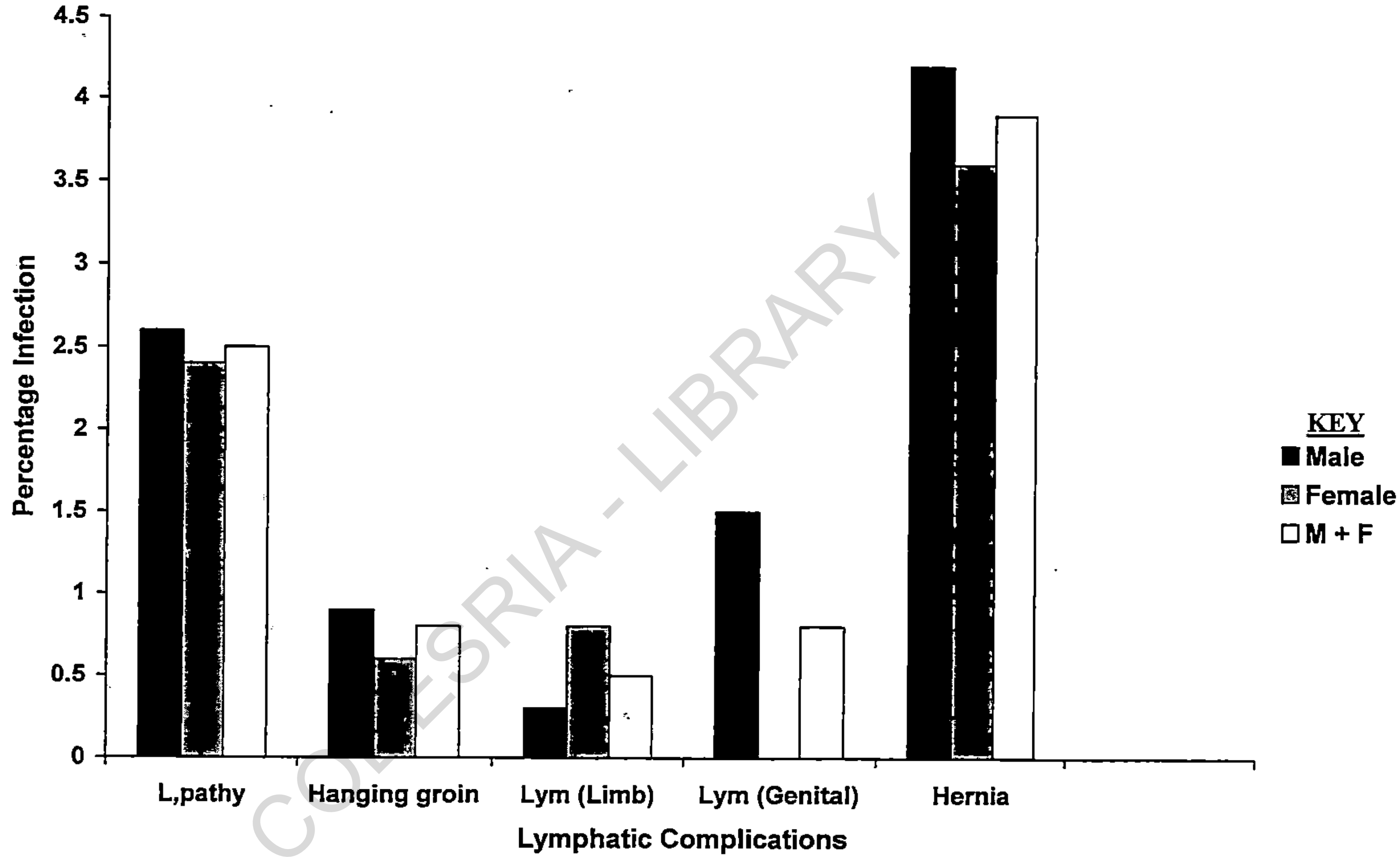

Fig. 27: Sex Distribution of Lymphatic Complications of Onchocerciasis in the Middle Imo River Basin

Table 38: Distribution of Ocular Signs and Symptoms of Onchocerciasis in the Middle Imo River Basin

Community	No examined	No and (%) infected	No (%) with ocular signs and symptoms			Total No (%) with ocular signs and symptoms
			Itchy eye	Impaired vision	Blindness	
Umukabia	186	23 (12.4)	18 (9.7)	34 (18.3)	0 (0.0)	52 (28.0)
Nzerem	174	53 (30.5)	32 (18.4)	38 (21.8)	0 (0.0)	70 (40.2)
Ezeoke	181	49 (27.1)	21 (11.6)	31 (17.1)	0 (0.0)	52 (28.7)
Umuoma	198	33 (16.7)	9 (4.5)	14 (7.1)	0 (0.0)	23 (11.6)
Ikpem	221	71 (32.1)	28 (12.7)	53 (24.0)	2 (0.9)	81 (36.7)
Umuopara	216	17 (7.9)	14 (6.5)	27 (12.5)	0 (0.0)	41 (19.0)
Umuduru	164	25 (15.2)	11 (6.7)	24 (14.6)	0 (0.0)	35 (21.3)
Ikperejere	247	43 (17.4)	12 (4.9)	38 (15.4)	0 (0.0)	50 (20.2)
Umuzi	213	40 (18.8)	5 (2.3)	19 (8.9)	0 (0.0)	24 (11.3)
Umueze	189	54 (28.6)	9 (4.8)	25 (13.2)	1 (0.5)	35 (18.8)
Umunumu	193	39 (20.2)	3 (1.6)	14 (7.3)	0 (0.0)	17 (8.8)
Umukara	180	27 (15.0)	7 (3.9)	9 (5.0)	0 (0.0)	16 (8.9)
Umuawuchi	228	68 (29.8)	16 (7.0)	46 (20.2)	0 (0.0)	62 (27.2)
Amanyi Ukwu	169	31 (18.3)	3 (1.8)	11 (6.5)	0 (0.0)	14 (8.3)
Umungwa	192	41 (21.4)	19 (9.9)	56 (26.2)	1(0.5)	76 (39.6)
Amanze	185	33 (17.8)	35 (18.9)	48 (25.9)	1 (0.5)	84 (45.4)
Okwuohia	197	19 (9.6)	26 (13.2)	14 (20.8)	0 (0.0)	67 (34.0)
Umuoke	173	27 (15.6)	20 (11.6)	34 (19.7)	0 (0.0)	54 (31.2)
Ehume	164	21 (12.8)	7 (4.3)	31 (18.9)	0 (0.0)	38 (23.2)
Amuzi	189	24 (12.7)	11 (5.8)	23 (12.2)	0 (0.0)	34 (18.0)
Umunachi	178	28 (15.7)	14 (7.9)	50 (28.1)	0 (0.0)	64 (36.0)
Total	4037	766 (19.0)	320 (7.9)	666 (16.5)	6 (0.1)	992 (24.6)

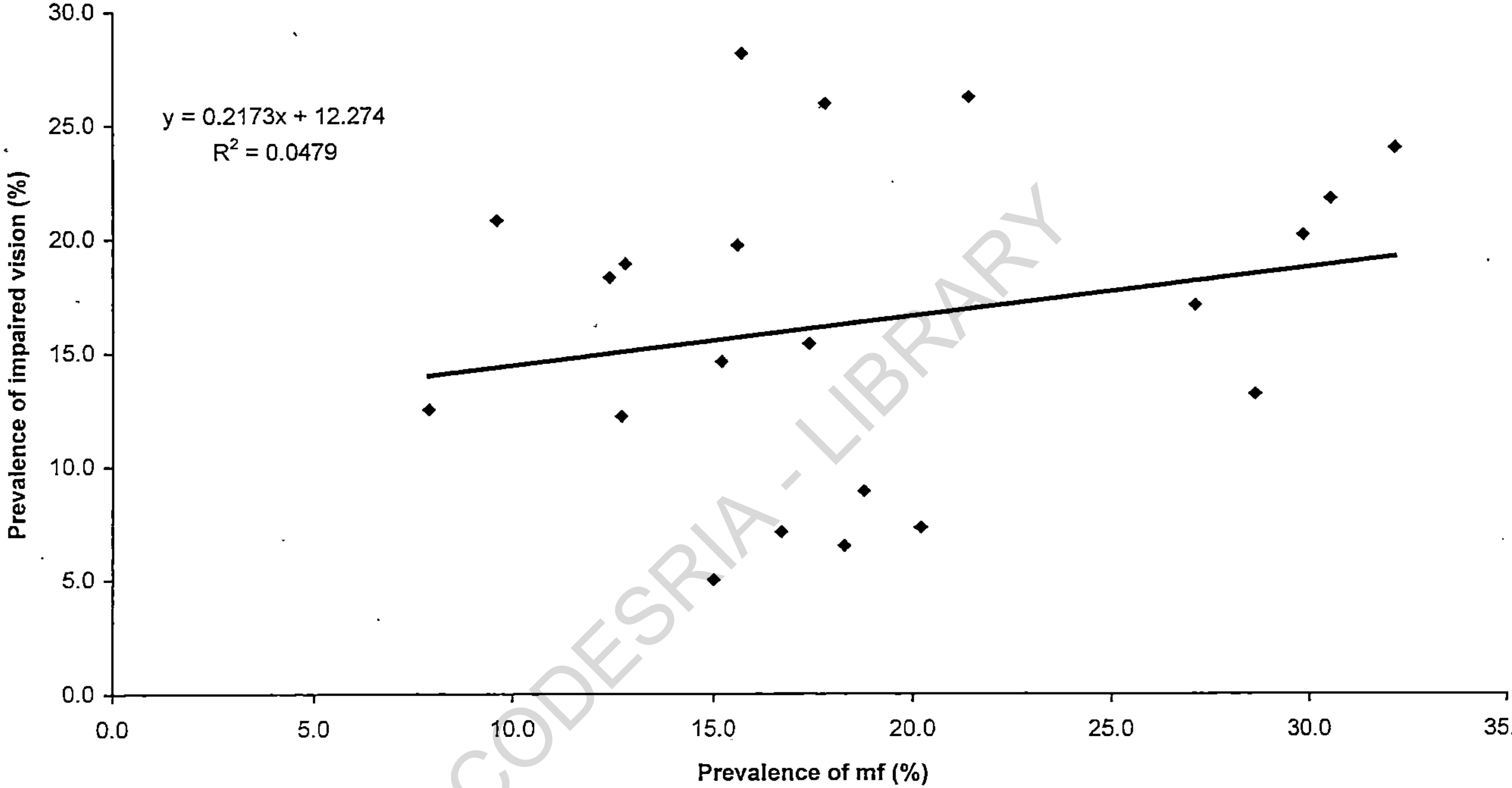

Fig. 28a: Relationship Between Prevalence of Onchocerciasis and Impaired Vision in the Middle Imo River Basin

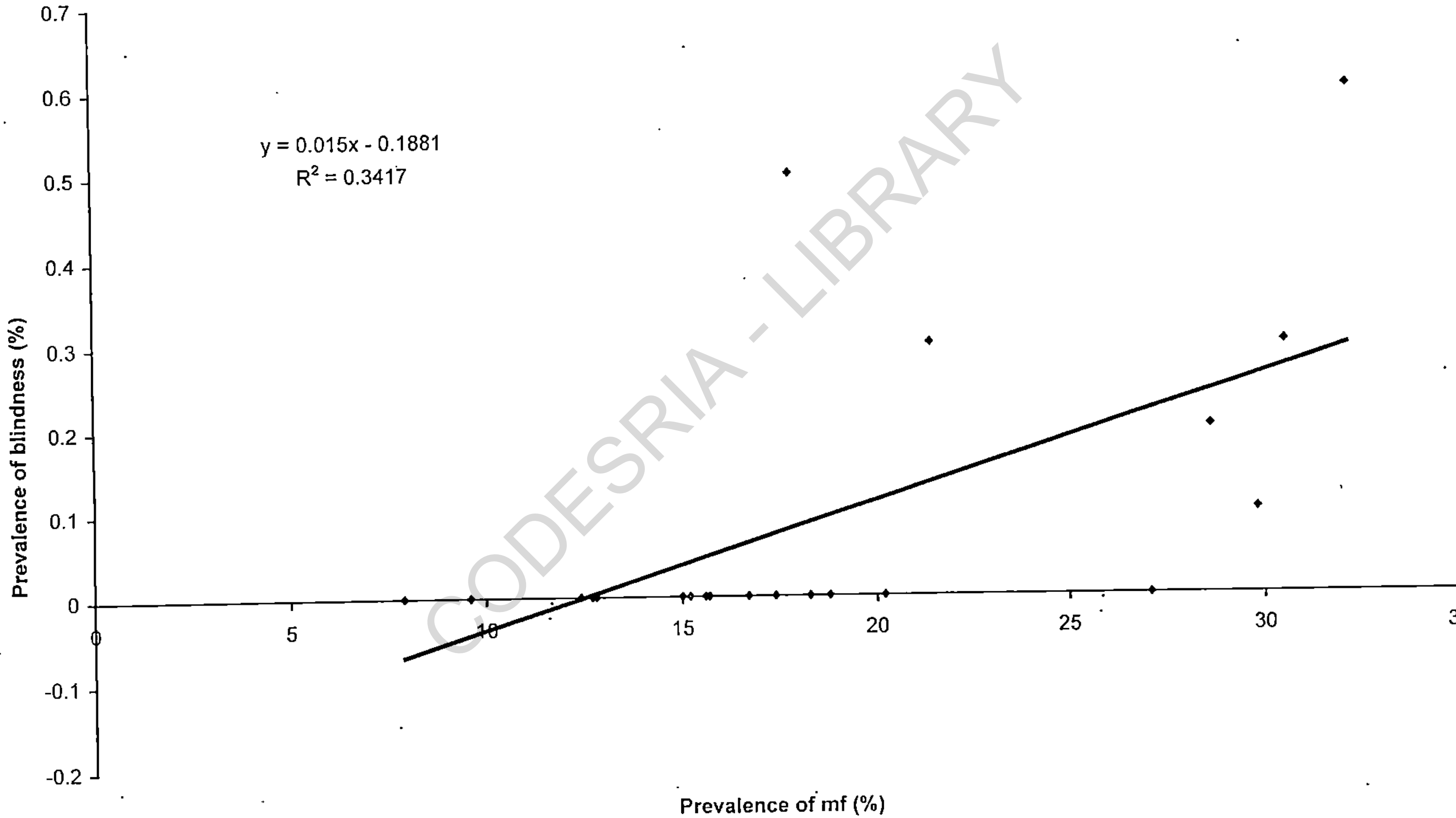

Fig.28b: Relationship Between Prevalence of Onchocerciasis and Blindness in the Middle Imo River Basin

Table 39: Age-specific Distribution of Ocular Signs and Symptoms of Onchocerciasis in the Middle Imo River Basin

Age (years)	No examined	No (%) infected	No (%) with Ocular Signs and Symptoms			
			Itchy eye	Impaired vision	Blindness	Total No. (%) with Ocular Signs and Symptoms
< 5	130	7 (5.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
5-9	377	26 (6.9)	5 (1.3)	0 (0.0)	0 (0.0)	5 (1.3)
10-19	507	44 (8.7)	21 (4.1)	0 (0.0)	0 (0.0)	21 (4.1)
20-29	608	66 (10.9)	37 (6.1)	0 (0.0)	0 (0.0)	37 (6.1)
30-39	735	85 (11.6)	54 (7.4)	127 (17.3)	0 (0.0)	181 (24.6)
40-49	769	143 (18.6)	66 (8.6)	158 (20.5)	1 (0.1)	224 (29.1)
50-59	523	206 (39.4)	78 (14.9)	218 (41.7)	2 (0.4)	298 (57.0)
≥ 60	388	189 (48.7)	59 (15.2	163 (42.0)	3 (0.8)	225 (58.0)
Total	4037	766 (19.0)	320 (7.9)	666 (16.5)	6 (0.1)	992 (24.6)

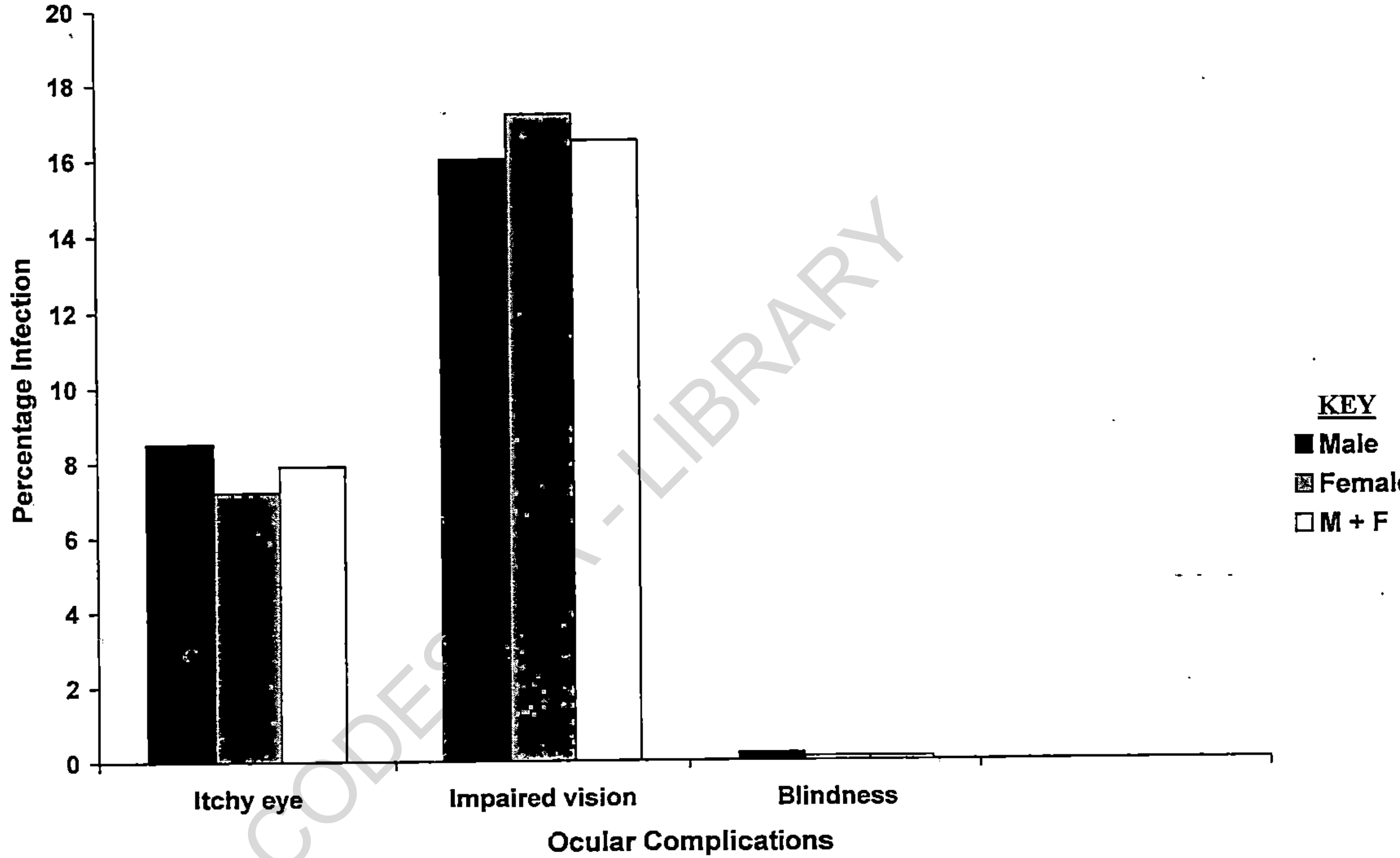

Fig. 29: Sex Distribution of Ocular Signs and Symptoms of Onchocerciasis in the Middle Imo River Basin

Table 40: Distribution of Signs and Symptoms of Non-classical Onchocerciasis in the Middle Imo River Basin

Community	No examined	No (%) infected	No (%) with non-classical Onchocerciasis				Total No (%) with non-classical Onchocerciasis
			Musculoskeletal Pain	General Debility	Epilepsy	Dwarfism	
Umukabia	186	23 (12.4)	17 (9.1)	38 (20.4)	0 (0.0)	0 (0.0)	55 (29.6)
Nzerem	174	53 (30.5)	54 (31.0)	64 (36.8)	0 (0.0)	0 (0.0)	118 (67.8)
Ezeoke	181	49 (27.1)	9 (5.0)	18 (9.9)	0 (0.0)	0 (0.0)	27 (14.9)
Umuoma	198	33 (16.7)	12 (6.1)	27 (13.6)	0 (0.0)	0 (0.0)	39 (19.7)
Ikpem	221	71 (32.1)	38 (17.2)	79 (35.7)	3 (1.4)	0 (0.0)	120 (54.3)
Umuopara	216	17 (7.9)	16 (7.4)	21 (9.7)	1 (0.5)	0 (0.0)	38 (17.6)
Umuduru	164	25 (15.2)	23 (14.0)	28 (17.1)	0 (0.0)	0 (0.0)	51 (31.1)
Ikperejere	247	43 (17.4)	23 (9.3)	21 (8.5)	0 (0.0)	0 (0.0)	44 (17.8)
Umuzi	213	40 (18.8)	9 (4.2)	17 (8.0)	0 (0.0)	0 (0.0)	26 (12.2)
Umueze	189	54 (28.6)	28 (14.8)	34 (18.0)	1 (0.5)	0 (0.0)	63 (33.3)
Umunumu	193	39 (20.2)	11 (5.7)	8 (4.1)	0 (0.0)	0 (0.0)	19 (9.8)
Umukara	180	27 (15.0)	14 (7.8)	14 (7.8)	0 (0.0)	0 (0.0)	28 (15.6)
Umuawuchi	228	68 (29.8)	45 (19.7)	48 (21.1)	4 (1.8)	0 (0.0)	97 (42.5)
Amanyi Ukwu	169	31 (18.3)	6 (3.6)	19 (11.2)	0 (0.0)	0 (0.0)	25 (14.8)
Umungwa	192	41 (21.4)	39 (20.3)	43 (22.4)	2 (1.0)	0 (0.0)	84 (43.8)
Amanze	185	33 (17.8)	21 (11.4)	51 (27.6)	1 (0.5)	0 (0.0)	73 (42.2)
Okwuohia	197	19 (9.6)	18 (9.1)	41 (20.8)	0 (0.0)	0 (0.0)	59 (29.9)
Umuoke	173	27 (15.6)	24 (13.9)	49 (28.3)	0 (0.0)	0 (0.0)	73 (39.5)
Ehume	164	21 (12.8)	13 (7.9)	27 (16.5)	0 (0.0)	0 (0.0)	40 (24.4)
Amuzi	189	24 (12.7)	27 (14.3)	33 (17.5)	0 (0.0)	0 (0.0)	60 (31.7)
Umunachi	178	28 (15.7)	35 (19.7)	45 (25.3)	2 (1.1)	0 (0.0)	82 (46.1)
Total	4037	766 (19.0)	482 (11.9)	725 (18.0)	14 (0.3)	0 (0.0)	1221 (30.2)

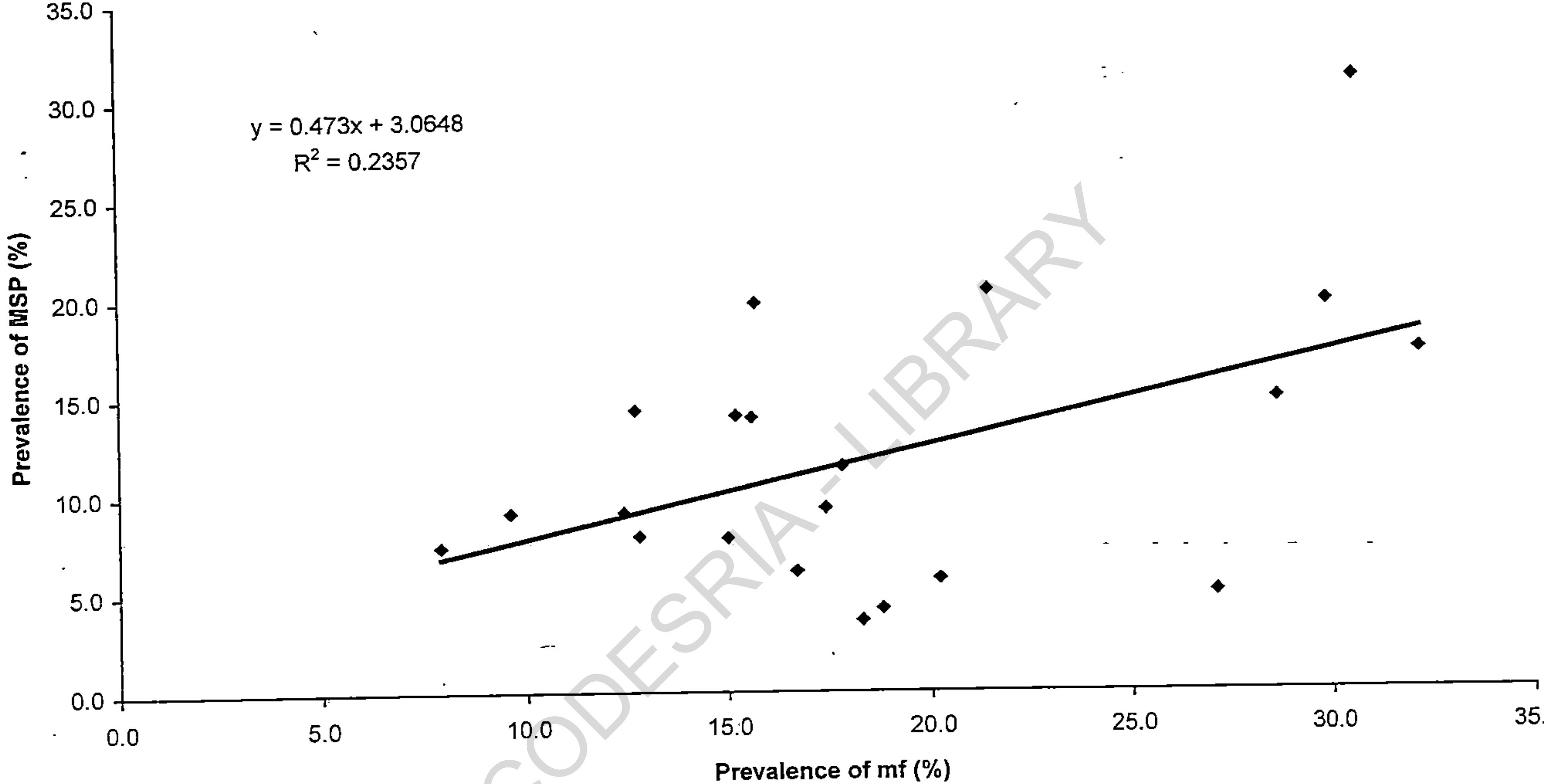

Fig. 30a: Relationship Between Prevalence of Onchocerciasis and Musculoskeletal Pain in the Middle Imo River Basin

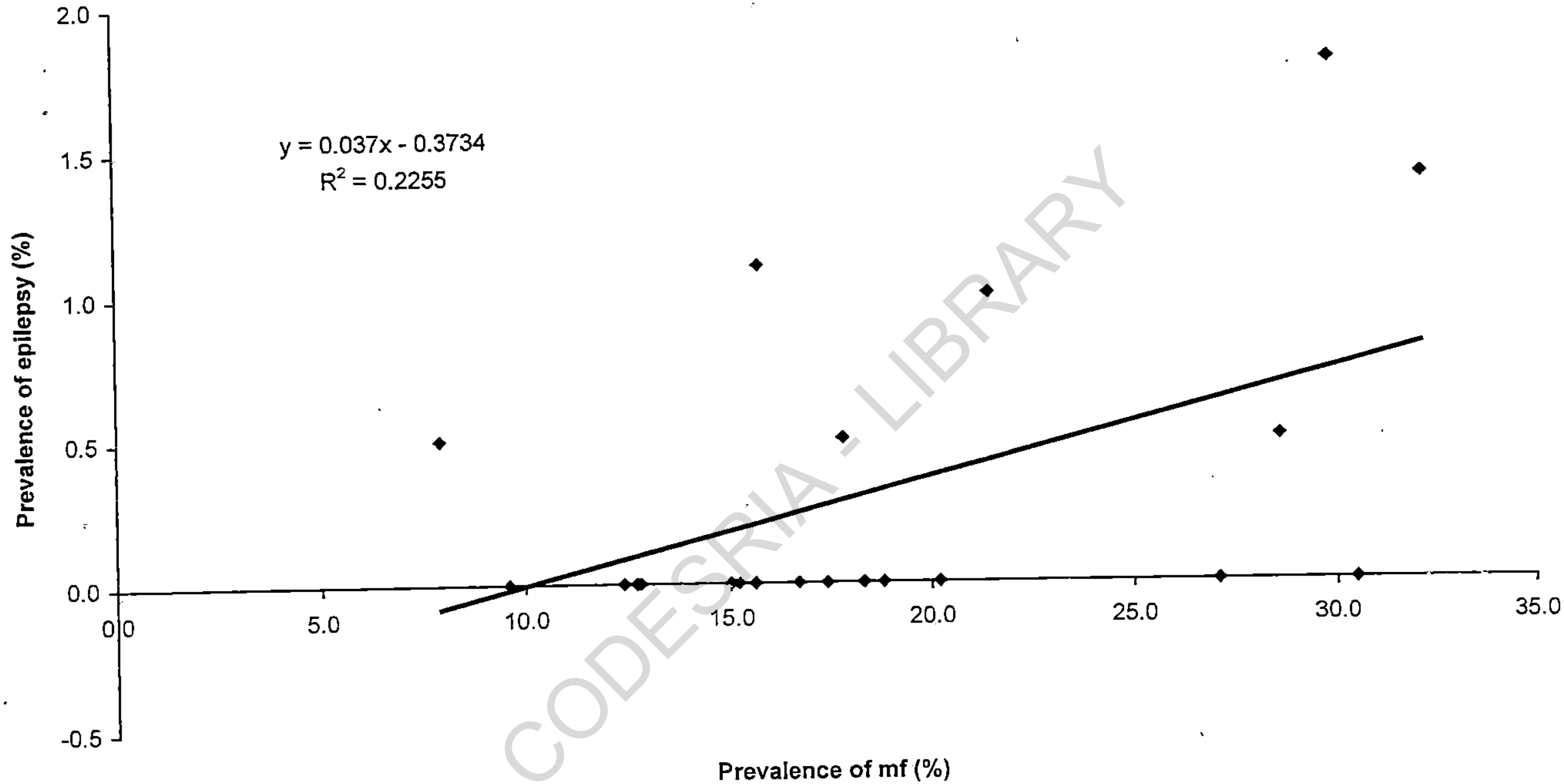

Fig. 30b: Relationship Between Prevalence of Onchocerciasis and Epilepsy in the Middle Imo River Basin

Table 41: Age-specific Distribution of Signs and Symptoms of Non-classical Onchocerciasis in the Middle Imo River Basin

Age (years)	No examined	No (%) infected	No (%) with non-classical Onchocerciasis				Total No (%) with non-classical Onchocerciasis
			Musculoskeletal Pain	General Debility	Epilepsy	Dwarfism	
< 5	130	7 (5.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
5-9	377	26 (6.9)	0 (0.0)	28 (7.4)	0 (0.0)	0 (0.0)	28 (7.4)
10-19	507	44 (8.7)	0 (0.0)	67 (13.2)	0 (0.0)	0 (0.0)	67 (13.2)
20-29	608	66 (10.9)	48 (7.9)	93 (15.3)	2 (0.3)	0 (0.0)	143 (23.5)
30-39	735	85 (11.6)	102 (13.9)	126 (17.1)	4 (0.5)	0 (0.0)	232 (31.6)
40-49	769	143 (18.6)	102 (13.3)	132 (17.2)	7 (0.9)	0 (0.0)	241 (31.3)
50-59	523	206 (39.4)	142 (27.2)	149 (28.5)	1 (0.2)	0 (0.0)	292. (55.8)
≥ 60	388	189 (48.7)	88 (22.7)	130 (33.5)	0 (0.0)	0 (0.0)	218 (56.2)
Total	4037	766 (19.0)	482 (11.9)	725 (18.0)	14 (0.3)	0 (0.0)	122 (30.2)

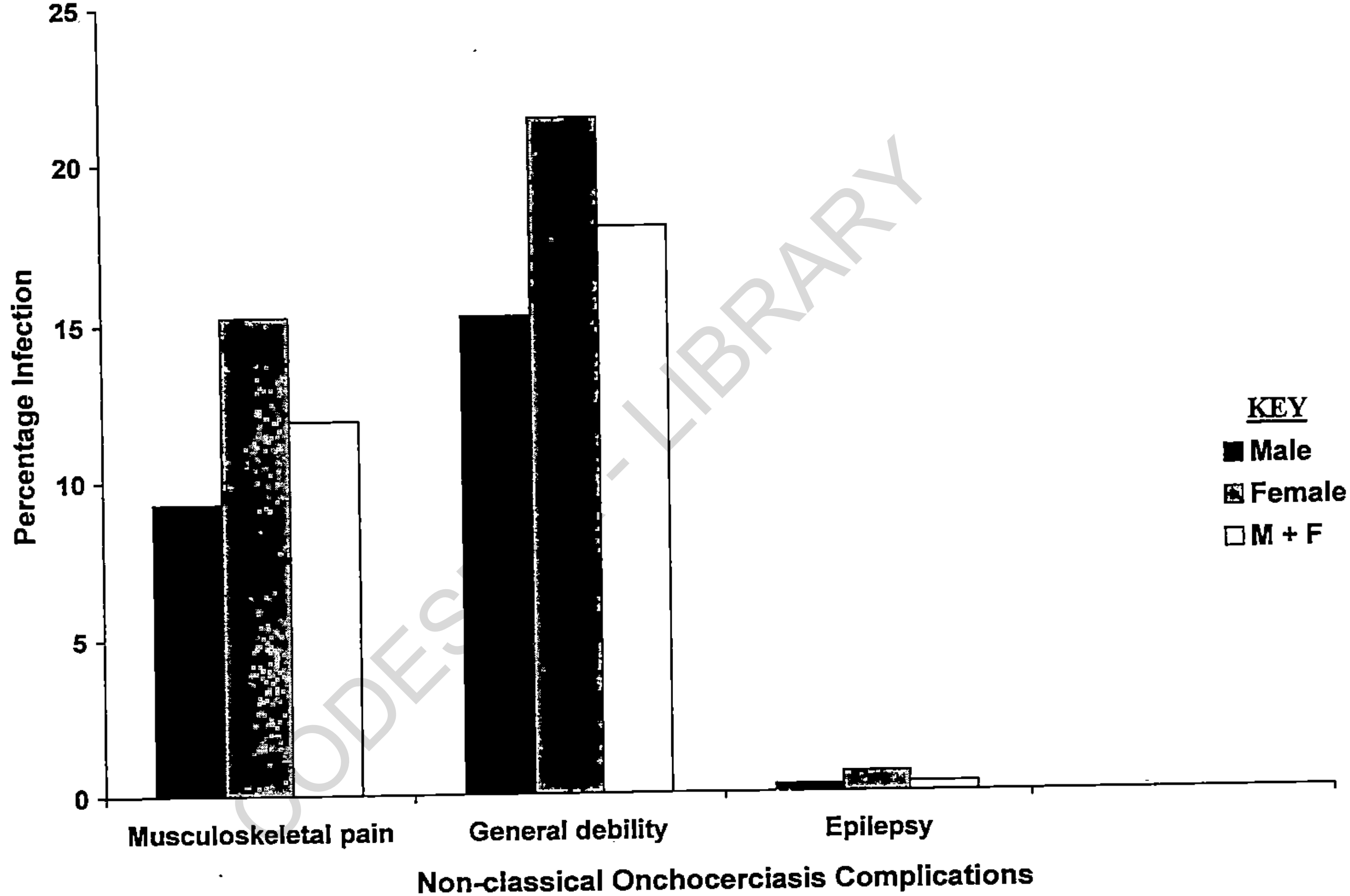

Fig. 31: Sex Distribution of Signs and Symptoms of Non-classical Onchocerciasis in the Middle Imo River Basin

Table 42: Characteristics of Respondents

Respondent Type	Average Age (yrs)	No (%) of respondents	Occupation					Education			
			I	II	III	IV	V	O°	1°	2°	3°
Father	47.2	93(24.5)	31	48	7	24	0	46	34	8	5
Mother	43.5	89(23.4)	27	53	12	7	0	73	11	4	1
Son	23.5	78(20.5)	12	11	0	2	35	26	27	23	2
Daughter	20.8	81(21.3)	5	7	1	0	29	51	24	6	0
Other (male)	32.4	26(6.8)	8	24	0	9	5	18	4	3	1
Other (female)	29.7	13(3.4)	3	16	1	3	0	7	4	2	0
		380	86	159	21	45	69	221	104	46	9
		%	(22.6)	(41.8)	(5.5)	(11.8)	(18.2)	(58.2)	(27.4)	(12.1)	(2.4)

KEY:

I.	Artisans & Traders	0° No education
II	Farmers	1° Primary school
III	Health Workers	2° Secondary school
IV	Civil Servants	3° Tertiary education
v.	Students	

educational attainment, over 50% of the respondents have had no formal education, while 12.1% and 2.4% have had secondary and tertiary education respectively. The average ages of fathers and mother enlisted din the study were 47.2 years and 43.5 years respectively. The average age of sons was 23.5 years while that of daughters was 20.8 years. The average age of other respondents ranged from 29.7 years for other females to 32.4 years for other males.

3.2.2 Local Assessment of Health Problems:

The result of the local assessment of health problems in the study area shows that Malaria, Typhoid fever and Eye problems were regarded as the most common health problems (Fig. 32). Dermatitis/pruritus (64%) was recorded as the next most common health problem. Others mentioned in order of public health importance include Hypertension (51%), Diarrhoea/stomach problems (43%), Pneumonia (34%), Hepatitis (31%) and STDs/AIDS (2%).

3.2.3 Knowledge of Onchocerciasis

Age and sex-related knowledge and attitude/practices

Of the 380 respondents, less than half (48.2%) knew about an illness called onchocerciasis (river blindness). Males (54.4%) showed higher scientific knowledge than females (42.0%) ($P < 0.05$). Most of the respondents knew about the disease from their elders and relatives. Other sources include friends, clinic/hospital and to a lesser extent in school. The age-related knowledge of the disease shows that respondents in the 5th decade and above had greater knowledge than respondents in other age groups. Respondents less than 20 years had lowest score (38.6%) on scientific knowledge of river blindness (Fig 33).

The overall mean scores on correct attitude to river blindness (51.2%) was slightly higher than that for knowledge (48.2%). Female respondents had higher acceptable attitude (54.5%) than male respondents (47.8%) ($P < 0.05$). The age – related correct attitude was highest for persons in the decade 5th and above (66.2%) and least for persons in the 2nd decade and below (36.6%) (Fig.33).

Scientific knowledge and attitude/practices scores by communities

The scores on knowledge varied amongst the communities with the highest in Umulolo (62.1%), Nzerem (54.3%), Ajabo (48.8%) and Umuawuchi (41.3%). The lowest score was recorded in Umungwa (36.1%). The prevalence of *O. volvulus* differed in the various communities and was strongly associated with scientific knowledge ($r=0.89$; $P< 0.043$) (Fig 34a).

The score on correct attitude varied also amongst the communities with Umulolo (64.4%) having the correct attitude followed by Ajabo (61.8%) and Umuawuchi (58.2%). The lowest correct attitude was observed in Umungwa (24.7%) (Fig. 35). The prevalence of disease also showed a strong correlation with attitude to the disease ($r= 0.79$; $p>0.104$) (Fig. 34b).

Effect of education on knowledge and attitude/practices to disease

The effect of education on the overall knowledge and attitude of onchocerciasis is shown in Fig 36. Respondents with primary education had higher scores (66.1%) on knowledge than any other group. The least score (33.6%) on knowledge was for respondents with tertiary education. On the influence of education on attitude, persons with secondary and tertiary education had scores of 57.9% and 56.8% respectively while those with primary education and no education at all (illiterates) had scores of 56.3% and 41.4% respectively.

Influence of occupation on knowledge and attitude of onchocerciasis

Knowledge of river blindness was highest amongst farmers (59.6%) and health workers (53.2%), followed by civil servants (48.8%) and artisans/traders (43.4%). The lowest scientific score on knowledge was obtained for students (36.3%). Furthermore, attitudes of healthworkers (69.7%) and civil servants (64.1%) were scientifically more correct than those of farmers (47.4%), students (37.9%) and artisans/traders (34.1%) (Fig.37).

Local terminology for onchocerciasis

All the communities investigated had no specific local name for onchocerciasis. However, upon presentation of photographs of the disease manifestations, most of the respondents agreed seeing them before, even though they felt that they were not symptoms of the same disease. The most frequently seen manifestation was dermatitis (67.6%) followed by nodules (58.2%) and depigmentation (55.0%) (Fig 38). The least observed clinical manifestations were lymphoedema (genital) (2.9%) and hanging groin (8.9%). None of the respondents agreed seeing lymphoedema (breast) before. Only 154 (40.5%) persons reported seeing blind people. Key informants revealed that the perceived higher responses for manifestations like nodules, dermatitis, depigmentation and blindness was because of their anatomical locations unlike lymphatic complications of inguinal/genital origins that are usually hidden because of their obscure locations and the possibility of concealment or denial of their existence by affected villagers.

Table 43 shows the local names for the recongnizable symptoms of the disease in the different communities. "AKPU" (ie boil that is hard and does not burst) is the common local name given to nodules in all the communities investigated. Various names were given to dermatitis. In Nzerem, Umuawuchi and Umungwa, it is commonly called "OKO VARI VARI" which is a simple description of the sound produced by the nail during intense scratching of the affected skin. In Umulolo and Ajabo communities, dermatitis is commonly referred to as "ORANMANU" (literally meaning oil eater) signifying the use of oil to reduce the swelling that may result from unprovoked intense itching. Additional information derived from key informants revealed that this skin condition in women is also referred to as "OSURU NWANYI AHIA DI" OR "OSURU AGBOHO EBU AHIA" meaning skin condition that cost a woman suitors. Furthermore, another name given to the skin condition is 'ONYIRI NCHA" which means a skin condition that cannot be cleared by soap.

The various forms of depigementtation in the study area are commonly called "UKWU OCHA" or OKPA OCHA" (literally meaning white legs). However in Nzerem and Umuawuchi some of the respondents referred to the skin condition as 'ORIA OCHA' meaning leprosy; ' ORIA NMOO' meaning disease caused by ghosts. Furthermore, some respondents in Umulolo called the condition "ORIA MIRI" meaning disease caused by contact with wet leaves in the bush. Additional information from key informants revealed that some of the villagers believed that the skin condition especially those on the legs could be caused by constant scratching of the legs with stones. Others attributed the condition to old age/hereditary factors.

Lymphadenopathy, is commonly called "AKPURU" or 'AKPURU IBI', seed of lymphoedema of genitalia in the communities investigated. Some of the key informants also referred to the condition as "NKPUMA NWOKE". "AKPURU KWA KWA NNEGI" meaning "MAY YOUR MOTHER BECOME AFFLICTED WITH LYMPHADENOPATHY" is a scarstic expression about this condition commonly used in the area.

In Umulolo, Ajabo, Nzerem and Umuawuchi communities, lymphoedema (limb) is commonly referred to as "ORIA OZIZA' meaning swollen disease condition.

while in Umungwa it is called "UKWU IDGHARA IDI" denoting rough and swollen legs. Additionally, in Nzerem it is also known as "UKWU OTITI".

In the study area all forms of genital complications (lymphoedema – genital and hernia) in males are called 'IBI', while the same complications in women are called 'MKPUMA'. Key informants confirmed these local terminologies and in addition revealed that hernia in some of the communities is called "MKPURU". Most of the discussants were not comfortable discussing these genital complications in the public and especially to the hearing of children since they affect the delicate and private organs in the body.

There are no local names for hanging groin and lymphoedema of the breast especially as the latter is not a common manifestation in the study area. Blindness irrespective of origin is commonly referred to as "ISHI" or ANYA ISHI".

The result of the local perception of the most serious clinical manifestation is showed in Fig. 39. One hundred and forty three (37.6%) of the respondents reported that onchocercal dermatitis was the most worrisome manifestation in the study area. Other feared manifestations include lymphoedema (genital) (26.6%), blindness (16.2%) and lymphoedema (limb) (11.3%). The least worrisome manifestations were depigmentation (0.5%), lymphadenopathy (0.5%) and nodules (1.3%). The high rating of dermatitis was further confirmed by the key informants who highlighted the socio-cultural and economic impacts of this condition on the affected individuals in the study area.

<u>Local perception of the relationship of different clinical manifestations</u>

The results of the local perception on the relationship of different clinical manifestations show that 253 (66.6%) of the respondents believed that the clinical manifestations were not related (Table 44). The other 127 (33.4%) respondents

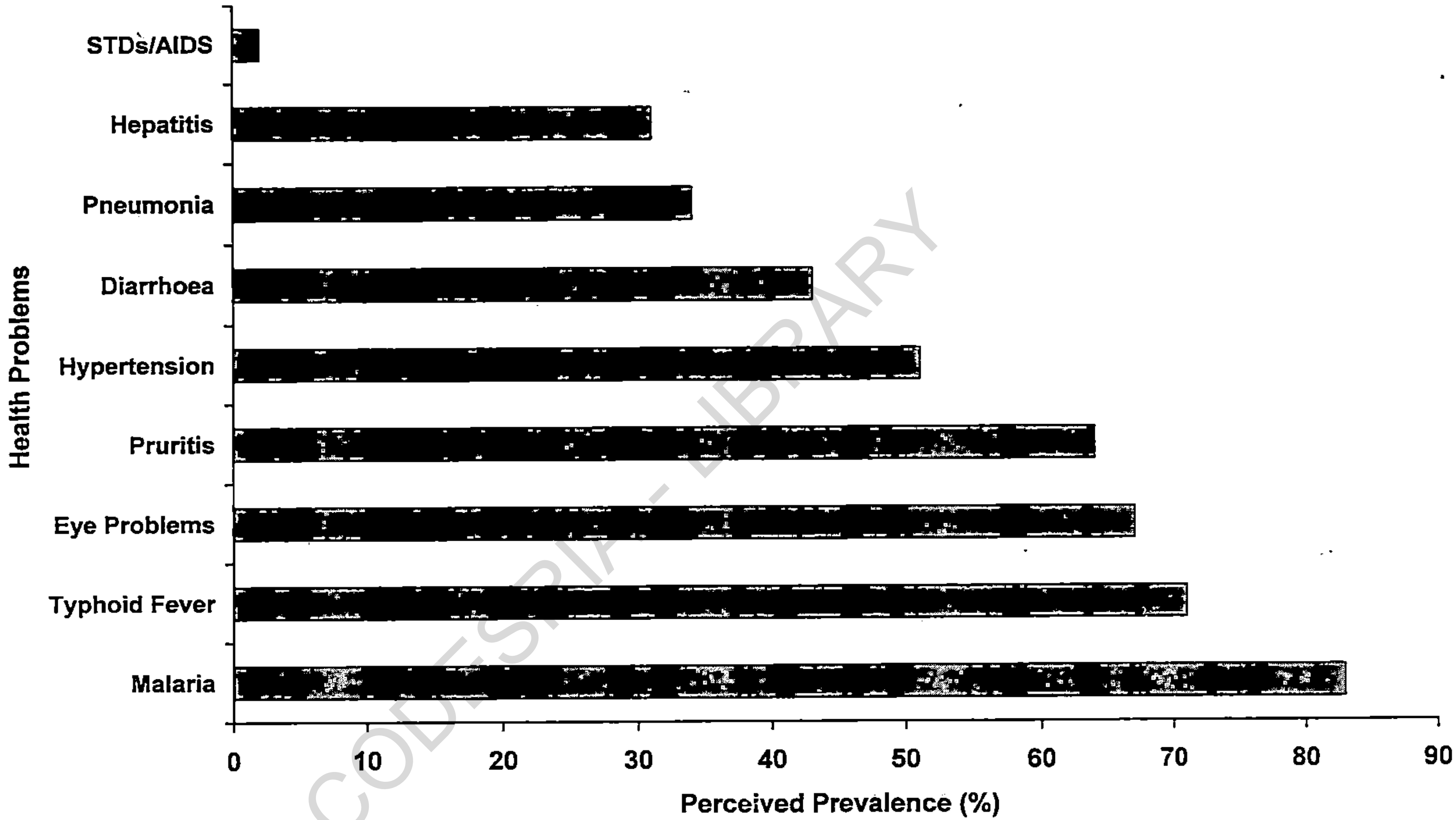

Fig. 32: Overall Local Assessment of Health Problems in the Study Area (n=380, Multiple Responses Possible)

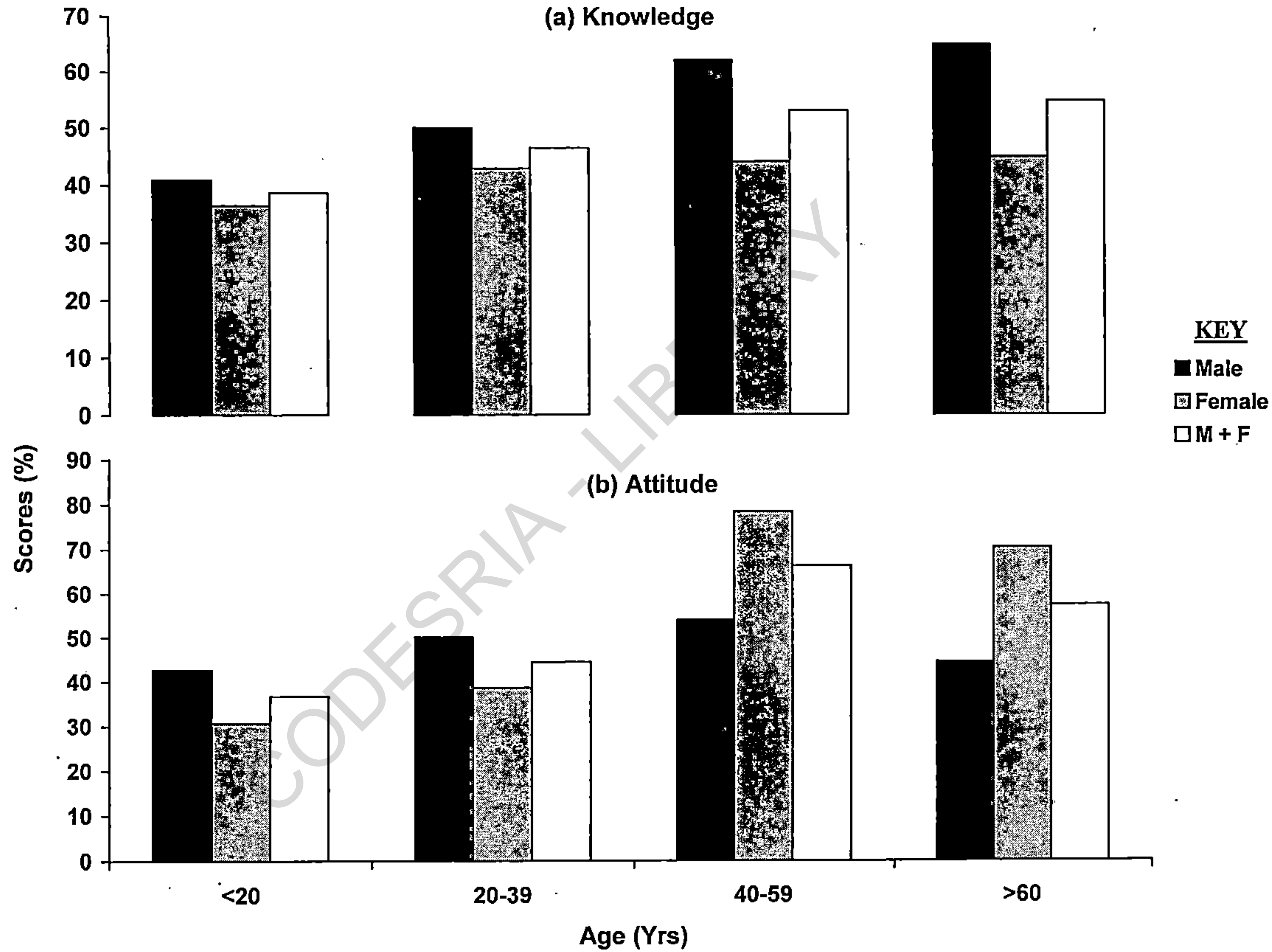

Fig. 33: Age and Sex-related Knowledge (a)* and Attitude/practices (b)* Scores (%)

*Expressed as percentage scores of questionnaire responses

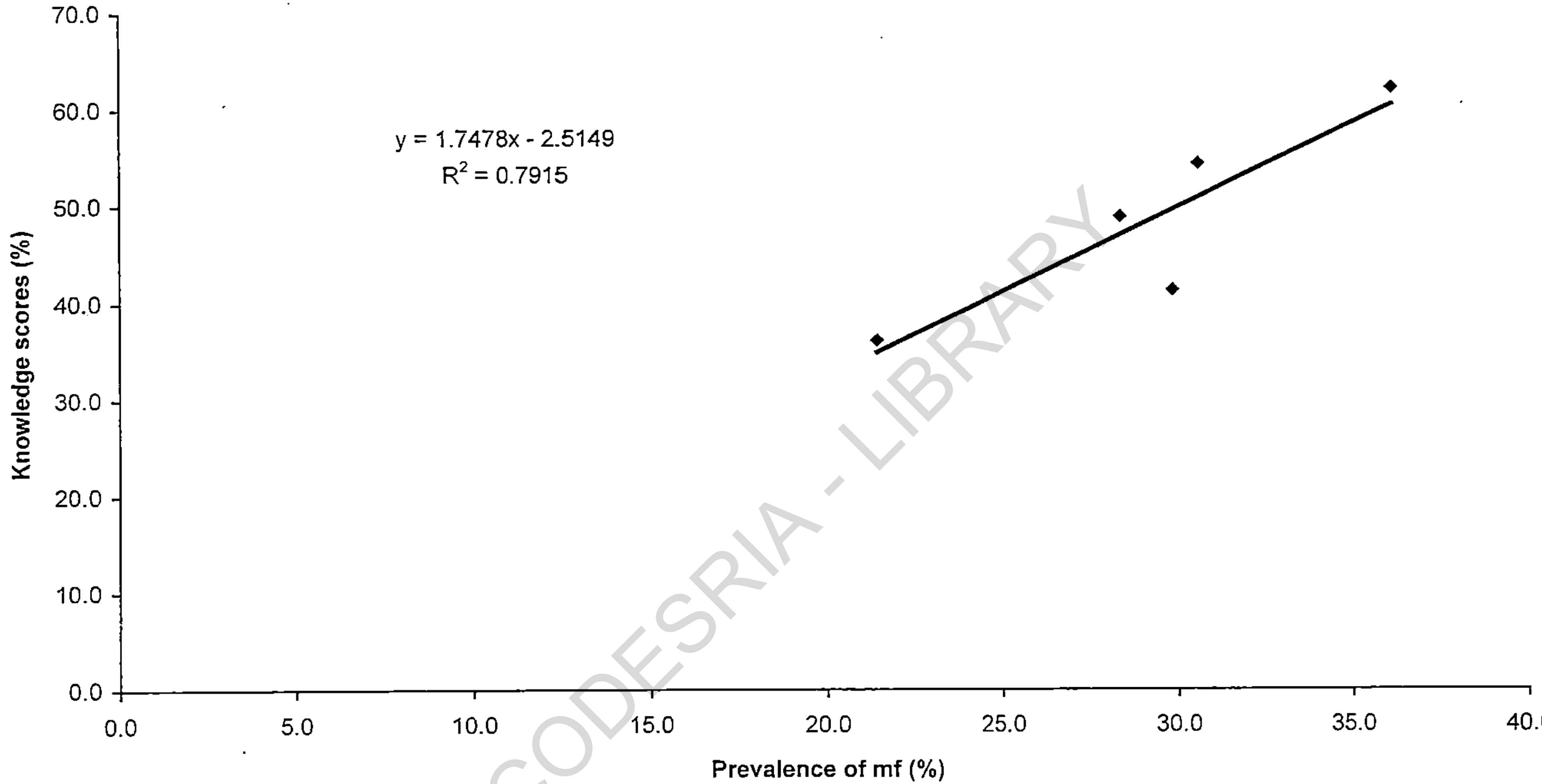

Fig. 34a: Relationship Between Prevalence of Onchocerciasis and Knowledge of Respondents in the Study Area

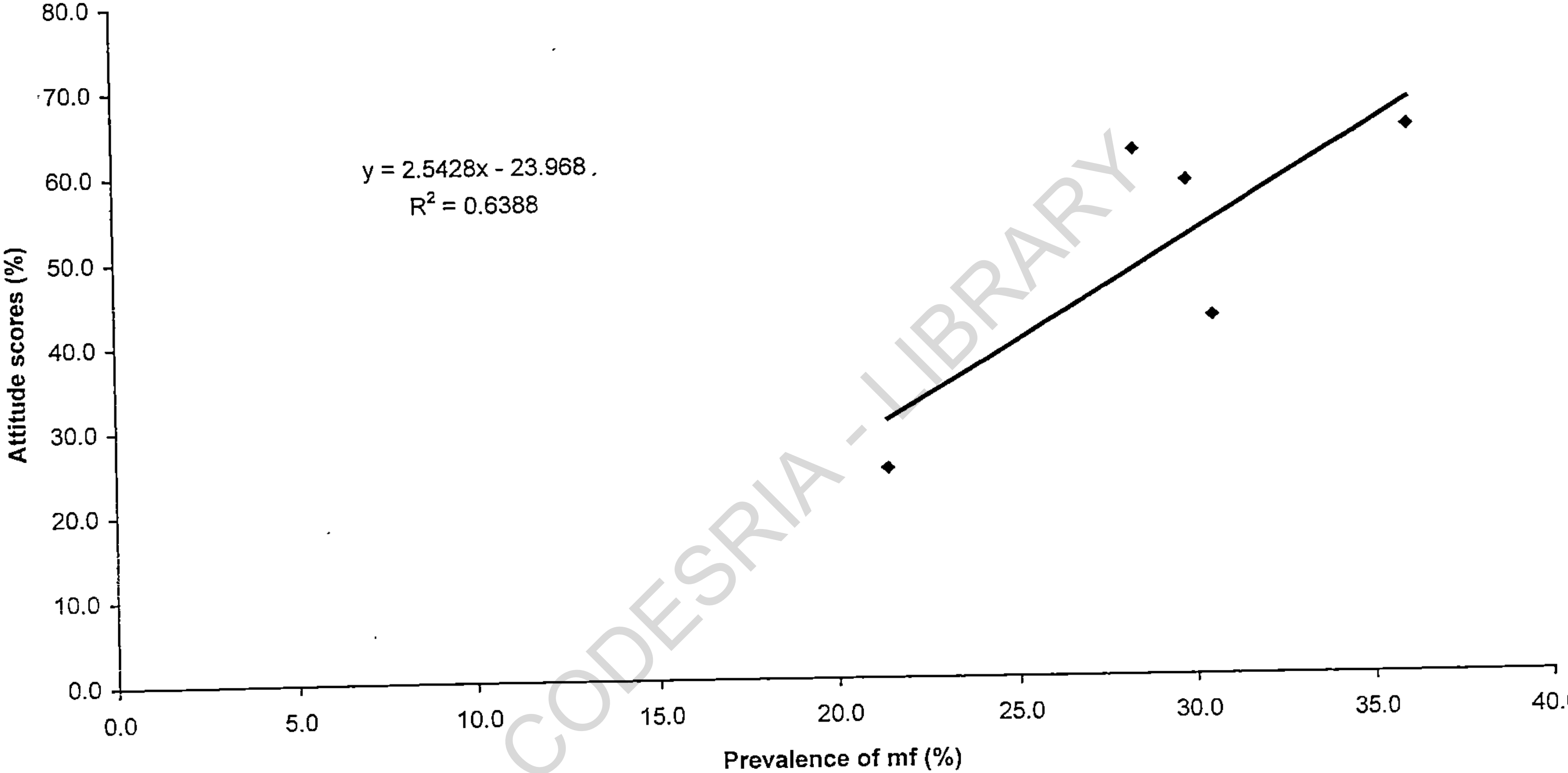

Fig. 34b: Relationship Between Prevalence of Onchocerciasis and Attitudes of Respondents in the Study Area

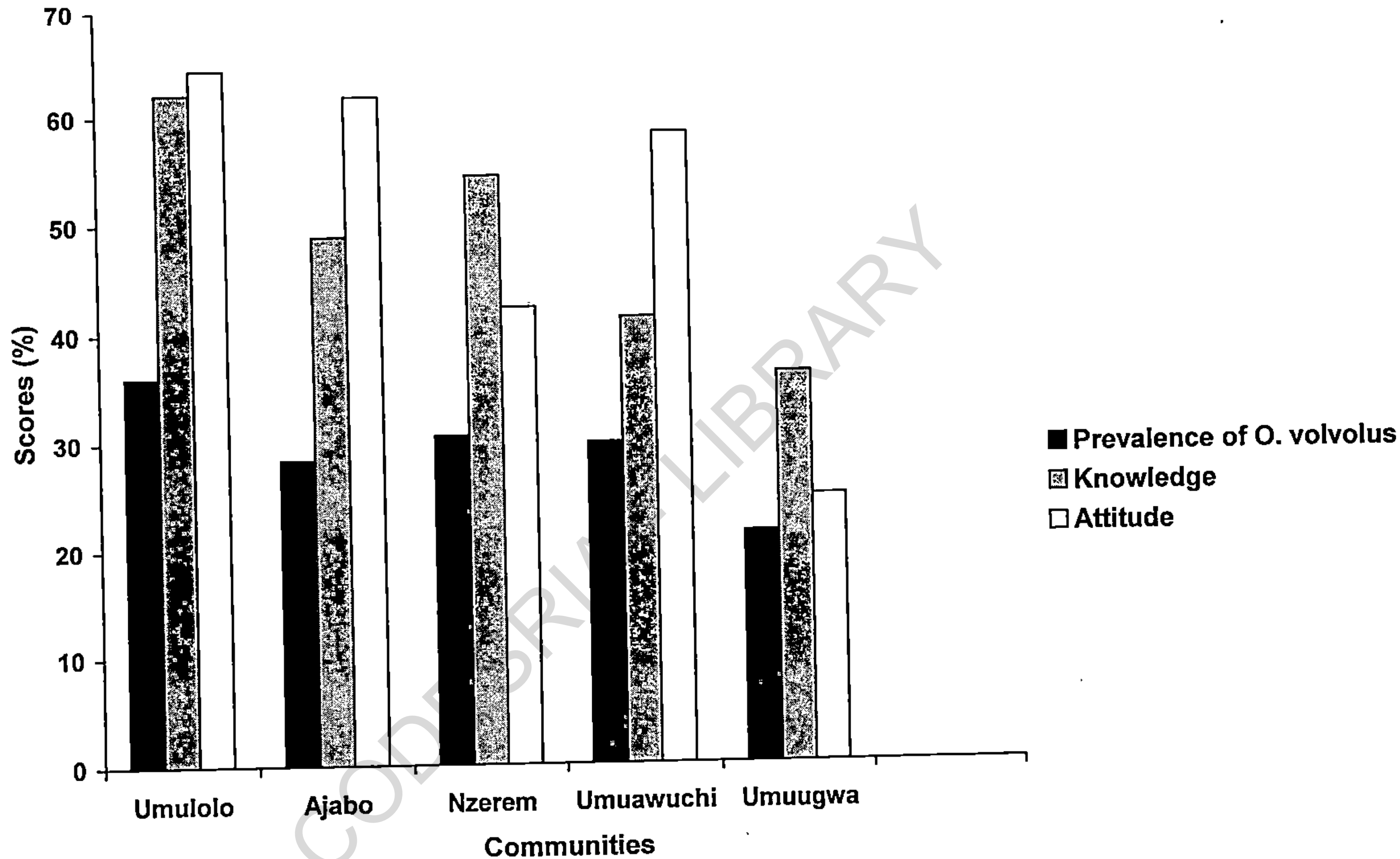

Fig. 35: Scientific Knowledge* and Attitude/practices* Scores in Different Communities

*Expressed as percentage scores of questionnaire responses

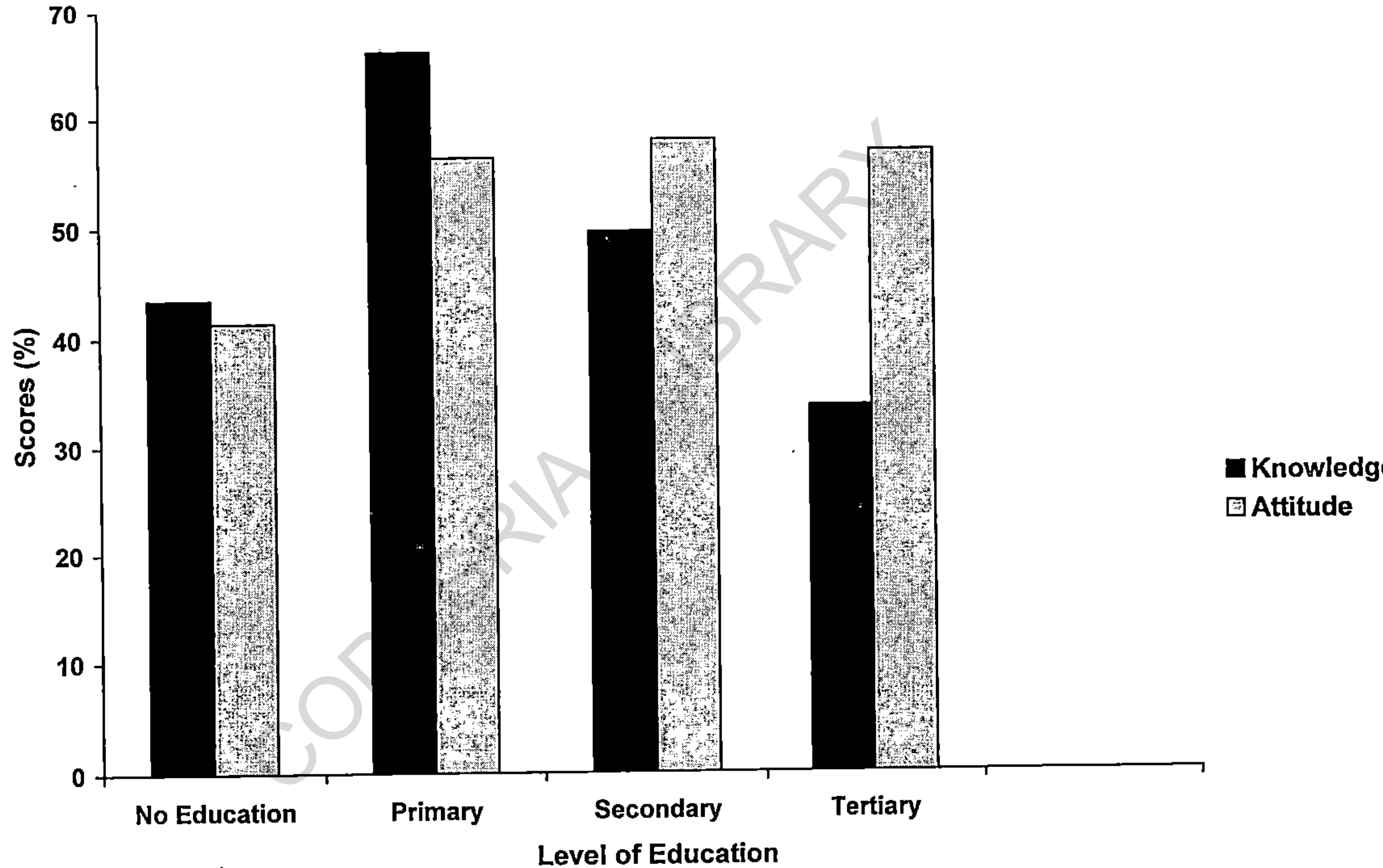

Fig. 36: Effect of Education on Knowledge* and Attitude/practices* to Disease in the Study Area

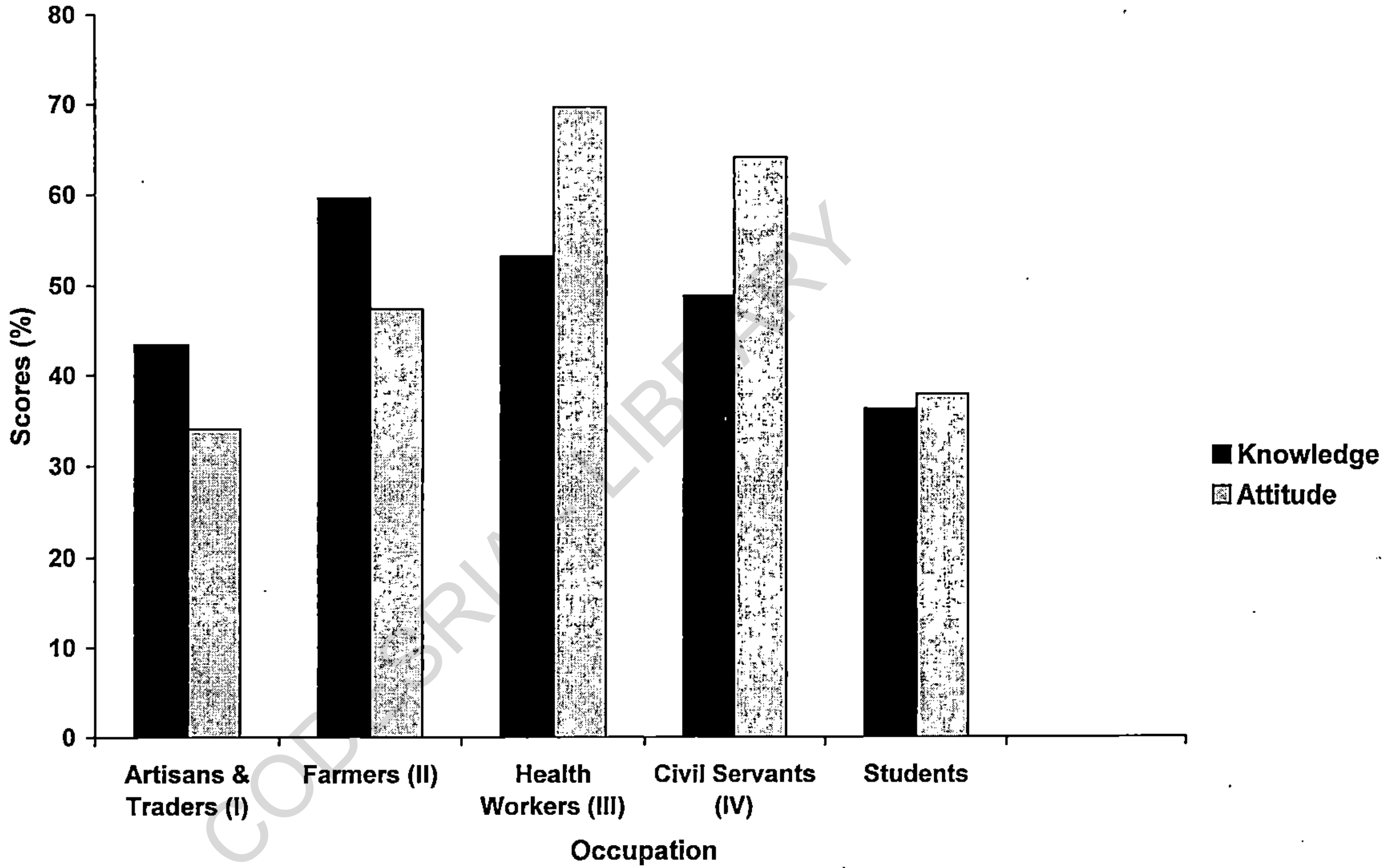

Fig. 37: Influence of Occupation on Knowledge* and Attitude/practices* to the Disease in the Study Area

*Expressed as percentage scores of questionnaire responses

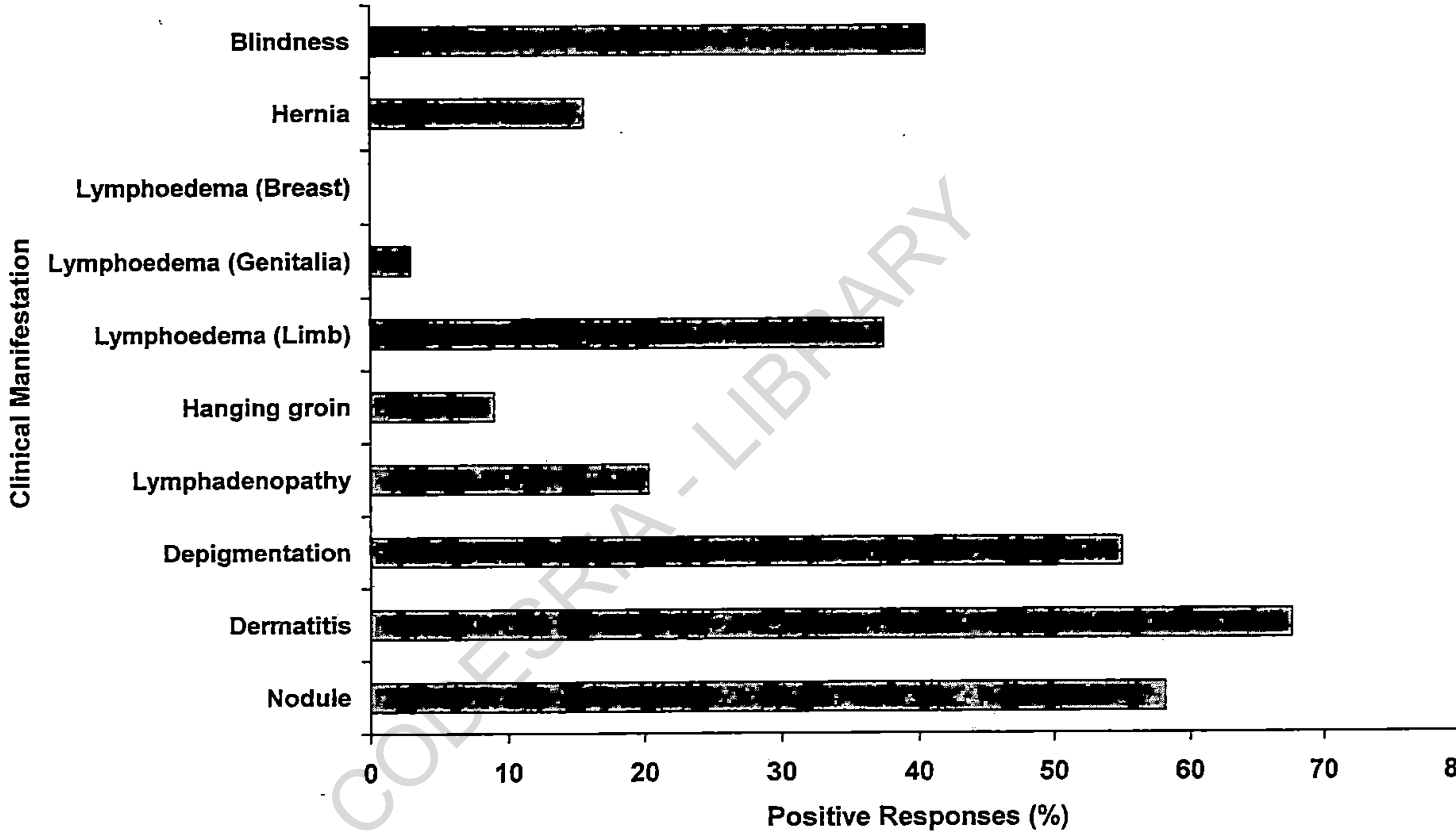

Fig. 38: Whether the Respondents have seen these Clinical Manifestations before

Table 43: Local Names for Clinical Manifestations of Onchocerciasis

CLINICAL MANFESTATIONS	LocalL Names by Different LGAs (Community)				
	Okigwe (Umulolo)	Ounimo (Ajabo)	Ehime Mbano (Nzerem)	Ihitte Uboma (Umuawuchi)	Obowo (Umugwa)
Nodule	Akpu	Akpu	Akpu	Akpu	Akpu
Dermatitis	Osuru nwanyi ahiadi Osuru agboho ebu ahia Oranmanu	Osuru nwanyi ahadi Oranmanu	Oko vari vari	Oko vari vari	Oko vari vari Oriyiri ncha
Depigmentation	Okpa ocha Okpa miri	Okpa ocha	Ukwu ocha Oria ocha Oria nmoo	Ukwu ocha Oria ocha	Ukwu ocha
Lymphadenopathy	Akpuru	Akpuru	Akpuru ibi	Akpuru ibi	Akpuru ibi Akpuru gede
Lymphoedema (Limb)	Oria oziza	Oria oziza	Oria oziza Ukwu otiti	Oria oziza	ukwu idighara idi
Lymphoedema (Genitalia)	ibi Mkpuma	ibi Mkpuma	ibi Mkpuma	ibi Mkpuma	ibi Mkpuma
Hernia	ibi Mkpuru	ibi Mkpuru	Mkpuru ibi	Mkpuru ibi	Mkpuru ibi
Blindness	Ishi	Ishi	Ishi	Ishi	Ishi

NB: No Local names for Hanging groin and Lymphoedema (Breast).

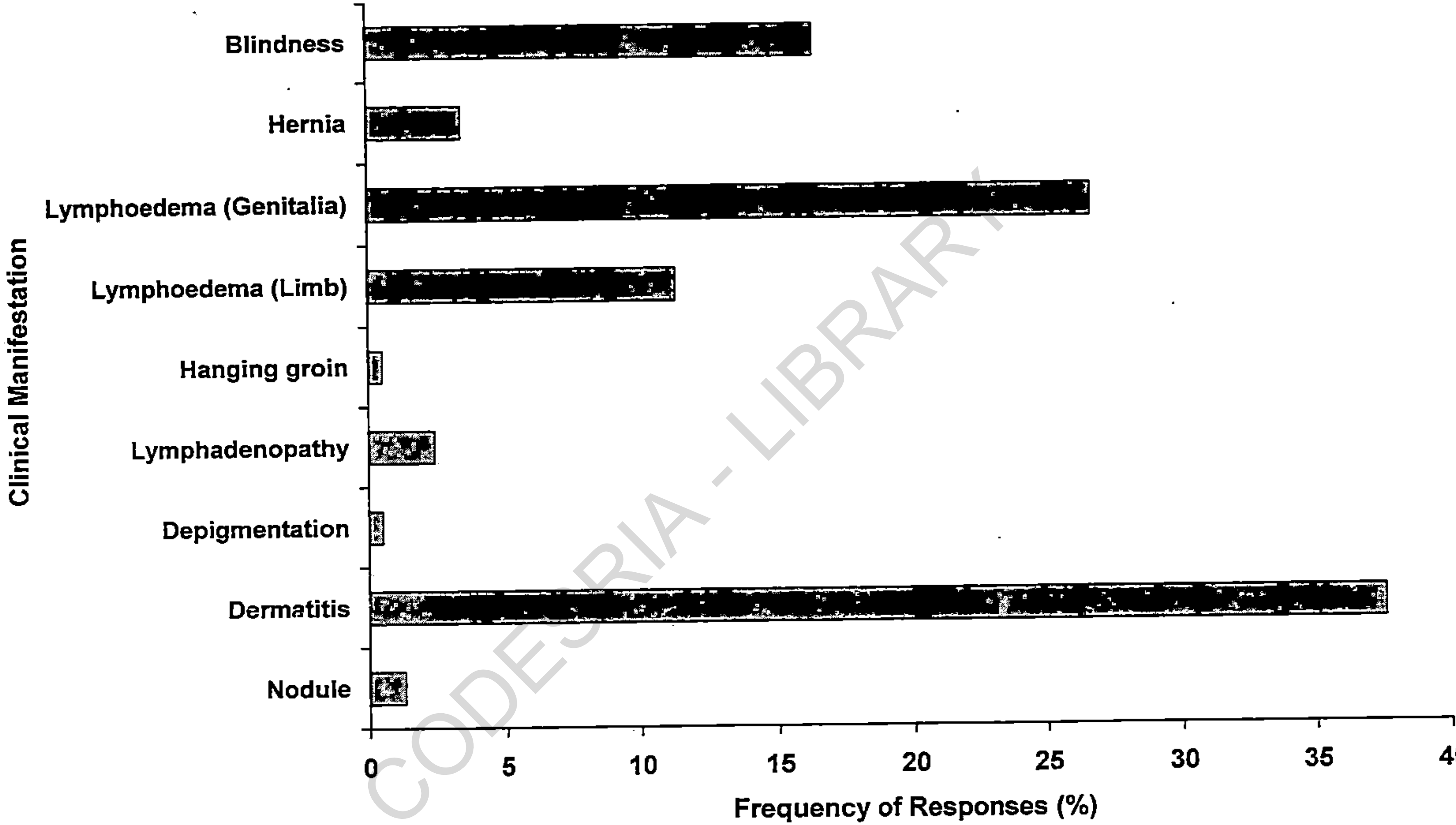

Fig. 39: Clinical Perception of the most Serious Clinical Manifestations

noted that there might be some form of relationship between these manifestations. Ninety –four (74.05) respondents in this groups believed that lymphadenopathy and hernia are related; 87(68.5%) and 83(65.4%) respondents were of the view that hernia/lymphoedema (genital) and lymphadenopathy/lymphoedema (genital) respectively are related. Another 47(37.0%) respondents accepted that hernia and hanging groin are related while the least accepted degrees of relationship were for dermatitis/ depigmentation (16.5%) and lymphoedema (genital)/lymphoedema (limb) (16.5%).

3.2.4 Local Perception of the Causes/Transmission of Onchocerciasis

The details of responses on the local perception of the causes/transmission of onchocerciasis are shown in Table 45.

Nodules

The most cited reasons for the perceived cause of nodules was overwork/hardwork (25.5%). Key informants revealed that respondents with nodules were regarded as very strong and hard working. Other perceived causes include accumulation of bad fluid (14.2%), witchcraft/enemies (11.3%), hereditary (7.9%), insect bite (6.8%), evil spirit/gods (6.3%), old age (3.9%) and drinking bad water (3.7%). Seventy seven respondents (20.3%) could not give any reasons for the cause of nodules.

Dermatitis

Dermatitis was perceived to be caused mostly by witchicraft/enemies (25.0%); evil spirit/gods (17.6%). Sixty one (16.1%) respondents believed that this skin condition could be caused by sleeping/contact with an infected person. Other cited reasons include poor personal hygiene (8.9%); hereditary (6.1%), punishment from

God (3.7%) and accumulation of bad fluid (2.6%). Thirty seven respondents had no idea of the perceived cause/transmission of dermatitis.

Depigmentation

Majority of the respondents believed that depigmentation was due to old age (29.2%) and hereditary (15.5%). Other respondents attributed it to contact with wet leaves (12.4%), evil spirit/gods (8.2%), witchraft/enemies (7.6%), sleeping/contact with infected persons (6.3%); punishment God (3.4%). The least cited cause of depigmentation was insect bites (1.8%).

Lymphadenopathy

One hundred and eight five (48.7%) respondents had no idea of the perceived cause of lymphadenopathy. However 15.0% and 11.3% of the responses attributed it to accumulation of bad fluid and overwork/hardwork respectively. Thirty one (8.2%) persons believed it was due to adultery, while other reasons given as possible causes include old age (6.8%), witchcraft/enemies (5.0%), drinking bad water (1.8%), punishment from God (1.8%), evil spirit/gods (1.1%) and hereditany (0.3%).

Hanging groin

The response pattern shows that majority of persons (51.1%) interviewed could not give any possible reasons for the cause of hanging groin. However the perceived causes given by other respondents include old age (16.8%), hereditary (13.2%), overwork/hardwork (8.2%), adultery (3.7%), witchcraft/enemies (3.7%), evil spirit/gods (2.4%) and punishment from God (1.1%).

Lymphoedema (Limb)

Details of responses on the perceived causes of lymphoedema (limb) showed accumulation of bad fluid (19.2%), evil spirit/gods (17.5%) and witchcraft/enemies (15.3%) as the most common reasons. The least cited reason was hereditary (1.3%) while 6.3% of respondents had no idea of the cause.

Lymphoedema (genital)

Adultery (22.9%) was cited as the most perceived cause of lymphoedema (genital). Other frequently mentioned reasons were evil spirits/gods (14.2%), witchcraft/enemies (12.4%), being around when infected person dies (11.1%), accumulation of bad fluid (10.3%) and punishment from God (10.0%). Only 4.7% responses attributed this condition to insert bites. The least cited cause was old age (1.3%). About 1.3% of responses could not advance any reason for its cause.

Information by key informants was quite revealing about the beliefs held in the different communities about lymphoedema (genitals). In Umuloio, patients with this condition were not allowed to die in the village rather they were taken to the evil forest to die. During burials, people were not permitted to cry and there would be no condolence visits till 7 weeks after the burial. As a result of the belief that the disease condition could be transmissible, the contents of the 'IBI' were usually removed by local surgery, inactivated with water and oil and buried separately with a clay pot in a deep hole. In Umungwa, it is believed that when an infected male with lymphoedema (genital) dies, the spirit of the man lingers in the air looking for another man to infect. As a result, it is the cultural belief that all non-initiated males vacate the community until the dead was buried. In some instances, only visitors or women from the community were permitted to bury the dead. The contents of the 'IBI' were also removed by surgery but unlike in Okigwe LGA where surgery was done to inactivate the contents, this was carried out in Obowo LGA with the intention of preventing the man from re-incanting in the next generation with that feature.

Hernia

The perceived causes of hernia were attributed mostly to witchcraft/enemies (13.4%), adultery (12.6%), overwork/hardwork (12.4%) and accumulation of bad fluid (11.3%). The least quoted reason was insect bites (1.1%). About 65(17.1%) persons had no reasons for the cause of hernia.

Blindness

Witchcraft/enemies (18.5%) was the commonest perceived cause of blindness. Other causes mentioned were evil spirits/gods (15.5%), old age (7.6%) insect bites (6.3%), punishment from God (5.0%) and hereditary (1.6%).. Only 2 persons thought that blindness could be due to adultery, while the majority of respondents (44.7%) could not give any reason for the cause of blindness.

Attempts to explain the role of vectors species in the transmission of onchocerciasis to key informants were met with a lot of questions. Nevertheless, some of the respondents knew about the vector species which they gave various names like NWANDUNTA, NWANMI, KPUKPUNTA, NKAKPO, NKANKA etc.

3.2.5 Local Perception of Methods of Treatment and Prevention

Table 46 shows the responses on whether the clinical manifestations can be treated or not. With the exception of those that had no idea on whether the manifestations can be treated or not, more respondents believed that nodules (36.1%) and hernia (25.5%) can be treated when compared with those 19.5% and 23.2% respectively who reported that they cannot be treated. On the contrary most of the respondents believed that dermatitis (47.6%), depigmentation (63.9%)

Table 44: Local Perception of the Relationship of Different clinical Manifestation

	Number of Respondents	Percentage (%)
No Relationship Exists	253	66.6
Relationship Exists	127	33.4*
Dermatitis & depigmentation	21	16.5
Lymphadenopathy & Hernia	94	74.0
Lymphadenopathy & Lymphoedema (Genitalia)	83	65.4
Hernia & Lymphoedema (Genitalia)	87	68.5
Hernia & Hanging groin	47	37.0
Lymphoedema (Genitalia) & Lymphoedema (limb)	21	16.5

* Percentage Calculated based on 127 respondents.

Table 45: Perceived Causes/Transmission of Clinical Manifestations of Onchocerciasis

PERCEIVED CAUSES	CLINICAL MANIFESTATIONS								
	NODULE	DERMATITIS	DEPIGMENTATION	LYMPHADENPATHY	HANGING GROIN	LYMPHOEDEMA (LIMB)	LYMPHOEDEMA (GENITALIA)	HERNIA	BLINDNESS
Poor personal hygiene	0(0.0)	34(8.9)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Drinking bad water	14(3.7)	0(0.0)	0(0.0)	7(1.8)	0(0.0)	31(8.2)	7(1.8)	11(2.9)	0(0.0)
Overwork/Hard work	97(25.5)	0(0.0)	0(0.0)	43(11.3)	31(8.2)	33(8.7)	14(3.7)	47(12.4)	0(0.0)
Punishment from God	0(0.0)	14(3.7)	13(3.4)	7(1.8)	4(1.1)	49(12.9)	38(10.0)	27(7.1)	19(5.0)
Insect bite	26(6.8)	39(10.3)	7(1.8)	0(0.0)	0(0.0)	23(6.1)	18(4.7)	4(1.1)	24(6.3)
Evil spirit/gods	24(6.3)	67(17.6)	31(8.2)	4(1.1)	9(2.4)	67(17.6)	54(14.2)	35(9.2)	59(15.5)
Witchcraft/Enemies	43(11.3)	95(25.0)	29(7.6)	19(5.0)	14(3.7)	58(15.3)	47(12.4)	51(13.4)	71(18.7)
Accumulation of bad fluid	54(14.2)	10(2.6)	0(0.0)	57(15.0)	0(0.0)	73(19.2)	39(10.3)	43(11.3)	0(0.0)
Hereditary	30(7.9)	23(6.1)	59(15.5)	1(0.3)	50(13.2)	5(1.3)	24(6.3)	17(4.5)	6(1.6)
Old age	15(3.9)	0(0.0)	111(29.2)	26(6.8)	64(16.8)	14(3.7)	5(1.3)	5(1.3)	29(7.6)
Adultery	0(0.0)	0(0.0)	0(0.0)	31(8.2)	14(3.7)	3(0.8)	87(22.9)	48(12.6)	2(0.5)
Sleeping/contact with infected person	0(0.0)	61(16.1)	24(6.3)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Contact with wet bush	0(0.0)	0(0.0)	47(12.4)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Being around when infected person dies	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	42(11.1)	27(7.1)	0(0.0)
Cannot say	77(20.3)	37(9.7)	59(15.5)	185(48.7)	194(51.1)	24(6.3)	5(1.3)	65(17.1)	170(44.7)

lymphadenopathy(72.6%), hanging groin (32.6%), lymphoedema (limb) (41.6%), lymphoedema (genital) (65.0%) and blindness (74.7%) cannot be treated when compared with responses 16.1%, 12.1%, 12.9%, 5.5%, 9.2% 7.1%, 4.2% respectively which believe that the manifestations can be treated.

The local perception on the preferred methods of disease treatment shows that majority of the respondents would either consult/appease gods or seek herbal/local therapy than go to the hospital/clinic (Table 47). Outside these options, others would ignore the disease manifestations.

Table 48 summarizes the local perception on whether the disease manifestations could be prevented or not. With the exception of hanging groin and blindness, majority of the respondents believed that nodules (64.5%), dermatitis (61.1%), lymphadenopathy (40.8%), lymphoedema (limb) (58.9%), lymphoedema (genital) (67.4), hernia (62.1%) could be prevented when compared with those who believed otherwise.

Table 49 shows the local perception of possible preventive measures for the different clinical manifestations of the disease. Majority of the respondents believed that avoidance of hard work/overwork where the best ways to prevent nodules (38.4%) and hanging groin (62.8%). The most cited reason for preventing lymphadenopathy and lymphoedema (limb) was accumulation of bad fluid. Avoidance of infected person (26.3%) was the best suggestion for preventing dermatitis. The most suggested ways of preventing lymphoedema (genital), blindness and hernia were avoidance of adultery (33.6%), avoidance of evil forest (40.2%) and consulting oracle/appeasing gods (34.7%). Generally, most of the cited reasons for preventing these manifestations are in agreement with the perceived causes of these manifestations.

3.3 SOCIOECONOMIC STUDIES

3.3.1 Social Costs Of Onchocerciasis

Characteristics of respondents

The characteristics of 380 respondents who took part in the study of the social impacts of onchocerciasis on the rural population is summarized in Table 42.

Attitudes of respondents towards people with clinical manifestations.

Table 50 summarizes the overall attitudes of respondents towards people with various clinical manifestations. The manifestations that elicited the most fear were dermatitis (51.6%), lymphoedema (limb) (47.1%) and lymphoedema (genital)(41.8%). Respondents in addition felt very insecure towards people with these manifestations. Majority felt sorry (70.3%) for blind persons and were indifferent towards people with nodules (93.2%), depigmentation (90.0%), hanging groin (81.8%) and lymphadenopathy (62.9%) . None of the respondents was happy with respect to persons with disease afflictions.

Attitudes towards marriage

The attitudes of respondents towards marrying persons afflicted with disease manifestations showed that majority agreed to marry persons with nodules (85.3%) and depigmentation (80.8%) as against those afflicted with lymphoedema (genital) (89.7%), blindness (85.8%), lymphoedema (limb) (80.5%), dermatitis (73.7%), hernia (68.9%), lymphadenopathy (59.2%) and hanging groin (48.2%). In particular, none of the 183 female respondents would agree to marry males with lymphoedema (genital) (Table 51). The suggested reason(s) for refusing to marry persons with clinical manifestations are summarized in Table 52. The effect on child bearing was the major reason for not marrying persons with lymphoedema (genital) (97.3%) and hernia (36.6%). Reduction in mobility /less productivity was cited as the reason for not marrying blind persons (74.6%) and those with lymphoedema (limb) (43.5%). The main reason for refusing people with dermatitis was the fear of contracting infection (35.5%) as well as its conception as a sign of bad omen /associated stigma (32.5%). Most respondents had no reason(s) for refusing marriage with persons with depigmentation (45.7%) and lymphadenopathy (40.0%). Some of the reasons given by respondents were also confirmed during key person interviews.

Attitude towards hiring / engaging afflicted persons for farm work or in other productive ventures.

Majority of respondents were willing to engage persons with nodules (92.4%), depigmentation (86.1%), lymphadenopathy (91.6%), hanging groin (84.5%), lymphoedema (genitals) (56.3%) and hernia (51.8%) as farm hands or in other productive ventures such as trading as against persons with blindness (96.8%) and those afflicted with lymphoedema (limb) (78.4%) and dermatitis (57.4%) (Table 53). Several reasons were given for refusing to hire afflicted persons as farm hands or in other productive ventures(Table 54). Reduction in mobility/less productivity was given for not engaging / hiring persons afflicted with blindness (96.7%) lymphoedema (limb) (75.5%), hernia (59.5%), lymphadenopathy (57.1%), and lymphoedema (genital) (46.3%). Frequent loss of attention/less productivity (49.1%) and visits for treatment (23.4%) were cited for not hiring persons with dermatitis.

Perceptions on whether afflicted persons can go to church / market / school /other social gatherings.

The result of the perception on whether afflicted persons could go to church/market/ school/ social gatherings shows that with the exception of dermatitis, a great majority of respondents agreed that villagers with other disease manifestations could attend such gatherings (Table 55). The cited reasons why persons with dermatitis cannot attend such gatherings include the concept of dirty skin / associated stigma (60.8%), fear of infecting people with affliction (15.0%) and its perception as a bad omen (14.4%). Reduction in mobility was the most perceived reason why those afflicted with blindness (74.5%) and lymphoedema (limb) (54.0%) cannot attend such functions. Bad omen / associated stigma was most cited for hanging groin (73.0%), hernia (72.7%), lymphoedema (genitals) (68.0%) and lymphadenopathy (60.8%) (Table 56).

Activities respondents would not want with afflicted persons.

Table 57 summarizes the activities respondents would not want with afflicted persons. Most of the respondents would not want to sleep / or have sexual relationship with afflicted persons, when compared with other activities including eating, discussion and handshake. For males afflicted with lymphoedema (genitals), 98.9% of females respondents would not agree to a sexual relationship.

On the relationship between respondents and close relatives with disease manifestations

For all clinical manifestations with the exception of lymphoedema (genitals), majority of respondents had normal relationships with afflicted relatives. However, some respondents felt withdrawn as well as isolated from close relatives with dermatitis and lymphoedema (limb) . All other respondents felt indifferent with respect to afflicted relatives, including the only respondent that had a relation with lymphoedema (genital) (Table 58).

Table 46: Local Perception on whether Clinical Manifestation can be Treated.

Clinical manifestation	Frequency(%) of local perception on treatment		
	Yes	No	Does not know
Nodule	137(36.1)	74(19.5)	169(44.5)
Dermatitis	61(16.1)	181(47.6)	138(36.3)
Depigmentation	46(12.1)	243(63.9)	91(23.9)
Lymphadenopathy	49(12.9)	276(72.6)	55(14.5)
Hanging groin	21(5.5)	124(32.6)	235(61.8)
Lymphoedema (Limb)	35(9.2)	158(41.6)	187(49.2)
Lymphoedema (Genitals)	27(7.1)	247(65.0)	106(27.9)
Hernia	97(25.5)	88(23.2)	195(51.3)
Blindness	16(4.2)	284(74.7)	80(21.1)

Table 47: Local Perception of the Preferred Methods of Disease Treatment.

Clinical manifestation	No of people who believed that it could be treated	Preferred methods of treatment			
		Hospital/ clinic	Oracle/ appeasing gods	Herbal/ local therapy	Ignore it
Nodule	137	13(9.5)	34(24.8)	51(37.2)	39(28.5)
Dermatitis	61	4(6.6)	13(21.3)	27(44.3)	17(27.9)
Depigmentation	46	1(2.2)	18(39.1)	12(26.1)	15(32.6)
Lymphadenopathy	49	7(14.3)	7(14.3)	24(49.0)	11(22.4)
Hanging groin	21	0(0.0)	5(23.8)	7(33.3)	9(42.9)
Lymphoedma (Limb)	35	4(11.4)	11(31.4)	13(37.1)	7(20.0)
Lymphoedema (Genitals)	27	1(3.7)	14(51.9)	11(40.7)	1(3.7)
Hernia	97	9(9.3)	39(40.2)	42(43.3)	7(7.2)
Blindness	16	1(6.3)	8(50.0)	2(12.5)	5(31.3)

Table 48: Local Perception on Whether the Disease Manifestation can be Prevented

Clinical manifestation	Local perception on disease prevention		
	Yes	No	Does not know
Nodule	245(64.5)	71(18.7)	64(16.8)
Dermatitis	232(61.1)	68(17.9)	80(21.1)
Depigmentation	120(31.6)	183(48.2)	77(20.3)
Lymphadenopathy	155(40.8)	69(18.2)	156(41.1)
Hanging groin	43(11.3)	127(33.4)	210(55.3)
Lymphoedema(Limb)	224(58.9)	64(16.8)	92(24.2)
Lymphoedema (Genitals)	256(67.4)	81(21.3)	43(11.3)
Hernia	236(62.1)	65(17.1)	79(20.8)
Blindness	97(25.5)	129(33.9)	154(40.5)

Table 49 : Local Perception of Possible Preventive Measures for Clinical Manifestation of the Diseases.

Clinical manifestation	No of people who believed that it could be prevented	Methods Suggested for Preventing Clinical Manifestations of Diseases										
		Avoid insect bite	Avoid infected person	Avoid Evil forest	Avoid adultery	Avoid accumulation of bad fluid	Avoid overwork/ hardwork	Avoid contact with wet bush	Avoid drinking bad water	Maintain personal hygiene	Consult oracle/ appease gods	Runaway when infected person dies
Nodule	245	26(10.6)	0(0.0)	17(6.9)	0(0.0)	51(20.8)	94(38.4)	0(0.0)	14(5.7)	0(0.0)	43(17.6)	0(0.0)
Dermatitis	232	39(16.8)	61(26.3)	34(14.7)	0(0.0)	10(4.3)	0(0.0)	0(0.0)	0(0.0)	34(14.7)	54(23.3)	0(0.0)
Depigmentation	120	7(5.8)	24(20.0)	25(20.0)	0(0.0)	0(0.0)	0(0.0)	46(38.3)	0(0.0)	0(0.0)	18(15.0)	0(0.0)
Lymphadenopathy	155	0(0.0)	0(0.0)	4(2.6)	31(20.0)	54(34.8)	41(26.5)	0(0.0)	7(4.5)	0(0.0)	18(11.6)	0(0.0)
Hanging groin	43	0(0.0)	0(0.0)	4(9.3)	7(16.3)	0(0.0)	27(62.8)	0(0.0)	0(0.0)	0(0.0)	5(11.6)	0(0.0)
Lymphoedma(Limb)	224	23(10.3)	0(0.0)	29(12.9)	2(0.9)	66(29.5)	31(13.8)	0(0.0)	19(8.5)	0(0.0)	54(24.1)	0(0.0)
Lymphoedema (Genitals)	256	18(7.0)	0(0.0)	48(18.8)	86(33.6)	36(14.1)	9(3.5)	0(0.0)	3(1.2)	0(0.0)	19(7.4)	37(14.5)
Her nia	236	4(1.7)	0(0.0)	21(8.9)	42(17.8)	29(12.3)	34(14.4)	0(0.0)	3(1.3)	0(0.0)	82(34.7)	21(8.9)
Blindness	97	21(21.6)	0(0.0)	39(40.2)	1(1.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	36(37.1)	0(0.0)

Table 50: Attitude Towards People with Clinical Manifestations (Multiple Response Possible)

Clinical Manifestation	Attitudinal response (%) Sorry	Fear	Happy	Insecure	Indifferent.
Nodule	9(2.4)	14(3.7)	0(0.0)	3(0.8)	354(93.2)
Dermatitis	87(22.9)	169(44.5)	0(0.0)	84(22.1)	40(10.8)
Depigmentation	7(1.8)	13(3.4)	0(0.0)	18(4.7)	342(90.0)
Lymphadenopathy	61(16.1)	124(32.6)	0(0.0)	54(14.2)	239(62.9)
Hanging groin	33(8.7)	27(7.1)	0(0.0)	9(2.4)	311(81.8)
Lymphoedema (Limb)	158 (41.6)	158(41.6)	0(0.0)	77(20.3)	26(6.8)
Lymphoedema (Genitals)	96(25.3)	139(36.6)	0(0.0)	111(29.2)	34(8.9)
Hernia	108(28.4)	115(30.3)	0(0.0)	93(24.5)	64(16.8)

Table 51: Attitude Towards Marrying Infected Persons with Different Clinical Manifestations.

Clinical Manifestations	Attitude to Marriage (%)		
	Yes	No	Does not Know
Nodule	324(85.3)	17(4.5)	39(10.3)
Dermatitis	35(9.2)	280(73.7)	65(17.1)
Depigmentation	307(80.8)	35(9.2)	38(10.0)
Lymphadenopathy	31(8.2)	225(59.2)	124(32.6)
Hanging groin	87(22.9)	183(48.2)	110(28.9)
Lymphoedema (Limb)	28(7.4)	306(80.5)	46(12.1)
Lymphoedema (Geniitals)	11(2.9)	341(89.7)	28(7.4)
Hernia	34(8.9)	262(68.9)	84(22.1)
Blindness	13(3.4)	326(85.8)	41(10.8)

Table 52: Suggested Reason(s) for not Marrying Persons with Different Disease Manifestations (Multiple Response Possible)

Clinical Manifestation	No of people who refused marriage	Reasons for Refusal							
		Can infect me/ contract disease	Dirty skin	Affect child bearing	Reduced mobility/less productivity	Looks old	Cannot Stand the sight	Bad omen/ associated stigma	No reason
Nodule	17	2(11.8)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	9(52.9)	0(0.0)	6(35.3)
Dermatitis	280	64(22.9)	37(13.2)	2(0.7)	4(1.4)	21(7.5)	42(15.0)	91(32.5)	19(6.8)
Depigmentation	35	1(2.9)	1(2.9)	0(0.0)	0(0.0)	11(31.4)	4(11.4)	16(45.7)	2(5.7)
Lymphadenopathy	225	16(7.1)	0(0.0)	27(12.0)	4(1.8)	0(0.0)	54(24.0)	34(15.1)	90(40.0)
Hanging groin	183	24(13.1)	7(3.8)	2(1.1)	0(0.0)	61(33.3)	49(26.8)	27(14.8)	13(7.1)
Lymphoedema(Limb)	306	9(2.9)	4(1.3)	4(1.3)	79(25.8)	14(4.6)	42(13.7)	133(43.5)	21(6.9)
Lymphoedema(Genitals)	341	38(11.1)	3(0.9)	178(52.2)	0(0.0)	7(2.1)	39(11.4)	64(18.8)	12(3.5)
Hernia	262	7(2.7)	0(0.0)	96(36.6)	8(3.1)	4(1.5)	61(23.3)	78(29.8)	8(3.1)
Blindnes	326	14(4.3)	0(0.0)	7(2.1)	195(59.8)	29(8.9)	19(5.8)	59(18.1)	3(0.9)

Table 53: Attitude Towards Hiring/ Engaging Persons with different Clinical Manifestation as Farm Hands or in Other Productive Ventures.

	Attitudinal Response (%)		
Clinical Manifestation	**Yes**	**No**	**Does not Know**
Nodule	351(92.4)	0(0.0)	29(7.6)
Dermatitis	146(38.4)	218(57.4)	16(4.2)
Depigmentation	327(86.1)	21(5.5)	32(8.4)
Lymphadenopathy	348(91.6)	7(1.8)	25(6.6)
Hanging groin	321(84.5)	31(8.2)	28(7.4)
Lymphoedema (Limb)	41(10.8)	298(78.4)	41(10.8)
Lymphoedema (genital)	214(56.3)	123(32.4)	43(11.3)
Hernia	197(51.8)	153(40.3)	30(7.9)
Blindness	0(0..0)	368(96.8)	12(3.2)

Table 54: Suggested Reason(s) for not Hiring / Engaging Persons with different Clinical Manifestation (Multiple Response Possible)

Clinical Manifestation	No of Persons who refused hiring Persons	Reasons For Refusal					
		Reduced mobility/Less productivity	Frequent loss of attention/less productivity	Frequent visits to hospitals for treatment	Bad Omen/associated stigma	Fear of contracting infection	No reason
Nodule	0	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Dermatitis	218	0(0.0)	107(49.1)	51(23.4)	34(15.6)	19(8.7)	7(3.2)
Depigmentation	21	0(0.0)	0(0.0)	0(0.0)	3(14.3)	2(9.5)	16(76.2)
Lymphadenopathy	7	4(57.1)	0(0.0)	1(14.3)	2(28.6)	0(0.0)	0(0.0)
Hanging groin	31	0(0.0)	0(0.0)	0(0.0)	11(35.5)	5(16.1)	15(48.4)
Lymphoedema (Limb)	298	225(75.5)	11(3.7)	27(9.1)	17(5.7)	11(3.7)	7(2.3)
Lymphoedema (Genitals)	123	57(46.3)	9(7.3)	14(11.4)	21(17.1)	5(4.1)	17(13.8)
Hernia	153	91(59.5)	17(11.1)	6(3.9)	12(7.8)	6(3.9)	21(13.7)
Blindness	368	356(96.7)	0(0.0)	0(0.0)	7(1.9)	0(0.0)	5(1.4)

Table 55: Local Perception on Whether Infected Villagers can go to ChurchMarket/School or other Social Gatherings.

Clinical Manifestation	Perception towards attending church/ market/school social gathering (%)		
	Yes	No	Does not Know
Nodule	339(89.2)	9(2.4)	32(8.4)
Dermatitis	148(38.9)	153(40.3)	79(20.8)
Depigmentation	309(81.3)	25(6.6)	46(12.1)
Lymphadenopathy	294(77.4)	51(13.4)	35(9.2)
Hanging groin	317(83.4)	37(9.7)	26(6.8)
Lymphoedema (Limb)	223(58.7)	126(33.2)	31(8.2)
Lymphoedema (Genitals)	289 (76.1)	75(19.7)	16(4.2)
Hernia	273(71.8)	66(17.4)	41(10.8)
Blindness	264(69.5)	98(23.4)	27(7.1)

Table 56: Perceived Reason(s) why Afflicted Persons Cannot go to Church/Market/School/other Social Gatherings.

Clinical Manifestation	No of respondents With negative Perception	Reasons for such perception					
		Can infect me/contract disease	Dirty Skin/ Associated stigma	Looks old/can't Stand sight	Reduced mobility	Bad omen/ Associated stigma	No reason
Nodule	9	0(0.0)	0(0.0)	0(0.0)	0(0.0)	3(33.3)	6(66.7)
Dermatitis	153	23(15.0)	93(9.8)	15(9.8)	0(0.0)	22(14.4)	0(0.0)
Depigmentation	25	1(4.0)	5(20.0)	5(20.0)	0(0.0)	9(36.0)	5(20.0)
Lymphadenopathy	51	0(0.0)	0(0.0)	0(0.0)	7(13.7)	31(60.8)	13(25.5)
Hanging groin	37	3(8.1)	1(2.7)	0(0.0)	0(0.0)	27(73.0)	6(16.2)
Lymphoedema (Limb)	126	9(7.1)	4(3.2)	21(16.7)	68(54.0)	17(13.5)	7(5.6)
Lymphoedema (Genitals)	75	0(0.0)	0(0.0)	0(0.0)	7(9.3)	51(68.0)	17(22.7)
Hernia	66	0(0.0)	0)0.0)	0(0.0)	7(10.6)	48(72.7)	11(16.7)
Blindness	98	0(0.0)	0(0.0)	0(0.0)	73(74.5)	25(25.5)	0(0.0)

Table 57: Activities Respondents would not want with Infected Persons (Multiple Responses Possible).

Clinical Manifestations	Activities respondents would not want with infected persons (%)				
	Eat	Sleep	Sexual intercourse	Discussion	Handshake
Nodule	0(0.0)	2(0.5)	0(0.0)	0(0.0)	0(0.0)
Dermatitis	17(4.5)	76(20.0)	84(22.1)	2(0.5)	14(3.7)
Depigmentation	1(0.3)	1(0.3)	4(1.1)	0(0.0)	0(0.0)
Lymphadenopathy	0(0.0)	14(3.7)	29(7.6)	0(0.0)	1(0.3)
Hanging groin	1(0.3)	23(6.1)	97(25.5)	1(0.3)	9(2.4)
Lymphoedma (Limb)	7(1.8)	39(10.3)	41(10.8)	2(0.5)	2(0.5)
Lymphoedema (Genitals)	32(8.4)	46(12.1)	181(98.9)*	0(0.0)	7(1.8)
Hernia	14(3.7)	28(7.4)	147(38.7)	0(0.0)	3(0.8)
Blindness	4(1.1)	7(1.8)	94(24.7)	0(0.0)	2(0.5)

* Out of 183 Female Respondents.

Table 58: Relationship of Respondents with Infected Relatives

Clinical Manifestation	No of Respondents who have infected relatives	Relationship of Respondents with infected relatives (%)			
		Normal	Withdrawn	Isolation	Indifferent
Nodule	152	127(83.6)	0(0.0)	0(0.0)	25(6.6)
Dermatitis	167	76(45.5)	54(32.3)	14(8.4)	23(13.8)
Depigmentation	119	104(87.4)	4(3.4)	0(0.0)	11(9.2)
Lymphadenopathy	3	2(66.7)	0(0.0)	0(0.0)	1(33.3)
Lymphoedma (Limb)	9	4(44.4)	2(22.2)	1(11.1)	2(22.2)
Lymphoedema (Genitals)	1	0(0.0)	0(0.0)	0(0.0)	1(100.0)
Hernia	17	15(88.2)	0(0.0)	0(0.0)	2(11.8)
Blindness	4	3(75.0)	0(0.0)	0(0.0)	1(25.0)

Social costs of onchocerciasis on afflicted individuals and coping mechanisms.

Table 59 shows the reactions of afflicted respondents on observation of their manifestation for the first time. Majority of the patients with nodules (80.5%) and depigmention (73.9%) felt normal about their conditions. Those with dermatitis, lymphadenopathy, hanging groin, lymphoedema (limb), lymphoedema (genital), hernia and blindness showed varied reactions from being afraid/disturbed to frustrated and hopeless/insecure. Only a few patients felt indifferent about their condition.

Table 60 describes the effect of disease manifestation on personal life. While the majority of patients with dermatitis (76.5%), lymphadenopathy (85.7%), hanging groin (50.0%), lymphoedema limb (50.0%), hernia (64.3%) and blindness (100.0%) felt inferior about their conditions, those presenting with nodules (95.1%) and depigmentation (73.9%) felt normal about their conditions. Sixty – six percent of patients with lymphoedema (genital) refused to comment on the issue.

The effects of the disease on the degree of interaction of infected persons with other villagers showed that patients with nodules (95.1%), depigmentation (82.6%) and hanging groin (50.0%) had normal interactions when compared with patients with other manifestations (Table 61). On the contrary, patients with dermatitis (70.6%), lymphoedema (limb) (50.0%) and blindness (100.0%) suffered from reduced interactions with villagers. All the patients presenting with lymphoedema (genital) refused to discuss the issue.

The responses on whether the manifestations could prevent afflicted persons from attending or performing any village activity showed that majority of the persons with nodules (100.0%), depigmentation (91.3%), lymphadenopathy (71.4%), hanging groin (100.0%), hernia (50.0%) stated that their afflictions have not prevented them from any village activity (Table 62). However, patients presenting with dermatitis (70.6%), lymphoedema (limb) (50.0%) and blindness (100.0%) confirmed that their afflictions have affected them. Majority of patients with lymphoedema (genital) refused to comment on the issue.

Table 63 reveals that lymphoedema (limb) (50.0%) and blindness (100.0%) affected job/productivity of afflicted villagers when compared with nodules (100.0%),dermatitis (70.6%), depigmentation (100.0%), lymphadenopathy (71.4%), hanging groin (100.0%) and hernia (71.4%) that did not have much effect on job/productivity of patients.

Table 64 summarizes the steps taken by afflicted villagers to treat their disease manifestations. While majority of the villagers consulted either herbalist or oracles, others used orthodox forms of treatment (hospital/clinic) or hid their afflictions. However, most patients with nodule (78.0%), dermatitis (17.6%), depigmentation (43.5%), lymphadenopathy (14.3%), hanging groin (50.0%) and hernia (7.1%) did nothing about their conditions.

3.3.2 Economic Costs Of Onchocerciasis

Onchocercal skin disease (OSD) in the household and school attendance.

The result of the impact of onchocercal skin disease (OSD) in the household on school attendance of pupils is summarized in Table 65. The overall mean percentage drop out in school attendance was significantly higher in households where heads had severe – OSD when compared with households where heads were of non-OSD status ($P<0.05$). The respective drop out rates differed in all the

Table 59: Reaction of Infected Respondents on Observation of their Manifestation for the first time (Multiple Responses Possible)

Clinical manifestation	No of respondents with manifestation	Reactions (%)				
		Afraid/ Disturbed	Frustrated	Hopeless/ insecure	Normal	Indiff-erent
Nodule	41	3(7.3)	0(0.0)	0(0.0)	33(80.5)	5(12.3)
Dermatitis	17	9(52.9)	7(41.2)	7(41.2)	1(5.9)	0(0.0)
Depigmentation	23	1(4.3)	0(0.0)	0(0.0)	17(73.9)	5(21.7)
Lymphadenopathy	7	5(71.4)	2(28.6)	4(57.1)	1(14.3)	0(0.0)
Hanging groin	4	2(50.0)	0(0.0)	1(25.0)	0(0.0)	1(25.0)
Lymphoedma (Limb)	4	2(50.0)	0(0.0)	2(50.0)	0(0.0)	0(0.0)
Lymphoedema (Genitals)	3	3(100.0)	3(100.0)	3(100.0)	0(0.0)	0(0.0)
Hernia	14	9(64.3)	5(35.7)	5(35.7)	0(0.0)	2(14.3)
Blindness	1	1(100.0)	1(100.0)	1(100.0)	0(0.0)	0(0.0)

Table 60: Effect of Disease Manifestation on Personal Life (Multiple Responses Possible)

Clinical manifestation	No of respondent with clinical manifestation	Effects on personal life (%)			
		Normal	Withdrawn	Inferior	No comment
Nodule	41	39(95.1)	0(0.0)	2(4.9)	0(0.0)
Dermatitis	17	0(0.0)	9(52.9)	13(76.5)	0(0.0)
Depigmentation	23	17(73.9)	0(0.0)	2(8.7)	4(17.4)
Lymphadenopathy	7	1(14.3)	0(0.0)	6(85.7)	0(0.0)
Hanging groin	4	1(25.0)	0(0.0)	2(50.0)	1(25.0)
Lymphoedma (Limb)	4	0(0.0)	1(25.0)	2(50.0)	1(25.0)
Lymphoedema (Genitals)	3	0(0.0)	0(0.0)	1(33.3)	2(66.7)
Hernia	14	3(21.4)	6(42.9)	9(64.3)	0(0.0)
Blindness	1	0(0.0)	0(0.0)	1(100.0)	0(0.0)

Table 61: Effect of Disease on Degree of Interaction with people.

Clinical Manifestation	No. of respondents with clinical manifestation	Effect on interaction with people (%)			
		Normal	Improved	Reduced	No comment
Nodule	41	39 (95.1)	0(0.0)	0 .(0.0)	2 (4.9)
Dermatitis	17	1 (5.9)	0(0.0)	12 (70.6)	4 (23.5)
Depigmentation	23	19 (82.6)	0(0.0)	1 (4.3)	3 (13.0)
Lymphadenopathy	7	3 (42.9)	0.(0.0)	2 (28.6)	2 (28.6)
Hanging groin	4	2(50.0)	0.(0.0)	1 (25.0)	1(25.0)
Lymphoedema (Limb)	4	1(25.0)	0(0.0)	2 (50.0)	1(25.0)
Lymphoedema (Genitalia)	3	0.(0.0)	0(0.0)	0 (0.0)	3 (100.0)
Hernia	14	4 (28.6)	0(0.0)	5(35.7)	5(35.7)
Blindness	1	0(0.0)	0(0.0)	1(100.0)	0(0.0)

Table 62: **Whether Manifestation has Prevented Respondent from Attending or Performing any Village Activity**

Clinical Manifestation	No of respondents with clinical manifestation	Frequency (%) of prevention			
		Yes	No	Does not know	No comment
Nodule	41	0(0.0)	41(100.0)	0(0.0)	0(0.0)
Dermatitis	17	12(70.6)	1(5.9)	1(5.9)	3(17.6)
Depigmentation	23	0(0.0)	21(91.3)	2(8.7)	0(0.0)
Lymphadenopathy	7	0(0.0)	5(71.4)	0(0.0)	2(28.6)
Hanging groin	4	0(0.0)	4(100.0)	0(0.0)	0(0.0)
Lymphoedema (Limb)	4	2(50.0)	1(25.0)	0(0.0)	1(25.0)
Lymphoedema (Genital)	3	1(33.3)	0(0.0)	0(0.0)	2(66.7)
Hernia	14	2(14.3)	7(50.0)	1(7.1)	4(28.6)
Blindness	1	1(100.0)	0(0.0)	0(0.0)	0(0.0)

Table 63: Whether the Disease Manifestation has Affected Job/ Productivity in any way

Clinical Manifestation	No of respondents with clinical manifestation	Frequency (%) of prevention			
		Yes	No	Does not know	No comment
Nodule	41	0(0.0)	41(100.0)	0(0.0)	0(0.0)
Dermatitis	17	4(23.5)	12(70.6)	1(5.9)	0(0.0)
Depigmentation	23	0(0.0)	23(100.0)	0(0.0)	0(0.0)
Lymphadenopathy	7	0(0.0)	5(71.4)	2(28.6)	0(0.0)
Hanging groin	4	0(0.0)	4(100.0)	0(0.0)	0(0.0)
Lymphoedema (Limb)	4	2(50.0)	1(25.0)	1(25.0)	0(0.0)
Lymphoedema (Genital)	3	0(0.0)	1(33.3)	2(66.7)	0(0.0)
Hernia	14	2(14.3)	10(71.4)	2(14.2)	0(0.0)
Blindness	1	1(100.0)	0(0.0)	0(0.0)	0(0.0)

Table 64: Steps taken by Afflicted Respndents toTreat Disease manifestations.

Forms of Treatment Undertaken	Clinical Manifeestation								
	Nodule (N = 41)	Dermatitis (N =17)	Depigmentation (N = 23)	Lymphadenopathy (N = 7)	Hanging Groin (N = 4)	Lymphoedema (Limb) (N = 4)	Lymphoedema (Genital) (N = 3)	Hernia (N = 14)	Blindness (N = 1)
Went to Hospital	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	2(14.3)	0(0.0)
Went to Clinic	0(0.0)	1(5.9)	0(0.0)	1(14.3)	O(0.0)	1(25.0)	0(0.0)	1(7.1)	0(0.0)
Went to Herbalist	9(22.0)	7(41.2)	4(17.4)	2(28.6)	0(0.0)	1(25.0)	1(33.3)	7(50.0)	1(100.0)
Consulted Oracle	0(0.0)	4(32.5)	9(39.1)	3(42.9)	1(25.0)	2(50.0)	2(66.7)	1(7.1)	0(0.0)
Hid infection	0(0.0)	2(11.8)	0(0.0)	0(0.0)	1(25.0)	0(0.0)	0(0.0)	2(14.3)	0(0.0)
None	32(78.0)	3(17.6)	10(43.5)	1(14.3)	2(50.0)	0(0.0)	0(0.0)	1(7.1)	0(0.0)

schools investigated and showed a fairly strong but insignificant association with community microfilarial prevalence (r = 0.63, P>0.372)

Direct costs of treatment

Table 66 shows the mean costs of treatment of patients with OSD. For all types of health care utilized, cases spent ₦368.34 more than controls over the 6-month period. A further analysis using the paired t-test statistic revealed that for the health care types chemist/drug peddlar, herbalist/ oracle and self medication, cases spent significantly ₦ 185.74, ₦ 82.19 and ₦ 35.00 respectively more than controls. For hospital/clinic , cases spent ₦ 65.41 more than controls, even though different was not significant(P>0.077). The mean costs of treatment of patients with chronic lymphatic complications is summarized in Table 67. Overall cases spent ₦ 685.54 more than controls over the 12months period of study. The use of the paired t-test statistic showed that cases spent significantly ₦ 250.03 more than controls for chemist/ drug peddlar. For all the other types of healthcare utilized, cases spent more than control, although differences were not statistically significant.

The number of times health care was sought by OSD patients is shown in Table 68. Cases spent significantly more times than controls for the health care types chemist/drug peddlar (P<0.003) and herbalist/oracle (P<0.001). For health care types, hospital/clinic and self medication, cases spent more times than control although differences were not significant. Patients with chronic lymphatic complications spent significantly more times than control for the health care types hospital/clinic, chemist/drug peddlar and herbalist/oracle (Table 69). Similarly, cases spent more times seeking healthcare than controls for self medication but difference was not significant statistically (P>0.057).

Indirect costs: activity patterns

Table 70 shows the ability and disability with respect to various activities amongst OSD patients within the 6 months study period. Few persons with OSD were able to perform the activities investigated when compared with controls. The Chi-square analysis revealed that for all activities the difference in ability and disability were significant ($P<0.05$).

The ability and disability amongst people with chronic lymphatic complications with respect to various activities are presented in Table 71. Few people were able to perform various activities when compared with controls. The differences in ability and disability were significant ($P<0.05$) for all activities with the exception of household chores, childcare/breast feeding and animal rearing ($P>0.05$)

Loss of revenue

Loss of revenue due to direct cost of treatment

Loss of revenue due to direct cost of treatment (including those associated with food and transport) was estimated using population prevalence or proportion, and on the assumption the individual household is the unit of activity. Estimates show that about ₦6.3 million is lost annually to the direct costs of treatment of non-ocular onchocerciasis in the study area.

Loss of revenue as a result of incapacitation due to disability.

Loss of revenue as a result of incapacitation due to disability was also made using population prevalence and on 2 assumptions namely; that the households is the unit of activity and the mean period of total incapacitation due to OSD was 1.5 days. Estimate shows that about 1846.5 days was lost per annum as a result of incapacitation due to OSD. The value of man-days lost and its equivalent labour replacement cost in monetary terms was then estimated as the product of total period of incapacitation and the value of marginal productivity of labour (VMPL) (which is the same as wage rate in the area). As at the time of the study the average wage rate per day was ₦850. Therefore revenue loss due to incapacitation was about ₦1.6 million annually.

Total revenue loss due to non-ocular onchocerciasis in the Imo River Basin derived from the direct costs of treatment and indirect costs (measured by incapacitation) is conservatively estimated at ₦7.9 million annually. The overall cost benefit analysis of the control of human onchocerciasis in the study area is complicated by the absence of empirical evidence on the economic impacts of onchocercal blindness.

3.4 KNOWLEDGE, ATTITUDES AND PERCEPTIONS (KAP) ON IVERMECTIN (MECTIZAN) TREATMENT

To assess the knowledge, attitudes and perceptions of villagers on treatment with ivermectin (mectizan), 247 persons were interviewed. The results of their responses are summarized in Table 72.

3.4.1 Knowledge

More than half (59.5%) of those interviewed knew about the drug ivermectin. The age distribution showed that respondents aged 20-49 had the highest knowledge (71.2%) of the drug, followed by those 50years and above (60.7%), while respondents 20 years and below (43.9%) had the least knowledge. The sex distribution also showed that males (61.0%) had higher knowledge than females (57.7%). The responses in relation to occupation revealed that all health workers (100.0%) interviewed knew about ivermectin as against 67.9% of farmers, 60.7% of civil servants, 55.4% of students and 30.2% of artisans/traders. Most of the

Table 65: Onchocercal Skin Disease (OSD) in the Household and School Attendance in the Imo River Basin

School	Head of Household OSD Status						Community Microfilarial Prevalence (%)
	Severe-OSD Status			Non-OSD Status			
	1st term	3rd term	% drop	1st term	3rd term	% drop	
Amuro Community Primary School	47	45	4.3	51	50	2.1	34.3
Ihube Community Primary School	49	47	4.1	53	53	0.0	15.7
Aku Primary School	42	40	4.8	46	45	2.2	27.8
Umulolo Community Primary School	47	44	6.4	48	46	4.2	36.0

* {(1st term - 3rd term)/1st term} x 100

Table 66: Mean Costs of Treatment of OSD Patients (N = 52)

Types of Health Care Utilized	Cases (₦)	Controls (₦)	Difference[a] (₦)	P -Value for paired t-test
Hospital/Clinic	196.74	131.33	65.41	>0.077
Chemist/Drug Peddlar	447.56	261.82	185.74	<0.001
Herbalist/Oracle	319.01	236.82	82.19	<0.0001
Self Medication	161.73	126.73	35.00	<0.047

a Difference = (case value - control value)

Table 67: Mean Costs of Treatment of Patients with Chronic Lymphatic Complications

Types of Health Care Utilized	Cases (₦)	Controls (₦)	Difference (₦)	P -Value for paired t-test
Hospital/Clinic	545.38	219.51	325.87	>0.103
Chemist/Drug Peddlar	506.12	256.09	250.03	<0.001
Herbalist/Oracle	210.97	161.55	49.42	>0.074
Self Medication	275.97	215.75	60.22	>0.056

Table 68: Number of Times Health Care was Sought by OSD Patients

Types of Health Care Utilized	Cases	Controls	Difference	P -Value for paired t-test
Hospital/Clinic	3.13	2.25	0.88	>0.133
Chemist/Drug Peddlar	6.60	3.60	3.00	<0.003
Herbalist/Oracle	4.64	2.91	1.73	<0.001
Self Medication	3.80	2.60	1.20	>0.109

Table 69: Number of Times Health Care was Sought by Patients with Chronic Lymphatic Complications

Types of Health Care Utilized	Cases (₦)	Controls (₦)	Difference (₦)	P -Value for paired t-test
Hospital/Clinic	3.00	1.75	1.25	<0.015
Chemist/Drug Peddlar	3.57	2.29	1.28	<0.022
Herbalist/Oracle	2.60	1.80	0.80	<0.016
Self Medication	3.33	2.00	1.33	>0.057

Table 70: Ability and Disability Amongst OSD Patients

Activity	No. able to perform activity (No. tested) OSD Cases	OSD Controls	X^2 and P Value
Farming	16(49)	45(47)	14(<0.0001)
Household Chores	8(35)	35(35)	44(<0.0001)
Childcare/ Breast Feeding	3(9)	8(9)	9(0.0156)
Market Activities	8(43)	35(39)	41(<0.0001)
Animal Rearing	5(18)	16(18)	14(<0.0001)
Meetings/Social Functions	15(49)	44(47)	40(<0.0001)

Table 71: Ability and Disability Amongst Patients with Chronic Lymphatic Complications

Activity	No. able to perform activity (No. tested)		X^2 and P Value
	Chronic Cases	Controls	
Farming	7(28)	23(27)	20(<0.0001)
Household Chores	8(17)	11(14)	3(0.0731)
Childcare/ Breast Feeding	3(5)	3(4)	1(0.6353)
Market Activities	6(23)	19(21)	19(<0.0001)
Animal Rearing	5(9)	4(7)	0(0.9496)
Meetings/Social Functions	18(27)	24(27)	4(0.0495)

respondents knew about the drug from an NGO (Global 2000 River Blindness Programme) staff working in the area, village health workers and older relatives. There were no specific local names for the drug in all the communities investigated. However, the drug was easily known by reference to several factors like the name of the village based distributor ("ogwu John" meaning "drug being distributed by John"). It was also commonly identified by reference to some of the clinical manifestations of the disease like itching ("ogwu oko vari vari" meaning "drug for itching") or the disease vector ("ogwu nwanmi" meaning "drug used to kill *Simulium damnosum* parasite) .

3.4.2 Acceptance

About 79.8% of respondents agreed that the drug was well accepted in the study area. The degree of acceptance was higher with increasing age as respondents below 20 years had the least acceptance (72.0%) as against those 50 years and above that had the highest acceptance (86.9%). Overall, females showed higher acceptance of ivermectin (86.5%) than their male counterparts (74.3%). Amongst occupational groups, health workers (90.5%) and farmers (88.9%) had the highest acceptance while artisans/traders (48.8%) had the least acceptance of ivermectin.

3.4.3 Compliance with Yearly Treatment

The results of the compliance of respondents with yearly treatment showed that the older age groups 20-49 (75.0%) and 50^{+} (73.8%) were more compliant than the younger respondents, 20 years and below (57.3%). Female respondents (76.5%) were also more compliant than male respondents (62.5%). For occupational groups, those with more knowledge of the drug namely health workers (81.0%) and those at greater risk of infection, farmers (80.0%) were more compliant to yearly treatment than the other groups namely civil servants (71.4%), students (68.9%) and artisans/traders (39.5%).

3.4.4 Perceived Efficacy of Ivermectin

Responses with respect to the perceived efficacy of the drug showed that 67.2% of overall responses perceived ivermectin as being moderately to quite effective. While 6.1% of responses said that the drug had no effect, another 26.7% of responses were indifferent to the perceived efficacy of the drug. Older respondents perceived ivermectin as being more effective than younger respondents. In a similar manner, health workers and farmers perceived the drug as being more effective than respondents in other professions (students, civil servants, artisans/traders). The benefits of the use ivermectin included dissolution of palpable nodules, improvement of vision and skin conditions, expulsion of intestinal worms, the relief of muscular pains etc.

3.4.5 Amount Willing to Pay per Dose of Ivermectin

About 38.1% of respondents agreed to pay between ₦31 to ₦60 per dose of ivermectin, while 6.5% agreed to pay between ₦61 to ₦100 per dose . 25.1% of respondents could pay between ₦1 to ₦30 per dose, while 30.4% of respondents indicated inability to pay but would show interest in any community programme meant at controlling the disease. Responses also showed that the occupational group at the greatest risk ^ infection, farmers (96.3%) and those with greater knowledge about benefits of the drug, health workers (100.0%), civil servants (100.0%) were willing to pay more than those at lower risk of infection namely, artisans/ traders (79.1%) and students (14.9%).

Table 72: Attitudes and Perception of Villagers Towards Ivermectin (Mectizan) Treatment

	Age Group			Sex		Occupation					
	20 n=82 No(%)	20-49 n=104 No(%)	50+ n=61 No(%)	Male n=136 No(%)	Female n=111 No(%)	Farmers n=81 No(%)	Artisans/ Traders n=43 No(%)	Health Workers n=21 No(%)	Civil Servants n=28 No(%)	Students n=74 No(%)	Total n=247 No(%)
a) Knowledge of drug	36(43.9)	74(71.2)	37(60.7)	83(61.0)	64(57.7)	55(67.9)	13(30.2)	21(100.0)	17(60.7)	41(55.4)	147(59.5)
b) Acceptance of drug	59(72.0)	85(81.7)	53(86.9)	118(86.8)	79(71.2)	72(88.9)	21(48.8)	19(90.5)	20(71.4)	65(87.8)	197(79.8)
c) Compliance with yearly treatment	47(57.3)	78(75.0)	45(73.8)	104(76.5)	66(59.5)	65(80.0)	17(39.5)	17(81.0)	20(71.4)	51(68.9)	(170(68.8)
d) Perceived Efficacy											
Quite effective	11(13.4)	37(35.6)	23(37.7)	46(33.8)	25(35.2)	27(33.3)	13(30.2)	11(52.4)	9(32.1)	11(14.9)	71(28.7)
Moderately "	9(11.0)	53(51.0)	33(54.1)	58(42.6)	37(33.3)	47(58.0)	13(30.2)	8(38.6)	15(53.6)	12(16.2)	95(38.5)
No effect	0(0.0)	10(9.6)	5(8.2)	8(5.8)	7(6.3)	7(8.6)	4(9.3)	0(0.0)	4(14.3)	0(0.0)	15(6.1)
Can't say	62(75.6)	4(3.8)	0(0.0)	24(17.6)	42(37.8)	0(0.0)	13(30.2)	2(9.5)	0(0.0)	51(68.9)	66(26.7)
e) Amount willing to pay per month for ivermectin ₦											
1 - 30	11(13.4)	35(33.7)	16(26.2)	38(27.9)	24(21.6)	18(22.2)	14(32.6)	14(66.7)	12(42.9)	4(5.4)	62(25.1)
31 - 60	9(11.0)	63(60.6)	22(36.1)	71(52.2)	23(20.7)	50(61.7)	17(39.5)	6(28.6)	14(50.0)	7(9.5)	94(38.1)
61 - 100	4(4.9)	4(3.8)	8(13.1)	13(9.6)	3(2.7)	10(12.3)	3(7.0)	1(4.8)	2(7.1)	0(0.0)	16(6.5)

3.5 CLINICO-MICROBIOLOGICAL STUDIES

3.5.1 Prevalence Of Microorganisms in Excoriated Onchocercal Lesions

Out of the 1231 persons presenting with reactive onchocercal skin disease screened, 85 (6.9%) had excoriated lesions suggestive of being infected secondarily with bacterial agents. Sixty one (71.8%) persons proved to have bacterial infections, and in most cases of a mixed origin. The frequency of isolation of the different agents is given in Table 73. *Staphylococcus aureus* was the most encountered occurring in 53 (89.9%) of the positive cases. This was followed by *Escherichia coli* and β- hemolytic *Streptococcus pyogenes* which were isolated from 37 (60.7%) and 31 (50.8%) of positive lesions respectively. *Pseudomonas aeruginosa* and other unidentified *Pseudomonas* spp gave recovery rates of 21.3% and 8.2% respectively. *Bacteriodes* spp and unidentified *Clostridium* spp were associated with 7 (11.5%) positive cases each. The least recovered organism was *Clostridium tetani* which occurred in only 2 (3.3%) positive cases. Besides the bacterial organisms, they yeast-like fungus *Candida albicans* was isolated from 24 (39.3%) positive cases. Two dermatophytes *Trichophyton rubrum* (3.3%) and *Microsporum gypseum* (6.6%) were associated with some of the scrapings collected around excoriated lesions.

3.5.2 Sites of Infection and Clinical Features

The different body sites from which microorganisms were isolated are shown in Table 74. Lesions on the feet (90.3%) and legs (85.2%) were the commonest sites of infection by superinfecting organisms. The other sites of infection were the hand (55.6%), trunk (36.4%) and the face (14.3%). Lesions yielding microbial cultures were in general clinically indistinguishable except for the sites where dermatophytes were recovered from. Itching, inflammation, soreness and occasionally suppuration and erythema were the most common symptoms. Scaling was more characteristic of the sites from where dermatophytes were recovered.

3.5.3 Antimicrobial Susceptibility Tests

The result of the antimicrobial sensitivity testing is shown in Table 75. All the isolates showed variation in susceptibility to the antibiotics used. *S. aureus* and *S. pyogenes* gave a 100% susceptibility to ciproxin and tarivid. *E. coli* and *Bacteroides* spp similarly gave remarkable susceptibility to both drugs while *P. aeruginosa* was the least susceptible. Generally, all the isolates showed low susceptibilities to rifampin, ampicillin and ampiclox. Only *P. aeruginosa* exhibited marked resistance to most of the drugs used including rifampin, ampiclox, chloramphenicol, ampicillin, togamycin and colimycin.

Table 73: Relative Frequency of Isolation of Microorganism From 61 cases of Excoriated Onchocercal Lesions.

Microorganism	No (%) Isolated
Staphylococcus aureus	53(89.9)
β-hemolytic *Streptococcus pyogenes*	31(50.8)
Pseudomonas aeruginosa	13(21.8)
Pseudomonas species	5(8.2)
Escherichia coli	37(60.7)
Bacteroides species	7(11.5)
Clostridium species	2(3.3)
Candida albicans	24(39.3)
Trichophyton rubrum	2(3.3)
Microsporum gypseum	4(6.6)

Table 74: Positive Microbial Cultures according to Different Sites of Excoriated Lesions

Site of Lesion	Total No of Samples	No (%) Positive for Microorganism	No (%) Negative for Microorganism
Feet	40	36(90.0)	4(10.0)
Leg	35	30(85.7)	5(14.3)
Hand	17	9(52.9)	8(47.1)
Trunk	19	7(36.8)	12(63.2)
Face	15	2(13.3)	13(86.7)
Total	126	84(66.7)	42(33.3)

Table 75: Antimicrobial Sensitivity of Some of the Isolates from Excoriated Onchocercal Lesions.

Antimicrobial Agents	Disc Potency	No(%) of susceptibility of isolates				
		S. aureus	*S. pyogenes*	*P. aeruginosa*	*E. coli*	*Bacteroides Spp*
Norfloxacin (NB)	30ug	48 (90.6)	27 (87.1)	7(53.8)	30 (81.1)	5 (71.4)
Ampiclox (AFX)	30ug	11 (20.8)	9 (29.0)	0(0.0)	20(54.1)	2(28.6)
Streptomycin (S)	30ug	28(52.8)	14(45.2)	6(46.2)	20(54.1)	1 (14.3)
Erythromycin (E)	30ug	46 (86.8)	26 (83.9)	4 (30.8)	17 (45.9)	3 (42.9)
Ampicilin (PN)	30ug	9(17.0)	9(29.0)	0(0.0)	14 (37.8)	3 (42.8)
Colimycin (COL)	30ug	31 (58.5)	19(51.4)	2 (15.4)	23(62.2)	2 (28.6)
Zinnat (CXM)	30ug	35 (66.0)	26 (83.9)	6 (46.2)	31 (83.8)	3 (42.9)
Augumentin (AU)	30ug	17 (32.1)	19 (51.4)	4 (30.8)	17 (45.9)	4 (57.1)
Nalidixic acid (NA)	30ug	41 (77.4)	23 (74.2)	4 (30.8)	17 (45.9)	3 (42.9)
Rifampin (RD)	10ug	9 (17.0)	7 (22.6)	0 (0.0)	11 (29.7)	2 (28.6)
Ciproxin (CPX)	10ug	53 (100.0)	31 (100.0)	7 (53.8)	35 (94.6)	5(71.4)
Gentamycin (GN)	10ug	48 (90.6)	7 (22.6)	7 (53.8)	25 (67.6)	0 (0.0)
Tarivid (OFX)	10ug	53 (100.0)	31 (100.0)	6 (46.2)	36 (97.3)	4 (57.1)

CHAPTER FOUR

DISCUSSION

4.1 ONCHOCERCIASIS IN THE IMO RIVER BASIN

4.1.1 <u>Overall Prevalence, Intensity and Distribution</u>

The result of the present study attest to the endemicity of onchocerciasis in communities within the Imo River Basin. It further suggests that infection has a wider distribution in the basin than was previously reported (Nwoke *et al.* 1994). The prevalence and intensity of infection varied (P <0.05) with communities in the Upper Imo River Basin having a mean higher score (26.8%) and CMFL (22. Imf/ss) respectively than those in the Middle Imo River Basin with prevalence of 19.0% and CMFL of 18.1 mf/ss. This variation may be explained in terms of unequal exposure of villagers to the bites of the disease vectors, S. *damnosum*, apparently because of differences in the hydrogeological and topographic features of the basin. Communities in the Upper Basin are characterized by rocky and hilly terrain, and presence of numerous rivulets and streams with exposed basement rocks which form resistant rapids that favour the breeding of the vectors. The lowland communities of the Middle and Lower Basin on the other hand are drained by bigger and more sluggish stream and rivers.

Overall majority of skin snip positive persons had low skin mf density (1-25mf/ss). This could be attributed to the mass treatment of endemic communities with vermectin by Global 2000 River Blindness Program (GRBP) which had gone through 4 cycles before the commencement of the study. In addition, the use of local herbs and Diethyl carbamazine, DEC (Banocide) before the introduction of Ivermectin might have affected the prevalence of the disease.

The overall sex-related incidence of infection showed a similar pattern in males and females. This could be attributed to equal exposure to the vectors of the disease which might occur through their involvement in the same occupational activities (in particular, farming) or by living in close proximity to the breeding sites of the vectors. To a lesser extent, the local dress code for women which exposes some of the body parts especially the head, hands and feet may be a contributory factor. A few related studies in the rainforest had established near similar infection rates in males and females in endemic communities either as a result of equal occupational exposure or nearness to breeding sites (Edungbola, 1981; Nwoke *et al.* 1994).

Generally, these findings suggest that sex-differential with respect to infection may be the same in the rainforest zone irrespective of the degree of endemicity. This is in contrast to what is obtained in the northern bioecological savanna zone where the degree of endemicity determines the pattern of sex infections. For instance, in hypo-and mesoendemic communities living far away from the foci of infection, male subjects show significantly higher prevalence and intensities of infection than females (Nwoke *et* al 1989; Nwoke *et al.* 1991; Anosike and Onwuliri, 1995). This is because the surroundings of such villages are not easily accessible to the vector flies and therefore occupational exposure tends to play a more prominent role than living in close proximity to the breeding sites of vectors (Crosskey, 1954b). In hyperendemic communities on the other hand where almost every activity brings the individual into contact with the vector, the distribution of infection between sexes is the same irrespective of nature of occupation (Bradley, 1976; Akogun and Onwuliri, 1991). The observed lower prevalence in females in such hyperendemic communities may be the result of unexplained hormonal factors during childbearing years that may affect response to infection (Anderson *et al.* 1974a; Ramaiah *et al.* 1989; Brabin, 1990). In addition, the traditional dress code for Moslem women gives enough protection against the bites of the vectors (Anosike and Onwuliri, 1995). Furthermore, the fact that these women spend the greater part of the day on indoor activities could be contributary to their lower disease incidence.

The chronic and cryptic nature of onchocerciasis which is characterized by an increase in infection with age as have been previously reported (Crosskey and Crosskey, 1974; Buck, 1974; Edungbola *et al.* 1983; Nwoke *et al.* 1987; Onwuliri *et al.* 1987; Anosike and Onwuliri, 1995) was also demonstrated in the present study. The prevalence and intensity of infection increased with age from 7.4% and 7.6mf/ss in persons aged 0-9 years to a peak prevalence of 52.4% and 33.5mf/ss in those aged 60 years and above. Like Nwoke *et al.* (1994) had earlier reported, it is plausible that children in endemic communities in the study area have early man/fly contact by their habits and frequent visits to the foci of infection by assisting with farming and participating in other activities like swimming, washing, hunting, fishing and fetching water. Since these activities may be maintained throughout life in these communities, the contact with infected flies become regular and thus the age-related prevalence and intensity show a gradual increase with age.

Amongst the occupational groups encountered during the study, farmers, fisherman and hunters were the most infected while pre-school pupils were the least infected. This pattern of prevalence is not suprising since such field activities bring humans closer to the foci of the vector flies. Previous reports have shown that farmers among other man- water professions are usually highly infected as a result of their continued exposure to the disease vectors (Edungbola, 1982; Nwoke *et al.* 1987; Onwuliri *et al.* 1987; Onwuliri and Payne, 1988; Onwuliri and Anosike, 1989; Akogun and Onwuliri, 1991; Anosike and Onwuliri, 1995).

Of particular interest in the savanna bioecological zone is the reported strong association between acquisition of infection as a consequence of occupational exposure amongst the Fulani nomads and the possibility of these nomads becoming potential sources of infections (more than any other occupational groups) as a result of their habitual movement (Edungbola, 1982; Nwoke *et al.*, 1987). The reported high intensity of infection amongst the nomadic Fulanis is due to the considerable man hours spent daily in pasture grazing their livestock which often carry them to the banks of perennial but *Simulium* breeding streams and rivers where fresh grasses could be obtained even in the dry months (Nwoke *et al.*, 1987).

The appreciable prevalence amongst traders, civil servants, pupils/students and indoor/sedentary workers could be a consequence of their increased exposure to vector flies as a result of their additional involvement in subsistence farming in order to sustain the meager economy of the household. The prevalence of infection was strongly correlated with intensity of infection in the study. It is not surprising therefore that intensity of infection was highest in farmers and hunters while it was lowest in pre-school pupils.

Clinical manifestations

Onchocercal lesions

Nodules and itching were the most common onchocercal lesions encountered in the study while LOD was the least common. Nodules are more common features of rainforest than savanna onchocerciasis . A total of 1299 nodules were obtained in the present study with a greater distribution around the lower extremities (the iliac crest, greater trochanter of the femur, the coccyx and sacrum) than other parts of the body. A few nodules were located in the upper part particularly the trunk and head. Like in previous studies that had established a positive correlation between anatomical location of nodules and distribution of mf (Kershaw *et al.*, 1954; Nelson, 1958b; Edungbola, 1982; Nwoke *et al.*, 1989; Amuta and Onwuliri, 1997; 1998; Kale, 1998), the location of nodules in the lower part of the corresponded with higher microfilarial distribution. A similarity has been reported in Guatemala and Mexico for head nodules which are associated with relatively high concentration of mf in the skin of the head and neck region and a higher risk of ocular complications (Lagraulet *et al.* 1964; Salazer, 1974; Fuglsang *et al.*, 1976).

Itching and scratching have been reported to be most important early manifestations of onchocerciasis and may affect any part of the body (Wyatt, 1971; Nwoke *et al.*, 1987; Ufomadu *et al.*, 1992; Hagan, 1998). Overall, 15.2% of individuals showed this early clinical sign and there was a borderline difference in prevalence between the Upper and Middle Imo River Basins. Like onchocercal nodule, itching is a more common feature of onchocerciasis in the rainforest than savanna (Nwoke, 1991). Itching may be mild and intermittent or severe and continous. In this study, there was not much difficulty in recognizing one of the endemic communities (Umulolo) as a cross-section of the population was busy scratching during the epidemiological investigation. The socioeconomic consequences of itching in the Imo River Basin have been highlighted in the study.

The prevalence of the various skin lesions in this study is in agreement with earlier reports on the dermatological manifestations of human onchocerciasis in Nigeria (Edungbola *et al.*, 1983; Onwuliri *et al.*, 1987, Amazigo and Obikeze, 1991; Murdoch *et al.*, 1993; Amazigo, 1994; Nwoke *et al.*, 1994; WHO, 1995b; Hagan, 1998). Generally, most of the skin lesions especially the reactive ones (APOD, CPOD, LOD) in addition to DPM were observed on the trunks, hands, and legs of O. *volvuvlus* positive individuals and may be onchospecific. The possibility of some overlap however, with other filarial worms like *Mansonella perstans*, *M. streptocerca*, *Wuchereria bancrofti* and *Loa loa* in the area which share the same clinical signs with O. *volvulus* cannot be ruled out. This is especially with the finding of some persons with lesions being negative for O. *volvulus* skin biopsies.

The prevalence of LOD was low but not suprising since LOD has been reported to be characteristic of onchocerciasis in certain geographical areas such as Sudan and Yemen (WHO, 1995b). This difference may reflect vector- parasite differences. Furthermore, the interaction between *O. volvulus* and host's defense system is vital to an individual's tolerance of infection and differences in people's immune responses are probably central to the variations in the clinical pattern of onchocerciasis (Mackenzie *et al.*, 1985). The few persons with LOD however, showed marked pruritis with characteristic plaques of thickened skin.

The overall prevalence of ATR would have been grossly underestimated in this study as it was investigated only in subjects who were 50 years of age and below in order not to confuse ATR due to onchocerciasis with senile atrophy. This could account for the observed low prevalence. ATR is due to repeated episodes of acute inflammation associated with microfilarial death and destruction (Mackenzie *et al.*, 1985). Its striking feature made Laigret (1929) describe it as a condition which makes young people look like old and old people look like lizards, which Hughes and Daly (1951) called ' crocodile skin'.

In the present study, DPM included pale brown depigmentation and complete pigmentation or typical leopard skin (LS). It was observed mostly on the shins with a few cases on the buttocks, hands and scrotum of adults engaged in outdoor activities (farming, hunting and fishing). Edungbola et al. (1987) had earlier suggested the use of LS as a diagnostic index for rapid estimation of onchocerciasis endemicity in Africa. They showed a positive association between mf rate and LS and argued that the finding of such association was consistent for endemic areas in Nigeria where there had not been any intervention, changes in the local ecology or in the composition of the inhabiting population. Besides, LS is easy to assess with no religious or cultural infringement and no special diagnostic skills required by survey teams.

Age and sex differences were observed in the prevalence of onchocercal lesions. Itching and nodules increased with age but dropped in prevalence in persons in the 6th decade and above. This decline could be due to the non viability of adult female worms in long standing infection in producing more mf which can cause acute skin irritation/itching or mature into adult worms with the formation of nodules around them. Chronic papular onchodermatitis, LOD and DPM were noticed mostly among the older age groups which is an indication that they could be signs of long standing onchocercal infection. DPM has been reported as having a greater preponderance in adults in endemic communities than in the younger group (Buck, 1974; Edungbola 1982; Nwoke, 1990; Nwoke *et al.* 1994, Anosike and Onwuliri, 1995). Acute papular onchodermatitis was encountered most in persons aged 10-39 years and its prevalence decreased with age. In a recent study, Hagan (1998) had reported a similar pattern of prevalence for the reactive forms of onchcercal skin lesions. With the exception of itching and the reactive lesions, males showed higher prevalence in the other lesions than females. The observed differences could be due to an interplay of a number of factors including number of infective bites, parasite load, host immune response, nutritional factors etc.

Lymphatic complications

Lymphatic complications as a consequence of O. *volvulus* infection has been reported by previous workers (Yamada, 1978; Ogunba, 1982; Onwuliri *et al.*, 1987; Nwoke et al., 1989; Akogun and Onwuliri, 1991; Ufomadu *et al.*,1992; Anosike and Onwuliri, 1995). The observation of various complications in the present study is a further confirmation of the preponderance of these clinical manifestations in onchocerciasis endemic communities. The overall higher prevalence in the Middle Imo River Basin with a lower disease prevalence may be due to the higher number of hernia cases obtained in the basin rather than to the involvement of other filarial pathogens in the aetiology of these complications. Moreover, cases of lymphadenopathy, hanging groin and lymphoedema (genital) which have been strongly associated with onchocerciasis from previous reports (Kirk 1947, 1957; Burkitt 1966a, b; Gratama, 1966; Connor *et al.*, 1970; Buck *et al.*,1971, Connor, 1978; Connor and Palmieri, 1985) were higher in the Upper than in the Middle Imo River Basin. Although there is an overlap between O. *volvulus* and other filarial pathogens in the aetiology of Lym(limb), most of the cases encountered in the study were in persons with O. *volvulus* positive biopsies. Generally, no differences have been established with respect to the prevalence of lymphatic complications in savanna and rainforest onchocerciasis.

The pathogenesis of these complications is poorly understood and perhaps controversial. Onchocercel lymphadenities and especially the alterations in the lymphoid tissues are believed to play a role in the inflammatory and immunological responses that result in the development of hanging groin and Lym (limb and genital) (Connor *et al.*, 1970; Gibson and Connor, 1978; Connor *et al.*, 1985). Acquired hernia on the other hand is more associated with disorders of collagen metabolism caused by the presence of O. *volvulus* in the groin of infected individuals (Guderian and Kerrigan, 1990; Edungbola *et al.*, 1991) rather than the weight of hanging tissues which weaken the femoral and inguinal canals (Nelson, 1958a).

Besides lymphadenopathy and hernia, the other complications (hanging groin, lymphoedema limb and genital) could be associated with long standing infection in the Imo River Basin as only persons in the 4th decade and above had them. The decline in the prevalence of lymphoedema (limb and genitalia) in persons in the 7th decade could be attributed to morbidity due to their disabilities which probably prevented them from coming to designated centers for examination. Several studies have reported that people with large hydroceles and advanced elephantiasis are often confined to their homes resulting in a reduction in their productive capacity, (Kessel, 1957; Wijers, 1977; Wegesa *et.al.* 1979; Muhondwa, 1983).. With the exception of Lym (limb); more males than females presented with various lymphatic complications. Lym (genital) was investigated only in males because of the ease with which they were convinced to undergo a thorough physical examination. This was not the situation with females who were more reluctant to undergo vaginal examination conducted by female assistants in the team. Inspite of this limitation, genital distortion may also be a feature of onchocerciasis in the basin, since it has been reported in previous studies (Cherry, 1959).

Ocular lesions

Onchocercal blindness is the most serious clinical manifestation of onchocerciasis because of its irreversibility. An overall blindness prevalence of 0.2% was obtained in this study which by any known epidemiological definition index is low. Similarly Nwoke *et al.* (1994) had in an earlier study reported low blindness rates for communities living around the Imo River Basin. This is not suprising since the prevalence of onchocercal ocular disease (OOD) and blindness in West Africa has been reported to be much lower in the rainforest than in the savanna zone (Budden, 1963; Anderson *et al.*, 1974; Prost, 1980). This difference is due to the reported greater invasiveness and pathogenicity for the cornea of the eye by savanna strains of parasite than the forest strains (Duke 1976; 1981). In addition, climatic factors may play a role in this reported difference especially with the continous and intense sunlight combined with the harmattan dust and dryness in the savanna which could influence corneal metabolism, making it more susceptible to microfilarial invasion. It is however possible to observe a comparatively low blindness rate in onchocerciasis hyper-endemic communities in the Savanna Zone of Nigeria because of the habitual migration of disabled people from endemic villages of the savanna zone to urban centers to beg for alms (Nwoke *et al*, 1987; Nwoke 1991; Anosike and Onwuliri, 1995).

The prevalence of impaired vision (22.8%) in this study is comparable with that reported in the savanna zone (Budden, 1957; Nelson, 1970; Akogun and Onwuliri, 1991). The observed high prevalence could be due to other ocular conditions of non-onchocercal origin like cataract, glaucoma etc. An 8.4% prevalence for itchy eye obtained is comparable also with that of savanna (Anosike and Onwuliri, 1995). The pathogenesis of ocular pathology has been attributed more to the presence of dead mf than living mf (Nwoke and Dozie, 1997). Although various ocular lesions have been observed in the Imo River Basin, the overall visual consequences of onchocerciasis can be fully appreciated when the importance of anterior and posterior segment diseases including punctate keratitis, sclerosing keratitis, anterior uveitis, chorioretinitis, optic atrophy are fully taken into consideration.

Ocular lesions were observed to increase with age vis-à-vis prevalence and intensity of infection. Similar observations, have been reported in other endemic communities in Nigera (Budden 1963; Dipeolu and Gemade, 1983; Onwuliri et al. 1987; Nwoke, 1991). Males are more frequently affected than females because male dominated occupations such as farming and fishing lead to greater exposure to infected vectors (Abiose, 1998). In addition, Anderson *et. al*, (1974) reported that the lower ocular incidence in females may be attributed to possible unexplained hormonal effects during their reproductive years (Dipeolu and Gemade, 1983).

Signs and symptoms of non-classical onchocersiasis

Besides the classical dermal, ocular and lymphatic complications of onchocerciasis, certain features of uncertain association, aetiology or pathogenesis which have been described (WHO, 1995a) were observed in the study. These include MSP

(17.6%), general debility (19.5%) and epilepsy (0.5%). Generally, the distribution of these non-classical signs and symptoms follow an epidemiological trend in this study where clinical signs and symptoms that are pathognomic for onchocerciasis have been observed to have higher prevalences in the Upper River Basin than the Middle River Basin because of the higher prevalence and intensity of infection in the Upper Basin. About 68.8% of persons who presented with MSP had positive skin biopsies in addition to other clinical lesions such as nodules, pruritis and DPM which could suggest a degree of causal association with O. *volvulus*. Previous studies had established an association between MSP and onchocerciasis (Dejous, 1939; Lamp, 1971; Thompson, 1971; Pearson, 1985, 1988; Pearson *et al.* 1985). Lamp (1967) reported that 63.7% of the 77 patients diagnosed as positive for onchocerciasis in the Ile-Ife had muscular or joint pains which Shell (1981) called "Filarial rheumatism". Pearson (1988) had earlier advocated that besides the established name of" Riverblindness", onchocerciasis could also be called "Tropical Rheumatism" or "Tropical Backache". Ukaga (1997) has in a recent study suggested that MSP may affect sexual life, in addition to causing maternal mortality in endemic communities in Nigeria due to the inability to "bear down" during labour because of associated pains. The potential use of MSP as a premonitory sign or symptom in rapid, low cost diagnosis of onchocerciasis has been advocated (Nwoke, 1992). The establishment of a causal relationship between O. *volvulus* infection and general debility is difficult because of an array of confounding factors like presence of microorganism/ parasities that cause debilitation which could be complicated by poor nutritional status of persons in endemic communities.

Epidemiological surveys have indicated that the prevalence of epilepsy is higher in developing countries than in industrialized countries (Senanayake and Roman,1993). Apart from neurocystocercosis due to *Taenia solium*,little is known about specific causes to explain this difference (Commission on Tropical Diseases of the International League against Epilepsy, 1994). Recent studies, however, have established some association between epilepsy and onchocerciasis. Kaiser *et al.* (1996) in a survey in Kabarole district, Western Uganda had established a significant association between epilepsy and onchocerciasis in the absence of the only known confounding variable *T. solium*. In the present study, an overall prevalence rate of 0.5% was obtained in which 16 out of the 38 epileptic persons were positive for O. *volvulus* skin biopsies, in addition to other clinical manifestations. In the absence of confounding factors like *T. solium*, there may be a causal role for *O. volvulus* in the development of epilepsy in the basin.

The present study established a direct proportional relationship between community mf prevalence and age – related distribution of MSP. Middle aged adults (30-59 years) showed higher prevalence than the other age groups. The observed trend may not be suprising since these persons are responsible for maintaining the fragile economy of the rural households through activities like farming, fishing, hunting etc that expose them to the vectors of the disease. General debility was observed in all age groups and with no specific pattern of prevalence. Overall, more females than males had non-classical onchocerciasis. This could be due to an interplay of several epidemiological factors relating to the parasites and the resulting immune responses which affect clinical outcome.

4.1.2 Prevalence, Intensity and Distribution in the Upper Imo River Basin

This study has revealed a mean microfilarial infection of 26.8% and CMFD of 22.1mf/ss in communities in the Upper Imo River Basin. Eleven communities out of the 17 investigated had prevalence rates of 20% and above with the highest at Umulolo (36.0%); 3 communities has rates of between 10-20% while the rest had rates of below 10%. The observed variation in infection rates amongst the communities is not suprising considering their distances from the breeding sites of the vectors. All the communities with 25% prevalence rates and above are located very close to established breeding sites and thus are exposed to the most intense level of transmission obtainable in the basin. These communities are designated as 'first line'. Several earlier studies have shown that communities nearest to the breeding sites of the vectors are characterized by high prevalence of infection and the associated clinical diseases like blindness which could be in excess of 10% in such populations (WHO, 1976); onchocercal skin lesions and troublesome itching (Kale, 1998). Nwoke *et. al.* (1994) had earlier reported a 45% prevalence of skin mf in some communities living around the Imo River Basin, in addition to over 55% prevalence of skin mf in adult farmers in the area. Generally, these findings according to recommendations of WHO Expert Committee on Onchocerciasis (1966), OCP (1973) and Prost *et al.*, (1979) suggest that the Imo River Basin is mesoendemic for onchocerciasis. The overall prevalence, however, would have been higher if not for the treatment programme going on in the basin by the Global 2000 River Blindness Project.

In the absence of a carefully planned, implemented and sustained intervention programme, the intensity of infection should be a direct function of intensity of exposure to infective bites. This was established in this study as all the designated first line communities with high prevalence of mf also had very high microfilarial densities. Although sex differences with respect to infection were observed in most of the communities investigated, yet the overall sex pattern of infection in the area was similar. This could be explained in terms of equal exposure to the vectors of the disease either by means of close proximity of residence/ workplace to the breeding sites of the vectors or by occupational activities (Duke, 1968; Edungbola, 1981; Edungbola and Asaolu; Nwoke *et al.*, 1994). Another significant behavioural variable affecting the incidence of infection in women in the rainforest zone is the mode of dressing since it relates to exposure of the body to insect bites . Besides, the massive rural to urban migration of the population of the male segment of endemic communities in search of white collar jobs has left hitherto male-dominated activities like farming, fishing, canoeing, trading in the hands of women. This has also affected the disease incidence in women and if this trend continues, the sex pattern of infection may tilt with more females being infected than males.

The age-related prevalence and intensity showed an increase with advancing age. This is a function of a steady build up of infection acquired early in life and maintained throughout the period of existence in endemic communities (Nwoke et al.,1994). Occupation is clearly a risk factor in onchocerciasis (Kale, 1998), and as a result fishermen, ferrymen, and farmers whose occupations bring them into close and intimate relationship with the vectors are at relatively high risk of infection. The intensity of infection in these groups is related to the annual transmission potential (ATP) and tends to be significantly higher than the mean value for their home villages (WHO, 1976). This established trend was obtained in the present study where the occupational prevalence of infection showed a strong association with intensity. Thus farmers and fisherman had higher infection rates and intensities than the other occupational groups.

Clinical manifestations

Onchocercal lesions

All the first line communities namely Umulolo, Aku, Amuro, Ajabo and Uhiowerre with high disease incidence showed higher prevalences of onchocercal lesions. This suggests that some degree of association exist between the distribution of these lesions and the prevalence/intensity of infection in the Upper Basin. Similarly, communities with lower infection rates like Umule, Amanchara and Okanachi had lower distribution of lesions. The most observed lesion in the Upper Basin was nodules. Twenty one percent of those examined were nodule carriers. Nodules are pathognomonic for onchocerciasis and have been reported to be a common feature of rainforest onchocerciasis. Besides, several studies have established a positive correlation between the distribution of nodules and mf prevalence (Kershaw *et.al.*, 1954: Nelson, 1958; Edungbola, 1982; Nwoke *et al,* 1989; Amuta and Onwuliri 1997, 1998; Kale, 1998). The distribution of nodules was strongly correlated with the prevalence of infection in this study and this could account for the higher clinical diseases observed especially in the first line communities. This could also account for the low mf prevalence and associated clinical manifestation in Okanachi where nodules were not obtained. The burden of Onchocercal Skin Disease (OSD) and itching is relatively high, given an almost 53% prevalence in the basin. This is in agreement with an earlier report by WHO (1995a) of a greater than 50% prevalence of OSD and troublesome itching in adult populations of some communities in the rainforest belt.

Lymphatic complications

About 8% of persons examined presented with various lymphatic complications. Previous studies have also reported the occurrence of the complications in onchocerciasis endemic communities in Nigeria (Udonsi, 1986; Nwoke *et.al.*, 1987; Onwuliri *et.al.*, 1987; Onwuliri *et.al,* 1987; Onwuliri and Anosike, 1989; Akogun and Onwuliri, 1991; Ufomadu *et.al.*, 1991; Anosike and Onwuliri, 1995). The observed low prevalence may be due to differences in immune response to acquisition of *O. volvulus* infection which is central to the development of clinical lesions. The preponderance of these complications in the older persons is a confirmation that they are associated with long standing infection in the basin.

Ocular signs and symptoms

An overall prevalence of 39.6% reported for all forms of ocular disorder may be a gross overestimation of the ocular problems due to *O. volvulus* infection because of other factors and physical conditions that may be responsible for the impairment or total loss of vision in the basin. This could explain the weak association observed for prevalence of mf and impairment of vision on one hand and prevalence of mf and blindness on the other hand. The very low prevalence of blindness recorded in the study is a further confirmation that the rainforest region is not known to be endemic for *O. volvulus* strains that cause blindness (Budden, 1963; 1968). Generally, the overall importance of visual consequences due to onchocerciasis can be fully appreciated with the further refinement in diagnostic criteria as well as use of sophisticated equipment in the diagnosis of ocular disorders of onchocercal origin. The pattern of occurrence of itchy eye and impaired vision seem to suggest that they are early signs of ocular disorder in the basin, while blindness is associated with long standing infection.

Signs and symptoms of non-classical onchocerciasis

Forty seven per cent of those examined were positive for signs and symptoms of non-classical onchocerciasis. Majority of the villagers with MSP were adult farmers resident in communities with high mf rate. This could explain the fairly strong correlation between mf rate and MSP. Earlier studies had shown a relationship between MSP and onchocerciasis (Dejous, 1939; Lamp, 1971; Thompson, 1971; Pearson, 1985, 1988; Pearson *et al.*, 1985). Nwoke (1992) had in addition advocated for the use of MSP in a rapid, low cost diagnosis of onchocerciasis. A weak association was established between mf rate and epilepsy in the present study. This could be due to a number of confounding variables such as neurocystocercosis due to *Taenia solium*.

4.1.3 Prevalence, Intensity and Distribution in the Middle Imo River Basin

Onchocerciasis was present in the 21 communities investigated in the Middle Imo River Basin in varying degrees of endemicity ($P<0.05$). The prevalence of disease was much lower in Umuopara and Okwuonia than in the other communities investigated in the basin. However, the communities nearest to the breeding sites of the vectors designated as first line communities namely Nzerem, Ikpem, Umuawuchi, Umueze and Umungwa had the highest prevalences and intensities of infection. Generally, the prevalence of infection showed a weak relationship with mfd. This could be attributed to treatment in the area with ivermectin, in addition to the movement of people across communities of differing endemicity.

More males than females were infected in the Middle River Basin. This may be due to increased exposure to the bites of the vector fly, *S. damnosum* as a consequence of occupation rather than living close to the breeding sites. The infection rate and mfd which were significantly lower (P>0.01) in children than adults increased with advancing age. This according to Nwoke *et .al.* (1994) could be due to early man/fly contact in children in the basin by their habits and frequent visits to the foci of infection which is maintained throughout life and result in a continous build up of infection. The occupation – related prevalence was strongly associated with intensity of infection and thus farmers and fishermen had the highest prevalence and intensity of infection than other groups. This is in agreement with previous reports that occupational activities which bring humans closer to the foci of the flies files are worst hit by onchocerciasis.

Clinical manifestations

Onchocercal lesions

All the classical onchocercal lesions were observed in the communities investigated in the Middle Imo River Basin which gives support to the parasitological findings. The only exceptions were APOD and LOD which were not observed in Umunumu/Umukara and Umuzi, Amanze, Ehume/Amuzi communities respectively. The ability to develop clinical lesion has been reported to be a function of many factors, the most important being individual's host immune response to *O. volvulus* infection. This could also explain the higher preponderance of lesions in females than in males.

Onchocercal nodule was the most common lesion obtained in the basin and showed a strong association with mf rate. The prevalence of 15.5% was comparable to that obtained in the rainforest zone by previous workers namely; 16.5% by Nwoke *et al* (1994) in communities around the Imo River Basin and 21% by Wyatt (1971) in Ibarapa, Western Nigera. The prevalence however, varied significantly with that obtained in savanna zone of Nigeria; 1.6% by Anosike and Onwuliri (1995) in parts of Bauchi State and 0.6% in the Lower Jos Plateau by Ufomadu *et al* (1992). This is a further confirmation of the observation that nodules are more common features of onchocerciasis in the rainforest than savanna zone. Itching was the second most common lesion after nodules. It has been severally reported as an important early sign, which is a reflection of mf death (Wyatt 1971; Mackenzie et al., 1985). Overall, OSD gave a prevalence of 25.3% and the reactive ones (APOD, CPOD and LOD) gave a 13.3% rate. The high prevalences of itching and OSD are significant since they have been associated with insomania, skin appearance and fatigue (Hagan, 1998) and in addition, are perceived to affect social life and productive activities (Workneh *et al.*, 1993).

Onchocercal lesions were associated with all age categories with the exception of OSD that was absent in the 0-9 group. The higher preponderance of the reactive skin lesions (particularly, APOD and CPOD) in subjects aged 20-50 years agrees with earlier reports by Hagan (1998). The association of DPM with long-standing onchocercal infection was further confirmed in this study.

Lymphatic complications

Lymphatic complications were observed in the Middle River Basin in varying rates in the different communities investigated. The overall low prevalence (8.6%) is consistent with similar reports on this clinical feature in the different bioecological zones of Nigeria. Hernia was the most encountered complication while Lym (limb), was the least. Although acquired hernias have been suggested to be consequences of disorders of collagen metabolism caused by *O. volvulus* in the groin of infected individuals (Guderian and Kerrigan, 1996; Edungbola *et al.*, 1991), it is possible that some of the cases observed in this study may be due to other physiological disorders. With the exception of L,pathy and Hernia, all other features seem to be associated with long standing infection.

Ocular signs and symptoms

Itchy eye and impaired vision were more common features of ocular involvement than blindness which was observed in only 4 communities. The low blindness rate (0.1%) is consistent with previous reports of low ocular involvement of rainforest *O. volvulus* strains (Duke, 1968). Both impaired vision and blindness showed a weak but linear relationship with mf rate. This can be explained in terms of the treatment with ivermectin which has affected the mf load in the basin. It is possible that the observed ocular complications may be due to aetiological factors other than *O. volvulus*. Unlike itchy eye which is an early sign, impaired vision and blindness are associated with old infections.

Signs and symptoms of non-classical onchocerciasis

Features of non-classical onchocerciasis were encountered in varying rates in the basin with MSP and general debility having greater distribution in the communities investigated than epilepsy. The associations between MSP and epilepsy with mf rate were fairly strong. This suggests a causal role for *O. volvulus* in the aetiology in the absence of confounding variables.

4.2 COMMUNITY KNOWLEDGE ON ONCHOCERCIASIS

4.2.1 Indigenous Knowledge of Disease

Less than half of the respondents (infected and uninfected) knew about onchocerciasis. Indigenous knowledge of disease was associated more with older than younger ones in endemic communities and this according to Lu *et .al.* (1988) may be a reflection of years of exposure and interaction between the community and the disease. This possibly explains why communities with higher prevalences had higher scientific knowledge of the disease, which is further confirmed by the strong association between prevalence and knowledge. Similar recognition of endemic diseases such as filariasis, malaria, schistosomiasis, measles, child disability by rural populations has been reported (Grove et. al., 1978; Jackson, 1984; Stanfield and Galazka, 1984; Riji, 1986; Zaman et al., 1990; Richards et al., 1991; Ittiravivongs et al., 1992; Eberhard et al., 1996). Overall respondents with formal education had slightly higher knowledge and better attitudes about the disease than those without education. This finding should simplify future efforts towards providing community education aimed at prevention and control.

All the communities investigated had no specific local name for onchocerciasis as a disease entity. However, because of the marked clinical manifestations of onchocerciasis, most villagers recognized and had local names that reflect the physical conditions of their afflictions. Dermatitis for instance was known by the local names "Oko vari vari" and "oranmanu". The former is a simple description of the sound produced by the nails during the scratching of the affected skin while the later signifies the use of oil to reduce the occasional swelling that may result from unprovoked intense itching. The socioeconomic and cultural significance of dermatitis on the beauty of the skin is further underscored by the reference to this condition in women as " Osuru nwanyi ahia di" or "

Osuru aghoho ebu ahia" meaning skin conditions that cost a woman suitors; " onyiri ncha" meaning skin condition that cannot be removed or cleared by use of soap.

Generally, skin lesions of any origin have been identified as a handicap for girls because of the social significance of appearance and culturally acceptable standards of beauty and such girls are likely to be victims of overt discrimination at school and social gatherings (Goodman et al., 1963; Cash, 1977; Muhondwa, 1983; Porter and Beuf, 1991; Amazigo and Obikeze, 1992; Anon, 1998). In addition, Goffman (1963) and Hagan (1998) observed that stigmatized persons suffer social and psychological stress. It is believed that the socio-economic and cultural consequences associated with dermatitis might be responsible for its perception and ranking as the most worrisome/feared manifestion in the study.

The theory of causation and transmission did not show any correct knowledge between the clinical manifestations of the disease in relation to the disease parasites, *O. volvulus* and the vectors, *S. damnosum*. This is not suprising because in African societies, disease is usually attributed to supernatural causes and is rarely seen as having an organic origin (Akogun, 1989). The perceived causes of the different manifestations were attributed to several reasons which include mostly but not limited to the following : witchcraft/enemies, evil spirits/gods, punishment from God, overwork/hardwork, accumulation of bad fluid, sleeping/ contact with infected persons, adultery, hereditary, ageing, etc. Furthermore, additional information by key informants was quite revealing with respect to the beliefs held in the different communities about these conditions. In Umulolo, for instance, people with lymphoedema (genital) or 'IBI' were taken to the evil forest to die and no burial rites/ceremonies including condolence visits were allowed until about 7 weeks after. And because of the belief that the disease condition could be transmissible on re-incarnation, the contents of the IBI were removed by local surgery, inactivated with water and oil and then buried separately in a clay pot inside a very deep hole. In Umungwa it is believed that when an infected male with this condition dies, the spirit of the man lingers in the air waiting for another man to infect. As a result, it is the cultural practice that all non-initiated males run away from the community until after burial. Occasionally too, the content of the IBI was removed to prevent the man from re-incarnating in the next generation with that feature.

Attempts made to explain the role of vector species in the causation/transmission of onchocerciasis were met with several questions. Majority of the respondents refused to accept that small insects were capable of causing/transmitting such disabling and disfiguring diseases. Given such age long internalized beliefs by the people, there may be difficulty in changing their attitude and perception about habits and customs that expose them to the disease vectors. Nevertheless, some of the key informants knew about the vector species which they called various local names like NWANDUNTA, NWANMI, KPUKPUNTA, NKAKPO, NKANKA etc. In a related survey in India, Ramaiah *et al.* (1996) were asked such questions by respondents Furthermore, in studies of human behaviour conducted in malaria – endemic zones with different levels of transmission, Ittiravivongs *et al.* (1992) observed that the perception of diseases may vary greatly based on clinical severity, mortality rates and lost work days.

4.2.2 Local Perception of Disease Treatment and Prevention

The perceived cause of a disease determines the type of treatment applied to it. As a result of the existing indigenous theories on causation and transmission, the overall treatment options were often directed mainly at consulting/appeasing gods and seeking herbal/local therapy . A few respondents agreed on the use of orthodox means as way of treating their afflictions. While herbal/local therapy were considered the best option for the treatment of nodules, dermatitis, lymphadenopathy, hanging groin, lymphoedema (limb) and hernia; consulting oracle/appeasing gods was the most acceptable option for depigmentation, lymphoedema (genital) and blindness.

The removal of nodules (nodulectomy) by traditional healers is a common practice in endemic communities in the study area. Unlike in endemic areas in Central and North America where it is a long-standing control strategy (Richards et al., 1991), this was undertaken in this study mostly to improve on the beauty of the skin. Similarly, the use of local surgery and other traditional methods to reduce the enlargement of the scrotum in males was undertaken to lessen the degree of physical incapacitation rather than as a treatment option as reported in previous related studies (Wegesa *et al.*, 1979; Muhondwa, 1983; Eberhard *et al.*, 1996).

Due to obvious misconceptions and ignorance on the perceived causes and transmission, the local perception regarding preventive measures were often misdirected to reasons other than the avoidance of the disease vectors, *S. damnosum*. For instance, majority of the respondents believed that lymphoedema (genital) could be prevented by avoiding adultery. Other cited reasons include avoidance of evil forest, run away when infected person dies. Only very few people gave avoidance of insect bites as a possible preventive measure. On why villagers relied on consulting oracles, discussants and key informants noted that it was a common practice since afflictions / diseases were believed to have supernatural rather than organic causes. With respect to healthy men keeping away when a person with lymphoedema (genital) dies, key informants confirmed that since it was the cultural belief that the spirit of the dead person together with the 'IBI' lingers in the air looking for whom to infect, the only way to avoid infection was for the un-initated men to vacate the vicinity during such periods.

From the foregoing, it is clear that the degree of ignorance in endemic communities has affected the overall perception of appropriate management and prevention of the disease and its clinical manifestations. There is an important need therefore to put in place careful community education programmes that will build more awareness of the clinical conditions in order to ensure successful onchocerciasis control programmes in the Imo River Basin.

4.3 SOCIOECONOMIC STUDIES

4.3.1 Social Costs of Onchocerciasis.

The present study showed that villagers exhibited different attitudinal responses towards people with various clinical manifestations. Like majority of the respondents were indifferent towards people with nodules, depigmentation, lymphadenopathy and hanging groin. Other respondents felt sorry for blind patients and those with lymphoedema (limb). The clinical manifestations that elicited the worst attitudinal responses (fear and insecurity) were dermatitis and lymphoedema (genital).

The practice of respondents towards infected villagers was a function of the degree of attitudinal response, as well as the local perception of the nature of the affliction. This explains why majority of the respondents would not want to marry persons with dermatitis, hanging groin, lymphoedema (limb and genital), hernia and blindness . The major reason for not marrying an individual with lymphoedema (genital) and hernia was on procreation. Kessel (1957) observed that woman with elephantiasis were considered " undesirable as wives" and men with scrotal elephantiasis "exhibited an obvious social and procreative handicap". This is in contrast however with the situation in the Phillipines where Lu *et al.* (1988) noted that men with hydrocele married, had children and lived with their families. Reduction in mobility, in addition to less productivity was the main reason for the contracting marriage with a blind person. Nwoke (1991) had reported that disability through oncho-blindness and serious visual impairment withdraws the affected individuals potential supply labour of years in activities requiring vision, and partial visual impairment and/or other non-disabling manifestations may also reduce the efficiency of labour days worked.

Majority of the respondents were not willing to marry persons with dermatitis because of the concept of dirty skin/contamination as well as the associated bad omen/social stigma. This agrees with the findings of Amazigo and Obikeze (1992) in a rural community (Etteh) in the rainforest of south Eastern Nigeria, that onchodermatitis led to withdrawal behaviour, isolation and societal maladjustment since it destroys the skin and beauty of adolescent girls and hinders their prospects for marriage and if married, it affects the stability of the marriage and jeopardizes their future happiness. Furthermore, the devastating impacts of onchodermatitis on the social lives of women in endemic communities is underscored by the observation that " more than men, women depend on their physical appearance for their self esteem. Women are economically dependent, and physical defects caused by diseases (like onchocerciasis) may seriously harm their prospects for marriage and survival" (WHO, 1993).

The extent to which afflicted patients were stigmatized depended on the severity and visibility of the clinical manifestations. Thus afflicted persons besides those with dermatitis might go to Church/Market/School or attend other social functions because of the degree of concealment afforded by their dressing. This may not be so for patients with dermatitis since it could extend to the extremities of the hands and legs making concealment difficult. Moreso, the occasional unprompted itching and scratching might make such persons uncomfortable with public outings.

In an attempt to ascertain the activities that respondents would not want with afflicted persons, the response pattern showed that majority would not want to sleep and/or have sexual intercourse with afflicted persons unlike other activities such as eating, discussion and handshake. Key informants revealed that what discouraged such interactions with persons having dermatitis was the concept of dirty skin and fear of contracting the disease. For genital complications, the fear of attracting punishment from the gods was the most deterrent reason.

The participant – observation technique into the local habits, and customs of the people that help in transmission and maintenance of the disease revealed that the local dress code is an important behavioural factor. While the men worked in the farms dressed only in shorts and occasionally with singlets on top, the women dressed in skirts and short wrappers exposing most parts of the extremities of the body. Another important factor is the period of farming divided into early/mid – morning and late afternoon/early evening which concide with the bimodal peak biting intensity of the local disease vectors.

<u>Psychosocial effects and coping mechanisms of afflicted persons</u>

Nodules and DPM elicited less psychosocial concern than the other manifestations, since majority of infected persons felt normal on observation of these manifestations for the first time. This finding agrees with earlier observation in parts of the rainforest zone of South Eastern Nigeria that DPM is regarded as a sign of wealth and ageing, in addition to being associated with beauty and thus not stigmatized (Hagan,1998). On the contrary, people with other manifestations showed varied reactions such as being afraid/disturbed, frustrated, hopeless/insecure. About 70% of those with dermatitis reported being embarrassed by loss of aesthetic value of their skin, in addition to the constant skin itching and scratching. People with lymphoedema (limb) reported being teased. Sixty six per cent of lymphoedema (genital) patients noted that they were avoided in the community because of folk tales associated with their conditions. One of the patients reported being reminded by his enemy that his rightful home was the evil forest. As a result of the foregoing, these afflicted persons felt inferior, withdrawn and developed low self esteem. Generally, they felt socially uprooted from their communities.

In addition to the social consequences, the study showed that these afflictions had some affect on job employment and overall productivity. People with lymphoedema (limb) and varying forms of visual impairment to blindness were not hired as farm hands in the communities because of their physical incapacitation. Three persons with dermatitis reported suffering from insomania which affected their jobs and overall out put domestically. Workneh *et al.* (1993) had earlier observed that workers with non-blinding onchocerciasis were more likely than control' to be absent from work due to illness, in additional to earning significantly less. Nwoke (1991) had also noted that as a cause of permanent disability through blindness and serious/partial visual impairment, onchocerciasis affected the supply of labour.

The use of herbal cure and consulting of oracle were more favoured treatment options than seeking orthodox treatment by afflicted individuals. Discussions with key informants showed that this treatment approach was due more to age long traditions, beliefs and perceptions about causation/transmission of clinical mainfestions rather than lack of confidence on the orthodox medical practice. Furthermore, it was revealed that the cost of these local remedies was far cheaper than that for seeking treatment in hospitals/clinics. Lu *et al.* (1988) observed a similar situation in the Phillipines, where because of the high cost of surgery, patients resorted to indigenous, traditional health practices that provided local healers with a sizeable number of cliental. In another study, Hagan (1998) reported that more than 40% of affected respondents favoured a modern doctor and hospital as important sources of help, but the associated costs were often considered high. Further discussions revealed that another important factor that deterred villagers from seeking orthodox treatment especially for those with surgical problems was the state of " temporary death" (referring to the use of anasthetia) the patients passed through. This they reported happened in a neigbouring community and thus had made a lot of people with surgically related cases to seek local surgery, even though they admitted was quite painful.

Several coping strategies were adopted by afflicted persons. Some with dermatitis scratched their skin with sharp objects like stones and sticks. Others used traditional mixture, palm oil, palm kernel oil to relieve their itching and associated swellings. A few others resorted to warm baths as cold water was perceived to worsen their conditions. To cope with the stigmata associated with their clinical conditions, the affected persons used psychosocial defence mechanisms such as denial, suppression, resignation to fate. Nevertheless, some persons with nodules and DPM took pride in their affliction since nodules was associated with hardwork and DPM, a sign of achievement/ageing.

4.3.2 Economic Costs Of Onchocerciasis

Onchocercal skin disease (OSD) in the household and school attendance

The present study showed that the percentage drop in school attendance was higher in households where heads had severe-OSD than in households where heads had no OSD. The drop out rate was attributed to a number of factors; the most important being the participation of pupils in intra-household labour substitution as a means of making up for the slack in income generation and in other household activities. Such labour substitution activities included helping out in the farms and in market and other economic activities. Previous studies have shown that in hyperendemic communities with high blindness rates like in the Taraba River Valley, Nigeria, a child guide is attached to every blind adult (Akogun and Onwuliri, 1991). Such a child – guide withdraws from school if already enrolled and spends a substantial part of the pre-teenage years leading a blind member of the household. The reallocation of tasks amongst members of the household appears to be an effective coping strategy to deal with illness-related production losses in the Imo River Basin. This strategy is in consonance with the findings of Adeyemi (1990) that the occurrence and perception of tropical diseases in less developed countries (LDCS) like Nigeria is taken to be a family rather than an individual problem, in which case responses to a tropical disease is a joint undertaking by household members. Impacts therefore at the individual level may appear less than real because the individual's work schedules are distributed to other healthy members of the household. The aggregate production of the household, nonethless, may be likely affected.

Besides the indirect impact of onchocerciasis on school attendance of pupils, the direct consequences of the disease on pupils affect their overall educational development. Children may be too sick from either pruritis (itching) or malnutrition or in some cases may show early signs of ocular onchocerciasis and leave school for treatment. Occasionally, such children may be given out as house helps to relatives or other people who live in onchocerciasis – free urban areas. Previous studies have also shown a relationship between teenage absenteeism as a direct result of incapacity due to different diseases including malaria, asthma, whipworm infection (Nokes and Bundy, 1994) ; dracunculiasis (Nwosu *et.al.*, 1982; Ilegbodu 1986; Dozie *et.al.*, 1994). No consistent pattern with respect to absenteeism and disease incapacity has been associated with schistosomaisis, while malaria treatment has been shown to enhance school attendance of pupils (Colbourue, 1955).

The direct and indirect impacts of onchocerciasis on school attendance might have long term detrimental consequences on the overall socioeconomic development of endemic rural communities in the study area. Firstly, the onchocerciasis disease burden may prevent school aged pupils from taking full advantage of their only opportunity for formal education. This is especially as evidence suggests that even a few years of schooling is associated with important changes of economic value in individual skills (Selowsky, 1981). Secondly, human capital especially with respect to health and educational levels in developing countries has become widely recognized as an important determinant of and indicator for general socioeconomic development in any given country. Furthermore, the accumulation of human capital (through higher literacy levels over time is increasingly considered a significant factor in ensuring national socioeconomic well-being and long –term economic growth by economists as well as by development institutions such as the World Bank and United Nations Development Programme (UNDP). Against the back drop of the present study, the need for the continued control of human onchocerciasis in endemic communities in the Imo River Basin becomes imperative. The import of this cannot be overstated in the light of future gains in educational achievements of rural dwellers and its practical positive consequences for the overall development of the basin.

Direct costs of treatment

In general terms, direct costs refer to health related expenditures borne at the individual level as well as by communities. In less developed countries such as Nigeria, these costs which tend to be associated more with curative than preventive care can represent a significant drain in the resources of the fragile economy of the rural households. The present study revealed that villagers sought various forms of treatment to alleviate the itching and scratching due to episodes of OSD and the problems associated with lymphatic complications. Few persons did not seek treatment because of the local concepts about the cause of the disease, the poor financial status of families and the fact that episodes of OSD would be over in a few days. A similar observation was made for lymphatic filariasis where a few individuals suffering from adenolymphangitis (ADL) did not seek treatment for their conditions partly because of local concepts about the cause of their condition as well as treatment-seeking behaviour (Gyapong *et.al.* 1995).

For all types of health care facilities used by patients, the mean costs of treatment of patients with OSD and chronic lymphatic complications were higher than that of controls. The highest costs of treatment were incurred by OSD patients who patronized chemist/drug peddlers and herbalists/diviners when compared to other healthcare facilities utilized. This is not surprising since the sale of drugs across the counter and without prescription is a common practice in the study area. Furthermore, as a result of the extended family system, most subjects had easy access to the expertise of traditional healers, some of whom maybe relatives. Although individual costs of treatment in such cases maybe low, but because of the high patronage of such traditional healers, the associated cumulative costs might be high over a period of time.

For patients with chronic lymphatic conditions, the mean costs of treatment incurred was highest for health center/clinic /hospital. Such costs as seen in the present study were associated with corrective surgery for those with scrotal elephantiasis. This is because corrective surgery involved long periods of hospitalization for the patient. This is in addition to the costs incurred by accompanying persons. Besides this situation, previous studies have revealed low patronage of such facilities (especially, in predominantly poor and illiterate population) because of the high cost of treatment and the fear of anesthesia that often put patients into a state of "temporary death". In the Philippines, most men with hydrocele did not seek treatment in such facilities because of the costs involved (Lu *et.al.*, 1988). Some consulted folk-healers or treated themselves in ways which though unscientific and extremely painful, apparently gave them relief. In Tanzania on the other hand, Muhondwa (1983) reported that men were reluctant to undergo surgery because of the fear of anesthesia

Indirect costs due to disability

The current estimate of the disability associated with onchocerciasis in Africa (OCP and APOC countries) have been put at 884 500 Disability Adjusted Life Years (DALY) lost annually (Remme, 1998). This is an underestimate of the real burden of the disease since it was based mainly on disability associated with onchocercal blindness. The morbidity due to non-ocular onchocerciasis and in particular OSD (an important cause of incapacitation) has until recently not been given sufficient importance. The present results however, indicate that OSD causes severe morbidity and incapacitation, and as a result loss of income- earning potential. OSD generally caused at least $1^1/_2$ days of incapacitation in the study communities in the Imo River Basin. On a cumulative basis, it is estimated that the total period of incapacitation was about 1847 days lost per annum in the basin.

Despite the social support from the extended family system, such periods of inability to perform normal activities including farming, household chores, child care/breast feeding, market activities, animal rearing etc can have grave social and economic consequences. In communities where subsistence farming is the economic mainstay of the people (such as those studied) total incapacitation during the farming season could translate to inadequate food and industrial raw materials being produced for the year. Although the present study was short to show a clear trend, the incidence of itching was reported to be worse when it rained, when patients perspired or after a bath – all related to the chemotactic tendency of microfilariae. Such periods coincide with periods preparatory to the actual farming season when farmers worked under the blazing sun to the rainy season (the time of peak agricultural activity). The impact of disability associated with OSD could be very severe, with all of an affected individual's economic activity coming to a stand still.

The disability associated with obvious chronic lymphatic manifestations did not appear to be as debilitating as that associated with OSD. This was largely because persons with chronic disease adopted several coping mechanisms. Most of those with lymphoedema of the scrotum and limb took up relatively sedentary jobs such as petty trading, cloth making, basket and mat-making. Muhondwa (1983) similarly observed that patients with hydrocele in Tanzania moved from more productive to less productive and demanding pursuits in order to cope with late stage chronic disease. Many more persons with advanced disease became confined to their homes and such confinment and changes in occupation resulted in income and production losses (Kessel, 1957; Wijers, 1977; Wegesa *et. al.,* 1979).

Another mechanism by which chronic disease induced income and production loses related to the situation where men with scrotal elephantiasis sought corrective surgery. Income loss occurred in 2 ways. Firstly, no income was earned during the time spent in hospital and complications like sepsis acquired during operations could extend this time considerably. Secondly, men were told to perform only light duties until the healing process was completed, which also reduced their productive capacity. Similar observations have been documented from studies in East Africa (Wijers, 1977; Muhondwa, 1983). The above factors, however, reduced income only temporarily as it is possible that the operation might have a net positive impact on earning potential in the long run. This would occur if preoperative levels of economic activity were restricted because of scrotal elephantiasis and the operation allowed patients to return to normal levels of activity. Besides, the social stigma and psychological impairment associated with this stage of the disease, it was obvious that most of patients at the chronic stage of the disease in the present study found themselves an economic burden to the rest of the family. Their situation was often made worse by concurrent OSD. Chronic disease with super- imposed OSD appears to be more debilitating and longer lasting than either condition alone.

Loss of revenue

Total revenue loss due to the effects of non-ocular onchocerciasis in the Imo River Basin derived from the direct costs of treatment and indirect costs from disability is conservatively estimated at about ₦7.9 million annually. This represents a significant rural drain on the poor resources of the endemic communities such as those studied. This finding underscores the need for the sustenance of the control of human onchocerciasis in the basin which is being executed presently by APOC through the Ministries of Health (Federal and State) and NGDO coalition

APOC activities have been projected to reach progressively large sections of the target population. It is assumed that once a certain proportion of the target population is reached, incidence levels of blindness and OSD will decline subsequently over a course of time (Kim *et.al.*, 1997a, Benton, 1998) and this would augment the productive labour force and yield additional agricultural output. The economic rates of return (ERR) derivable therefore, has been projected to range from 6% to 17% (Benton, 1988), depending almost entirely upon whether APOC achieves its primary goal of long term sustainable treatment of onchocerciasis in all the areas within its geographical mandate including the Imo River Basin area of Nigeria.

4.4 KNOWLEDGE, ATTITUDES AND PERCEPTIONS (KAP) ON IVERMECTIN (MECTIZAN)

More than half of the respondents knew about the drug ivermectin (mectizan) from Global 2000 River Blindness programme staff working in the area as well as from village based health workers and older relatives. Indigenous knowledge of the drug was associated more with older than younger respondents and might be a reflection of many factors including the interaction between the community and the disease (Lu *et.al.*, 1988). This could explain why respondents in professions most at risk of infection (like farmers and health workers) had higher knowledge of ivermectin than others. The respondents had no specific local name for the drug. The drug was however identified easily by reference to several factors like the name of the village based distributor ("ogwu John", meaning, " drug being distributed by John") . It was also commonly identified by reference to some of the clinical manifestations of the disease like itching ("ogwu oko vari vari" meaning "drug for itching") or the disease vector ("ogwu nwanmi", meaning " drug used to Kill *S. damnosum* parasite").

The present study showed that treatment with ivermectin was well accepted in the Imo River Basin. This was attributed to many factors including effective grassroot mobilization through public health education, community participation in the planning and implementation of the treatment programme, the perceived efficacy of the drug and the nature of side effects. Majority of the respondents (67.2%) agreed that ivermectin was moderately or quite effective in relieving some of the symptoms of onchocerciasis especially the eye and skin manifestations. Previous studies have shown that at its effective single oral dose of 150 mg/kg body weight, ivermectin eliminated skin microfilariae as well as providing long lasting suppression of microfilaridermia (Awadzi *et. al.*, 1985; Greene *et. al.*, 1985; Boatin *et. al.*, 1998). Several other studies have shown improvements in both eye lesions (Whitworth *et. al.* 1991; Abiose *et. al.*, 1993) and skin lesions (Pacque *et. al.*, 1991; Burnham, 1995) which are the two most prominent symptoms of onchocerciasis.

Besides improvements in eye and skin lesions, respondents also mentioned other benefits of the use of ivermectin in the study area including dissolution of palpable nodules, expulsion of intestinal worms and the relief of muscular pains and aches. A recent study in some communities around the basin reported dissolution of palpable nodules following repeated ivermectin treatment (Ukaga, Dozie & Nwoke, 2001). Several other studies have reported anti-parasitic activity against nematodes and arthropods (Richard – henoble, 1988; Campbell, 1989; Freedman *et. al.*, 1989; Naquira *et. al.*, 1989; Campbell, 1991; Whitworth *et. al.*, 1991; Cupp, 1992; Abanobi *et. al.*, 1994). Resumption of menstruation in women with secondary amenorrhea following ivermectin treatment has been documented (Anosike & Abanobi, 1995). Despite the reported success with ivermectin, concerns have been raised as to whether a single annual dose is enough for the treatment of onchocerciasis disease lesions. Burnham (1995) has indicated that a single annual dose of 150mg/kg of ivermectin might be suboptimal for the treatment of onchocercal skin lesions. He suggested that a 3 monthly dose of ivermectin, an interval that corresponds to the gestation period of microfilariae (Duke *et. al.*, 1992) would seem a reasonable basis for further study.

The acceptability of ivermectin treatment in the Imo River Basin was also a function of the nature of the side effects. In the present study, respondents reported mild side reactions following drug treatment. These side reactions which include body itching, swelling of the limbs and face, body weakness, nausea and vomiting, headache and diarrhoea were treated with appropriate reaction management drugs by the community based distributors under supervision of the village based health worker using the approved protocols. The mild reactions reported in the present study contrasts with the adverse reactions that have been reported in previous studies (Rothova *et. al.* 1989, Burnham, 1993; Dadzie, 1997). Although, the mechanisms involved in the pathogenesis of these reactions are unknown, host immune responses to dead microfilariae are thought to be involved (Rothova *et. al.*, 1989; Campbell, 1991; Goa *et. al,* 1991). The co-existence of onchocerciasis with other filarial parasites, in particular *Loa loa* has been reported to increase the severity of the side – effects of ivermectin treatment (Dadzie, 1997).

Another factor that was instrumental to the acceptance of ivermectin was effective grassroot mobilization through public health education. The results of the study, revealed that several misconceptions were held about ivermectin especially at the commencement of treatment including the possibility of ivermectin being a contraceptive drug meant to increase sterility in males and females. These misconceptions were further strengthened by the fact that the drug was been given out at no cost to the individuals. Key informants revealed that items and articles that are either too cheap or given out for free are believed in rural communities to have something phoney about them. This caused some major set back in the acceptance of the drug initially especially in communities that had political problems including weak leadership. However, intensive and sustained public health education has helped in correcting these misconceptions as well as buttressing the great and immense benefits of ivermectin.

Community participation in the planning and execution of the treatment of ivermectin was most important to its success in terms of acceptability in the study area. Key informants attributed this success to a good degree of interaction and understanding between the communities exemplified by its leadership and the health system including the NGO (Global 2000 River Blindness Programme (GRBP)) working in the area. Under this arrangement which is part of APOC's strategy towards creating an environment for sustainability, communities were empowered to select the community based distributors (CDD). In addition, the communities were made to understand the need to support their CDDS in the execution of their duties through the provision of logistic support as well as some incentives. These according to respondents have helped in the timely collection and distribution of the drug in endemic communities.

The present study showed that a good degree of compliance (68.8%) to yearly treatment with ivermectin was achieved in the Imo River Basin. This could be attributed mainly to the mild or moderate side effects of the drug in the area, in addition to effective grassroot mobilization through public health education. Studies have show that the nature of side effects could be a major factor affecting compliance. Wijers and Kaleli (1984) in a study in Kenya reported that the side effects experienced during a first round of treatment with DEC reduced the degree of compliance in the second round. In addition, the fear of side effects often severe enough to result in loss of work days and thus loss of income to already poor families was also given as an explanation for low compliance. Besides the fear of side effects of the drug, one other reason that affected compliance was the fear of skin snipping. Key informants revealed that some villagers declined participation in the drug treatment when they found out that they had to be skin snipped as part of treatment. The use of non-invasive technique for the rapid assessment of onchocerciasis endemicity has overcome the problems associated with repeated skin snipping. In related studies on filariasis, cultural barriers like antagonism towards providing blood samples for screening, especially in areas of noctural periodicity has been reported to affect compliance (Rao, 1982; Wijers and Kaleli, 1984; Hyma, Ramesh and Gunasekaran, 1989). Logistic reasons including the seasonal timing of distribution was also reported as a factor affecting compliance in the present study.

Majority of the respondents (69.9%) would be willing to pay between ₦1 to ₦ 100 per dose of drug for sustenance of its procurement and delivery system in the event of the donors withdrawing from the programme. This to a large extent is indicative of the fact that the villagers are very enthusiastic about ivermectin and its many benefits. About 30.4% of respondents indicated their inability to pay for sustenance. Majority of people in this group were students (85.1%) and artisans/traders (20.9%) whose occupations are at low risk of infection. Adequate health education targeting this low –risk group is required towards mobilizing everyone to part of sustaining the treatment programme.

The present results have show that the delivery of ivermectin in the study area using the community directed approach is best suited for the area. This is largely because of the communities involvement in the planning, design and execution of the ivermectin delivery system. This form of community empowerment has a great potential for sustainability. According to Dadzie (1997), it integrates well with the existing health care system and avoids the pit falls of control programmes that are vertical in nature. Besides, the effectiveness of the ivermectin delivery system in areas under APOC control, the ability to interrupt onchocerciasis transmission in Africa under APOC strategy needs to be re-examined. Under this strategy, mectizan distribution is delivered only once a year and only in communities where the prevalence of infection is 20% and above. By excluding people living in hypoendemic communities (where prevalence of infection is less than 20%), APOC risks leaving enough infected persons untreated to infect many blackflies. The implication is that mectizan delivery may have to be continued indefinitely rather than the projected 10-15 year period . APOC's strategy is unlike the situation in the Americas where an aggressive, semi-annual ivermectin therapy in all endemic communities is expected to not only stop disease (blindness and skin disfiguration) from onchocerciasis but also prevent new infections (ie interrupt transmission) of onchocerciasis.

4.5 CLINICO-MICROBIOLOGICAL STUDIES

The prevalence of microorganisms associated with excoriated onchocercal skin lesions has hardly been reported in the biomedical literature because of the previous lack of attention given to the non-ocular aspects of onchocerciasis especially the medical, public health and socio-economic aspects of the onchocerciasis skin diseases (OSD).

The present study however, has demonstrated that excoriated skin lesions were infected by concomitant microorganisms of mixed origin. The relatively high prevalence of microorganisms in excoriated lesions could be attributed to several factors such as the scratching of itching body sites with soil-contaminated sticks, stones, dirty farm tools and the poor hygiene culture of villagers in endemic communities. Generally, lesions yielding microbial cultures were clinically indistinguishable except for the sites where fungi particularly dermatophytes were recovered from. Itching, inflammation, soreness and occasionally suppuration and erythema were the most common symptoms. Scaling was more characteristic of the sites from where dermatophytes were recovered.

Of all the microorganisms recovered from excoriated lesions, the contributions of *Staphylococcus aureus*, β-hemolytic *Streptococcus pyogenes*, *Pseudomonas aeruginosa*, *Bacteriodes* and *Clostridium* species in aggravating the onchocercal skin disease are more significant clinically than that of *Escherichia coli*, *Candida albicans* and the dermatophytes *Trichophyton rubrum* and *Microsporum gypseum*. *S. aureus* though an occasional normal flora of the skin (in small numbers) is a major human pathogen causing infections ranging in severity from food poisoning or minor skin infections to severe life threatening cases. The pathogenic capacity of a given strain of *S. aureus* has been reported to be due to the combined effect of extracellular factors or enzymes (hyaluronidase, staphylokinase, proteinases, lipases, β-lactamases) and toxins together with the invasive properties of some of the strains (Jawetz et .al., 1998). The clinical involvement of the skin (as in excoriated lesions) is characterized by an intense, localized, painful inflammatory reaction that undergoes central suppuration and heals quickly when the pus is drained (Mulligan 1993; Kloos and Bannerman, 1994).

β-*hemolytic S. pyogenes* is associated with invasive (erysipelas, puerperal fever, sepsis) and localized (streptococcal sore throat, streptococcal pyoderma) infections as well as infective endocarditis (Jawetz *et al.*, 1988). The recovery of *P. aeruginosa* in the present study is not suprising since this organism becomes pathogenic only when introduced into areas devoid of normal defenses, for example when mucous membranes and skin are disrupted by direct tissue damage; when intravenous or urinary catheters are used, or when neutropenia is present as in cancer therapy (Bodey, 1983). The pathogenic process is promoted by the pilli, enzymes (elastases, proteases, hemolysins) and toxins (particularly, exotoxin A) (Pollack, 1983).

Bacteriodes spp and *Clostridium* spp accounted for 11.5% and 3.3% of organisms recovered from excoriated lesions in the study. *Bacteriodes* spp are anaerobic organisms whose pathogenic potential is due to synergistic action with other anaerobic species (Finegold and Goldstein, 1993; Styrt and Gorbach, 1989; Hofstad, 1990; Shah and Gharbia, 1993). The isolation of unidentified species of clostridia is quite significant and interesting as powerful and lethal exotoxins characterize their pathogenic ability. Of particular concern is that spores of *C. tetani* which causes tetanus are present throughout the soil environment from where they easily contaminate and germinate in devitalized tissues on the legs at an oxidation-reduction potential (Eh) of + 10mV and elaborate the toxin, tetanospasmin (Jawetz *et. al.,* 1998). The toxin spreads along nerves to the central nervous system, where it binds to gangliosides, suppresses the release of inhibitory neurotransmitters and causes muscle spasm and death results from inability to breathe (Styrt and Gorbach, 1989).

The feet and legs provided more sites for the recovery of microorganisms than other body sites. This may be attributed to the higher mf density in the lower extremities because of the biting habits of the local vector. The death of these mf and the associated severe itching and scratching give rise to excoriations which are easily superinfected because of the relative proximity of the extremities of the body to the soil.

All the isolates from excoriated lesions showed remarkable susceptibility to Tarivid, Ciproxin (and its derivative, Norfloxacin) when compared to other antibiotics used. This could be due to the lack of substance abuse because of their relative newness in clinical practice. Despite their potency, great caution must be exercised in their use for treating bacterial infections to avoid treatment failure due to development of resistance. The susceptibility of *S. aureus* to Ciproxin, Norfloxacin, Erythromycin and Gentamycin in this study is in agreement with reports of several other workers (Coker *et.al.,* 1983; Onoaolopo, 1988; Ikeh *et.al.,* 1993; Osuide *et.al.*, 1996). Similarly, the resistance exhibited by *S. aureus* to Augumentin, Ampicillin and Ampiclox in this work has also been documented (Coker et.al., 1983; Onoaolopo, 1988). Resistance may have resulted from the indiscriminate use by the carriers (Watanabe, 1967) and because many strains of *S. aureus* produce ß-lactamase, an extracellular inducible enzyme which inactivates penicillin and related antibiotics.

Most of the drugs did not show any significant antimicrobial activity on *P. aeruginosa.* This is not suprising since *P. aeruginosa* has been reported to develop rapid resistance to disinfectants and antibiotics especially when used as a single therapy

(Washington and Sutter, 1980). Combination therapies especially with penicillin products and aminoglycosides or the newer quinolines like Ciproxin and Norfloxacin have been indicated in the treatment of infections involving Pseudomonads (Jawetz *et. al,* 1995). The overall susceptibility patterns of isolated microorganisms to the various antimicrobial agents are quite significant in the light of the fact that their use in combination with mectizan may be of great value in reducing the burden associated with superinfections of excoriated lesions in onchocerciasis endemic communities.

4.6 CONTRIBUTIONS TO KNOWLEDGE

This study has made the following contributions to knowledge.

1. The study showed that the sex-related infection with *O. volvulus* was similar in male and female subjects, an indication of equal exposure to the vector fly, *Simulium damnosum* in the rainforest area.
2. The study also established some degree of causal relationship between *O. volvulus* infection and the development of signs and symptoms of non-classical onchocerciasis such as musculoskeletal pain (MSP) and epilepsy.
3. The study showed that visible disease manifestations like dermatitis, lymphoedema (limb) and blindness led to withdrawal behaviour and isolation and also hindered the prospects of marriage as well as affected employment in productive ventures.
4. The study revealed that the prevalence of onchocercal skin disease (OSD) in the head of households had an overall negative impact on school attendance of school-aged pupils.

5. The total revenue loss due to direct costs of treatment and man-days lost to incapacitation was calculated at ₦ 7.9 million annually.

6. The study showed that the delivery of ivermectin to endemic communities using the community directed approach is practicable and has potentials for sustainability especially with the involvement of the communities in the planning and execution of the treatment programme.

7. For the first time, concomitant microorganisms which aggravate the onchocercal skin disease resulting in various skin changes were isolated and characterized.

4.7 LIMITATIONS OF STUDY

Every human endeavour has peculiar factors that tend to affect the progress of execution. In this study, some of the factors that affected the work in many ways include:

1. The inaccessibility to some of the communities during the rainy season because of the muddy and slippery nature of the terrain. This resulted in revisits of such communities during the dry season which in turn affected the time frame of the study.

2. A detailed ophthalmological examination of the eye to determine the presence of intra-ocular microfilariae and pathological changes attributable to infection was not carried out because of lack of sophisticated optical equipment including fundus photography and fluorescein angiography.

3. Owing to the absence of adequate database on life expectancy, the death and disability data due to onchocerciasis and other related diseases , it was

not possible to estimate the burden of the disease in terms of disability adjusted life years (DALY) as well as the overall cost effectiveness of control programmes.

4.8 RECOMMENDATIONS

For the effective management of human onchocerciasis in Imo State Nigeria, a number of specific strategies are recommended.

1. There should be intensive and sustained public health education aimed at improving the knowledge of the people about the causes/transmission of onchocerciasis.
2. This study recommends a semi-annual dose of ivermectin to all persons in endemic communities if the target of 2017 by APOC to stop clinical disease (blindness and skin disfiguration) from onchocerciasis as well as preventing new infections would be achieved.
3. It is recommended that broad spectrum antibiotics be included in the treatment regimen of infected persons especially those that present with excoriated skin lesions.
4. It is also recommended that Community Directed Treatment with Ivermectin (CTDI) should continue to be the basis for sustainability of control efforts.

4.9 FUTURE RESEARCH PRIORITIES.

As a result of the defined scope of the present study, the following are suggested as possible areas for future research.

1. Reliable empirical estimation of the onchocercal disease in school children as well as assessment of the impact of physical illness on school attendance, cognitive development and educational achievement.
2. Assessment of the precise role of microfilariae of *O. volvulus* in the development of signs and symptoms of non-classical onchocerciasis especially epilepsy and general debility.
3. Assessment of the impact of semi-annual treatment with ivermectin on the eye and skin lesions of onchocerciasis.
4. Assessment of the precise pathogenic role of concomitant microorganisms in aggravating the onchocercal skin disease process.
5. Development of a probe to detect possible ivermectin resistance in endemic communities that have undergone not less than 5 cycles of treatment.
6. The precise role of ivermectin in the dissolution of onchocercal nodules.
7. Assessment of any relationship between Human Immunodeficiency Virus (HIV) induced immunodeficiency and the development of clinical signs and symptoms of onchocerciasis.

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APPENDIX 1

INDIVIDUAL CLINICAL, PARASITOLOGICAL AND MICROBIOLOGICAL FORM

A. PERSONAL DATA

(a) Village ....(b) Village Code ....

(c) Community............................... (d) L.G.A...

(e) Name..(f) Household name/code.......................

(g) Age................................(Years)(h) Sex...(M/F)

(i) Marital Status..........(M/S/W/D)* (j) Educational Status..............(0/1°/2°/3°)

(k) Occupation..........(I/II/III/IV/V)***(l) No. of Years Resident.........................

(m) Date of Examination.................(n) Examiner..

NOTE: * (M/S/W/D): Married/Single/Widow/Divorcee

** (0/1°/2°/3°): 0° = No education (illiterate); 1° = Primary; 2° = Secondary; 3° = Tertiary

*** (I/II/III/IV/V): I = Artisans & Traders; II = Farmers; III = Health workers; IV = Civil Servants; V = Students & Pupils

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B. CLINICAL EXAMINATION

a) ONCHOCERCAL SKIN LESION

i) Nodule ______________________________(0 = Absent; 1 = Present)

ii) Acute papular onchodermatitis (APOD)_______0 = Absent; 1 = Present)

iii) Chronic papular onchodermatitis (CPOD)____(0 = Absent; 1 = Present)

iv) Lichenified onchodermatitis (LOD)__________(0 = Absent; 1 = Present)

v) Atrophy (ATR)_________________________(0 = Absent; 1 = Present)

vi) Depigmentation (DPM)___________________(0 = Absent; 1 = Present)

vii) Itching____(0 = No; 1 = Yes)

(For those with excoriations in their skin conditions, refer to section D below)

b) LYMPHATIC COMPLICATIONS

i) Lymphoedema (Limb)______________________________(0 = No; 1 = Yes)

ii) Lymphoedema (Genitalia)__________________________(0 = No; 1 = Yes)

iii) Lymphoedema (Breast)____________________________(0 = No; 1 = Yes)

iv) Lymphadenopathy________________________________(0 = No; 1 = Yes)

v) Hanging groin ____________________________________(0 = No; 1 = Yes)

vi) Hernia ____(0 = No; 1 = Yes)

c) OCULAR LESIONS

i) Itchy eye ______________________________________(0 = No; 1 = Yes)

ii) Impaired vision__________________________________(0 = No; 1 = Yes)

iii) Blindness_______________________________________(0 = No; 1 = Yes)

iv) Others (specify)..

d) SIGNS AND SYMPTOMS OF UNCERTAIN ASSOCIATION, PATHOGENESIS OR ETIOLOGY

i) Musculoskeletal pain________________________(0 = NO; 1 = Yes)
ii) Epilepsy________________________(0 = NO; 1 = Yes)
iii) General debility________________________(0 = NO; 1 = Yes)
iv) Dwarfism________________________(0 = NO; 1 = Yes)

C. PARASITOLOGICAL EXAMINATION

a) *Onchocerca volvulus* ________________________(0 = Absent)
________________________(1 = Present)

Right iliac crest ____________(0 = No; 1 = Yes)
Left iliac crest ____________(0 = No; 1 = Yes)

b) Others (specify)..
....

D. MICROBIOLOGICAL STUDIES

a) Excoriated Onchocercal Lesions
APOD.. (0 = Absent; 1 = Present)
CPOD.. (0 = Absent; 1 = Present)
LOD.. (0 = Absent; 1 = Present)

b) Site of Lesion..

c) Microorganisms recovered from lesions..
....
....
....

E. GENERAL COMMENTS AND REMARKS

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....
....
....
....
....
....

APPENDIX 2

SOCIO-ANTHROPOLOGICAL STUDIES

GENERAL QUESTIONNAIRE ON KNOWLEDGE OF ONCHOCERCIASIS AS WELL AS ITS SOCIAL COSTS IN THE STUDY AREA

A. CHARACTERISTICS OF RESPONDENTS

(a) Respondent No............................ (b) Date of Survey.........................
(c) LGA.. (d) Community...............................
(e) Village.. (f) Household number/code...........
(g) Age (yr)... (h) Sex (M/F).................................

(i) Marital Status: Single ☐ Married ☐ Widow/Widower ☐ Divorcee ☐

(j) Position in Household: Father ☐ Mother ☐ Son ☐ Daughter ☐ Others ☐

(k) Occupation[x]: I ☐ II ☐ III ☐ IV ☐

(l) Education:[xx] 0^0 ☐ 1^0 ☐ 2^0 ☐ 3^0 ☐

(m) No of years resident in village...

NOTE: x Occupation: I = Artisans and Traders; II = Farmers; III = Health workers; IV = Civil Servants; V = Students.

xx Education: 0^0 = No education (illiterate); 1^0 = Primary; 2^0 = Secondary, 3^0 = Tertiary

B. QUESTIONNAIRE

KNOWLEDGE

1. What is the commonest disease in this village?.......................................
2. What is the cause of the disease?...
3. Which other diseases are common in the village?..................................
4. Do you know the disease called Onchocerciasis (River Blindness)?
   Yes ☐ No ☐
5. From whom did you learn about it?
   Old people ☐ Friends ☐ School ☐
   Persons with disease ☐ others (specify)....................................
   ....
6. Do you have any local name(s) for it? Yes ☐ No ☐
7. If yes, what are the names...

8. Look at these photographs, have you ever seen any person(s) afflicted by any of these manifestations before? (Tick ✓)

Clinical manifestations	Code	Yes	No
Nodule	1		
Dermatitis	2		
Depigmentation	3		
Lymphadenopathy	4		
Hanging groin	5		
Lymphoedema (Limb)	6		
Lymphoedema (Genitalia)	7		
Lymphoedema (Breast)	8		
Hernia	9		
Blindness	10		

9. What are the local (village) name(s) for these manifestations?

Code I...

2...

3...

4...

5...

6...

7...

8...

9...

10...

10. Of all these disease manifestations, which one is the most serious that requires attention (Tick ✓)

Code 1. ☐ 6. ☐
2. ☐ 7. ☐
3. ☐ 8. ☐
4. ☐ 9. ☐
5. ☐ 10. ☐

11. Do you think that these manifestations are related?

(Tick ✓) Yes ☐ No ☐

12. If yes, which of these manifestations are related?

....

....

....

....

....

13. What do you think are the cause(s) of each of these disease manifestations?

Code I...

2...

3...

4...

5...

6...

7...

8...

9...

10...

14. Do you have any treatment for these diseases in your village? (Tick √)

Code	Yes	No	Does not know	If Yes, how? (Tick √)			
				Oracle/appeasing gods	Hospital/ clinic	Herbal/local therapy	Ignore it
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

15. Can these disease manifestations be prevented? (Tick √)

Code	Yes	No	Does not know
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

16. If the answer to 15 is Yes, what are the possible preventive measures practiced by your people (Tick √)

Code	Avoid insect bite	Avoid infected person	Avoid charmed/ evil forest	Avoid adultery	Personal hygiene/ clean environ-ment	Avoid contact with wet bush	Avoid accumu-lation of bad fluid	Consult oracle/ appease gods work	Avoid over work/ hard	Runaway when infected person dies	Others (specify)
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

17. Give any other information on the local habits and customs of your people that can help in the transmission, treatment and prevention of these disease manifestations.

....

....

....

....

....

C. SOCIAL COSTS OF THE DISEASE

18. How do you feel when you see a person(s) with these manifestations? (Tick ✓)

Code	Sorry	Fear	Insecure	Happy	Indifferent
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

19. Would you want to marry somebody with these manifestations? (Tick ✓)

Code	Does not know	Yes	No and why?
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

20. Would you want to hire somebody with disease manifestation as a farm hand or in any other productive ventures? (Tick ✓)

Code	Does not know	Yes	No and why?
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

21. Can a person with these manifestation still go to church/market/school or other social gathering? (Tick √)

Code	Does not know	Yes	No and why?
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

22. What would you not want to do with person(s) afflicted with any of these manifestations? (Tick √)

Code	Eat	Sleep	Sexual intercourse	Others/ specify	Explain
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

23. Does anybody close to you have any of these diseases? (Tick √)

Code	Does not know	No	Yes	If Yes, how do you relate to the infected person?			
				Normal	Withdrawal	Total isolation	Indifference
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

). SOCIAL COSTS FOR PERSONS AFFLICTED WITH ONCHOCERCIASIS

Ask the following additional questions if respondent has any of the clinical manifestations of onchocerciasis.

24. How did you feel when you first observed this disease on your body? (Tick √) and why?
    - Disturbed/Afraid ☐ ………………………………
    - Frustrated ☐ ………………………………
    - Hopeless ☐ ………………………………
    - Normal ☐ ………………………………
    - Insecure ☐ ………………………………
    - Indifferent ☐ ………………………………

25. What effect has this disease had upon your personal life? (Tick √)
    - Feel normal ☐ ………………………………
    - Withdrawn from people ☐ ………………………………
    - Feel inferior ☐ ………………………………
    - No comment ☐ specify ………………………………
    - Others ☐ ………………………………

26. What effect does this disease have on your level of interaction with people? (Tick √) and why?
    - Normal ☐ ………………………………
    - Improved ☐ ………………………………
    - Reduced ☐ ………………………………
    - Others ☐ specify………………………………
    - No comment ☐ ………………………………

27. Has this manifestation prevented you from attending or performing any village activity (Tick √) specify places/reason
    - Yes ☐ ………………………………
    - No ☐ ………………………………
    - Don't know ☐ ………………………………
    - No comment ☐ ………………………………

28. Has this disease affected your job/productivity in anyway? (Tick √)
Specify how.

Yes	☐	....
No	☐	....
Don't know	☐	....
No comment	☐	....

29. What form of treatment did you take when you observed this affliction on your body? (Tick √)

Went to hospital	☐
Went to clinic	☐
Went to herbalist	☐
Consulted oracle	☐
Hid infection	☐
None	☐

30. Would you be willing to participate in any programme meant for controlling the disease in your community?
Yes ☐ No ☐

Interviewer................................ Date..

APPENDIX 3

ECONOMIC IMPACT OF NON-OCULAR ONCHOCERCIASIS

CLINICAL EXAMINATION FORM FOR IDENTIFICATION OF SEVERE - OSD AND NON-OSD PERSON AS WELL AS THOSE WITH LYMPHATIC COMPLICATION

A. PERSONAL DATA

1. Village________________ 2. Village Code____________________
3. Community____________ 4. L.G.A.________________________
5. Name_________________ 6. Household name/code____________
7. Age_____________(years) 8. Sex______________________(M/F)
9. Occupation___(I/II/III/IV/V) 10. Date_____________________
11. Examiner____

NOTE: * I = Artisans & Traders; II = Farmers; III = Health Workers
IV = Civil Servants; V = Students & Pupils.

B. PERSONAL EXPERIENCE OF ILLNESS

1. How are you and the family? ______________________________
2. What of your health? ___________________________________
3. Have you been troubled by any particular health problems? (If yes, ask the next question) ________________________
4. How troubling has it been for the past month?_______________
5. Has any of the following sickness been a problem to you recently?
   (i) Headache_____________ (ii) Cough ___________________
   (iii) Joint-Bone pain _________(iv) Backache _________________
   (v) Fatigue/weakness _______(vi) Itching ____________________
   (vii) Diarrhoea ____________ (viii) Insomnia_________________
   (ix) Fever _________________(x) Other (specify) _____________
6. Which of these has troubled you most? _________________________

   (If subject has not mentioned itching, skip the next questions and proceed with physical examination)

7. How often does the itching occur? __________________________
8. How long does the itching last? ____________________________
9. Does the itching regularly disturb your sleep or other activities?________

C. PHYSICAL EXAMINATION

1. Acute Papular Onchodermatitis (APOD)
   - i) Presence ______________________ (0 = Absent; 1 = Present)
   - ii) Severity Code# ______________________

2. Chronic Papular Onchodermatitis (CPOD)
   - i) Presence ______________________ (0 = Absent; 1 = Present)
   - ii) Severity Code# ______________________

3. Lichenified Onchodermatitis (LOD)
   - i) Presence ______________________ (0 = Absent; 1 = Present)
   - ii) Severity Code# ______________________

4. Onchocercal Depigmentation
   - i) Presence ______________________ (0 = Absent; 1 = Present)

5. Palpable Onchocercal Nodules
   - i) Presence ______________________ (0 = Absent; 1 = Present)

6. Lymphatic Complication
   - i) Presence ______________________ (0 = Absent; 1 = Present)
   - ii) Type ______________________

KEY: Severity Code#

0 = No Lesion; 1 = Lesion without scratch marks; 2 = Lesion with scratch marks;
3 = Excoriation; 4 = Excoriation & Superinfection

Physical Examination Completed by ______________________

____

D. CLASSIFICATION

Non-OSD ______________

Severe - OSD ______________

Others (Lymphatic Complication) ______________

Severe - OSD (With self reported, troublesome itching)

- i) Duration ______________
- ii) Frequency ______________

Appendix 4: Yearly School Attendance Record Form for Children 10 - 15 Years

Name of School ....

Location of School ....

Class ....

Name of Class Teacher ....

Serial No.	Household No.	Name	Age	Sex	Village	Attendance History (1997/98 Session)		
						1st term	2nd term	3rd term

APPENDIX 5

GUIDE FOR ASSESSING DIRECT AND INDIRECT COSTS OF OSD AND OTHER CHRONIC COMPLICATIONS OF ONCHOCERCIASIS

The following questions were used as a guide to gather information about direct and indirect costs of onchocerciasis. All information obtained were recorded on the data collection form (Appendix 6).

A. GENERAL GREETINGS AND OTHER PLEASANTRIES

B. HEALTH SEEKING BEHAVIOUR

1. Have you gone for treatment, treated yourself, or done anything else for relief of any health problems since I was here 2 weeks ago?
2. If no, why ____________________
3. If yes, what kind of help ____________________
4. How many times have you sought such help ____________________
   (For categories not yet mentioned, inquire further)
5. (i) Have you made use of any drugs or herbs at home or any other cosmetics, oils, and so forth that you purchased, received, or had at home or from friends or relatives outside?

(ii) Have you visited any pharmacy or chemist shop to obtain medicines or advice for your health problems?

(iii) Have you gone to any doctor, clinic, or hospital?
(If so, was it a private, government, or mission clinic? ____________________

(iv) Have you gone to any traditional healer for help? ____________________

(v) Have you gone to a diviner, oracle, spiritual help or someone like that? ______

(vi) Did you make use of any other source of help for your health problems? (If so, specify details) ____________________

NB: Specify the number of visits or consultations on the data sheet for each category of care mentioned.

C. DIRECT COSTS OF SEEKING TREATMENT

1. How much time did it take to travel there and back, and to get the help you went there for?__________
2. Did anyone accompany you when you went for this help? (If, so, how many?)_
3. How much did you spend on transportation?__________
4. How much did you pay for this service (consultation etc? __________
5. Was there any additional cost for drugs? (If, so, how much?)__________
6. Did you pay or give anything else for this service? (If so, how much or what was it?) __________

D. INDIRECT COST OF DISEASE (ACTIVITY PATTERNS)

1. Were you able to go to the farm during the period of your ill-health?__________
2. If no, how many days were absent from the farm?__________
3. What other activities were you unable to perform during such periods?__________

APPENDIX 6

DIRECT COSTS OF SEEKING TREATMENT ASSESSMENT FORM

A. PERSONAL DATA

1. Name ____________________ 2. Identification No ________________
3. Age ________________(Years) 4. Sex ______________________(M/F)
5. Village ____________________ 6. Community ____________________
7. L.G.A. ____________________ 8. Assessment Date _______________
9. Prior Assessment Date ______ 10. Field Assistant __________________

B. HEALTH CARE AND ASSOCIATED COSTS

1. Type of health care facility used ______________________________
2. Number of times visited ______________________________________
3. Total time spent by subject _______________________________(Hours)
4. Total time spent by attendants ____________________________(Hours)
5. Cost of consultation _____________________________________(₦)
6. Cost of drugs/other remedies ______________________________(₦)
7. Cost of Transportation ___________________________________(₦)
8. Cost of Feeding ____(₦)
9. Cost of Hospitalization/Accommodation _______________________(₦)
10. Other commodities (specify) _____________________________
11. Any other health-seeking direct costs ________________________

____

____

C. SUMMARY OF ASSOCIATED COSTS

1. Cash expenditures _____________________________________
2. Expenditures-in-kind ___________________________________
3. Time spent in seeking health care _________________________

Assessment Completed by ____________ Next Assessment Date ____________

APPENDIX 7
PREPARATION OF MEDIA

Nutrient Agar

Nutrient Agar was rehydrated by suspending 23grams in 1liter of distilled or deionized water. The mixture was heated to boil to dissolve completely and then sterilized by autoclaving at 121^{0}C for 15 minutes. After cooling to 45^{0}C, the medium was dispensed into sterile Petri dishes and test tubes.

Blood Agar

Forty grams of dehydrated blood agar base (oxoid) was suspended in 1liter of distilled or deionized water and heated to boil to dissolve completely. The mixture was sterilized in the autoclave for 15 minutes at 121^{0}C and cooled to 45^{0}C - 50^{0}C. Five percent, defibrinated, room temperature blood (volume by volume) was aseptically added and shaken gently to achieve homogeneity. The mixture was then dispensed into Petri dishes or tubes.

MacConkey Agar

Powdered MacConkey was rehydrated by suspending 52grams in 1liter of distilled or de-ionized water. The mixture was boiled to dissolve completely and then sterilized by autoclaving at 121^{0}C for 15 minutes. After cooling to 45 - 50^{0}C, it was dispensed into sterile plates.

Sabouraud Dextrose Agar

Powdered medium was suspended in 1 liter of distilled or deionized water, mixed thoroughly and heated to boil to dissolve completely. It was then sterilized by autoclaving at 121^{0}C for 45 minutes.

PREPARATION OF TURBIDITY (OPACITY) STANDARD

This is a barium chloride standard against which the turbidity of the test and control inocula can be compared. When matched with the standard, the inocula should give semiconfluent growth. The turbidity of the standard is equivalent to an overnight broth culture.

1. A 1% v/v solution of sulphuric acid is prepared by adding 1ml of concentrated sulphuric acid to 99ml of water and mixed well.

2. A 1.175% w/v solution of barium chloride is prepared by dissolving 2.35g of dihydrate barium chloride ($Ba\ Cl_2.2H_20$) in 200ml of distilled water.

3. The turbidity standard is made by adding 0.5ml of the barium chloride to 99.5ml of the sulphuric acid solution and mixed well.

4. A small volume of the turbid solution is transferred to a screw-cap bottle of the same type as used for preparing the test and control inocula.

The standard can be kept for up to 6 months when stored in a well-sealed bottle in the dart at room temperature (20 - 28°C).

CAUTION: Concentrated sulphuric acid is hygroscopic and highly corrosive and therefore should not be mouth pipetted. In addition, the water should never be added to the acid.

APPENDIX 8 : Regression analysis and ANOVA Table of Prevalence of onchocerciasis and intensity of infection (Fig. 12)

Regression Statistics	
Multiple R	0.382059438
R Square	0.145969414
Adjusted R Square	0.089034042
Standard Error	2.727583476
Observations	17

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	19.07373749	19.07373749	2.563773769	0.130183
Residual	15	111.5956743	7.439711618		
Total	16	130.6694118			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	18.33011949	1.56771707	11.69223698	6.16051E-09
X	0.109411676	0.068331951	1.601178869	0.130183

Note: Test is significant at 5% if Significance F and P-value for X are both less than 0.05.

APPENDIX 9 : Regression analysis and ANOVA Table of Prevalence of onchocerciasis and intensity of infection amongst occupational groups (Fig.14)

Regression Statistics	
Multiple R	0.917514644
R Square	0.841833123
Adjusted R Square	0.815471976
Standard Error	5.934069952
Observations	8

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1124.519633	1124.519633	31.93461752	0.001317676
Residual	6	211.2791172	35.2131862		
Total	7	1335.79875			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	2.847696565	4.021764874	0.70807137	0.505463671
X	0.974974403	0.172529099	5.651072245	0.001317676

Note: Test is significant at 5% if Significance F and P-value for X are both less than 0.05.

APPENDIX 10: Regression analysis and ANOVA Table of Prevalence of onchocerciasis and palpable nodules (Fig. 15a)

Regression Statistics	
Multiple R	0.7339213
R Square	0.538640474
Adjusted R Square	0.507883172
Standard Error	7.014938841
Observations	17

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	861.7842017	861.7842017	17.51260492	0.000796997
Residual	15	738.1405041	49.20936694		
Total	16	1599.924706			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-0.71472113	4.03193503	-0.177265041	0.861671686
X	0.735436253	0.175739611	4.184806438	0.000796997

Note: Test is significant at 5% if Significance F and P-value for X are both less than 0.05.

APPENDIX 11: Regression analysis and ANOVA Table of Prevalence of onchocerciasis and depigmentation (Fig. 15b)

Regression Statistics	
Multiple R	0.065649622
R Square	0.004309873
Adjusted R Square	-0.062069469
Standard Error	3.611194997
Observations	17

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.846707482	0.846707482	0.064927924	0.802330589
Residual	15	195.6109396	13.04072931		
Total	16	196.4576471			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	10.73227885	2.075585253	5.170724176	0.000113966
X	0.023052205	0.090468359	0.254809584	0.802330589

Note: Test is significant at 5% if Significance F and P-value for X are both less than 0.05.

APPENDIX 12 : Regression analysis and ANOVA Table of Prevalence of onchocerciasis and impaired vision (Fig. 18a)

Regression Statistics	
Multiple R	0.483190897
R Square	0.233473443
Adjusted R Square	0.182371672
Standard Error	8.826333788
Observations	17

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	355.9280661	355.9280661	4.568793617	0.049433624
Residual	15	1168.562522	77.90416814		
Total	16	1524.490588			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	17.19269858	5.073059822	3.389019484	0.004047967
X	0.472636098	0.221119029	2.137473653	0.049433624

Note: Test is significant at 5% if Significance F and P-value for X are both less than 0.05.

APPENDIX 13 : Regression analysis and ANOVA Table of Prevalence of onchocerciasis and blindness (Fig. 18b)

Regression Statistics	
Multiple R	0.260732961
R Square	0.067981677
Adjusted R Square	0.005847122
Standard Error	0.556132974
Observations	17

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.338388793	0.338388793	1.094104189	0.312127468
Residual	15	4.639258265	0.309283884		
Total	16	4.977647059			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-0.091357038	0.31964527	-0.285807572	0.778934627
X	0.014573161	0.013932351	1.045994354	0.312127468

Note: Test is significant at 5% if Significance F and P-value for X are both less than 0.05.

APPENDIX 14 : Regression analysis and ANOVA Table of Prevalence of onchocerciasis and musculoskeletal pain (Fig. 20a)

Regression Statistics	
Multiple R	0.401263801
R Square	0.161012638
Adjusted R Square	0.105080147
Standard Error	10.58833299
Observations	17

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	322.7386559	322.7386559	2.878696	0.110405696
Residual	15	1681.691932	112.1127955		
Total	16	2004.430588			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	13.06226314	6.085793712	2.146353255	0.04860958
X	0.450060878	0.265260975	1.696672037	0.110405696

Note: Test is significant at 5% if Significance F and P-value for X are both less than 0.05.

APPENDIX 15 : Regression analysis and ANOVA Table of Prevalence of onchocerciasis and epilepsy (Fig. 20b)

Regression Statistics	
Multiple R	0.053953075
R Square	0.002910934
Adjusted R Square	-0.06356167
Standard Error	0.627309986
Observations	17

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.017232731	0.017232731	0.043791489	0.837057489
Residual	15	5.902767269	0.393517818		
Total	16	5.92			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.431595265	0.360555261	1.197029448	0.249871323
X	0.003288689	0.015715492	0.209264161	0.837057489

Note: Test is significant at 5% if Significance F and P-value for X are both less than 0.05.

APPENDIX 16: Regression analysis and ANOVA Table of Prevalence of onchocerciasis and intensity of infection (Fig. 22)

Regression Statistics	
Multiple R	0.445292545
R Square	0.198285451
Adjusted R Square	0.156089948
Standard Error	6.939371289
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	226.2897771	226.2897771	4.699208176	0.043084837
Residual	19	914.9426039	48.15487389		
Total	20	1141.232381			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	8.499477054	4.440150179	1.914231887	0.070773804
X	0.480310874	0.221569551	2.167765711	0.043084837

Note: Test is significant at 5% if Significance F and P-value for X are both less than 0.05.

APPENDIX 17: Regression analysis and ANOVA Table of Prevalence of onchocerciasis and intensity of infection amongst occupational groups (Fig. 24)

Regression Statistics	
Multiple R	0.840145542
R Square	0.705844531
Adjusted R Square	0.65681862
Standard Error	7.672695302
Observations	8

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	847.5772308	847.5772308	14.39737702	0.009026889
Residual	6	353.2215192	58.8702532		
Total	7	1200.79875			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-2.41172554	6.851849619	-0.35198168	0.73688454
X	1.407470924	0.37093494	3.794387569	0.009026889

Note: Test is significant at 5% if Significance F and P-value for X are both less than 0.05.

APPENDIX 18: Regression analysis and ANOVA Table of Prevalence of onchocerciasis and palpable nodules (Fig. 25a)

Regression Statistics	
Multiple R	0.655477001
R Square	0.429650098
Adjusted R Square	0.399631682
Standard Error	4.239588728
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	257.2613847	257.2613847	14.3128838	0.001256951
Residual	19	341.5081391	17.97411258		
Total	20	598.7695238			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	5.690607359	2.712696852	2.097767525	0.049532875
X	0.512126505	0.135367273	3.783237211	0.001256951

Note: Test is significant at 5% if Significance F and P-value for X are both less than 0.05.

APPENDIX 19: Regression analysis and ANOVA Table of Prevalence of onchocerciasis and depigmentation (Fig. 25b)

Regression Statistics	
Multiple R	0.539758079
R Square	0.291338784
Adjusted R Square	0.254040825
Standard Error	3.788286925
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	112.0982851	112.0982851	7.811118724	0.011552822
Residual	19	272.6712387	14.35111782		
Total	20	384.7695238			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	2.036419227	2.423931818	0.840130573	0.411282906
X	0.338056613	0.120957504	2.794837871	0.011552822

Note: Test is significant at 5% if Significance F and P-value for X are both less than 0.05.

APPENDIX 20: Regression analysis and ANOVA Table of Prevalence of onchocerciasis and impaired vision (Fig. 28a)

Regression Statistics	
Multiple R	0.218940596
R Square	0.047934985
Adjusted R Square	-0.0021737
Standard Error	6.957249416
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	46.30359741	46.30359741	0.956620289	0.340329987
Residual	19	919.6630693	48.40331943		
Total	20	965.9666667			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	12.27373676	4.451589481	2.757158272	0.01253878
X	0.217268776	0.222140387	0.978069675	0.340329987

Note: Test is significant at 5% if Significance F and P-value for X are both less than 0.05.

APPENDIX 21: Regression analysis and ANOVA Table of Prevalence of onchocerciasis and blindness (Fig. 28b)

Regression Statistics	
Multiple R	0.584516246
R Square	0.341659242
Adjusted R Square	0.307009728
Standard Error	0.150018946
Observations	21

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.221915812	0.221915812	9.860433999	0.005390098
Residual	19	0.427607997	0.022505684		
Total	20	0.64952381			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-0.1881105	0.095989481	-1.959699108	0.064866563
X	0.015041255	0.004790006	3.1401328	0.005390098

Note: Test is significant at 5% if Significance F and P-value for X are both less than 0.05

APPENDIX 24 : Regression analysis and ANOVA Table of Prevalence of onchocerciasis and knowledge of respondents (Fig. 34a)

Regression Statistics	
Multiple R	0.889676559
R Square	0.79152438
Adjusted R Square	0.722032506
Standard Error	5.42996943
Observations	5

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	335.834296	335.834296	11.39017183	0.043252869
Residual	3	88.45370402	29.48456801		
Total	4	424.288			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-2.514928143	15.31550095	-0.164208024	0.88000733
X	1.747771512	0.517868527	3.374932863	0.043252869

Note: Test is significant at 5% if Significance F and P-value for X are both less than 0.05.

APPENDIX 25 : Regression analysis and ANOVA Table of Prevalence of onchocerciasis and attitude of respondents (Fig. 34b)

Regression Statistics	
Multiple R	0.799222327
R Square	0.638756329
Adjusted R Square	0.518341772
Standard Error	11.57586674
Observations	5

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	710.8259278	710.8259278	5.304643759	0.10468265
Residual	3	402.0020722	134.0006907		
Total	4	1112.828			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-23.96831726	32.65031236	-0.734091515	0.516063093
X	2.542750591	1.104016724	2.303181226	0.10468265

Note: Test is significant at 5% if Significance F and P-value for X are both less than 0.05.