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HUMAN LICE

THEIR PREVALENCE, CONTROL AND RESISTANCE TO INSECTICIDES

A REVIEW 1985 - 1997

by
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1. INTRODUCTION

Historical and archeological evidence shows that human lice infestations were present throughout the world thousands of years ago (118). Infections carried by body lice, such as epidemic or louse-borne typhus and epidemic or louse-borne relapsing fever, killed millions of people. Infestations of body lice were common in every army during World War I. During this period, outbreaks of typhus, relapsing fever and trench fever occurred in troops, prison camps and among refugees as well as in central Europe, the Balkans and the middle east (30). Though epidemic typhus and relapsing fever have disappeared from Europe and most of Asia, infections persist in the mountainous areas of eastern Africa and Central and South America. (132). Furthermore, body lice are reappearing in many countries and trench fever has returned to the United States and Europe (19, 83,138), where the infestations are clearly a manifestation of poverty and homelessness (115).

Neither head lice (*Pediculus capitis*) nor pubic nor crab lice (*Pthirus pubis*) are vectors of disease, though head lice have been infected in the laboratory with typhus rickettsiae (123). Pubic lice have never been found to harbor any disease organism, but infestations by this species are frequently associated with the infection of other sexually transmitted diseases (STDs) (55, 56, 141, 155).

Head lice infestations are rampant among school children in both developed and developing countries (69) and large sums are spent on the purchase of medications to treat infestations. It has been estimated that the cost of head lice infestations is $367 million annually in the USA, including sums expended for the purchase of across the counter pediculicides and expenses to school systems (39). Schools will often send home infested children, insisting that they be treated before returning to class (14). Often, there is a sense of shame on the part of parents whose children have infestations, as many do not realize how commonly children are infested.

There are many surveys on the extent of head lice infestations, particularly among school children. Rates of infestation vary greatly from place to place, but in many countries more than half the school children may be infested. Unlike body lice, head lice are found among children at all socioeconomic levels. Generally, rates are heavier among girls but the influence of length of hair on frequency of infestations appears to be unresolved, with some surveys finding it significant (154, 163) while others fail to find differences between children with long and short hair (42, 156). It is equally unclear as to whether racial differences are a factor in infestations (105,131, 135).

Human lice infestations has been reviewed by many authors (23, 24, 68, 69, 118, 148) although a plethora of recent literature warrants a new, comprehensive review. Information on the current distribution of human lice, the extent of louse-borne diseases, developments in the control of lice and problems encountered in the control such as that of insecticide resistance, will therefore be examined below.

2. THE SPECIES OF HUMAN LICE

There are three species of human lice: the body louse, *Pediculus humanus*, the head louse, *P. capitis* (formerly *Pediculus humanus capitis)* and the crab or pubic louse, *Pthirus pubis*. There is now general agreement that head and body lice are two valid and separate species (29, 53, 69, 92, 147, 169, 179) and they will be so considered in this review. The only host for the three species are humans of any age or sex. They can not be long separated from their human host, the sole source of blood meal, and will starve to death after two or three days of separation.

The body louse is found mainly on undergarments or clothing next to the skin. It leaves clothing only to feed and when it has completed its blood meal returns to the fibres of the clothes where its eggs are laid in the seams. The head louse is found primarily on the hair of the head though it can sometimes be found in the eyebrows,

and its eggs or "nits" are attached to hairs. The pubic or "crab" louse lives mainly in the pubic or genital region of the human body, although it is frequently found on eyelashes and elsewhere in cases of heavy infestation. It also attaches its eggs to hairs. It is called the "crab" louse because its strong, grasping legs give it a distinct crab-like appearence.

The female body louse lays some 200-300 eggs during her life time of 2 to 4 or 5 weeks. The head louse lays about 50 to 150 eggs and lives for approximately the same time period. The crab louse produces some 30 to 50 eggs during her life time. Eggs generally hatch in 8 to 10 days. All species molt three times before reaching the adult stage. The life span of human lice is up to 30 days under optimum conditions.

Body lice are generally some 2 to 4 mm in length, but the head louse is usually somewhat smaller and the crab louse measures only 0.8 to 1.2 mm. Only the human body louse can, with some difficulty, be reared on laboratory animals but no successful colonies have been established of the head louse or crab louse.

Of the three species, only the body louse is a vector of disease. Its obligatory association with mankind has enabled the body louse to be a vector of diseases that have been among the great scourges of history. During wars, civil disturbances, in prisons and in refugee camps and during any massive displacements of populations precluding personal cleanliness and washing of clothes, epidemic typhus caused by *Rickettsia prowazekii* and epidemic relapsing fever caused by *Borrelia recurrentis* have ravaged populations. Though not a cause of great mortality, trench fever caused by *Borrelia quintana* was responsible for much illness during the trench warfare of World War I.

The association of the head and pubic louse with people is as close and obligatory as that of the body louse and their distribution and incidence is greater than that of the body louse.

Louse-borne typhus and louse-borne relapsing fever were, until recently, diseases reportable under the terms of the International Sanitary Regulations to the World Health Organization (WHO). In the past two to three decades, incidence of louse-borne typhus and relapsing fever has diminished and reporting of the two diseases is no longer required. The remaining foci are mainly in mountainous areas of Burundi, Rwanda and Ethiopia, although cases still appear sporadically in foci in South and Central America.

The prevalence of body lice is closely related to the socioeconomic and hygienic status of any given population. The body louse is now uncommon in developed countries but infestations are widespread in several countries of east Africa, central and south America and in Asia. There is evidence that a recrudescence is occurring in some developed countries. The head louse persists almost everywhere as the most common human ectoparasite. The pubic louse is probably also very common but little information is available on the frequency of its infestations other than they are often associated with other sexually-borne diseases.

3. THE PREVALENCE OF HUMAN LICE INFESTATIONS

3.1 HEAD LICE

Head lice infestations are unpleasant and, if not treated, may cause secondary skin infections due to scratching of irritated scalp, especially among children. The prevalence of infestations is high everywhere, particularly among children but frequently among adults as well. Information on the extent of lice infestations is important in determining the priority that should be given to their control and the following section reviews published reports of head louse infestations. Attempting to present survey results in tabular form would be misleading as the methods of examination, number of children examined, and the age and sex involved in the different surveys vary considerably from each other. The number of persons may range from hundreds to tens of thousands. Infestation rates found are likely to

depend greatly on the method of examination and how assiduous a search is made for lice and/or nits. Some surveys count only living lice, others eggs as well; some make only visual observations on the presence of lice and/or nits while others comb the hair for a fixed period of time.

3.1.1 The Americas

Argentina. In a one year study from 1992 to 1993, the prevalence of head lice in Argentina was studied in 15 districts of Buenos Aires; 552 children from 1 to 16 years were sampled. During the year, prevalence ranged from 12% in February to 56.8% in August with an annual mean of 38.04% (32).

Brazil. Of 1,412 school children examined for head lice in Ceara State in 1984, 56% were infested, including 63.7% of the girls and 49.2% of the boys. The length of hair did not seem to be a factor (42).

From 1975 to 1982, during a survey in Manus, in the Amazon region, 100,939 children were examined for leprosy and other skin diseases. 107 of the children were positive for leprosy while 28,301 of them (28%) were positive for head lice along with 6,714 cases of scabies (165). A survey of 1,696 school children Paulina found a 37.3% prevalence among the 169 black students, a 35.7% prevalence among the 1,504 white students and a prevalence of 26.1% among the 23 Asian students (105). It has been calculated that 5 to 6% of the entire population of Brazil is infested with head lice (101).

Canada. Three studies carried out in western Canada have been reported. In surveys of 163 and 405 children in schools in rural central Alberta in 1978, each child was examined for three minutes in the first survey and 1.5 minutes in the second. 17 (10.4%) had nits and/or lice in the first survey and 11 (2.7%) were found to have lice in the second. Head lice were significantly more frequent among American Indian students than in Caucasian students and were more common among town children than those living in rural areas (58). A school survey in

British Colombia in the spring of 1987 found an infestation rate of 12% among the students. However, this high rate of infestation was reduced to 1.1% by fall of that year as a result of the activities of a parent volunteer programme (108). In Hamilton, Ontario, 14 (5.7%) out of 245 school children in grades 1 to 4 had lice and 48 (19.6%) had evidence of past infestations (38).

Chili. Surveys have shown that head lice infestations are a serious problem among school children. In 1981, 7,327 children were randomly sampled in 10 elementary schools for scabies and head lice. The overall rate for scabies was 4.3% while for head lice it was 21.7%, with sex specific rates of 15.8% and 27.1% for males and females respectively (74). In an examination of 207 children in two rural schools in 1986, 46.8% had head lice and 24% had scabies in the worst affected school (124).

USA. The presence of lice is generally viewed with much concern by parents and most communities. An interesting manner of measuring the interest and concern with head lice in the USA is the fact that a search for the topic "head lice" on the Internet resulted in several hundred sites, the actual number depending on the "search engine" utilized. Most sites originate from the USA, but other countries are also represented. Many schools will send infested children home, not allowing them to return until they bring a certificate that they have been effectively treated (this is despite the fact that many of the infestations are contracted at the school). One country has even placed its administrative procedure regarding headlice infested school children on a website which states in part, "children suspected of having head lice and/or nits shall be isolated..." and "the parent shall be required to submit proof of treatment or medical certification of treatment and the child shall be free from headlice and nits before returning to school".

Head lice are regarded as a substantial public health problem both by school authorities and parents. Among severely infested children, pruritus is the cardinal symptom of infestation. Generally, infestations have few adult lice but a myriad of eggs (56). In 1985, an

increase in head lice infestations was noted in California (91). Overall, infestation rates were thought to range from 6 to 12 million cases of head lice infestation per year, (39, 157), with most of the cases in the 5 to 12 year old age group. Infestation rates increased in the 24 to 36 year group due to exposure to infested children. Head lice affect several million children in the USA every year and these infestations are "...more prevalent than all other childhood communicable diseases combined" (49).

The US National Pediculosis Association is dedicated to strengthening activities for the control of head lice. It is estimated that 2.6 million households experience an outbreak of head lice each year and that 8% of the school children population is infested (3). Due to the high rates of infestations, control is important and considerable sums are expended on chemical preparations for head lice control. As noted above, it has been estimated that the cost of head lice infestations in the USA is $367 million annually, including sums expended for the purchase of over the counter pediculicides and expenses to school systems. (39).

Two surveys carried out in elementary schools in Florida showed infestation rates of 6.7% in one school and 8% in the other, with rates sometimes twice as high as this within individual classes. In one of the schools, the students were examined four times at three month intervals. 97 (6.4%) of the 1,515 white, Hispanic and Asian students were infested but none of the 436 black students were. The distribution of the pediculosis in the infected students was significantly affected by season of the year, sex, hair length, family size, crowding in the home and degree of infestation of other family members as well as the mode of transport to and from school. In the classrooms, the factors associated with infestations were the use of headsets, crowding at tables and sitting on the floor (135).

Several authors have noted that head lice infestation rates are higher among white children than blacks in the USA. It has been said that "the head louse does not bother American black children although he does torment youngsters in Africa" (131). After a review of head

lice problems in school children, race is considered as an important factor in whether children were infested or not: prevalence in whites and other races (Asiatic) was 35 times higher than in blacks. Only 0.3% of the black children surveyed in Florida were infested with head lice as compared to an overall prevalence of 8% in the schools studied (87). There was also a very low prevalence of head lice among black children in a multi-ethnic society in Guiana (8). However, the same prevalence of infestation among black students as among white was found in a survey in Paulinia, Brazil (105).

Females in several surveys in the United States were more frequently infested than males (87), although another author thought that head lice were found more frequently on boys than girls (131). As the reported surveys carried out in the United States cover different population groups in different areas, it is difficult to compare and resolve whether head lice are more frequently found among on young males or females. Finally, it has been concluded that the incidence of head lice in the United States is not truly known (110).

3.1.2. WESTERN EUROPE

Head lice are a persistent and troublesome problem in all countries of Western Europe from which information has been reported. The large quantities of products sold for the control of lice infestations attests to the magnitude of the problem and to the concern of families in attempting to control infestations. Only countries with published information are reviewed.

Denmark. The Danish Pest Infestation Laboratory provides advice to the public on the control of both public health nuisances and agricultural pests and records the yearly number of inquires for each pest by species. The yearly number of inquires regarding head lice were: 292 inquires (1993), 397 inquires (1994), 405 inquires (1995) and 481 (1996), clearly showing a rising trend over several years. There has been a notable increase in the number of inquires about headlice from parents with children of 3 to 6 years of age in the

Copenhagen municipal area. This has also been reflected in the number of preparations purchased for the control of headlice, as can be seen in the following table:

Purchase of Head Lice Preparations in Denmark*

Year	Organophosphorous insecticides	Pyrethroid insecticides
1992	19,778	68,581
1993	21,276	67,030
1994	36,982	105,704
1995	64,570	84,888
1996	78,501	59,662

*Information provided by Dr. Kim Larsen, Danish Pest Infestation Laboratory, Lyngby, Denmark.

France. Head lice began to be a problem in France in 1969. Rates of infestation were 2% in the least infested schools but in the north of the country schools with infestation rates of 50 to 60% were found (170). Further evidence of the increase in infestations emanated from a study in Tours where between 3,600 and 4,800 pupils were checked yearly. The rate in 1970-1971 was 8%, in 1971-1972, 11%, in 1972-1973, 12% and in 1973-1974 it had risen to 14.6% though by 1981 the rate, among 1,200 pupils had increased to only 15.1% (61). As early as 1979, it was reported that a recrudescence of pediculosis was occurring in the southern coastal region of the country (167). In a comprehensive review of the head lice situation in the Touraine, infestations varied from 15% to 18% in some schools and it appeared that the rates of infestation, at least in this region, were not progressing (41). An indication of the magnitude of infestations in France is that in 1984, only 2,793,000 individual treatments were sold in 1984 whereas in 1989 4,656,000 were sold. Families are becoming more aware of the head louse problem in the country and are more willing to take part in louse control programmes.

Even heavier infestations were found in schools in the Bordeaux region where 38.8% to 62.6% of the pupils were infested with lice, with girls (20%) more heavily infested than boys (40%). The highest

prevalence was in a suburban school where 17% of the parents of the children were unemployed. The peak age of infestation was 7 years of age but 19.4% of the nursery school children had been infested at least once. Most transmission occured at school and generally, it was the local pharmacist who advised families on control measures (43).

In a survey in Paris schools in 1992, 8,353 children were screened, 279 (3.4%) of whom were infested. Many of the children had 20 lice or more per head (36).

There are more than 20 different louse-control products with significant sales on the French market. The majority of these are based on formulations containing malathion or permethrin . Overall sales in recent years have been as follows:

Sales in Thousands of Individual Formulations for Lice Control for the 20 Leading Products

1991-2	1992-3	1994-5
5,839.8	3,819.5	3,611.5

The value of these sales is in the vicinity of 100,000,000 FF per annum (Personal communication, Mr C. Gil, Chef de Produits, Pierre Fabre Santé). The decline in sales is more likely due to economic reasons rather than a lessening of the problem of headlice infestations.

Germany. No detailed reports were found on the prevalence of head lice in Germany other than an observation that the incidence of head lice infestations in Germany had considerably increased during the period 1977-1979. This increase was ascribed to the increasing number of communal facilities for young people coming from many different places, increased bus transportation of children to schools and increased tourism to countries where young people may become infested. "Body contact" between young German children and

adolescents had increased. Lice infestations among foreign workers on the other hand were not common. The most frequent causes of reinfestations were "problem" families and improper treatments (75).

Greece. A survey of 6,279 children of 3 to 12 years of age was conducted in 47 nursery schools and 56 elementary schools in Athens and rural areas. 4,834 of the children lived in Athens and 1,445 in rural areas of central Greece. Of the entire group, 325 girls (10.5%) and 272 boys (8.6%) were infested. Infestations were almost 28% in girls and 21% in boys in urban areas and in rural areas the highest rate was 11% among girls and 8.9% among boys (177). There does not appear to be any other survey carried out in Greece (Anna Samanidou, National School of Public Health, Athens, personal communication).

Italy. Head lice have been found to be widespread in Italy (133). In a 1980 survey of 1,988 school children, 9.6% were positive. Most (74%) had a low level of infestation (less than 20 eggs), although about 14% of the cases in primary and secondary schools had more than 50 eggs or nits. Head louse infestations were checked among 1,500 students selected at random from nursery, primary and secondary schools in Bari on the southeast coast of Italy in 1980, with 14.8% of the children infested. Nursery school children had low rates of infestation. Infestations were highest among children from socially and economically underprivileged areas (162).

A 12 year review was made of dermatological problems at the Military Hospital of Messina. 15,1290 soldiers had been seen of whom 135 (1.59%) had head lice and 802 (9.46%) had scabies (13). In a survey of 7,374 schoolchildren at primary schools in Gela, Sicily, 1,332 (18%) harbored headlice. The authors were concerned about the high rate of infestation as they considered head lice might transmit the hepatitis virus (100). Butera, also in Sicily, is a small country town of 6,158 inhabitants. The town is improvished by immigration and only 15% of the population had active work in 1983. Yet only 7.61% of 210 school children were infested. The reasons for the difference from Gela was not clear other than the fact that Butera is smaller and rural (62).

There are few recent surveys reported in Italy, but there seems to be little change from the study carried out in 1977 on 1,211 children of 30 schools of Rome. The rate of infestation was 7.8% and was highest among elementary school children (10.5%), followed by secondary school pupils (6.6%) and nursery schools (6.6%). In October, 1977, the city of Rome had approximately 380,000 students enrolled and it was therefore assumed that the number of cases of pediculosis would have been about 30,000 (107).

Spain. Concern about head lice infestations in Barcelona led to an examination of 18,373 children in state schools in 1987 (14). The percentage of children infested ranged from 1.07% to 14.35%, with an average of 6.21%. All infested children had to be treated by their parents before they were allowed to attend school again. Three months later, rates had fallen to 0.41% to 3.75%, with an average of 1.92%.

In 1987 in Galicia, 19.9% of 1,000 children examined had head lice with the rate almost evenly divided between boys and girls. There was a marked variation with age: rates were 0-2 years, 10.6%; 3 to 5 years, 56.3%; 6 to 9, 27.1%; and 10-15 years, 6% (5).

An extensive survey in the school system of Bilbao in the Basque region of 23,624 children 3 to 14 years of age revealed an overall infestation rate of 9.39% (between 1.8% to 31.6% in different schools). The percentage of infested girls was 1.7% as compared to 1% of the boys. The peak infestation rate was in the 9 to 11 year old age group (106).

Sweden. While no information was found on surveys on lice infestations in Sweden, the following information was obtained on the overall sales of products for headlice and scabies:

Sales of Preparations for the Control of Human Lice and Scabies in Sweden (in thousands)*

Year	Amount of sale	Year	Amount of sale
1985	87.8	1991	127.4
1986	75.8	1992	128.7
1987	116.8	1993	153.7
1988	128.7	1994	91.7
1989	127.4	1995	109.9
1990	128.7		

*Personal Communication, Dr. Ingrid Trolin, Department of Drug Information, Medical Products Agency, Uppsala.

The products available included formulations containing lindane, malathion, permethrin, phenothrin and pyrethrins

Switzerland. No published information has been found on the prevalence of lice infestations in Switzerland. However, in 1993, some 74,500 "individual units" of lotions or shampoos were reported to have been sold in the country specifically for use against headlice. In addition, when sales of other preparations recommended for the treatment of body or head lice (but almost certainly used for control of head lice) are added for the same year, the total sales of lice control products is approximately 110,550 units. A number of other preparations are sold locally in small quantities and the total number of units sold in 1993 is estimated at 120,000 (Dr. G. Touzau, Pharmacie du Landeron, Le Landeron, Switzerland, personal communication).

UK. There has been much concern with head lice in the UK. Louse infestations are generally high, although there is much disagreement as to why this should be so. A 1971 review found that the overall head louse infestation of 5.7% reported from schools considerably underestimated the extent of the problem. School nurses only recorded live lice, not nits, which accounts for the low figures. Based on a sample survey in Teesdale, it was estimated that 10,000 (12%) of the children were infested. A more detailed survey of 3,600 children in 40 schools was therefore carried out. The highest rates of infestation (23.1%), were in downtown areas of poor and overcrowded housing

while infestations were low (0.4%) in suburban areas. Only two secondary schools were inspected and the infestation rate was 30.3% in one and 22.6% in the other. One result of these inspections was the decision to exclude infested children from the school. A note was sent to the parents requesting that the child be treated and presented for reinspection in 48 hours. In 360 cases a legal notice was sent to the parents following a failure to control their child's infestation. These measures resulted a significant, though not complete, decline in infestations (40).

A large survey was carried out in 1975 at the request of the UK Health Education Council. A total of 15,654 primary school children plus 7,291 secondary school children were examined. Out of this total, 312 boys and 363 girls were infested. Rates varied from 0.4% to 2.3% in rural areas and 4.4% to 6.3% in urban. There were marked differences between the poor and good zones. The rate for the country as a whole was 2% to 4% in primary and 2.5% in secondary schools. The study was limited only to school children subject to surveillance by school nurses (48).

From the replies of a questionnaire sent to parents of primary and junior school children it was concluded that 33% of the pupils suffered head lice infestations at least once a year, with infestations of 21% to 63% from different schools (18) .

After a period of some stability, head lice infestations in the UK may be increasing. The figures collected by the Department of Health are not thought to reflect accurately the level of infection as a whole as peak infestation levels are amongst children of pre-school age about whom no figures are collected. Furthermore, the number of pupils examined for lice has dropped (149).

In an overview of 200 years of lice in Glasgow, charts reviewing the history of lice infestations and lice-borne diseases are provide the results of surveys of head lice infestations in the early years of the twentieth century. Routine health inspections of children no longer take place in Glasgow (102). The Health Service now

reports low infestations among school entrants (only 4% among girls), but 19,000 to 36,000 treatments for headlice control are sold in the city every year, suggesting that head lice remain a persistent and poorly monitored problem (103).

3.1.3. CENTRAL AND EASTERN EUROPE

Relatively little information is available from this region. Several articles on health conditions refer to serious increases in parasitic infections in Russia, including increases in both head and body lice (6, 159). While increases are said to be occurring in other countries of the former USSR, too little is known to be able to judge their magnitude.

Hungary. A single survey in Budapest, Hungary, in 1983-1984 found that only 1.25% of the children in primary schools had head lice It was noted that the incidence was ten times higher among children with long hair than among pupils with short hair and a well-groomed appearance. Infestations were also 2.6 times higher in overcrowded schools with poor sanitary facilities. Fewer infestations were found in schools more frequently visited by school doctors or nurses than in those receiving only infrequent visits. Infestations in nurseries were low, only 0.3% (11).

Poland. A report of a 1990-1992 study in the cities of Gdansk, Sopot, Gdynia and their vicinities in Poland sampled 27,800 school children of 6 to 15 years of age, finding 881 (3.2%) infested with head lice. Socioeconomic factors influenced the frequency of infestations which were greater in families with 4 or more children (48.9%). In families whose parents had only an elementary school education, 79.4% of the children were infested. About 50% of the village school children infested lived in old houses with only cold water or no running water at all (178).

Czech Republic. Head lice are a common nuisance in the Czech Republic, but no published reports on the incidence of infestations

have been seen either from the Czech Republic or from Slovakia. Several articles on the testing of insecticides for head louse control shows that, as elsewhere, they are present and a cause for concern.

Serbia. In 1990, 37,005 children in different regions of Serbia were examined and 2,476 of them (6.7%) were found to be infested with head lice. The range was from 4.9% in the least infested locality to 13.6% in the highest, with the most heavily infested age group the 7 to 10 year olds, and the lowest the 3 to 7 year olds. There was little difference between sexes. The children of workers and parents with less education were more heavily infested (161).

Reports from U.N. organizations and relief agencies in Croatia, Serbia, and Bosnia indicate that there were heavy body and head louse infestations, especially among refugee populations in 1994 and 1995, but no data are available with respect to percentage of persons infested nor species of lice. Large quantities of insecticides for louse control have been ordered, doubtlessly indicating a need for them.

Turkey. In a review of the records of the Dermatology Clinic of Istanbul University for a 20-year period, 1970-1989, it was noted that the number of cases of pediculosis gradually increased, reaching a peak of 1.08%, or 173 of 15,995 patients in 1981. Of the positive cases, there were more women (78.57%) than men (21.34%). Traditionally, an infestation with head lice carries a stigma in the community and most people conceal their infestations; it was estimated that the real rate may be two or three times higher (10).

Rates of infestation were considerably higher among 11,156 pupils between the ages of 7 to 12 years examined in 13 primary schools in six different townships of Istanbul. Of 5,363 girls and 5,393 boys, 2,014 had pediculosis (18.05%). There was a greater difference between sexes than seen in most other surveys with 30.9% of the girls infested and only 6.9% of the boys. There was also a difference between townships: those with shanty towns and poor or irregular water supplies had higher levels of infestation (182).

In 1990-1992, 5,086 students from one secondary and four elementary schools in the Izmir region were screened for head lice eggs and/or adults. Of the 4,086 elementary school students, 5.7% were positive while 5.3% of those from the 1,000 secondary school students were infested. As in Istanbul, the differences between males and females was substantial, with 9.3% of the female students being positive as compared to only 2.3% of the males. In four localities, infestations had declined but in one they had increased (80).

A screening in the Izmir region examined 878 students in two village and one urban primary school. Eggs were detected in 305 (35.4%) of the children while lice were present in 13 (1.4%). (145). Examinations of 112 children in an orphanage in Sivas showed that only 4 girls were infested, which the authors ascribed to the shortness of the children hair. However, 33% of the children were infested with scabies. (127).

There are significant differences in infestations rates between the various areas in Turkey and the reasons for this are not clear. However, the considerable difference between rates of infestation in females and males is consistent in all the surveys reported.

3.1.4. MIDDLE EAST

Egypt. Head lice rates are high in Egypt. The infestation rate among 486 children between the ages of 6 to 12 was 16% in Qualyobia City (113). In later surveys, rates of infestation were 17.58% of the school children in Qualyob City, and averaged 30% in Zahazig city. In some schools infestation rates of 50% were found (114). Infested children had clinical manifestations ascribed to their head lice, including pruitis with or without lymphadenopathy, crusts behind the ears and psoriasis. The children in poor areas of the cities and rural villages were heavily infested.

Iran. Few studies on head lice infestations in Iran are available. In a study in Bandar Chabahar of 2,260 children, 304 (13.45%) were found

infested by lice or nits. Infestations among girls were especially high, at 78.29%. Only four cases of *Tinea capitis* were associated with head lice infestations (183).

Israel. Head lice are a common problem in most schools and most segments of the population. Surveys of large numbers of school children in various parts of the country (116) showed infestation rates in 15-20% of all children 3 to 14 years of age. Virtually all children attend kindergarten from the age of 3, involving close contact between them in the classes. In a kibbutz or communal settlements, children generally live together in the same dormitories until the age of 18. A total of 1,431 school children between 6 and 15 years of age in rural and urban environments were examined before carrying out an intervention program against lice. The rate of infestation was generally high (55%), with the highest among children of the kibbutz, who had an infestation rate of 80%. In the urban areas the rate was 37% (146). In an examination of 3,079 children in a medium sized community near Jerusalem, 11.2% were infested with living lice and eggs and another 23% had only nits. Infestations rates were about equal between sexes and were highest in the 4-11 age group. Some 78% of the children were carrying 1 to 11 lice. Boys with medium length hair and girls with short hair showed the highest incidence of lice. It was also noted that children with brown and red hair were more infested than those with black or blond hair (121). An examination of 2,643 children was made to determine the percentage of those infested with lice and the clinical symptoms that were associated with the infestations - 19% of these children were infested, with the distribution nearly equal between boys and girls. Bite reactions, pruritus, excoriations, lymphadenopathy and conjunctivitis were more frequently seen in infested children than non-infested. Pruritus was the most common symptom but as the infestation continued in time, the pruritus subsided (120).

The sociodemographic variables related to head-lice infestations were studied in a primarily immigrant community. A comparison was made between 57 lice infested children with 57 non-infested children. Children whose fathers were less educated, or who were born in Israel

and children of younger mothers were at greater risk of infestation. There was no association between the sex of the child, the mother's years of schooling, the size of the family or the number of siblings under 14 years of age (140). Louse infestations were especially high among newly arrived immigrants from Ethiopia. 65.1% of 304 persons examined were positive, with rates among the children of 65% to 100% (122).

Results of examinations of notifications of head and pubic lice infestations among soldiers in the Israeli Army showed a significant negative association between the number of years of formal education and measure of socioeconomic status. These findings suggested that infestations are more common in lower socio-economic groups, which should be taken into account in planning public health campaigns for lice control. Among the Army groups studied, the incidence of headlice infestations increased from 5.2/1,000 in 1977 to 18.1/1,000 in 1979 and then declined to 3.6/1,000 in 1987 with a higher incidence in summer months (63, 64).

Libya. It was noticed that there was a large attendance for head lice at dermatology clinics in Benghazi and a mass survey was therefore carried out (12). The results revealed high rates of infestation in school children from 27 schools which were considered "alarming", i.e., 78.6% of 13,734 students, including 85.5% in rural areas and 44.3% in urban areas. Infestations were 67.2% for boys and 88.1% for girls, with no significant difference between younger or older children or, generally, between sexes. Treatment for head lice was only sought when bacterial infections occurred on the scalp.

Saudi Arabia. In an assessment of the prevalence of head lice in Jeddah in 1987, among 300 children in a 0 to 10 year old age group, 37 (12%) were positive. Only 2% of the children were positive in the first year of life and by 6 to 8 years this rose to 30%, but declined thereafter (17). A survey of skin disorders among 2,788 students in Jeddah showed that 11.01% of the younger students were positive for head lice (183).

In conclusion, head lice are certainly present at high rates in all the other countries of the Middle East, but no other reports have been found in the literature.

3.1.5. AFRICA

Despite reports from the USA that black students are less infested than white, head lice are a serious problem in Africa. Most published surveys have been carried out in countries of West Africa with a few in East Africa. In southwest Cameroon, a survey of 2,312 school children (1,462 urban and 850 rural) found an overall infestation rate of 31.6% in urban schools and 32.6% in rural ones. The rate among girls was 36.3% in urban areas and 35.1% in rural and among boys, 26.9% in urban and 30% in rural areas (9). These high rates were ascribed to general overcrowding in both urban and rural schools and a generally poor level of hygiene. Also in West Africa, a study in the Gambia on the effect of insecticide impregnated bednets on nuisance arthropods showed that prior to the insecticide trial, head lice infestation rates were 28.8% in children less than 10 and a 37.5% rate of infestation of beds by bedbugs (104). Infestation rates in Accra, the capital city of Ghana, were 49.53% (158 out of 319 pupils infested). The older age group was more heavily infested. Plaiting of hair, communal toilet facilities, and crowding were all contributing factors. The relative intensity of infestations in some 74% of the students was considered by the author to be low and this appeared to be the case in most other areas. (96). A survey of 1,007 children in 5 primary schools in Sierra Leone found 6.8% were infested by head lice (8.3% of the girls and 5.4% of the boys) (60).

Nigeria. Many surveys have been carried in Nigeria with considerable variations between rural and urban areas and the different age groups. Infestation rates in urban areas ranged from approximately 5% of the school children to a high of more than 28%. Rates were lower in rural areas. The frequency of lice infestations in Ibadan in western Nigeria and three surrounding villages were studied. In urban schools, 106 (5.7%) of 1,860 schoolchildren were infested compared to only 7 out

of 473 in rural schools. Pediculosis is considered to be primarily an urban problem and the high rates of infestation may be associated with overcrowding in the urban schools. The number of lice per infestation was not high. 74.6% of all the lice infested children harbored between one to five lice per head and only 5% had more than 30 lice per head (125). Higher infestation rates among girls is ascribed to being plaited their hair. The prevalence of lice in primary school children in Ile-Ife was 12.75%, with incidence higher among the children of artisans and workmen than among the children of professionals. A more important observation was that of the lice infested children, 14.2% had impetigo as compared to only 1.8% of the non-infested (84). Among 7,360 inhabitants of the Niger Delta area of Nigeria, 5.7% were infested with headlice. The rate in the 6 to 13 year olds was 13.5% and decreased progressively with age. More females were infested than males (4). In a survey in Nsukka, in Eastern Nigeria, 17.6% (749 out of 4,242) students had head lice, with the highest rates in those between 9 and 17 years of age (81).

A study of 6,882 urban school children in Illorin compared infestation rates among children belonging different religious groups. Overall, 3.76% of the children were infested with headlice. The rate among girls from an Islamic community was 4.1% whereas in the Christian area it was 3%. More girls (5.6%) than boys (2.1%) were infested. When assessed by socio-economic class, 28.4% of the girls and 11.2% of the boys were infested. Factors associated with lice infestations were overcrowding, long hair, size of the family, age, living in a "sordid" environment and a low degree of personal hygiene (52).

Kenya. In Kenya, a 1986 survey reported that infestation rate was 17.1% among 1,270 school children from urban and rural primary schools. Negroid children had fewer infestations than the non-negroid, and this was thought to be related to the hair type. The levels of infestation were low, as most individuals had no more than one or two adult lice (37).

Tanzania. In a study of the frequency of skin disease in Tanzania, 5.34% of persons examined had lice infestations. The average age of infested individuals was 12.5 years and infestations were more common in boys (73).

Seychelles. A survey in the Seychelles islands with several different racial groupings showed much higher rates of infestations, ranging between 27.5 to 28.7% in schools (67).

Ethiopia. Body lice and louse-borne diseases are a serious problems in Ethiopia, but head lice infestations are also common. A US Navy team (149) examined 3,133 people in 49 towns and villages and 23 prisons. Head lice infestations were higher on non-prisoners (24.4%) than on prisoners (11%). Of the 2,359 persons examined for lice in Addis Ababa, head lice infestations were 26.2%, somewhat higher than in the towns and villages. There was a significant decrease of head lice infestations with age in all areas, with males and females equally infested. While most head lice infested individuals had between 1 to 25 lice, one person had 2,167(!).

A survey was made of 1,842 elementary school children in North Ethiopia for skin diseases. Only 16 of the children had no skin disease of some sort and 66.5% of them had head lice (45).

3.1.6. SOUTHEAST ASIA

Bangladesh. Though head lice are known to be common, the only report on their incidence in published literature is one associated with an insecticide control trial carried out in a school and a children's home in Dkaka. (25). Before the trials, head lice infestations were 75% to 100% in the two named study sites, high rates for any country.

India. Head lice and scabies are serious problems in both urban and rural areas of India but especially so in rural villages. A survey of 936 persons in 166 families studied in a semi-urban community of Goa, 56.6% had a member infested with head lice. 17.3% of all 936 persons

were infested but 55% of children 5-14 years of age. There was a considerable difference between sexes and ages - 34.4% of the females were infested, but only 2.1% of the males. Infestation rates were 13.1% among children less than 4 years of age, 55% among school children of 5 to 14 years but only 17.3% among the 25 to 39 years age group. Rates were highest among farming families and lowest among those in higher income families. Head lice infestations were considered normal by most people and mutual grooming was a common social activity (70). In Shillong, the presence of head lice in all age groups was high. 59.7% of the lower class and 15.8% of the middle class were infested with head lice and many with body and pubic lice as well (142). Though little else is published, a rapid inspection of children in most villages in India and city schools shows that head lice are very common.

Malaysia. Head lice infestations in Malaysia are relatively high among all national groups in the country. In a large survey in Peninsular Malaysia in 1981, 10.7% of the 308,101 children studied were infested. By contrast, 34% of economically disadvantaged children were infested. The highest rate of infestation in Mekala State was among the Indian ethnic group and the lowest was among the Chinese. Rates were higher for children with long hair and girls had higher rates than boys (153).

A survey in the capital city of Kuala Lumpur, covering 4,112 primary school children, revealed an overall prevalence rate of headlice of 12.9%. There were substantial ethnic differences in the rates of infestation with 28.3% of the Indians and 18.9% of the Malays, but only 4.6% of the Chinese being infested. The correlation between rates of infestation and socio-economic status, length of hair, family size and age was close (154). In rural Kelang, Selangor, 41.5% of 1,243 children were infested with head lice and ethnic differences were again substantial. Infestations were 51.8% among the Indians, 42% in Malays and 27.3% in Chinese. These rates were much higher than the 10.7% national average rate of infestation in urban children. More girls were infested than boys (152).

Pakistan. Few reports exist from Pakistan, but head lice are as serious problem here as in India. Of 2,287 school children (8 to 16 year olds) in Peshawar in the north of the country, 49% of the 1,499 girls and of 40% of the 788 boys were infested. The rate of pediculosis was reported as directly related to the length of the child's hair, but these rates decreased with age. The infestations were clearly related to crowding at home and, curiously, negatively associated with dandruff, as the head louse probably does not thrive well on dry hair and a scaly scalp. The degree of infestation, like the prevalence, was higher among the girls than in the boys, although decreasing linearly with age (163).

Surveys of 1,002 persons, 656 females and 346 males, in four urban localities of the North West Frontier Province in 1986 showed an overall infestation rate of 36.7%, again higher in females (41.5%) than in males (27.7%). Pediculosis was high in the 5 to 19 year old age group, but then decreased. It is felt that the higher rate of infestation among the females was due to their longer hair. A significant negative association between pediculosis and dandruff was again seen, but only among males. Crowding in the home, the number of children per family and a low level of education were associated with higher rates of infestation. Intensity of infestation was determined by counting the number of lice recovered in a two-minute combing. Only a small proportion of females (16%) and an even smaller proportion of males (3%) were heavily infested, i.e., more than 20 lice per head. Overall, the density of infestation was higher in females (with an average of 12.4 lice per head) than males (with an average of 10.3 lice per head) (164).

A survey of school children from grades one to ten and of three socio-economic groups classified as upper, middle and lower classes was conducted in Lahor. The presence of lymphadenopathy and any secondary infections were recorded, as was the length of hair. Children were marked as positive if they had either living lice or nits or both in their hair. A total of 3,600 children (1,800 boys and 1,800 girls from six schools all between 5 and 16 years of age, were examined. The overall prevalence for headlice was 25.5% with the

highest incidence in 8 to 10 year olds . Of this number, 340 boys were positive (9.44%) and 573 girls (16.5%). Of the positive boys, 180 (53.01%) had pruritus, 64 (19.02%) lymphadenopathy and secondary infections were noted in 17 (5%). Among the 1,800 girls, 326 (56.6%) of those positive complained of pruritus, 121 (20.99%) had lymphadenopathy and 48 (30%) secondary infections. The infestations were highest in the lower socioeconomic class and lowest in the upper class. Pruitis was seen in almost all economic classes, while lymphadenopathy was more common among the lower class. This may be linked to the poor nutritional status of the group (90)

3.1.7. WESTERN PACIFIC

Australia. Records indicate that large outbreaks of head lice appear in Tasmania every two years and that there has been a marked upsurge in 1989-1990 (66). Lice infestations were common in nursery schools, and 44 out of 92 day care centers reported outbreaks of head lice in the early 1990s (86).

New Zealand. No recent data are available from New Zealand, but outbreaks of head lice are more frequently reported, after a period of low prevalence in the 1950s and 1960s. There was a higher prevalence in the North Island than the South Island and infestations tended to be more common among Maori and Polynesian New Zealanders (2).

China. Titles of a substantial number of papers on lice infestations were seen, particularly in the Chinese Journal of Parasitology, indicating that head and crab lice are common. No mention was made of body lice in the titles. During a visit to China, the author was told that body lice were an occasional problem in only some regions of China.

Japan. Head lice persist as a problem and in Okayama city, 31% of the schools reported in 1992 that they had some children infested though the rates of infestations were only 1%, mostly among girls

(168). The rates of infestation were thought to be increasing in the country (71).

Korea. Head lice seem to be a particularly severe problem in Korea, with many articles describing the results of surveys. Overall infestations were 73.5% among the 615 primary school children examined in Chunggman Province. The rate in girls reached 78.8% and among the boys 67.6%, and were highest among the 3rd and 4th grade students. The greater the number of family members the higher the risk of infestation of the children from the home (99). An examination of a much larger number of students (5,837) in 23 primary and 3 middle schools in another area of Korea found that overall infestation rates occurred in 44.5% of the children, with the rates in the schools ranging from 19.6% to no less than 88.6%, for an average of 53%. Again, rates among the girls were higher (55.6%) than among the boys (33.2%) (93).

Even higher rates of infestation were found in another area among 420 school children at 3 primary schools and a nursery school. 91.9% of the children were lice infested, reaching 96.1% of the girls and averaging at 88.9% among the boys (129). In a survey among school children in Kangwon-do, 412 children from 4 primary schools were examined. The overall infestation of nits or lice was 37.2%, though the rate at one school was 66% (79).

Infestations were lower among 1,530 children in a primary school in the port city of Inchon. Only 4 out of 768 boys had either nits or lice, while 72 out of 762 girls (9.4%) were positive. The infestation rate for girls was 19 times higher than that of the boys (76).

In a comparison made of the prevalence of louse infestation between urban and rural areas (130), the overall prevalence among 11,865 children in 9 urban and 8 rural areas was 24% (2,900 positive). The overall rate for children in rural areas was 58.9% and for urban children 14.4%. Infestations were higher for girls than boys, except in preschool children, where there were no significant differences.

Rates of infestation by nits in girls in an orphanage and women in a mental hospital averaged 70%, with 60.7% of the girls positive for adult lice (128). Infestations were also high among adults in a mental hospital in Seoul (77). Of the 438 women in the hospital, 146 (33.3%) were positive for nits or lice, while 22 of 143 men were positive (15.4%). Examinations for any stage of head lice was made of 36,055 vagrants and children admitted to public welfare facilities. 20.5% of them were found to have infestations (78).

Taiwan. An overall infestation rate of 39.8% was reported among 2509 students in three different districts of two counties. However, in one primary school, 66.7% of the students were infested, although most of the infestations were light (34). In December, 1990, 35 children in a single kindergarten, 7,870 students in 26 primary schools, and 2,657 students in 3 junior high schools in Yunlin country were examined. The overall infestation rate was 16%, ranging from 8% in one school to 25% in the highest. 21% of the primary school students were infested as compared to only 2% of those in the junior high schools. As in other countries, there was a considerable sex differential. 34% of the girls in primary schools had lice as compared to 9% of the boys, and in the junior high schools 4% of the girls were infested as compared to 1% of the boys (59).

3.1.8. HEAD LICE - CONCLUSIONS

Though numerous articles have been cited, there are many countries from which no published reports on the incidence of head lice are available. Nevertheless, the available reports show that infestation rates of head lice are high almost everywhere, both in developed and developing countries and in tropical and temperate countries. In many of the studies cited, infestations were found among 90% or more of the children. Despite the high frequency of infestations, the density of adult lice per person is usually very low, no more than a few per head. Infestation rates were usually higher among girls than boys. Most of the studies have been carried out on school or preschool children and only a few among adults. However, where

carried out on these latter, rates of infestation are also high. Reactions towards head lice infestations vary greatly from one society to another and within different segments of a community. In some societies, the finding of head lice on their children elicits shock and even shame among the parents. In others, infestations are accepted as normal, if even remarked upon at all. In most countries however, efforts are made to rid children of head lice infestation which, as has been seen, accounts for the considerable expenditure on insecticide prepartions for the control of lice.

It must once again be emphasized that the reported rates of infestation vary greatly depending on the competence and diligence of the persons carrying out the survey to detect lice or living nits. Keeping in mind that adult lice numbers per head are genrally low and that the small number of eggs associated with a new or recent infestation are not easily found, it can, in fact, be assumed that many of the reports reviewed above probably under estimate actual prevalence.

3.2. BODY LICE

Little information is available on the prevalence of body lice in most countries. This is due in part to the assumed low rate of infestation in the developed counties and the very few studies that have been conducted. Nevertheless, there is evidence that a recrudescence of body lice infestations is occurring. However, in those countries where body lice and diseases transmitted by them are common, it is difficult to obtain information from the affected regions due to the difficulty of access to affected areas and civil disturbances in many of the endemic areas.

Today, as throughout history, body lice infestations flourish under conditions of war, civil unrest, natural catastrophes, refugee camps and prisons and everywhere else where sanitary facilities for personal hygiene or clothes washing are poor or absent. In the developed world, body lice infestations are rare, although seen among

homeless people in the USA (L. Jackson, personal communication, 1997) and Europe or on the economic margins of society or where poverty has made personal hygiene difficult. A report from Russia states that the presence of body, head and crab lice is widespread due to the short supply of soap and other hygiene products (6). Published suggestions have been provided for Russian Army physicians on the control of lice, especially on how to treat clothes, underwear, uniforms and linen (95).

In one of the few instances in Europe where detailed figures are available, body lice were found in the Netherlands on two homeless men, aged 32 and 38, who had come to a clinic complaining of persistent itching. Body lice are generally rare in the country, but during 1993 and 1994, body lice were found 41 times on 31 patients at a clinic for the homeless in Utrecht (98).

There is evidence that body lice are not uncommon in refuges populations in the countries of former Yugoslavia. However, hostilities have prevented any inspection of populations either in camps or towns. Eggs were seen on clothes on clotheslines but no study could be made of the magnitude of the problem (K. Chetwyn, Royal Army Medical College, London, personal communication).

The reports of inquiries made to the Danish Pest Infestation laboratory have already been referred to above. For the years 1993, 1994 and 1995, the number of inquiries about body lice were 1, 3 and 3 respectively.

Body lice were reported in Czechoslovakia in 1991, the first time since 1945 that they had been seen in the country (143).

Trench fever, which is normally louse-borne, has been reported among homeless men in the USA and Europe in the last few years. In France, the presence of antibodies to *B. quintana* is significantly associated with the presence of body lice, among other factors (19). Unfortunately, no mention is made of the presence - if any - of body lice infestations in the majority of the articles describing the finding of

persons positive for antibodies for *B. quintana*. Investigation of the long disappearance of this infection, the mechanism of its persistence and reasons for its reappearance present an epidemiological challenge.

Body lice are frequently found among people living in mountainous areas where the cold climate requires heavy dress but where poverty makes the changing or washing of clothes a rare occurrence. There are occasional reports of infestations in Nepal, India and China in Asia, Turkey in the Middle East as well as in mountainous areas of Central America and the Andean countries of South America.

The countries where the highest density of body louse infestations occur are Ethiopia, Sudan, Rwanda, Burundi, Uganda and Zaire all located in eastern Africa. A WHO mission visited Goma, Zaire to recommend measures for body louse control to avert epidemic outbreaks of louse-borne diseases. Body lice were common among the refugees in the camps. Some 8,000 were treated with an insecticidal powder (31, 54). Under the existing conditions and heavy louse infestations, the risk of disease transmission is great. The last epidemic of louse-borne typhus occurred in Burundi in 1975, when 9,000 cases were reported, although no further cases have been reported since 1990. However, as a consequence of the civil strife in Burundi, which started in 1993, some half a million people have been living in refugee camps in the highlands. Several cases of fever of unknown origin were observed in August, 1995 and a prolifereation of lice, associated with cases of fever, occurred in a prison in Ngozi in December, 1995. Serological examinations of the body lice and blood samples confirmed that there had been cases of epidemic typhus. Since that time, a large outbreak of louse-borne typhus has developed in 5 provinces of Bjumbura, Gitega, Kayanza, Muramvya and Ngozi. In 1996, 3,500 cases were reported and nearly 24,000 cases occurred from January to May, 1997, which is the largest outbreak to have occurred in over 50 years. Blood from 200 patients and 95 lice was tested and 80% of the patients and 25% of the lice were found positive for *R. prowazekii*. The case fatality rate is thought to range from 1% to 20%. (1).

In Ethiopia, body lice are widely pervasive. Of 1,544 elementary school students (aged 6 to 25) examined in 1989, 66.8% harbored from 1 to 598 body lice. Lice were more common in villages at higher altitudes where water was not readily available for washing. Infestation rates were lower in the 1 to 6 year old age group, possibly because of greater parental attention to these very young children. From 1974 to 1984, the Ministry of Health reported between 8,000 to 17,000 cases of louse-borne typhus per year (171). The study by Scholdt et al. (149) should be consulted for its wealth of details on body louse infestations in Ethiopia. Louse-borne relapsing fever caused by *Borrelia recurrentis* persists as a serious public health problem in Ethiopia and it has been estimated that there are some 10,000 cases a year in the country (137). An outbreak of relapsing fever occurred in Jimma, in south-western Ethiopia in 1991 among students, returning soldiers and homeless. Two-thirds of the population were infested with body lice and the household attack rate of the disease was 15%, although higher among children (111). After cessation of the war in Ethiopia, soldiers accounted for 50% of the cases of relapsing fever. One-third of the hospital admissions in the areas to which they returned were due to this disease which had a mortality rate of close to 4% (15).

3.3. PUBIC LICE

Pubic or "crab"- lice are usually found on the hairs of the pubic region and transmission is for the most part through sexual contact. As will be seen, the presence of pubic lice is very often associated with other sexually transmitted infections, though not necessarily so among infants. The lice may occasionally be found on short hairs elsewhere on the body. Pruritus is the most common symptom of infestation by this species and the severe itching will usually cause the patient to seek treatment. Understandably, few statistics exist on the incidence of pubic lice infestations as few people of any age would be readily inclined to take part in surveys to determine the presence of infestations. Published data are mainly from reports of sexually

transmitted disease (STD) clinics, underlining the association between pubic lice and STDs. Patients presenting with pubic lice or scabies should routinely be tested for other STDs (141).

A study of eight cases of infestations of the eyelids by pubic lice among six women and two men indicated the close relation of infestations to other sexually transmitted diseases. Four of the infested individuals admitted to oral-genital intercourse. Clinical examination showed lice present in five cases, pelvic inflammatory disease in one, bacterial vaginosis in two, perianal warts in one, and subclinical human papilloma virus in the cervix of three. The contact of one of the patients was found to have latent syphilis and of four other contacts, two had pubic lice but had neither noted nor complained about them (155).

A case of tubo-ovarian conglomerate tumor in Germany was ascribed to *P. pubis* (180). A high rate of STDs was seen among 235 homosexually active Finnish men, with 88.5% reporting at least one STD infection. The most common infection was a pubic lice infestation, present in 64.7% of the patients (172). In the USA the number of infestations among homosexual men increased with age and with the number of episodes of sexually transmitted disease, with whites having more infestations than blacks. Homosexually active men living alone were more prone to infestations than those with a single companion (160).

In contrast, no other STDs were found in the 60 pubic lice infested young, single patients in the region of Gdansk, Poland. Several of these patients said the source of their lice infestations was not sexual but that they had become infested through contaminated clothing (134). Scalp and eyelash infestations in infants are not uncommon (33, 57, 151).

4. THE CONTROL OF HUMAN LICE INFESTATIONS

The literature on the control of human lice, particularly head lice, is voluminous. Little is to be gained from a review of articles describing efficacy trials, the toxicology or the use of insecticides which have been withdrawn due to their mammalian toxicology or which are no longer used due to the development of widespread insecticide resistance in louse populations, such as the case with DDT (174). Many compounds have been withdrawn from registration by the manufacturers for these reasons and only those insecticides for which registration exists and which continue to be used are considered here. Reviews of the two compounds commonly used in the past but which are now only rarely found in use, e.g., DDT, and those presently used are available (24, 118). The World Health Organization has a listing of compounds that have been found to be effective in the control of human lice (35).

4.1. STRATEGIES OF CONTROL

The control of head lice is essentially the control of a nuisance, as they are not vectors of disease. While infestations may lead to secondary infections, particularly in children, the purpose of control is primarily to regulate unpleasant or annoying infestations. Control is usually on an individual basis, less frequently on a family basis. In most instances, the parents of school children purchase insecticidal preparations individually, often at the instigation of school nurses or teachers. As it is generally considered that the source of most infestations is at the school, entire classes of school children, both infested or uninfested, may be treated in some countries. However, unless infested siblings are also treated in the home, infestations will gradually be reintroduced. Parents should be encouraged to examine all children in a family and treat them as necessary. Schools should provide simple educational brochures to students which would inform families about the life cycle of head lice and means of control, the most effective insecticides, their manner of use and where to procure them. Introducing a sense of shame among infested students and their

families is counterproductive. Informed cooperation of the families should be sought instead.

Pubic lice infestations should be regarded as a warning of the possible presence of another sexually transmitted infection. Control of the lice infestations, usually through the agency of a physician, should be used as an opportunity to examin the patient to determine whether another sexually transmitted infection is present and to provide education on the risk and prevention of STDs.

The control of body lice should be regarded as essential in the prevention of louse-borne diseases. In most foci where body louse populations are present in significant population densities, louse-borne diseases remain endemic or have usually been present at some time in the past. If louse-borne or epidemic typhus has been present in an area, health authorities should keep in mind the possible recrudesence of the infection years after the primary attack (as is the case with Brill-Zinsser disease). Should this occur, rickettsiae will also reappear in the blood of the ill person and, if louse infestations are also present in the population, this may lead to another epidemic of the disease. However, in most endemic areas, the disease continues to circulate at a low level and when conditions occur that lead to the close contact of large numbers of people under circumstances of poor personal hygiene, such as in refugee or prison camps, body lice populations may quickly increase and epidemics of typhus, relapsing fever or trench fever quickly follow. Under such circumstances, large scale interventions for the control of lice populations are necessary to prevent transmission. Health personnel should be trained to recognize body louse infestations as well as in the organization and implementation of large-scale control interventions. All persons at the site should be treated, whether infested or not, especially when louse-borne infections are already present or threatening. Application equipment should be stock-piled in circumstances where body-lice populations are known to be increasing and arrangements made for the rapid procurement of an effective insecticide. Insecticide susceptibility tests on the louse populations should be regularly carried out to guide the selection of an effective insecticide.

4.2. CHEMICALS IN COMMON USE FOR THE CONTROL OF LICE

LINDANE With the general cessation of use of DDT for louse control, lindane is the only organochlorine still used in lotion, creme and shampoo formulations, which usually contain 1% of the active ingredient. Two applications about 10 days apart should be made to assure control of lice that may have emerged from the nits (eggs) after the initial treatment. The USA Environmental Protection Agency (EPA) considers lindane as a probable carcinogen based on animal studies. Its use by the US Department of Defense for delousing has been discontinued (7). Severe reactions to lindane therapy may occur with increased skin absorption and, where used, lindane should be applied with caution to avoid excess skin penetration. It should not be used to treat infants, young children, or pregnant or lactating women (20). A review concluded that lindane was not sufficiently effective to justify its continued use and that the odds on treatment failure are likely to be 8 times higher with lindane than with permethrin (173). Physiological resistance among both head and body louse populations to lindane is wide spread (109). Nevertheless, lindane formulations remain in use. Where they continue to be used, care should be taken in their application, as noted above. Due to toxicological concern, and the spread of insecticide resistance, it seems likely that use of lindane for lice control will decline, especially where alternative compounds are available.

MALATHION An organophosphorous insecticide formulated in concentrations of 1.0% and 0.5%, malathion has been widely used in the USA and Europe. It works rapidly against adult lice and is usually an effective ovicide (137). However, not all formulations tested were necessarily ovicidal and for most formulations, a 10 hour or overnight treatment was required, with a second application after one week (22). In the survey of insecticides used against head lice in Glasgow (where 19,000 to 36,000 bottles of insecticides have been bought by the public every year), malathion formulated as a shampoo was the most

popular and was recommended by the Health Board and by pharmacists and physicians (103). Body louse resistance to malathion has been reported from Burundi (112) and Ethiopia (150) as well as in refugees in Zaire (report to the WHO).

Head lice resistance to malathion in France is reported to be based on clinical failure to control infestations (82) and malathion resistance at high levels is spreading in the UK (Dr. I Burgess, personal communication) . Malathion is however still effective against head lice in most areas and is considered safe to use. Like most compounds, its success against the eggs varies, and at least two treatments a week apart are recommended. The deodorized formulation of malathion may be preferred in some communities.

CARBARYL Carbaryl formulations at concentrations from 0.5% to 1% have been used since 1976. While generally quite effective, two treatments of this carbamate insecticide, one week to 10 days apart, would assure better control of lice hatching from the nits. More recent reviews have reported carbaryl to be less effective and less persistent than earlier thought (21). The UK Committee on Carcinogenicity found evidence that carbaryl is an animal carcinogen and therefore, limiting human exposure to it would be prudent. Although the risk was considered only theoretical, as there are no reports of tumors associated with human carbaryl exposure, the recommendation was accepted by the Ministry of Health and in the UK, carbaryl is now available for lice control only on prescription (16, 47). However, where it is prescribed, it can be considered as a reasonably effective compound.

PERMETHRIN This pyrethroid insecticide has been available since the 1970s. Its use against head lice has been steadily increasing as concern has grown relating to the purported mammalian toxicity of some other compounds. The compound has been found to give a greater degree of control of eggs and adult lice than lindane as well as greater persistence (166). In a 1995 review of the clinical efficacy of all recent topical treatments for headlice, only permethrin 1% creme rinse was said to show efficacy in more than two of the seven trials

selected for detailed evaluation (173). In a post-marketing study of 1% permethrin creme rinse involving 18,950 patients, no serious, adverse events were detected among these of individuals (3).

The continued use of permethrin is threatened by permethrin/pyrethroid resistance. Resistance to permethrin appeared relatively soon after its introduction for head lice control and has been reported from the Czech republic (144), France (44), Israel (119) and the UK (26). It seems likely that resistance will develop much more rapidly to the pyrethroids than was the case with older compounds. This is a cause of much concern, as relatively few compounds with high efficacity against lice and low mammalian toxicity are available as possible alternative compounds for lice control at present. Concern has also been expressed at the possibility of the wide-spread use of pyrethroid impregnated bed nets in malaria endemic areas causing insecticide resistance to develop in both head lice and body lice populations.

PHENOTHRIN This pyrethroid is closely related to permethrin. A 0.2% phenothrin shampoo was compared to malathion and found to be as effective as malathion (97) and carbaryl (85). In laboratory studies (27), the alcoholic lotion was more effective in preventing the hatching of eggs than the permethrin. No serious side effects have been found in the course of its use, (50), but an unrelated irritancy has resulted in the withdrawal of phenothrin shampoo in the UK (24). As with permethrin, resistance to this compound has already appeared in the Czech Republic (144), France (36, 44) and the UK, (26). Further selection will likely limit the use of this and other pyrethroids including compounds little used in lice control such as bio-allethrin, deltamethrin and tetramethrin.

BENZYL BENZOATE Originally derived from the leaf oil of *Cinnamomum mollissimum*, this substance has been widely used at 10% to 30% concentrations for treatment of pediculosis and scabies, although it is not always an effective ovicide. Skin irritation is common, and there may be allergic reactions. It is used extensively in Russia (158) due to a shortage of other compounds (6), but is no

longer registered for lice control in the USA. In Canada, benzyl benzoate is only available on prescription.

Generally, pubic lice have been treated with the same compounds used to control headlice, though not in alcohol formulations. Lindane, malathion and carbaryl have been effective (28), as has 1% permethrin creme (72, 94), which is less likely to irritate the genital areas. A second treatment is advised for both lindane and permethrin (89).

Mercuric oxide ointment has been used for the treatment of eyelashes of a 4 years old girl after removing the eggs with forceps (88). However, nine male patients were seen in Italy with severe, generalized rashes and intensely erythemato-exudative lesions of the pubic region and genitals following use of an over-the-counter powder containing 11.2% ammoniated and 4.2% metallic mercury to treat pubic lice infestations (175).

Trials were carried out in Egypt of four insecticides against pubic lice infestations: a formulation of 0.6% tetramethrin plus 2.4% piperonyl butoxide was more effective than permethrin or benzyl benzoate (136). The use of fluorescein to control pubic lice on the eye lid margins and eyelashes is reported (176).

Insecticide resistance has not been reported in pubic lice. In treating patients infested with pubic lice, the possibility of the co-existance of other sexually transmitted diseases should be considered.

4.3 INSECTICIDE SUSCEPTIBILITY TEST KITS

Where indications exist that the use of a given insecticide is no longer providing adequate control of human lice, it would be prudent to carry out insecticide-suseptibility tests on lice from the area concerned. Lice susceptibility tests kits are available from the World Health Organization and can be obtained through the Division of

Control of Tropical Diseases, WHO, Geneva, Switzerland or through a WHO Regional Office.

4.4 NEW DEVELOPMENTS

Ivermectin, a macrocyclic lactone, is widely used throughout western Africa as a microfilaricide to control transmission of the human nematode *Oncherca volvulus*. It is also used world-wide for the control of intestinal nematodes. As it has proven effective against ectoparasites in veterinary use, it was thought to have the potential of becoming the drug of choice against mites and human lice (126). In field trials, observations on the effect on head lice and scabies were made two months after treatment with a single 100-200 µ/kg dose of ivermectin as a microfilaracide among children in Sierra Leone. Significantly fewer children (16% vs. 30%) had head lice after treatment, although there was no significant difference in the prevalence of scabies (51). In Tahiti, French Polynesia, 26 head lice infested patients were treated with oral ivermectin at a dose of 200 µ/kg. At day 14, 20 (77%) of the patients had responded to the treatment, while in 6 there was a complete disappearance of lice. At day 28, 7 patients still had no lice, but 4 of the 6 who had no lice at day 14 had become reinfested. Ivermectin was considered promising for the control of head lice but a second dose at day 10 was thought necessary (65).

In Egypt, topical application of ivermectin was made to 76 patients for head lice and scabies control. Lice were controlled by a single application, although a second application was necessary for 50% of the scabies patients (181). In a laboratory study, there was high mortality among body lice fed on rabbits treated with ivermectin at 200 mg/kg. This lasted for 2 to 3 days after feeding with the effect declining sharply thereafter. The surviving females laid fewer eggs than the untreated controls (117).

Ivermectin has not yet been registered for the control of human lice. The necessity of a second treatment to ensure the control of

infestations and the occurrence of relatively mild but frequent side effects among treated people may, however, limit the use of the compound for human lice control. At present time there is no systemic insecticide registered for human lice control.

4.5 NON-INSECTICIDAL METHODS OF CONTROL

Many different types of combs are sold for the control of head lice. Combs for the removal of adult lice and nits have been used since antiquity (118). It has been contended that careful grooming with the various types of combs available would either remove the lice or nits or that the combing would injure the adult lice resulting in their death. However Burgess, in his comprehensive review (26), considered the literature on the subject of head lice control by grooming and concluded that in most of the studies he reviewed, the number of lice in the test groups that groomed either increased or were undiminished.

As body louse eggs are attached to clothing rather than the hairs of the body, suitable laundering of the clothes of infested individuals with hot water and soap is, in fact, an essential part of a body-louse control programme. Unfortunately, facilities or means for laundering clothes are often inadequate in the very places where they are most likely to be needed for the control of body lice, i.e., in refugee camps or in other areas of civil unrest. Under such conditions, reliance will have to continue to be made on insecticide treatment, especially among populations who have no change of clothing, even if their clothes could be adequately laundered. During World War I, the practice of steam sterilization of soldiers uniforms and of other clothing was widespread, but this can not be considered practical under the difficult conditions in which most infestations of body lice and outbreaks of typhus now occur, especially in refugee camps.

It is certainly prudent to launder the bedding of children infested with headlice. While adult lice survive only briefly away from the human body, nits may remain on bedding and survive for some

period of time. Combs and hair brushes of persons infested with head lice should also be washed in hot water and strong soap.

5. CONCLUDING REMARKS

Infestations by all three species of human lice persist as a global problem. Head lice infestations are found everywhere, sometimes infesting large proportions of the children in schools. While body lice infestations are generally associated with a poor level of personal and environmental sanitation, head lice are generally found on children in all levels of society. In some areas however, crowded conditions at home may predispose persons to head lice infestation. Nevertheless, evidence indicates that most transmission actually occurs at school. Very large sums are expended for the purchase of insecticide formulations for the control of head lice infestations, especially in school children. Though little information is available on the prevalence of pubic lice, it has been seen that their presence is often associated with infections of sexually transmitted disease. It is generally agreed that persons infested with the pubic louse should be examined for the possible presence of other sexually transmitted diseases.

There is evidence of a recrudescence of body lice infestations in developed countries along with the reappearance of the louse-borne infection, trench fever. In Africa and in foci in the highlands of central and south America, louse-borne typhus and relapsing fever remain endemic. Furthermore, under conditions of civil unrest and war, epidemics of the disease occur, most recently in the form of a large outbreak in Burundi. Such conditions and large refugee populations in other parts of the world where louse-borne typhus and Brill-Zinnzer disease once were endemic could threaten the recrudescence of epidemic in these other areas as well.

Control of head and body lice is impeded by the development of louse populations resistant to insecticides. The development and

spread of head lice resistance to the pyrethroid insecticides relatively soon after their introduction is particularly troubling. There is clearly an urgent need for the development of safe and effective alternative insecticides, particularly based on molecules which have no cross-resistance to existing compounds. Unless such compounds become available, it will be difficult to achieve and maintain effective and facile control of these ancient nuisances and vectors of disease.

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