

## Head lice (Phthiraptera: Pediculidae: *Pediculus humanus capitis*) infestations in children and adults in Israel

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### ABSTRACT

Head lice infestation is a public health challenge even in developed nations, and 4–14-year old children are most affected; information regarding the infestation rates of adults in developed countries is scarce. An Internet-based survey on lice infestation was distributed to mothers in Israel and their responses were analyzed. Out of 959 responders, 895 (93.3%) were mothers (73.7% with >12 years of education). Mothers were more often infested (59.2%) and more likely (3 times or more) to be infested during adulthood, compared to fathers or other family adults. Mothers of three or more children were infested more often than those with 1 or 2 children. Mothers who reported professional contact with children other than their own (child care staff, teachers *etc.*) were infested significantly more often than those who did not report such contact. In families with more than one child, the eldest sibling was infested significantly more often than his/her brothers and/or sisters. In families in which the eldest child was infested at least once, the subsequent children were significantly more often infested than children in families, where the eldest child was never infested. In 67.4% of families with children of both genders, girls were infested more often than boys; in 42.1% of all-boy families with more than one boy, one of the boys was infested more often than his brothers, while in 47.6% of the all-girl families with more than one girl, one of the girls was infested more often than others. Responsibility for head lice treatment rested primarily on the mother (78%); in 18.8% of families it was shared by both parents. A relatively large proportion of highly educated mothers from a developed country such as Israel self-report head lice infestation during adulthood. The article lists a series of recommendations for health care and education authorities and professionals, academic institutions, pharmaceutical companies and parents, aiming to diminish the national prevalence of head lice infestation.

KEYWORDS: Head louse, *Pediculus humanus capitis*, epidemiology, adults, children, survey.

### INTRODUCTION

The head louse *Pediculus humanus capitis* De Geer, 1767 (Phthiraptera: Pediculidae) is an obligate ectoparasite of humans, along with the body louse (*Pediculus humanus humanus* Linnaeus, 1758) and pubic louse (*Phthirus pubis* (Linnaeus,

1758)) (see Alexander (1984) and Schaub *et al.* (2012) for comprehensive reviews of these species).

The number of cases of human head lice infestations has increased worldwide since the mid-1960's (Gratz 1997), reaching hundreds of millions yearly (Taplin & Meinking 1987). An increased rate of lice infestation has been reported from a number of countries worldwide (Speare & Buettner 1999; Downs *et al.* 1999; Burkhart & Burkhart 2000; Moradiasl *et al.* 2018).

Head lice infestations are usually of minor medical or public health consequence, but can cause itching and loss of sleep. While head lice are unknown to be vectors of pathogens in the field (laboratory experiments demonstrate the ability of *P. h. capitis* to transmit *Rickettsia prowazekii* (Robinson *et al.* 2003)), the itching can, at times, result in excessive scratching leading to secondary skin infections.

Head lice normally move to a new host during a close contact between individuals, with head-to-head contact being by far the commonest mode of lice transmission. Therefore, social contacts among children and parent–child interactions are more likely routes of infestation than shared combs, brushes, towels, clothing, beds or closets. The number of children per family, sharing of beds and clothes, hair washing habits, local customs and social contacts, lack of community-based health care system (e.g. school health services) and socio-economic status have all been reported as significant risk factors in head lice infestation. Girls are infested 2–10 times more often than boys, and children between 4–13 years are most frequently affected (Mumcuoglu *et al.* 1990, 2009; Govere *et al.* 2003).

Numerous epidemiological studies have been devoted to head lice infestation in children worldwide (e.g. Govere *et al.* 2003; Londoño-Peñaranda 2012; Gboeloh & Elele 2013; Bartosik *et al.* 2015; El-Sayed *et al.* 2017; Valle-Barbosa *et al.* 2017; and references therein), whereas very little is known about the incidence of lice infestation in adults (e.g. Kurhanova 2006). Most of the studies were performed in developing countries, slums or refugee camps, or among low socio-economic classes, homeless people, and immigrants (Mumcuoglu *et al.* 1993; Falagas *et al.* 2008; Nunes *et al.* 2015).

The aim of the current study is to evaluate the self-reported infestation prevalence among adults in Israel and to study risks of intra-family interactions for mutual infestation with head lice. Additional goals are to map sources of information on lice control and the frequency and means of examining children for potential head lice infestation.

## MATERIALS AND METHODS

An electronic devised based self-response questionnaire (Appendix 1, p. 31) consists of 20 questions, of which four are demographic and 16 questions document knowledge, attitudes and practices regarding head lice infestation.

The questionnaire was distributed via the Internet (facilitated by Like & Share Company) to a female-based virtual community of approximately 45,000 women

living in Israel. A total of 959 questionnaires were returned, but not all questions were answered by all participants.

The responses to the returned questionnaires were statistically analyzed by the SPSS software (ver. 21). The  $\chi^2$  test was used for comparisons in all analyses, and p-values <0.05 were defined as statistically significant.

## RESULTS

In most cases (93.3%) the mother replied to the questionnaire. The mothers in the study were relatively young (57.6% were 31–40 years old) and educated (73.7% had >12 years of education) (Table 1). In the majority of households, the mother was responsible for the diagnosis and treatment of head lice infestations.

**Table 1.** Demographic characteristics of the family members.

Characteristic	Range	N (%)
No. family members	2–3	192 (20.4)
	4–5	606 (64.3)
	>5	144 (15.3)
		942*
No. adults	1–2	818 (87.9)
	3–4	94 (10.1)
	>4	19 (2.0)
		931
No. children	1–2	580 (61.8)
	3–4	330 (35.1)
	>4	29 (3.1)
		939
Person who filled in the questionnaire		
Mother		895 (93.3)
Father		24 (2.5)
Other		40 (4.2)
		959
Age of the mother (yrs.)	20–30	182 (19.2)
	31–40	547 (57.6)
	>40	220 (23.2)
		949
Years of mother's education		
	1–6	2 (0.2)
	7–12	243 (26.1)
	>12	685 (73.7)
		930
Responsible for monitoring lice	Mother	740 (78.2)
	Mother & Father	178 (18.8)
	Father	17 (1.8)
	Other	11 (1.2)
		946

\*Differing totals are due to the fact that not all questions were answered by all participants.

**Table 2.** Percentage and frequency of head lice infestation in family members.

	<b>n</b>	<b>Infested</b>	<b>%</b>	<b>p</b>
Mothers	928	549	59.2	
Fathers	916	82	9	0.001
Other adults	706	67	9.5	
Mothers infested >2 times	591	183	31	
Fathers infested >2 times	170	25	14.7	0.001
Other adults infested >2 times	430	40	9.3	
Child 1	945	765	81	
Child 2	571	398	69.8	
Child 3	582	268	27.7	0.001
Child 4	400	102	10.5	
Child 5	299	30	10	

Mothers were infested with lice significantly more often than fathers (59.2% vs. 9.0%) and other adults in the family (9.5%) ( $p < 0.001$ ). Mothers were infested three times or more during adulthood (31% of infested mothers), significantly more often than fathers (14.7%) or other adults in the family (9.3%) ( $p < 0.001$ ) (Table 2). Mothers with 3 or more children ( $n=580$ ) were infested significantly more often than mothers with 1 or 2 children ( $n=359$ ) ( $p < 0.001$ ). In families where the mother was infested at least once, the father or other adults were not infested significantly more often than in families where mothers were not infested at all.

No significant differences in infestation rate was found between mothers with 1–12 years ( $n=245$ ) and those with over 12 years ( $n=685$ ) of education. Overall 25.4% (236/930) of mothers who reported professional contact with children other than their own (child care staff, teachers) were infested with lice significantly more often than mothers who did not report such contact ( $p < 0.001$ ).

In families with more than one child, the oldest sibling was infested significantly more often (81%) than his/her younger brothers and/or sisters (10–69.8%) ( $p < 0.001$ ) (Table 2). In families with the oldest child having been infested at least once, the second, third and fourth siblings were infested significantly more often compared to families in which the oldest child had never been infested ( $p < 0.001$ ).

The majority (564/837, 67.4%) of families with children of both genders reported that girls were more often infested than boys. Among the remaining 32.6% of the families, it was stated that girls and boys were equally infested (207/298, 69.5%); that boys were more often infested than girls (38/298, 12.7%), and 17.8% (53/298) did not answer this question. In 42.1% of the families ( $n=515$ ) with more than one

boy, one of the boys was more often infested than the others, whereas in 47.6% of the families with more than one girl (n=454), one of the girls was more often infested than the others.

The sources of information about lice and treatment recommendations (n=925) were pharmacists (25.8%), friends (23.5%), extended family members (16.6%), media (17.6%), commercial advertisements (6.7%), physicians (5.5%) and other sources (4.3%).

In 52.6% of the families (488/928), a lice comb was used for the diagnosis of head lice infestation, in 15.8% it was done visually by searching with fingers, and in 30.5% both methods were used (1.1% did not respond to this question). Overall, 0.1% of the parents reported examining their children for lice infestation monthly, 44.1% every 2–3 months, 8.2% every 4–6 months, 3.9% when the child was scratching its hair/scalp and 43.7% did not reply.

## DISCUSSION

Data concerning pediculosis capitis in the adult population in developed countries are sporadic. In Norway, head lice prevalence was higher in elementary school students than in other household members. Prevalence of previous infestations was higher in households with a higher number of children and in more densely populated municipalities, indicating that the density of hosts or groups of hosts is associated with transmission rates (Rukke *et al.* 2011). In the UK, head lice were significantly more prevalent among children and mothers (Downs *et al.* 1999).

In Israel, the incidence of head lice infestation in army recruits (18–19 years old) increased from 5.2 per 1000 in 1977 to 18.1 per 1000 in 1979, and then declined to 3.6 per 1000 in 1987 (Gillis *et al.* 1990, 1990/1991). Another study reported that pediculosis capitis incidence rates increased by 1.67 cases per 1000 soldiers (mean increase per year) between 1973 and 1981, with a 17.7-fold overall increase. Between 1982 and 1999, there was a gradual decrease in the reported incidence to a low level (0.14 cases per 1000 soldiers in 1999), a 113.6-fold decline (Mimouni *et al.* 2001, 2002).

In the present study, the incidence of reported infestation with head lice during adulthood among mothers was substantial (59%). Mothers were more often infested than other adults; mothers of three or more children and those with professional contact with children were also affected more. A higher rate of infestation in adult females was also found in other studies in developing (Nunes *et al.* 2015) and developed countries such as the UK (Downs *et al.* 1999). The fact that mothers are in closer physical contact with their children, wear longer hair, are those, who in most cases examine and treat their children for head lice, and are more represented in professional groups such as child care staff and primary school teachers, make them more prone to lice infestation.

In families in which the mother was infested at least once, the father or other adults in the family were not infested significantly more often than in the families

in which the mothers were not infested at all. This may indicate that the main source of head lice infestation is the child, not another adult.

In our study, mother's education was not significantly associated with infestation rates. Most previous studies showed that children from lower socio-economic sector are more prone to lice infestation than those from medium and high classes. This includes studies conducted in developed countries like Norway and Belgium (Willems *et al.* 2005; Rukke *et al.* 2014; but cf. Govere *et al.* 2003). However, in the current study, most mothers had over 12 years of education. The bias towards higher levels of mothers' education in our survey is likely caused by the use of an internet-based questionnaire in a web-based virtual community, which required the responders to have adequate computer skills and availability. According to the National Control Bureau of Statistics of Israel (Yaffe 2013), in 2011 46% of women aged 15 and over had 13 years of schooling or more, compared to 43% of men. In the present study 73.3% of the responders had an education of over 12 years.

To the best of our knowledge, the fact that mothers who have professional contact with children other than their own—e.g., child care staff and teachers—were infested with lice more often than mothers without such contact, is reported here for the first time.

In families with more than one child, the eldest one was infested significantly more often than his/her younger siblings, probably due to a longer period of possible contact with other infested children.

In families with the eldest child having been infested at least once with lice, the subsequent children were infested significantly more often than their peers in families, in which the eldest child had never been infested. The fact that infested siblings strongly increase the odds of head lice infestation of school children was reported in Jordan, Turkey and Norway (Mohammed 2012; Gulgun *et al.* 2013; Birkemoe *et al.* 2016).

In most families with children of both genders, girls were more often infested than boys in our survey. The majority of similar studies conducted on children report higher infestation rates in girls compared to boys. Possible reasons for gender differences in head lice infestation include girls' tendency to wear their hair long, which facilitates transmission of lice compared to usually shorter hair of boys, and gender-related behavioral traits, e.g. close social contact in small groups and forming pairs among girls (Mumcuoglu *et al.* 1993; Govere *et al.* 2003; Oh *et al.* 2010; Mohammed 2012; Degerli *et al.* 2013). Although there are some indications showing that usually one of the children in the family is more prone to infestation compared to his/her siblings, this could not be confirmed in this study. Apparently, the age and gender of the child are the more important factors influencing the infestation.

In our study, information regarding anti-lice treatment was obtained by parents primarily from pharmacists, friends, extended family members and media. Doubl-

geraki and Valari (2011) report similar results in Greece, where the percentage of parents who sought advice on treatment from the pharmacist was 73%, while 15% consulted their doctors, 6% friends and relatives, and 6% got information from media and through other means.

Most families in our survey used either a lice comb (52.6%) or a lice comb combined with visual examination (30.5%) to diagnose infestation. This method was earlier reported to be four times as efficient as direct visual examination and twice as fast (Mumcuoglu *et al.* 2001). The fact that only very few parents (0.1%) reported examining their children for infestation monthly, and 52.3% every 2–6 months, indicates a low level of concern about head lice in the study cohort.

Despite nearly 1000 responses included in the survey, our study may not be seen exhaustive. First, only a fraction of the target population responded. Second, the education level of the responding mothers in most cases was relatively high, which means that not all socio-economic classes were represented. Inclusion of all other socio-economic groups would most probably lead to overall higher infestation rate of adults in Israel. On the other hand, it is possible that families experiencing a problem of head lice infestation were more willing to answer the questionnaire, which may result in overestimating the overall infestation among parents and children.

#### RECOMMENDATIONS AND CONCLUSIONS

–Head lice infestation is a persistent public health problem in Israel. Approximately 15% of all 4–13-years old children were actively infested with head lice at any given moment (Mumcuoglu *et al.* 1990, 2009). While children are most likely to be infested, the present study suggests that mothers should be also be properly examined and treated if necessary.

–As in most developed countries in Europe and North America, there are no clear-cut guidelines from the Ministry of Health in Israel regarding the diagnosis and treatment of head lice, and there is no mandatory reporting of head lice infestation. In Israel, it is no longer the responsibility of school nurses to examine children for lice. Accordingly, the examination and treatment of head lice infestation remains the sole responsibility of the parents (as shown in this study primarily the mothers), who report receiving no substantial help or support from child care or school staff, school nurses, community nurses, pharmacists, pediatricians or family physicians.

–As shown in the present study, the majority of parents receive advice regarding the use of pediculicides mainly from pharmacists, friends, extended family members and media, which with the exception of pharmacists are not necessarily the most reliable sources of information. Therefore, medical entomologists, parasitologists, infectiologists from universities and the Ministry of Health should prepare accurate educational material that is to be published on the websites of the Ministry of Health, Ministry of Education, and those of the health funds. Similar

material printed as flyers is to be distributed to institutions such as Maternal Child Health Clinics ('Tipat Chalav'), day care centers, schools and health fund clinics. The media—TV, radio, both print and on-line newspapers and weekly/monthly popular magazines—should be also used to disseminate knowledge regarding diagnosis and treatment of head lice infestation.

–As the present study suggests, large families, girls, and mothers, who are professionally in contact with children other than their own, are more prone to lice infestation and should be specifically targeted regarding their education; these groups are to be examined more often.

–Head lice products are not included in the 'Health Basket' of nationally subsidized medications and present an additional financial burden, especially for people from lower socio-economic classes. These families often have more children, dwell in more crowded quarters, and have higher risk of contracting and spreading lice due to a longer physical contact between siblings.

–Many over-the-counter pediculicides are ineffective, and there are no published studies concerning their efficacy, even if they are used according to the instructions. Therefore, it is suggested that health authorities should introduce more competent methods of evaluation of pediculicides and more stringent regulations for releasing new products.

–Health care providers need to be aware of demonstrably effective anti-lice remedies and to be able of supporting families to deal with head lice control.

–Parents should regularly inspect their children, treat as necessary, while avoiding creating stigma and emotional problems for minors. This should be seen a routine, akin to brushing teeth or cutting nails. Education in the school environment should also emphasize destigmatizing the issue.

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### Conflict of interest and authors' contribution declaration

The authors declare no conflict of interest. KYM initiated and designed research, led the overall analysis and discussion, and drafted the manuscript; SA, EA and CSZ contributed to collecting data and writing the manuscript, while MF did the statistics. All authors approved the final manuscript.

**Appendix 1.** Questionnaire on head lice infestation.

Details of the person answering the questions

Status: Mother, father, other:

Age in years:

1. Number of people in the household:
2. Number of adults in the household (over the age of 18 years):
3. Number of children living in the house (under the age of 18)
4. Number of bedrooms in the house:
5. Who is responsible in examining and treating children for lice in the family: Mother, father, both, other:
6. Number of schooling of the mother: 1–6, 7–12, over 13 years. Number of schooling of the father: 1–6, 7–12, over 13 years
7. Was the child (no. 1) (Age in years ..., sex: M/F) ever infested with lice? Yes/No. If yes: 1–2, 3–5 or over 6 times. If yes, when the last time: 1–2, 3–5, or over 7 years ago
8. Was the child (no. 2) (Age in years ..., sex: M/F) ever infested with lice? Yes/No. If yes: 1–2, 3–5 or over 6 times. If yes, when the last time: 1–2, 3–5, or over 7 years ago
9. Was the child (no. 3) (Age in years ..., sex: M/F) ever infested with lice? Yes/No. If yes: 1–2, 3–5 or over 6 times. If yes, when the last time: 1–2, 3–5, or over 7 years ago
10. Was the child (no. 4) (Age in years ..., sex: M/F) ever infested with lice? Yes/No. If yes: 1–2, 3–5 or over 6 times. If yes, when the last time: 1–2, 3–5, or over 7 years ago
11. Was the child (no. 5) (Age in years ..., sex: M/F) ever infested with lice? Yes/No. If yes: 1–2, 3–5 or over 6 times. If yes, when the last time: 1–2, 3–5, or over 7 years ago
12. Was the mother ever infested with lice since the age of 18? Yes/No. If yes: 1–2, 3–5 or over 6 times. If yes when the last time: 1–2, 3–5, or over 7 years ago
13. Was the father ever infested with lice since the age of 18? Yes/No. If yes: 1–2, 3–5 or over 6 times. If yes when the last time: 1–2, 3–5, or over 7 years ago
14. Was any other adult in the household (no. 1) ever infested with lice since the age of 18? Yes/No. If yes: 1–2, 3–5 or over 6 times. If yes when the last time: 1–2, 3–5, or over 7 years ago
15. Was any other adult in the household (no. 2) ever infested with lice since the age of 18? Yes/No. If yes: 1–2, 3–5 or over 6 times. If yes when the last time: 1–2, 3–5, or over 7 years ago
16. Are girls in the family more often infested with lice than boys: Yes/No. If no: Boys more than girls, boys and girls equally infested, other:
17. Among boys or girls, are there ones who are more often infested than their siblings; Yes/No. If yes: Among boys, among girls, among boys and girls, other:
18. From whom do you get advice on what to use for treatment: Physician, pharmacists, family, friends, public media, advertisement, other
19. How lice are detected: By examining/parting the hair with fingers (visually), with a lice comb, lice comb and fingers (visually), other:
20. How often are children examined for head lice infestation: At least once a month, every 2–3 months, every 4–6 months, when signs of infestation are seen (scratching the head, being in contact with children probably infested with lice, when lice eggs are seen attached on the hair), other:

