PEDICULOSIS HUMANUS CAPITIS IN 6–7 YEARS OLD SCHOOLCHILDREN IN VALENCIA, SPAIN

María Morales-Suarez-Varela[1, 2], Blanca E. Álvarez-Fernández[3, 4], Isabel Peraita-Costa[1, 2], Agustín Llopis-Morales[1], M. Adela Valero[3, 5]

[1]Research Group in Social and Nutritional Epidemiology, Pharmacoepidemiology and Public Health, Department of Preventive Medicine and Public Health, Food Sciences, Toxicology and Forensic Medicine, Faculty of Pharmacy, University of Valencia, Burjassot, Spain
[2]CIBER of Epidemiology and Public Health (CIBERESP), Carlos III Health Institute, Madrid, Spain
[3]Department of Parasitology, Faculty of Pharmacy, University of Valencia, Burjassot, Spain
[4]Faculty of Chemistry-Biological Sciences, Autonomous University of Guerrero, Chilpancingo, Guerrero, Mexico
[5]CIBER of Infectious Diseases (CIBERINFEC), Carlos III Health Institute, Madrid, Spain

SUMMARY

Objectives: Pediculosis humanus capitis is a worldwide public health concern that affects mostly school-aged children. The aim of this study is to determine the rate of pediculosis and to determine possible risk factors in a group of primary school children in Valencia, Spain; 227 children, 6–7 years old, were selected from 7 schools.

Methods: A self-reported questionnaire completed by the parents/guardians about the presence of pediculosis in their children and their knowledge about pediculosis. The results recorded in the questionnaire were analysed by SPSS® software.

Results: 30.4% of the children had pediculosis. The results showed significant variation ($p < 0.05$) in prevalence depending on the following factors: sex, hair length, level of parental education, family size, presence of affected family member in the home, and frequency of hair washing. Less than half of parents/guardians showed an appropriate level of knowledge on pediculosis. Pediculosis remains a health problem in Valencian schoolchildren. The family size and existence of another member with pediculosis were shown to be the main potentiating factors.

Conclusions: Parents are not sufficiently informed about pediculosis and adopt inappropriate practices. There is a need to promote studies with the objective of determining risk factors for pediculosis as well as the need for actions to increase the knowledge of parents and healthcare professionals on this parasitosis to prevent outbreaks in the community, assure correct treatment and maintain effective epidemiological surveillance.

Key words: pediculosis humanus capitis, lice, prevalence, children, Spain

Address for correspondence: M. Morales-Suárez-Varela, Unit of Public Health, Hygiene and Environmental Health, Department of Preventive Medicine and Public Health, Food Science, Toxicology and Forensic Medicine, Faculty of Pharmacy, University of Valencia, Av. Vicente Andrés Estellés s/n, 46100 Burjasot, Valencia, Spain. E-mail: maria.m.morales@uv.es

https://doi.org/10.21101/cejph.a7640

INTRODUCTION

The human head louse, Pediculus humanus capitis (PHC), causes Pediculosis humanus capitis infectious disease that belongs to the group of epidermal parasitosis, in which the interaction of the parasite with the host occurs in the outer layers of the skin (1). It is an obligate holometabolous ectoparasite that spends its complete life cycle on the human head hair and feeds on the blood from the skin (2).

Transmission occurs mainly directly through person to person contact or through instruments such as shared combs, pillows or hats. Climate, geography, ethnicity, and hygienic conditions play a role in the spread of lice. Lice are blood-sucking insects that can cause pruritus, excoriation, conjunctivitis, secondary bacterial infection, local post-therapeutic dermatitis, posterior neck adenopathy, non-specific generalized dermatitis, and allergic reactions that result in nasal obstruction and rhinorrhoea. Lice infestation can also cause psychological distress and may affect learning performance in school children (3, 4).

The prevalence and morbidity of this type of infestation in populations with limited resources is very high (1). In addition, the likelihood of PHC outbreaks in schoolchildren is frequent, which is another cause for concern (5).

PHC is distributed throughout the world and affects all socioeconomic strata. The groups at greatest risk are children aged 3–12, especially those in preschool and primary school, along with people caring for children and those who live with infested individuals. Pediculus humanus capitis cannot jump or fly, transmission occurs by direct contact with the head of an infested individual and, to a lesser extent, by fomites (6–8).

The diagnosis is made by searching for individual parasites on the head and is hampered by the rapid movement of the parasite, which shuns the light. While the diagnosis using a lice comb is the efficient and fast (7, 9−11), wet combing remains the most accurate diagnostic method for pediculosis, as evidenced by a number of other recent publications (12).

The prevention of PHC is hampered by the frequency with which children establish head-to-head contact. In environments

where children are together, adults should be alerted to detect possible signs and symptoms of an infestation by Pediculus humanus capitis. Day care centres and camps where children share a room favour rapid dissemination (6).

Among the currently available option for pediculosis management are chemical pediculicides such as pyrethrins, permethrin and malathion, topically applied physical suffocation-based pediculicides, herbal preparations and mechanical methods (13). Chemical pediculicides with an insect neurotoxic mode of action are still the most common method of choice with malathion and permethrin remaining the most widely used pediculicides since their introduction on the market (13). Treatment should never be started unless there is a clear diagnosis of an active infestation, and never as a preventive measure. The preventive or inadequate use, without respecting the adequate intervals of application of the product, can lead to the emergence of resistance (6, 8, 14, 15).

Pediculicide resistance to currently used pediculicides, including lindane, carbaryl, malathion, pyrethrins and pyrethroids including permethrin has occurred worldwide and is increasing (13, 16). For example, previous studies have estimated organochlorine pediculicide resistance at 65% (17), pyrethroid resistance at 59% (18) with permethrin resistance rates being anywhere from 50% to 100% (19). It is one of the main causes of treatment failure and a crucial factor in the increasing incidence of head lice infestations (20). The most studied mechanism of resistance is through knockdown resistance mutations, with biomarkers M815I, T917I, and L920F most commonly reported but other reported mechanisms are also being investigated.

According to previous studies conducted, the global prevalence of head lice is estimated at 19% (21). In Europe, prevalence is estimated to be about between 0% and 20% (22, 23). Prevalence in individual countries for which data is available has been found to be from 1.3% in Iran (24), 5.8% in Korea (25), 6.8% in Turkey (26), 8.9% in Belgium (27), 13% in Australia (28), 35% in Brazil (29), to 52% in Ukraine (30). The infestation rates among schoolchildren vary from 0% to an alarming 78.6% in Libya (22, 31). It is essential to obtain epidemiological data from different regions to enable strategic planning for the control and prevention of PHC.

In the context of the Valencian community, there is a total absence of previous epidemiological studies on PHC, an unattended parasitosis that affects millions of people every year around the world and whose distribution is changing depending on different factors (1, 22, 32).

The objective of this study was to know the frequency and risk factors of PHC in schoolchildren from 6 to 7 years of age living in Valencia, Spain, as well as the knowledge of parents/guardians on the transmission and treatment mechanisms. To achieve this goal, data on the current prevalence and prevalence in the last 12 months in primary school students were collected.

MATERIALS AND METHODS

Study Population and Protocol

The present study is a case-control design. It comprises a group of schoolchildren between 6 and 7 years of age belonging to 7 primary educational centres located in Valencia, Spain. The study was carried out in primary educational centres located in Valencia City. The schools were selected by systematic random sampling. Authorization to carry out this observational study in humans was requested from the Committee of Ethics in Experimental Research of the University of Valencia, which granted authorization; in the same way, the authorization of the educational centre was obtained. Parental authorization in order to obtain individual informed consent and be able to use the survey for the study was also obtained. Informed consent was obtained from all individual participants included in the study.

The participating parents/guardians received a questionnaire designed to collect information that allowed the creation of a database. We designed a specific questionnaire and subsequently carried out a pilot test to evaluate its consistency (on 30 children). The questionnaire consisted of thirty questions in total, the first nineteen were aimed towards knowing the prevalence of PHC in children, the children's personal hygienic practice and family composition, as well as the possible factors that influence the distribution of PHC. The remaining eleven questions were used to determine the knowledge of the parents/guardians about PHC, its transmission and treatment.

The diagnosis of head lice infestation was declared by the parents. They were asked to only declare it if they had detected the presence of adult lice, nymphal stage, or eggs (nits) during an inspection of the scalp and hair under the light of a reading lamp, with the aid of a magnifier, during wet combing. Hair length was declared by the parents according to their perception of short/long hair, but no objective measurements were made. Parents were also asked about the type of pediculicide used (shampoo, lotion, etc.) but information on the active ingredient was not recorded.

Inclusion and Exclusion Criteria

As criteria for inclusion, students had to be enrolled in the first or second primary courses (age range of six to seven years) in one of the selected schools in the city of Valencia. The exclusion criteria were that the student did not return the authorization signed by the parents and/or the completed questionnaire answered, or that he/she did not attend class on the day of delivery of these documents. In total, 227 parents/guardians of the schoolchildren participated and completed the questionnaire.

Measures

The anthropometric data of height (Seca 213®, Hamburg, Germany) and weight with precision of 0.1 kg (Tanita BC-601) of each child was taken.

Statistical Analysis

Data were analysed using SPSS software version 21.0. Categorical variables were described as absolute frequencies and percentages, and quantitative variables as means and standard deviations (SD). For the comparative analysis, we used the chi-squared or Fisher's exact test in categorical variables, the t-test or ANOVA test in quantitative variables, and the chi-squared test in qualitative variables. Odds ratio (OR) and 95% confidence interval of the risk of infestation was calculated, $p < 0.05$ were considered significant.

RESULTS

The sample was made up of 227 children, 110 boys (48.5%) and 117 girls (51.5%) with an average age of 6.41 ± 0.50 years. The participation rate was 20.32%. The number of children that had suffered PHC in the previous 12 months is 69 (30.4%), 44 boys and 25 girls, compared to 158 (69.9%), 66 boys and 92 girls, who did not suffer it. There was a predominance of boys over girls, with statistically significant differences (OR: 2.45, 95% CI: 1.37–4.40, p=0.002). The socioeconomic factors of PHC are shown in Table 1.

Moreover, regarding children's hair length, the risk of PHC (OR=3.63, 95% CI: 1.99–6.65) was higher in those who had shorter hair. For the frequency of washes per week, divergences were found and PHC was more likely as the frequency of washes decreased. The place of residence was evaluated, revealing a greater risk of PHC amongst children living in a flat. The presence of domestic or farm animals had little relation with PHC, and no significant differences could be identified. However, increasing family size did appear to increase the risk of PHC (p=0.001). In relation to contagiousness, the presence of another infected member within the family increased the risk of PHC.

Table 2 shows the educational level and professional sector of parents/guardians regarding the presence of PHC. The frequency of PHC increased as parent/guardian educational level decreased (p=0.035). Significant differences were also found in relation to the parent/guardian professional sector with the highest rate of PHC appearing in children with parents/guardians working in the domestic service sector.

The percentage of response related with parent/guardian's knowledge about Pediculus humanus capitis infestation is shown in Table 3. It was observed that parents/guardians responded correctly to the 11 questions on the knowledge of the transmission and treatment in 47.2% of the cases. The question most often answered correctly was that lice are transmitted from head-to-head when in close proximity, and that answered correctly least often covered the aspect that lice cannot jump, only 21.4% answered correctly. All the products used in the treatment are documented in the Table 3.

DISCUSSION

In this study carried out in Valencia, a parasitosis of 30.4% was identified. Despite being carried out during spring, a period with usually the highest levels of parasitism in Valencia, it can be considered of low prevalence. Previous studies have shown infestation rates from 4.2 to 78% among schoolchildren (33). Numerous studies have been conducted on the prevalence of head lice among schoolchildren from almost all parts of the world, but not in Valencia, Spain, so the data here presented are a novel contribution to the information already available.

Significant differences were found in the study regarding gender and hair length, being grater in boys and short hair. Although,

Table 1. *Socioeconomic factors of PHC*

			Pediculosis n=69 (30.4%) %	No pediculosis n=158 (69.6%) %	p-value	OR (95% CI)
Sex	Male		63.8	41.8	0.002	2.45 (1.37–4.40)
	Female		36.2	58.2		1
Hair length	Medium		30.4	61.4	0.001	1
	Short		69.6	38.6		3.63 (1.99–6.65)
Washes/week	1		4.5	2.5	0.756	1
	2		52.2	38.6	0.057	0.77 (0.16–3.62)
	≥3		43.3	58.9	0.032	0.42 (0.09–1.97)
Place of residence	Flat		33.3	26.6	0.300	1
	House		66.7	73.4		0.72 (0.39–1.34)
Animals	Yes	Domestic	82.8	92.1	0.204	0.23 (0.04–1.45)
		Farm	10.3	6.9		1
		Both	0.0	2.6		–
	No		58.0	51.9	0.470	1
Family size	2		31.9	30.8	0.896	0.21 (0.07–0.63)
	3		27.5	39.1	0.091	0.14 (0.05–0.43)
	4		18.8	19.2	0.979	0.20 (0.06–0.64)
	5		18.8	3.8	0.001	1
Other affected family member	Yes		19.4	1.4	0.001	1
	No		80.6	98.6		0.06 (0.01–0.27)
Lice comb use	Yes		83.3	52.4	0.001	4.55 (2.04–10.14)
	No		16.7	47.6		1

p-value: pediculosis vs. no pediculosis

Table 2. *Effect of parental education and occupation on PHC rate*

		Pediculosis n = 69 (30.4%) %	No pediculosis n = 158 (69.6%) %	p-value
Parental education level	Secondary	34.3	23.4	0.035
	Baccalaureate	25.4	19.5	
	Technical Degree	23.9	27.9	
	Higher education	16.4	29.2	
Parental professional sector	Home or domestic service	26.1	20.8	0.001
	Primary	10.1	3.9	
	Industry	4.3	0.0	
	Building	0.0	10.4	
	Commerce	21.7	5.2	
	Hospitality and gastronomy	5.8	5.2	
	Transport and communications	25.0	75.0	
	Health or education	17.4	17.5	
	Public administration and defence	2.9	9.7	
	Finance and insurance	5.8	2.6	

p-value: pediculosis vs no pediculosis

some studies seem to suggest otherwise (34, 35), or indicate that there is no significant relationship between the length and prevalence of PHC (6). Given the fact that the prevalence in our study is greater in short hair is possibly due to the fact that we have a higher prevalence of parasitism among boys. However, a previous literature review showed that the significance of hair length is inconclusive (36). Previous studies point out that gender explains highly significant differences in prevalence among girls who are at higher risk of PHC than boys (28, 37–40). Most transmissions of lice occur when the hair of the new host encounters the hair of the old one (41). Girls often have more intimate relationship and according to the results a number of washes below three increases the risk of suffering PHC. Therefore, other studies suggest a relation between a low frequency of washes and the prevalence (35) whereas others (6) indicate a lack of relationship between wash frequency and PHC.

The results showed statistical significance for the educational level and professional sector of parents/guardians. It is proved that parents or guardians with a lower educational level were the ones whose children had PHC last year. Not only an educational level is related to parasitism in children, but also an economic level has impact on it. Some authors suggest that PHC is not related to socioeconomic status (22) whereas others (42, 43) suggest the opposite. Rukke et al. (44) found that families in developed countries were better able to control infestations. In this study, the prevalence rate among students with less educated parents was higher than in those with more education. The impact of family's socioeconomic status on the prevalence of PHC in children has been inconsistently reported (2, 45).

PHC is associated with overcrowding and the number of children within the family home (46). Kokturk et al. (26) discovered that the highest risk corresponded to families in which more than six members lived together. These results support those of this study: the children who suffer PHC coincide with the coexistence of five or more people at home, comparing with those without it. Furthermore, a bigger prevalence was found when there was another infected member at home. When having other children in the same living place increases the risk of PHC (27, 37, 38, 47). Interestingly, in a previous study that analysed children with and without siblings separately showed that children in one-child households had significantly higher risk of pediculosis than children in families with 2 elementary school children (38). A possible explanation for this could be that children without playmates at home interact more with children from outside their home and may therefore be exposed to a higher risk of PHC (38).

In this study, the prevalence of PHC in schoolchildren during the last year was 30.4% and this prevalence is similar to those found for Australia and China (28, 48).

The lack of knowledge about the transmission of Pediculus humanus capitis infestation, that was identified in this study, shows a lack of information on the subject. Therefore, an education programme and/or campaign about transmission and clear guidelines for rapid diagnosis would help to reduce the prevalence of this parasitisation. The question is also whether they had been thoroughly educated about pediculosis, e.g., finding a nit on a grown-out hair does not mean that the child suffers from pediculosis.

Limitations of the Study

PHC is accompanied by stigmatization and social exclusion. It was necessary to make great efforts to encourage parents/guardians to participate in the surveys, including informative meetings in which we tried to convey the importance of the study. So the parents/guardians only completed the questionnaire, in which they could indicate their subjective opinions, because of the fear of ostracizing their children in case they found lice. Also, due to the stigma associated with head lice and the lack of parental knowledge on the topic warrants a discussion on the validity and reliability of the parent/guardian-reported questionnaire data.

Table 3. *Parental knowledge questionnaire on PHC*

		Total N = 227 (100.0%) %	Pediculosis N = 69 (30.4%) %	No pediculosis N = 158 (69.6%) %
If the school emits a general notification on the presence of head lice, do you preemptively treat your child? (no) (p = 0.010)[1] (p = 0.001)[2]	Yes	24.8	22.2	26.0
	No	75.2	77.8	74.0
Head lice can jump (no) (p = 0.236)[1] (p = 0.236)[2]	Yes	78.6	83.3	76.3
	No	21.4	16.7	23.7
Head lice can survive for several days on clothes or sheets (no) (p = 0.406)[1] (p = 0.870)[2]	Yes	67.3	69.4	66.2
	No	32.7	30.6	33.8
People who get head lice start scratching immediately (no) (p = 0.001)[1] (p = 0.245)[2]	Yes	56.1	73.5	47.9
	No	43.9	26.5	52.1
Head lice are transmitted head-to-head when these are in close proximity (yes) (p = 0.013)[1] (p = –)[2]	Yes	93.6	94.4	93.2
	No	6.4	5.6	6.8
Head lice can survive a normal shampoo wash (yes) (p = 0.007)[1] (p = –)[2]	Yes	89.6	91.2	88.9
	No	10.4	8.8	11.1
Anti-head lice products kill all nits (no) (p = 0.014)[1] (p = 0.023)[2]	Yes	51.9	51.4	52.1
	No	48.1	48.6	47.9
Animals can transmit head lice (no) (p = 0.024)[1] (p = 0.001)[2]	Yes	60.0	55.9	62.0
	No	40.0	44.1	38.0
Only those with head lice should be treated with pediculicides (yes) (p = 0.332)[1] (p = 0.020)[2]	Yes	40.6	51.4	35.2
	No	59.4	48.6	64.8
Treatment with pediculicides should be given twice with 8–10 days between one time and another (yes) (p = 0.746)[1] (p = 0.746)[2]	Yes	76.8	75.0	77.6
	No	23.2	25.0	22.4
If head lice are found in the home, it should be thoroughly deep cleaned (no) (p = 0.149)[1] (p = 0.415)[2]	Yes	67.9	65.7	69.0
	No	32.1	34.3	31.0
People with head lice that are not treated can repeatedly infect others (yes) (p = 0.111)[1] (p = 0.080)[2]	Yes	90.7	94.3	89.0
	No	9.3	5.7	11.0
Product used as treatment (p = 0.230)[1] (p = 0.001)[2]	Shampoo	0.4	1.4	-
	Lotion	15.9	52.3	-
	Shampoo and lotion	4.4	14.5	-
	Mousse	7.0	23.2	-
	Lotion and mousse	0.9	2.9	-
	None	1.8	5.8	-

[1]chi-squared test; [2]pediculosis vs. no pediculosis

Given that there was no accompanying interview, the validity of the data should be considered.

Despite everything, the participation rate (20.32%), taking into account all the centres in which authorization was requested, was low compared to that of other studies – 49% in the United Kingdom (49) and 49.76% in Norway (38). Consequently, we obtained a small sample size, which may translate into insignificant results. One change that could be implemented in future studies to improve participation rate could perhaps be to prolong the time for return the questionnaires to school.

Once the surveys were collected, several inconsistencies in the database were detected and had to be addressed and the veracity of the information could not be verified. Some questions such as hair length, in addition, could have been answered subjectively, which would have favoured erroneous results. In this case, it could be good idea to give some limit (in cm – not subjective) as to what is considered short hair. Although the criterium for short for lice is approximately 1 cm this would probably not be an easily applicable limit in practice.

Another issue detected is that the number of misdiagnosed cases of pediculosis is unknown and also the number of cases where parents/guardians refused to complete the questionnaire and did not just simply forget it or not return it for any other reason. These issues may have significantly biased the findings, especially the findings on the social impact of pediculosis.

CONCLUSIONS

PHC outbreaks continue to exist, also in developed countries, and are a common health problem in primary school children. The present study showed the frequency of PHC and the associated risk factors in Valencian schoolchildren.

Parents are currently insufficiently informed about PHC and do not adopt appropriate control practices and treatments. Parent education is the best way to prevent PHC outbreaks in the community. Parental education programmes and campaigns could be helpful in controlling PHC, leading parents to become more aware and familiar with the prevention and treatment of PHC. All policies related to PHC should be reviewed by schools in order to reduce the stigmatization and detrimental effect of truancy and loss of attention during school hours by children. Paediatricians and paediatric nurses must carry out eye exams (evaluation of infestations, scratch injuries, school development) as well as educational actions with families in the periodic reviews of children. Therefore, it is necessary to implement joint educational and health campaigns within national community health plans, planning and developing a long-term management strategy by health and education authorities at the national and regional level.

Along with this, PHC is compounded by the great challenges of this 21st century. Research must continue to encompass the extension of the infection to other months of the year due to the effect of climate change (increased temperature), resistance to classic treatments and the assessment of the transmission of infectious diseases (pathogen vectors), especially with greater emphasis in this global "post-COVID-19" stage.

Conflicts of Interest

None declared

REFERENCES

1. Feldmeier H, Heukelbach J. Epidermal parasitic skin diseases: a neglected category of poverty-associated plagues. Bull World Health Organ. 2009;87(2):152-9.
2. Gutiérrez MM, González JW, Stefanazzi N, Serralunga G, Yañez L, Ferrero AA. Prevalence of Pediculus humanus capitis infestation among kindergarten children in Bahía Blanca city, Argentina. Parasitol Res. 2012;111(3):1309-13.
3. Dursun N, Cengiz ZT. [Distribution of head lice in the Erciş district of Van]. Turkiye Parazitol Derg. 2010;34(1):45-9. Turkish.
4. ALBashtawy M. Head lice infestation in schoolchildren and related factors in Mafraq governorate, Jordan. Int J Dermatol. 2012;51(2):168-72.
5. Rupeš V, Moravec J, Chmela J, Ledvinka J, Zelenková J. A resistance of head lice (Pediculus capitis) to permethrin in Czech Republic. Cent Eur J Public Health. 1995 Feb;3(1):30-2.
6. Frankowski BL, Bocchini JA, Jr; Council on School Health and Committee on Infectious Diseases. Head lice. Pediatrics. 2010 Aug;126(2):392-403.
7. Mumcuoglu KY. Prevention and treatment of head lice in children. Pediatric Drugs. 1999;1(3):211-8.
8. Smith CH, Goldman RD. An incurable itch: head lice. Can Fam Physician. 2012 Aug;58(8):839-41.
9. De Maeseneer J, Blokland I, Willems S, Vander Stichele R, Meersschaut F. Wet combing versus traditional scalp inspection to detect head lice in schoolchildren: observational study. BMJ. 2000 Nov 11;321(7270):1187-8.
10. Balcioglu C, Burgess IF, Limoncu ME, Şahin MT, Ozbel Y, Bilaç C, et al. Plastic detection comb better than visual screening for diagnosis of head louse infestation. Epidemiol Infect. 2008;136(10):1425-31.
11. Jahnke C, Bauer E, Hengge UR, Feldmeier H. Accuracy of diagnosis of pediculosis capitis: visual inspection vs wet combing. Arch Dermatol. 2009;145(3):309-13.
12. Nolt D, Moore S, Yan AC, Melnick L; Committee on Infectious Diseases, Committee on Practice and Ambulatory Medicine, Section on Dermatology. Head Lice. Pediatrics 2022;150(4):e2022059282. doi: 10.1542/peds.2022-059282.
13. Amanzougaghene N, Fenollar F, Raoult D, Mediannikov O. Where are we with human lice? A review of the current state of knowledge. Front Cell Infect Microbiol. 2020;9:474. doi: 10.3389/fcimb.2019.00474.
14. Downs AM, Stafford KA, Hunt LP, Ravenscroft JC, Coles GC. Widespread insecticide resistance in head lice to the over-the-counter pediculocides in England, and the emergence of carbaryl resistance. Br J Dermatol. 2002;146(1):88-93.
15. Tebruegge M, Pantazidou A, Curtis N. What's bugging you? An update on the treatment of head lice infestation. Arch Dis Child Educ Pract Ed. 2011 Feb;96(1):2-8.
16. Clark JM. New chemistries for the control of human head lice, Pediculus humanus capitis: A mini-review. Pestic Biochem Physiol. 2022;181:105013. doi: 10.1016/j.pestbp.2021.105013.
17. Abbasi E, Nasiri Z, Mohammadi J, Yazdani Z, Mohseni S. Knockdown resistance (kdr) associated organochlorine resistance in human head lice: systematic review and meta-analysis. MedRxiv. 2022. doi: 10.1101/2022.10.02.22280631.
18. Abbasi E, Daliri S, Yazdani Z, Mohseni S, Mohammadyan G, Hosseini SNS, et al. Evaluation of resistance of human head lice to pyrethroid insecticides: a meta-analysis study. MedRxiv. 2022. doi: 10.1101/2022.08.04.22278398.
19. Clark JM. Permethrin resistance due to knockdown gene mutations is prevalent in human head louse populations. Open Dermatol J. 2010;4:63-8.
20. Durand R, Bouvresse S, Berdjane Z, Izri A, Chosidow O, Clark JM. Insecticide resistance in head lice: clinical, parasitological and genetic aspects. Clin Microbiol Infect. 2012;18(4):338-44.
21. Hatam-Nahavandi K, Ahmadpour E, Pashazadeh F, Dezhkam A, Zarean M, Rafiei-Sefiddashti R, et al. Pediculosis capitis among school-age students worldwide as an emerging public health concern: a systematic review and meta-analysis of past five decades. Parasitol Res. 2020;119(10):3125-43.
22. Falagas ME, Matthaiou DK, Rafailidis PI, Panos G, Pappas G. Worldwide prevalence of head lice. Emerg Infect Dis. 2008 Sep;14(9):1493-4.
23. Feldmeier H. Pediculosis capitis: new insights into epidemiology, diagnosis and treatment. Eur J Clin Microbiol Infect Dis. 2012;31(9):2105-10.
24. Moradi A, Zahirnia A, Alipour A, Eskandari Z. The prevalence of Pediculosis capitis in primary school students in Bahar, Hamadan Province, Iran. J Res Health Sci. 2009;9(1):45-9.

25. Sim S, Lee IY, Lee KJ, Seo JH, Im KI, Shin MH, et al. A survey on head lice infestation in Korea (2001) and the therapeutic efficacy of oral trimethoprim/sulfamethoxazole adding to lindane shampoo. Korean J Parasitol. 2003 Mar;41(1):57-61.
26. Kokturk A, Baz K, Bugdayci R, Sasmaz T, Tursen U, Kaya TI, et al. The prevalence of pediculosis capitis in schoolchildren in Mersin, Turkey. Int J Dermatol. 2003;42(9):694-8.
27. Willems S, Lapeere H, Haedens N, Pasteels I, Naeyaert JM, De Maeseneer J. The importance of socio-economic status and individual characteristics on the prevalence of head lice in schoolchildren. Eur J Dermatol. 2005;15(5):387-92.
28. Counahan M, Andrews R, Büttner P, Byrnes G, Speare R. Head lice prevalence in primary schools in Victoria, Australia. J Paediatr Child Health. 2004;40(11):616-9.
29. Borges R, Mendes J. Epidemiological aspects of head lice in children attending day care centres, urban and rural schools in Uberlândia, central Brazil. Mem Inst Oswaldo Cruz. 2002;97(2):189-92.
30. Kurhanova I. Lice infestation and lice control remedies in the Ukraine. Ann N Y Acad Sci. 2006;1078(1):357-60.
31. Bharija SC, Kanwar AJ, Singh G, Belhaj MS. Pediculosis capitis in Benghazi, Libya: a school survey. Int J Dermatol. 1988;27(3):165-6.
32. Bush SE, Rock AN, Jones SL, Malenke JR, Clayton DH. Efficacy of the LouseBuster, a new medical device for treating head lice (Anoplura: Pediculidae). J Med Entomol. 2011;48(1):67-72.
33. Hodjati MH, Mousavi N, Mousavi M. Head lice infestation in school children of a low socioeconomy area of Tabriz city, Iran. Afr J Biotechnol. 2008;7(13):2292-4.
34. Birkemoe T, Lindstedt HH, Ottesen P, Soleng A, Næss Ø, Rukke BA. Head lice predictors and infestation dynamics among primary school children in Norway. Fam Pract. 2015;33(1):23-9.
35. AlBashtawy M, Hasna F. Pediculosis capitis among primary-school children in Mafraq Governorate, Jordan. East Mediterr Health J. 2012;18(1):43-8.
36. Chouela E, Abeldaño A, Cirigliano M, Ducard M, Neglia V, La Forgia M, et al. Head louse infestations: epidemiologic survey and treatment evaluation in Argentinian schoolchildren. Int J Dermatol. 1997;36(11):819-25.
37. Motovali-Emami M, Aflatoonian MR, Fekri A, Yazdi M. Epidemiological aspects of Pediculosis capitis and treatment evaluation in primary-school children in Iran. Pak J Biol Sci. 2008 Jan 15;11(2):260-4.
38. Rukke BA, Birkemoe T, Soleng A, Lindstedt HH, Ottesen P. Head lice prevalence among households in Norway: importance of spatial variables and individual and household characteristics. Parasitology. 2011;138(10):1296-304.
39. Speare R, Buettner PG. Head lice in pupils of a primary school in Australia and implications for control. Int J Dermatol. 1999;38(4):285-90.
40. Toloza A, Vassena C, Gallardo A, González-Audino P, Picollo MI. Epidemiology of Pediculosis capitis in elementary schools of Buenos Aires, Argentina. Parasitol Res. 2009;104(6):1295-8.
41. Chunge RN, Scott FE, Underwood JE, Zavarella KJ. A review of the epidemiology, public health importance, treatment and control of head lice. Can J Public Health. 1991;82(3):196-200.
42. Karakuş M, Arici A, Töz SÖ, Özbel Y. Prevalence of head lice in two socio-economically different schools in the center of Izmir city, Turkey. Turkiye Parazitol Derg. 2014;38(1):32-6.
43. Dehghanzadeh R, Asghari-Jafarabadi M, Salimian S, Asl Hashemi A, Khayatzadeh S. Impact of family ownerships, individual hygiene, and residential environments on the prevalence of pediculosis capitis among schoolchildren in urban and rural areas of northwest of Iran. Parasitol Res 2015;114(11):4295-303.
44. Rukke BA, Soleng A, Lindstedt HH, Ottesen P, Birkemoe T. Socio-economic status, family background and other key factors influence the management of head lice in Norway. Parasitol Res. 2014;113(5):1847-61.
45. Mahmud S, Pappas G, Hadden WC. Prevalence of head lice and hygiene practices among women over twelve years of age in Sindh, Balochistan, and North West Frontier Province: National Health Survey of Pakistan, 1990-1994. Parasit Vectors. 2011 Feb2;4:11. doi: 10.1186/1756-3305-4-11.
46. Badiaga S, Brouqui P. Human louse-transmitted infectious diseases. Clin Microbiol Infect. 2012 Apr;18(4):332-7.
47. Soultana V, Euthumia P, Antonios M, Angeliki RS. Prevalence of pediculosis capitis among schoolchildren in Greece and risk factors: a questionnaire survey. Pediatr Dermatol. 2009;26(6):701-5.
48. Fan CK, Liao CW, Wu MS, Hu NY, Su KE. Prevalence of Pediculus capitis infestation among school children of Chinese refugees residing in mountanous areas of northern Thailand. Kaohsiung J Med Sci. 2004 Apr;20(4):183-7.
49. Harris J, Crawshaw JG, Millership S. Incidence and prevalence of head lice in a district health authority area. Commun Dis Public Health. 2003 Sep;6(3):246-9.

Received October 27, 2022
Accepted in revised form March 14, 2023