

Original article

Impact and trend of factors affecting the prevalence of head lice (*Pediculus capitis*) infestation in primary school students

Amirhossein Zahirnia^a, Mohammad Ali Aminpoor^a, Hassan Nasirian^{b,*}

^aDepartment of Medical Entomology, School of Medicine, Hamadan University of Medical Sciences, Hamadan, Islamic Republic of Iran

^bDepartment of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences, Tehran, Islamic Republic of Iran

Background: Among arthropod-associated diseases or arthropods-pests of medical importance, *Pediculus capitis* is mentioned as one of the most common human obligate ectoparasites.

Objective: The aim of this study was to determine the impact and trend of factors affecting the prevalence of *P. capitis* infestation among primary school students in Gilan-e Gharb County.

Methods: Epidemiological information of students was completed using a questionnaire. To detect head lice or nits, the hair on scalp, the back of neck and around the student's ears was carefully examined by experienced individuals (males and females according to the gender of the students). In order to obtain the definite identity, samples were sent to a medical entomology laboratory.

Results: The present study showed that student age, gender and hygiene, bathing, father's and mother's education level, length and condition of hair, number of family members and income level, education level, and referring to the hairdresser are effective on the prevalence of *P. capitis* in students revealing significant differences between them ($P < 0.05$). The prevalence of *P. capitis* in girl students was higher than boys. The prevalence of *P. capitis* in students decreased with increasing student age and hygiene, bathing, father's and mother's education level, family income level, education level, and referring to the hairdresser. The prevalence of *P. capitis* in students increased with increasing number of student family members and hair length. The prevalence of *P. capitis* decreased with the change of student's hair condition from smooth to curly.

Conclusion: Primary-school students are intermingled in classes and have high contact rates. Then, *P. capitis* transmission occurs frequently. To efficiently decrease the prevalence of *P. capitis* in a community, all students or families at risk of being infested should be involved. Therefore, students and their parents should be informed about *P. capitis* infestation.

Keywords: Head lice, *Pediculus capitis*, prevalence, primary-school, students.

Body or crab louse and head louse (pediculosis capitis) infestations which remain a worldwide problem are commonly called pediculosis.^(1, 2) Pediculosis capitis, is an infestation caused by *Pediculus capitis* (De Geer) (Anoplura: Pediculidae) insects, infesting commonly the human hair and scalp. All stages of *P. capitis* insects are connected to human hosts during their life span. *Pediculus capitis* nymphs and adults

feed on only human blood without having wings and jumping ability. These insects are transmitted mainly through physical contact.⁽³⁻⁵⁾

Pediculus capitis can lead to pruritus, skin irritation, super infestation and urticarial from scratching, social stigmatization, and psychological distress. The most common symptoms associated to pediculosis capitis infestation are constant itching and scalp pruritus with occasional cutaneous infection caused by scratching. Pediculosis capitis infestation may even lead to anemia when affected individuals who are associated with poor social condition and inadequate diet. Lice insect injects their saliva into the host when they feed blood to promote vasodilation. An immune response may be produced in the host by

*Correspondence to: Hassan Nasirian, Department of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences, Tehran, Islamic Republic of Iran. E-mail: hanasirian@yahoo.com

Received: October 26, 2020

Revised: April 22, 2021

Accepted: May 11, 2021

the saliva, leading to pruritus. Fecal material from the lice insect may also contribute to scalp irritation. Scratching an itchy scalp occasionally causes cutaneous scalp infection. Although head lice infestation is associated with little morbidity, it cause much anxiety, lost days from school and work, and spent millions of dollars on medications. Recently, some studies provided novel information about pathogenic bacteria, namely *Coxiella burnetii* and *Rickettsia aeschlimannii* in head louse.^(3, 5-9)

Pediculus capitis infestation is a public health problem that occurs in various parts of the world affecting mostly school-aged children with a peak incidence below 15 years old^(3, 5-7), including Iran. Head lice infestation among primary-school-age children is the most prevalent communicable disease rather than all other communicable diseases except for the common cold.⁽⁴⁾ Although more common in developing countries, *P. capitis* infestation is endemic in many developed countries such as the United States, particularly among school-aged children. The prevalence of *P. capitis* in primary school students in developed countries is estimated at 2.0 – 10.0%.^(3, 6, 10, 11) Given that *P. capitis* prevalence varies well according to the social situation, genetic and cultural characteristics of different populations⁽³⁾, it is recommended to investigate it in local areas periodically. In some studies, *P. capitis* has been considered a neglected and re-emerging disease. In addition to cause direct problems, it can lead to social problems, academic decline and depression in infected individuals. As the development of the societies depends on their people public health and the public health of the societies have special importance. One of the most public health threats are obligate ectoparasites like *P. capitis* infestation which are still a public health problem despite the improving and advancing in medical science.⁽¹²⁾ Head lice infestation is common in community centers such as schools, barracks and dormitories, but it has been noticeable in primary school students, especially for girls. It may cause public health problems, psychological effects, social pressures and even academic failure in students.^(7, 13) In Iran, unfortunately, head lice infestation along with other infectious diseases is emerging due to the increase in the population, rural migration to towns, marginalization, the establishment of satellite towns with minimal public health and welfare facilities as a public health problem in some areas.⁽¹⁴⁾ The aim of this study was

to determine the impact and trend of factors affecting the prevalence of *P. capitis* infestation among primary school students in Gilan-e Gharb County.

Materials and methods

Study area

Gilan-e Gharb County located in the Southwest of Kermanshah Province with a population about 62,857 people at an altitude of 804 meters. It has two specific climates, summer and winter. In this study, all students of primary schools including 2,515 students (1,180 girls and 1,335 boys) present in the classroom were considered as the study population. All of them were included in this study by census and screened for head louse infestation in 2018.

Infestation investigation and head lice diagnosis

The necessary permits were obtained from the county health and medical network office before the field work. For explaining the study objectives, a coordination and justification meeting was held with school administrators, health educators and other stakeholders. Then, in accord with the school administrators and health educators, we went to primary schools for identifying infected students on specific days and according to the previous agreement. In encounter with students, ethical principles were observed. Questionnaires were completed by students. If a student was unwilling to cooperate, there was no insistence.

Data collection

Epidemiological information that includes student demographic information such as name, surname, age, gender, number of family members, education level, father's and mother's education level, family income level, number of bathing per week, hair type and length, personal hygiene, and referring to the hairdresser in the last two weeks was completed using a questionnaire. To detect head lice or nits, the hair on scalp, the back of neck and around the student's ears was carefully examined by trained and experienced individuals (males and females according to the gender of the students). To increase the accuracy of examining, a magnifying glass and tongue blades were used. The information of infected students was entered in the relevant sheets. If any of the students were infected, the school health educator will ask the parents to go to a near relevant health center for treatment. To obtain the correct diagnosis, the collected samples

were sent to the medical entomology laboratory of Hamadan University of Medical Sciences.

Ethical considerations

In order to obtain satisfy of the student parents and observe the moral considerations, a written testimonial form was presented to the student parents. If the student parents consented and allowed, each student was examined separately in a room. Female and male expert individuals were appointed to examine the students in girls' and boys' schools, respectively. Also, in order to maintain student confidentiality and prevent their psychological damage, no other person was informed about the infected students except the examiner and the school health educator.

Statistical analysis

Microsoft Excel and SPSS were used to analyze the data. The methods following Nasirian H.⁽¹⁵⁻¹⁸⁾ and Zahirnia A, *et al.*^(19,20) were used to estimate and calculate the scales, and impact and trend of factors including student age, gender and hygiene, bathing, father's and mother's education level, length and condition of hair, number of family members and income level, education level, and referring to the hairdresser affecting the prevalence of head lice infestation. Correlations between parameters were calculated using pearson's correlation coefficient (r). An analysis of Chi-square test was used to compare factors affecting the prevalence of student head lice infestation. *P*-value < 0.05 was considered statistically significant.

Results

The impact of factors affecting the prevalence of student head lice infestation

Table 1 shows the prevalence of *Pediculus capitis* infestation and effective factors among primary school students in Gilan-e Gharb County. In total, the prevalence of *P. capitis* in primary school students was 2.5%. The prevalence of *P. capitis* was 4.4 and 0.9% for girl and boy students, respectively (Table 1). Factors including student age, gender and hygiene, bathing, father's and mother's education level, length and condition of hair, number of family members and income level, education level, and referring to the hairdresser are effective on the prevalence of *P. capitis* in primary school students (Table 1 and Figures 1 - 2). Chi-square test analysis revealed a significant difference between factors affecting the prevalence of head lice infestation including student age, gender and hygiene, bathing, father's and

mother's education level, length and condition of hair, number of family members and income level, education level, and referring to the hairdresser (*P* < 0.002) (Table 2).

The trend of factors affecting the prevalence of student head lice infestation

The prevalence of *P. capitis* in primary school students decreased with increasing student age (Figure 1A) and hygiene, bathing (Table 1), education level (Figure 1B), father's and mother's education level (Figure 1C, D), family income level (Figure 2B), and referring to the hairdresser (Table 1). The prevalence of *P. capitis* in primary school students increased with increasing number of student family members (Figure 2A) and hair length (Figure 2C). The prevalence of *P. capitis* in girl students was higher than boy students in primary schools (Table 1). The prevalence of *P. capitis* decreased with the change of student's hair condition from smooth to curly (Figure 2D).

Discussion

Among arthropod-associated diseases like leishmaniosis, myiasis, and scabies, or *arthropods*-pests of medical importance such as ticks, mosquitoes, and cockroaches, *Pediculus capitis* mentioned as one of the most important human obligate ectoparasite.^(7, 21 - 37) Although the improvement of health system has had a significant impact on the reducing of *P. capitis* infestation, but infestation with this human ectoparasite is observed worldwide even in developed countries. The most vulnerable groups to head lice infestation are school-age children, whose infestation plays an important role in quality of their life and their education level, as well as in the spread of infestation to others.^(6, 14) The prevalence of pediculosis is usually related to the level of public health. The school health system plays a pivotal role for students and families by organizing information campaigns and practice sessions about the prevention, screening and treatment of pediculosis in a timely manner.⁽²⁾ The risk of pediculosis is related to several factors. Previous studies exhibit the infestation rate decreases significantly with age increasing due to more self-care of the students at older ages and their acquisition of the necessary skills to comply the principles of personal hygiene.^(38, 39)

In addition to the age and socioeconomic status, other factors that affect the prevalence of head lice infestation include gender, the number of

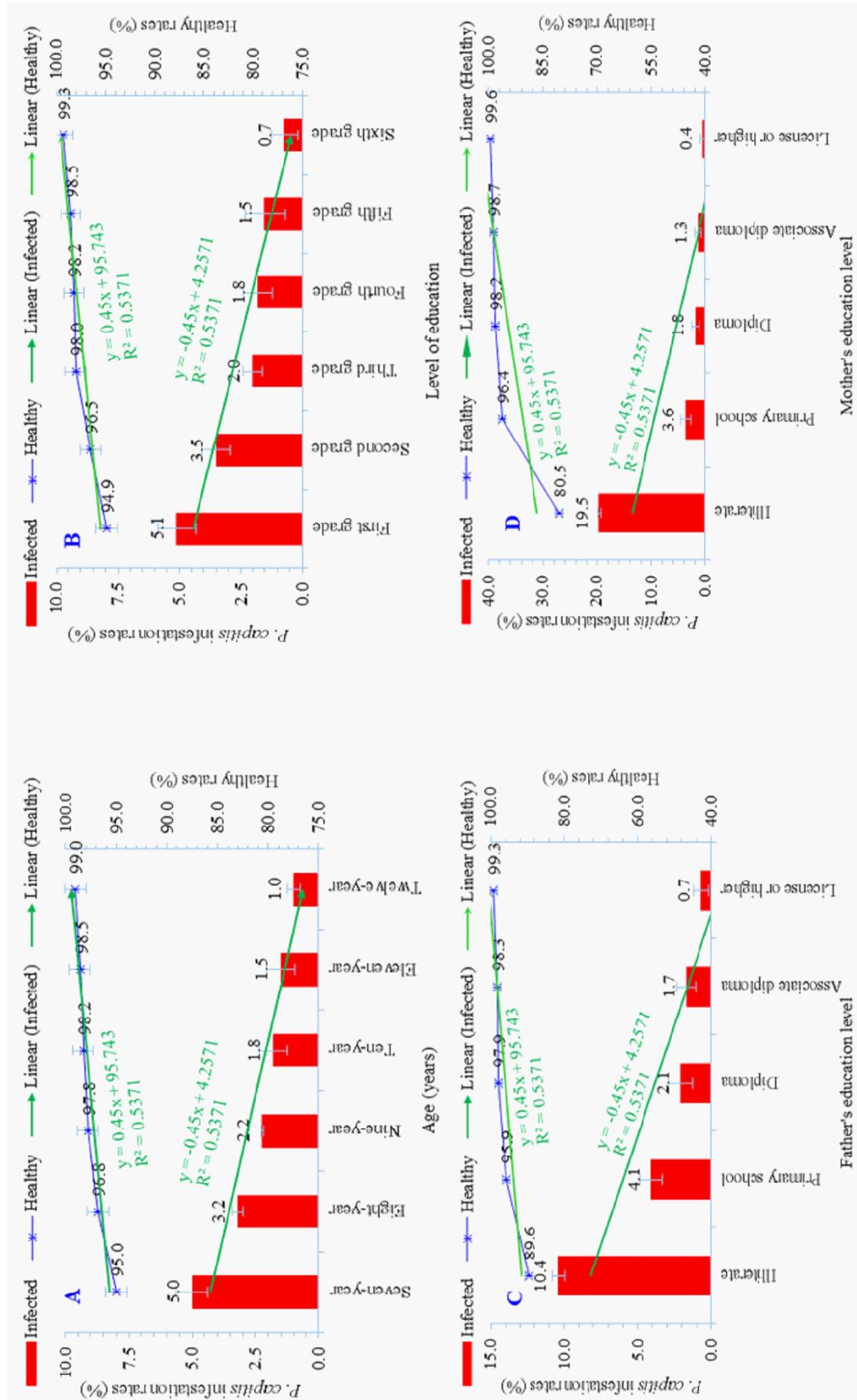


Figure 1. The impact and trend of factors affecting the prevalence of *Pediculus capitis* infestation among primary school students in Gilane-Gharb County: (A) The impact and trend of *P. capitis* morbidity by age; (B) The impact and trend of level of education of students on *P. capitis* infestation; (C) The impact and trend of father's education level on *P. capitis* infestation; and, (D) The impact and trend of mother's education level on *P. capitis* infestation.

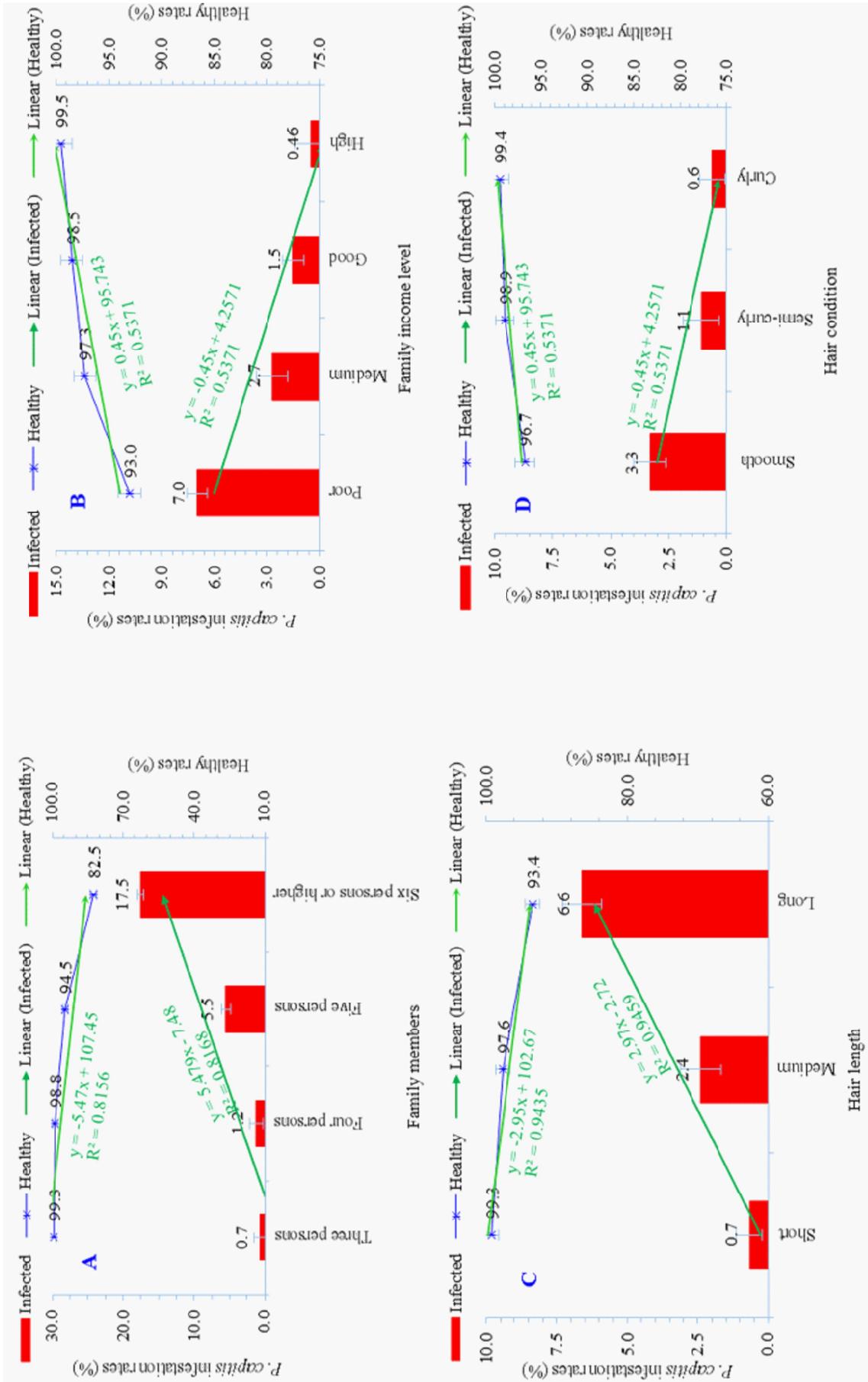


Figure 2. The impact and trend of factors affecting the prevalence of *Pediculus capitis* infestation among primary school students in Gilan-e Gharb County: (A) The impact and trend of number of family members on *P. capitis* infestation; (B) The impact and trend of family income level on *P. capitis* infestation; (C) The impact and trend of student hair length on *P. capitis* infestation; and, (D) The impact and trend of hair condition on *P. capitis* infestation.

Table 2. Chi-Square test analysis between factors affecting the prevalence of *Pediculus capitis* infestation among primary school students in Gilan-e Gharb County.

Analysis between	X ²	P - value
Age of students	38.6	0.0001
Student bathing	1993.5	0.0001
Education level of students	32.2	0.0001
Student family members	1157	0.0001
Father's education level of students	453.3	0.0001
Mother's education level of students	1005.2	0.0001
Student hair condition	1436.1	0.0001
Student referring to the hairdresser	173.7	0.0001
Student hair length	258.9	0.0001
Family income level of students	873.2	0.0001
Personal hygiene of students	113.6	0.0001
Gender of students	10.2	0.002

family members, status of environmental health, and literacy level.⁽⁴⁰⁾ The reason for the increase in the *P. capitis* prevalence can be attributed to the increase in the level of contact with each other and also the possibility of using common devices and thus the rapid transmission of infestation. Head lice infestation is a public health problem that affects mostly school-aged children with a peak incidence below 15 years old.^(3, 5-7, 11) A common misconception is that infestation occurs more frequently among lower income populations, but head lice are found among all socioeconomic groups.⁽⁶⁾ In areas with high population density, poor economic situation, lack of personal hygiene, and lack of health facilities are very common.^(7, 41, 42)

In the present study, a significant relationship was observed between the number of family members and the prevalence of *P. capitis* infestation. It seems that with the increase in the number of family members, parents will be less able to take care of their children's health. Currently, the prevalence of head lice infestation is not limited to specific socioeconomic status, but is usually more common in low-income and densely populated communities.⁽⁴⁾

In this study like previous studies⁽¹⁴⁾, a significant relationship was observed between the education level of student parents and the student *P. capitis* infestation. It can be explained that the higher education level of parents can lead to greater awareness and knowledge of their children health issues leading to a significant reduction in the student *P. capitis* prevalence. Another finding of the present study indicated a significant difference between family income level and *P. capitis* prevalence. Family income

level can increase *P. capitis* prevalence in accessing the students to sanitary facilities and personal belongings. In fact, family income level can be considered as a function of individual jobs and education level which education, income and job of individuals are integral components and affect the prevalence of head lice. The highest infestation rates occurred among students who take bathing every two weeks which directly related to family income level. Therefore, the lack of welfare and health facilities is a direct factor for more prevalence of head lice infestation in students.

The student's hair length has a significant impact on the prevalence of head lice that having long hair is more infected with *P. capitis* and having short hair is less infected with *P. capitis*. Of course, head lice lives near the roots of the hair and lays eggs there, so the effect of hair length on the prevalence of head lice should be sought along with other factors. Straight hair is more infected than semi-curly and curly hair. Head lice appears to be more adaptable living on straight hair, leading to more infestation in straight hair. The use of contaminated common equipment can increase the rate of *P. capitis* infestation exponentially.⁽⁴³⁾ The use of common equipment is one of the ways of *P. capitis* transmission, which was also shown in the present study to affect the prevalence of head lice infestation. However, as mentioned, the length of hair affects the *P. capitis* infestation, and going to the hairdresser and hair cutting can also be considered effective. The results indicated that the prevalence of head lice infestation among students who referred to the hairdresser is lower than others.

Studies on head lice infestation in populations with different social-economical levels have encountered significant differences between prevalence rates in different populations and regions around the world.^(3, 4) The prevalence rates of *P. capitis* have been reported from 5.8 to 35.0% in different regions around the world. In Iran, the prevalence rates of *P. capitis* were reported between 1.6 and 13.4% in various sociodemographic backgrounds.⁽²⁾ In total, our findings showed that the prevalence of *P. capitis* in primary school students was 2.5%. The prevalence of *P. capitis* was 4.4 and 0.9% for girl and boy students, respectively. This indicates that the role of behavioral factors in further *P. capitis* infestation in girl students than boys. In other words, there are differences in girl behavioral habits than boy students such as close contact of the girl heads, the suitability of girls' hair for *P. capitis* infestation due to its mass and long length, and wearing the girls' hair with a cover causes lack of timely detection and spread of *P. capitis* infestation in girls. Intimate and social behaviors of girls and their long-term contact with each other have been mentioned as the most common causes of more *P. capitis* infestation in girls. Although long and smooth hair of girls, wearing their hair with a cover and decrease attention to infestation are also mentioned in some cases as the cause of more prevalence of *P. capitis* in girls. Because, primary-school students are intermingled in classes and have high contact rates, *P. capitis* transmission occurs frequently. To efficiently decrease the prevalence of *P. capitis* in a community, all persons or families at risk of being infested should be involved. Therefore, primary school students and their parents should be informed about *P. capitis* infestation.⁽⁵⁾ For insect louse infestation control, maintenance of physical and psychological health, and the early diagnosis and treatment of infected individuals will be very important.^(3, 5 - 7)

Conclusion

Among arthropod-associated diseases or arthropods-pests of medical importance, *Pediculus capitis* is mentioned as one of the most common human obligate ectoparasites. The prevalence of *P. capitis* in girl students was higher than boy students. The prevalence of *P. capitis* in students decreased with increasing student age and hygiene, bathing, father's and mother's education level, family income level, education level, and referring to the hairdresser.

The prevalence of *P. capitis* in students increased with increasing number of student family members and student hair length. The prevalence of *P. capitis* decreased with the change of student's hair condition from smooth to curly.

Acknowledgements

This study forms part of M.A. Aminpoor M.Sc. thesis in Medical Entomology and Vector Control in the Department of Medical Entomology, School of Medicine, which was supported financially by the Research Deputy of Hamadan University of Medical Sciences (Grant No. 990119140). This study was also approved by the Ethics Committee of Hamadan University of Medical Sciences (Ir.umsha.rec.2018.1065).

Conflict of interest

The authors, hereby, declare no conflict of interest.

References

1. Frankowski BL, Bocchini JA Jr. Council on School Health and Committee on Infectious Diseases. Head lice. *Pediatrics* 2010;126:392-403.
2. Amirkhani MA, Alavian SM, Maesoumi H, Aminaie T, Dashti M, Ardalan G, et al. A nationwide survey of prevalence of pediculosis in children and adolescents in Iran. *Iran Red Crescent Med J* 2011;13:167-70.
3. 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;97:189-92.
4. Tappeh KH, Chavshin A, Hajipirloo HM, Khashaveh S, Hanifian H, Bozorgomid A, et al. *Pediculosis capitis* among primary school children and related risk factors in Urmia, the main City of West Azarbaijan, Iran. *J Arthropod Borne Dis* 2012;6:79-85.
5. Eroglu F, Basaran Ü, Kürklü CG, Yüceer M, Yalçýntürk RG, Tanrıverdi M, et al. *Pediculosis capitis* is a growing neglected infestation due to migration in southeast Turkey. *Parasitol Res* 2016;115:2397-401.
6. Hansen RC. Overview: the state of head lice management and control. *Am J Manag Care* 2004;10: S260-3.
7. Nutanson I, Steen CJ, Schwartz RA, Janniger CK. *Pediculus humanus capitis*: an update. *Acta Dermatovenerol Alp Pannonica Adriat* 2008;17:147-54, 56-7, 59.
8. Amanzougaghene N, Fenollar F, Sangaré AK, Sissoko MS, Doumbo OK, Raoult D, et al. Detection of

- bacterial pathogens including potential new species in human head lice from Mali. PLoS One 2017;129:e0184621.
9. Louni M, Amanzougaghene N, Mana N, Fenollar F, Raoult D, Bitam I, et al. Detection of bacterial pathogens in clade E head lice collected from Niger's refugees in Algeria. Parasites & Vectors 2018;111:1-11.
 10. Canyon DV, Speare R, Muller R. Spatial and kinetic factors for the transfer of head lice (*Pediculus capitis*) between hairs. J Invest Dermatol 2002;119:629-31.
 11. Ketzis JK, Clements K, Honraet K. Use of a poultry model to assess the transfer inhibition effect of head lice (*Pediculus humanus capitis*) products. Parasitol Res 2014;113:1943-8.
 12. Lee SH, Clark JM, Ahn YJ, Lee W-J, Yoon KS, Kwon DH, et al. Molecular mechanisms and monitoring of permethrin resistance in human head lice. Pestic Biochem Physiol 2010;97:109-14.
 13. Lesshaft H, Baier A, Guerra H, Terashima A, Feldmeier H. Prevalence and risk factors associated with pediculosis capitis in an impoverished urban community in Lima, Peru. J Glob Infect Dis 2013;5:138-43.
 14. Moosazadeh M, Afshari M, Keianian H, Nezammahalleh A, Enayati AA. Prevalence of head lice infestation and its associated factors among primary school students in Iran: A systematic review and meta-analysis. Osong Public Health Res Perspect 2015;6:346-56.
 15. Nasirian H. Contamination of cockroaches (Insecta: Blattaria) to medically fungi: A systematic review and meta-analysis. J Mycol Med 2017;27:427-48.
 16. Nasirian H. Infestation of cockroaches (Insecta: Blattaria) in the human dwelling environments: A systematic review and meta-analysis. Acta Trop 2017;167:86-98.
 17. Nasirian H. Recent cockroach bacterial contamination trend in the human dwelling environments: A systematic review and meta-analysis. Bangladesh J Med Sci 2019;18:540-5.
 18. Nasirian H. Contamination of cockroaches (Insecta: Blattaria) by medically important bacteria: A systematic review and meta-analysis. J Med Entomol 2019;56:1534-54.
 19. Zahirnia A, Boroomand M, Nasirian H, Salehzadeh A, Soleimani-Asl S. Comparing cytotoxicity of propoxur and *Nepeta crispa* (Lamiaceae) essential oil against invertebrate (SF9) and vertebrate (L929) cell lines. Vet World 2019;12:1698-706.
 20. Zahirnia A, Boroomand M, Nasirian H, Soleimani-Asl S, Salehzadeh A, Dastan D. The cytotoxicity of malathion and essential oil of *Nepeta crispa* (Lamiaceae) against vertebrate and invertebrate cell lines. Pan Afr Med J 2019;33:285.
 21. Nasirian H, Ladonni H. Artificial bloodfeeding of *Anopheles stephensi* on a membrane apparatus with human whole blood. J Am Mosq Control Assoc 2006;22:54-6.
 22. Poudat A, Nasirian H. Prevalence of pediculosis and scabies in the prisoners of Bandar Abbas, Hormozgan province, Iran. Pak J Biol Sci 2007;10:3967-9.
 23. Nasirian H, Ladonni H, Poudat A. Mass rearing of *Anopheles stephensi* on human blood by artificial feeding under laboratory conditions. Hormozgan Med J 2008;12:137-42.
 24. Ahmadi MS, Nasirian H, Gheshmi AMN, Ershadi MRY. Human extensive head skin myiasis. Iranian J Publ Health 2009;38:134-8.
 25. Nasirian H, Sadeghi SMT, Vazirianzadeh B, Moosa-Kazemi SH. New record of *Aedes vittatus* and *Culiseta subochrea* (Diptera: Culicidae) and their distribution from Shadegan Wetland, South Western Iran. J Entomol Zool Stud 2014;2:271-5.
 26. Nasirian H, Vazirianzadeh B, Taghi Sadeghi SM, Nazmara S. *Culiseta subochrea* as a bioindicator of metal contamination in Shadegan International Wetland, Iran (Diptera: Culicidae). J Insect Sci 2014;14:258.
 27. Abbas T, Younus M, Muhammad SA. Spatial cluster analysis of human cases of Crimean Congo hemorrhagic fever reported in Pakistan. Infect Dis Poverty 2015;4:9.
 28. Davari B, Kolivand M, Poomohammadi A, Faramarzi GA, Feizei F, Rafat BS, et al. An epidemiological study of *Pediculus capitis* in students of Pakdasht county, in autumn of 2013. Pajouhan Scientific J 2015;14:57-63.
 29. Martínez-Girón R, Martínez-Torre C, van Woerden HC. The prevalence of protozoa in the gut of German cockroaches (*Blattella germanica*) with special reference to *Lophomonas blattarum*. Parasitol Res 2017;116:3205-10.
 30. Zahirnia AH, Bordbar A, Ebrahimi S, Spotin A, Mohammadi S, Ghafari SM, et al. Predominance of *Leishmania major* and rare occurrence of *Leishmania tropica* with haplotype variability at the center of Iran. Braz J Infect Dis 2018;22:278-87.
 31. Akhlagh A, Salehzadeh A, Zahirnia AH, Davari B. 10-year trends in epidemiology, diagnosis, and treatment of cutaneous Leishmaniasis in Hamadan

- province, west of Iran (2007-2016). *Front Public Health* 2019;7:27.
32. Nasirian H, Salehzadeh A. Control of cockroaches (Blattaria) in sewers: a practical approach systematic review. *J Med Entomol* 2019;56:181-91.
 33. Nasirian H. Crimean-Congo hemorrhagic fever (CCHF) seroprevalence: A systematic review and meta-analysis. *Acta Trop* 2019;196:102-20.
 34. Nasirian H. New aspects about Crimean-Congo hemorrhagic fever (CCHF) cases and associated fatality trends: A global systematic review and meta-analysis. *Comp Immunol Microbiol Infect Dis* 2020; 69:101429.
 35. Kakeh-Khani A, Nazari M, Nasirian H. Insecticide resistance studies on German cockroach (*Blattella germanica*) strains to malathion, propoxur and lambda-cyhalothrin. *Chula Med J* 2020;64:357-65.
 36. Kassiri H, Nasirian H. New insights about human tick infestation features: a systematic review and meta-analysis. *Environmental Science and Pollution Research* 2021;28 14: 17000-28.
 37. Nasirian H, Zahirnia A. Detailed infestation spectrums about biological stages of hard ticks (Acari: Ixodida: Ixodidae) in humans: a systematic review and meta-analysis. *Acta Parasitologica*. 2021; <https://doi.org/10.1007/s11686-021-00362-y>.
 38. Gbakima AA, Lebbie AR. The head louse in Sierra Leone: an epidemiological study among school children, in the Njala area. *West Afr J Med* 1992;11: 165-71.
 39. Downs AM, Harvey I, Kennedy CT. The epidemiology of head lice and scabies in the UK. *Epidemiol Infect* 1999;122:471-7.
 40. Morsy TA, el-Ela RG, Mawla MY, Khalaf SA. The prevalence of lice infesting students of primary, preparatory and secondary schools in Cairo, Egypt. *J Egypt Soc Parasitol* 2001;31:43-50.
 41. Ferris GF. The sucking lice. *Mem Pac Coast Entomol Soc* 1951;27.
 42. Akhter S, Mondal M, Alim MA, Moinuddin M. Prevalence of lice infestation in humans in different socioeconomic status at Mymensingh in Bangladesh. *Int J Bio Res* 2010;1:13-7.
 43. Chew AL, Bashir SJ, Maibach HI. Treatment of head lice. *Lancet* 2000;356:523-4.