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ISSN 2358-291X (Online)

REVIEW ARTICLE

Epidemiological aspects of pediculosis by *Pediculus humanus capitis* (Phthiraptera: Pediculidae) in Minas Gerais: a systematic review

Aspectos epidemiológicos da pediculose por Pediculus humanus capitis (Phthiraptera: Pediculidae) em Minas Gerais: uma revisão sistemática

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How to cite: Castro PASV, Paranhos LS, Pessoa GCDA, Barbosa DS, Carneiro M, Bezerra JMT. Epidemiological aspects of pediculosis by *Pediculus humanus capitis* (Phthiraptera: Pediculidae) in Minas Gerais: a systematic review. Cad. Saúde Colet., 2023; 31(1):e30040425. https://doi.org/10.1590/1414-462X202230040425

Abstract

Background: Head lice, or head pediculosis, is a parasitosis considered a serious public health problem that affects mainly resource-limited countries. **Objective:** To describe epidemiological aspects of the *pediculosis capitis* in Minas Gerais, in Brazil. **Method:** This systematic review was conducted through the standards established by the Preferred Reporting Items in Systematic Reviews and Metanalyses (PRISMA). PubMed, LILACS, and SciELO databases, as well as the gray literature, were searched. **Results:** Nine of 1,167 studies were included, published between 1988 and 2019. These studies reported a total prevalence of parasitosis that ranged from 1.4% to 57.4%. The prevalence of head lice ranged from 0.0% to 66.7% for males and 2.3% to 57.4% for females, thus being higher in black-skinned people (1.4% to 40.3%). Regarding age, the highest prevalence was 10-12 years old (45.3%). As for the characteristics of the hair, there was a greater infestation in people with long (16.0% to 79.5%), wavy (0.0% to 44.7%), dark (0.0% to 36.6%), with low capillary density (35.4%), and thick hair (39.2%). **Conclusion:** Head pediculosis affects both sexes, different ages, and races, representing an important health problem in Minas Gerais, not only due to the presence of ectoparasite but also to the secondary complications that can be generated from this parasitism.

Keywords: head lice; lice infestation; *Pediculus humanus capitis*; systematic literature review; Minas Gerais.

Resumo

Introdução: A pediculose de cabeça é uma parasitose considerada um sério problema de saúde pública, afetando principalmente países com recursos limitados. **Objetivo:** Descrever os aspectos epidemiológicos da pediculose de cabeça em Minas Gerais, Brasil. **Método:** Revisão sistemática conduzida por meio dos padrões estabelecidos pelo Preferred Reporting Items in Systematic Reviews and Metanalyses

Study carried out at Universidade Federal de Minas Gerais (UFMG) - Belo Horizonte (MG), Brasil.
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Financial support: none.
Conflict of interests: nothing to declare.
Received on: Aug. 20, 2020. Accepted on: Jan. 11, 2021

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(PRISMA). Foram pesquisadas as bases de dados PubMed, LILACS e SciELO, bem como a literatura cinza. **Resultados:** Nove de 1.167 estudos foram incluídos, publicados entre 1988 e 2019. Relatou-se uma prevalência total da parasitose que variou de 1,4% a 57,4%. Ela variou de 0,0% a 66,7% para homens e 2,3% a 57,4% para mulheres, sendo maior em pessoas de cor negra (1,4% a 40,3%). Em relação à idade, a maior prevalência foi de 10 a 12 anos (45,3%). Quanto às características dos cabelos, houve maior infestação em pessoas com cabelos longos (16,0% a 79,5%), ondulados (0,0% a 44,7%), escuros (0,0% a 36,6%), com baixa densidade capilar (35,4%) e fios grossos (39,2%). **Conclusão:** A pediculose atinge ambos os sexos, diferentes idades e raças, representando um importante problema de saúde em Minas Gerais, não só pela presença do ectoparasita, mas também pelas complicações secundárias que podem ser geradas desse parasitismo.

Palavras-chave: piolhos; infestação por piolhos; *Pediculus humanus capitis*; revisão sistemática da literatura; Minas Gerais.

INTRODUCTION

Pediculosis capitis, also known as head lice infestation, is a disease caused by *Pediculus humanus capitis*[1]. It is a hemimetabolous insect that belongs to the suborder *Anoplura* (Order Phthiraptera) and it is an obligate and permanent ectoparasite of eutherian mammals[2,3], being highly specialized blood-sucking insects that live in close association with humans[2]. They are known to live, breed and lay their eggs at the base of hair shafts, feeding themselves by injecting small amounts of saliva, which has vasodilatory and anticoagulation properties, into the scalp, allowing them to suck blood from their hosts every 4 to 6 hours, approximately five times per day[4]. The average amount of blood imbibed at a single feed varies according to sex and life phase[5]. Its life cycle begins with an egg stage of approximately seven days, followed by three instars of approximately three days each before becoming adults that are capable of reproducing[4]. In most cases, its transmission occurs by direct contact[6,7], and indirect spread through contact with personal belongings is less likely to occur[8]. Since head lice depends on host blood for living, most of them perish 40 hours post-blood meal if they do not get another blood meal[9], possibly hampering the transmission by fomites.

Infestation by *P. capitis* is known to be very common worldwide, especially among schoolchildren and people who are in constant contact with them, such as parents and teachers[10], whatever their hygiene status[11]. For that reason, the risk group for head lice are children between the ages of three and 10 years[12]. Infestations can be asymptomatic, but pruritus, which is the main symptom of the disease[13], may occur if the infested individual becomes sensitized to antigenic components of lice saliva[14]. Even though head lice infestation is associated with limited morbidity and its agent is not recognized as an important disease vector, it causes a high level of anxiety among parents of school-aged children[15], lack of concentration in school and it can lead to dangerous secondary infections of the excoriated scalp lesion[16]. Moreover, it can lead to iron deficiency anaemia[17,18] and even autosensitization dermatitis[19].

Head lice treatment is diverse, and it comprises different strategies. One of them is related to the nonpharmacologic strategy, which relies on manual removal of lice using combs, practice also known as wet combing[20], or by hand. Other physical methods, such as heating[21], have also been described. While hair cutting facilitates the handling of the hair during manual removal, the use of creams can fix the insect. The pharmacologic strategy, on the other hand, is based mainly on topical drugs, focuses on three general mechanisms: neurotoxicity resulting in paralysis of the lice (insecticidal treatments); suffocation via "coating" the lice; or dissolution of the wax covering on the exoskeleton[20,22]. An issue related to the pharmacologic therapy for head lice is the growing concern about the parasites' resistance to drugs, particularly to pyrethroids and organophosphate malathion[23].

In Brazil, studies conducted in different regions show contrasting results. While in the city of Manaus (Amazonas state)[24], there was an occurrence of lice infestation in 3.68% in children, it could be noted that in Jundiaí (São Paulo state)[25], and Nova Iguaçu (Rio de Janeiro state)[26] the prevalence of *P. capitis* was higher than 35%. It should be noted that most studies underestimate the general prevalence, assessing it over a specific period[27]. Furthermore, this underestimation could be due to political neglect, absence of health education activities, social stigma and/or even underreporting[28,29].

Head lice infestation is a dynamic process that can spread hypergeometrically in closed environments such as schools and in the community[30], which means that the probability of infestation success varies according to each case and cases are dependent on each other to occur. Therefore, studies that evaluate the infestation in different places and different points in time are essential to estimate a more accurate statistic data. Moreover, with the increase in the indiscriminate use of some drugs used to control pediculosis in Minas Gerais, due to the current pandemic of Coronavirus Disease-2019 (COVID-19)[31,32], studies that assess how pediculosis behaved before the pandemic are important for future comparisons, given the recent reporting of concerns by segments of society with possible outbreaks[33]. Considering this scenario, this systematic review aimed to determine the epidemiological aspects of pediculosis by *P. humanus capitis* in the state of Minas Gerais, *i.e.*, one of the most populous states in Brazil, and which studies describe factors involved in this health problem. To this date, no systematic reviews have been published about the situation of this disease in the state of Minas Gerais.

METHOD

Protocol design and registration

A systematic literature review was carried out. The study protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO), under the number CRD42020175190[34] and in the Open Science Framework (OSF) registries (https://osf.io/vqfd9) with the registration DOI: 10.17605/OSF.IO/VQFD9. The report of this review is in line with the recommendation Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA)[35].

Eligibility criteria

Cross-sectional studies conducted in the state of Minas Gerais, Brazil, which described the prevalence of pediculosis only by the species *P. humanus capitis*, were considered eligible. There were no restrictions on the characterization of study participants. Searches were conducted considering scientific articles published in English, Spanish and Portuguese from 1980 onwards. Studies carried out that included pediculosis for species other than *P. humanus capitis*, that did not correspond to the languages adopted in the search strategies, that did not correspond to studies from Minas Gerais state or that did not fit the study question, were excluded.

Information sources and search strategies

Searches were carried out in the sources U. S. National Library of Medicine (PubMed), *Literatura Latino-Americana e do Caribe em Ciências da Saúde* (LILACS) and Scientific Electronic Library Online (SciELO). The lists of bibliographic references for the relevant studies were examined to identify eligible studies. Searches were conducted in the first half of October 2019 and updated until July 2020.

Searches were performed using descriptors cataloged in the *Descritores em Ciências da Saúde* (DeCS) and Medical Subject Headings (MeSH), in English, Spanish and Portuguese. The studies that contained these terms in the title or abstract were selected. Boolean operators "AND" and "OR" were used, in addition to quotation marks to facilitate the search for manuscripts. In each of databases (PubMed, LILACS and SciELO), combinations of terms were used, together or separately, in the three languages mentioned above: Lice Infestations, *Infestaciones por Piojos*, *Pediculose* (similar terms: "*infestação por piolhos*", " *pediculoses*"); *Pediculus capitis* (similar terms: *Pediculus humanus capitis*); Epidemiology, *Epidemiología*, *Epidemiologia* (similar terms: "*endemia*", "*epidemia*", "*frequência*", "*incidência*", "*morbidade*", "*ocorrência*", "*prevalência*", "*surto*", "*vigilância*").

Gray literature was also searched through access to Google Scholar for additional publications to avoid an inadequate or non-comprehensive selection, including only publication of scientific articles, which would reduce the representativeness of the identified or included studies.

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Studies selection and data extraction

For the studies selection and data extraction, after removing duplicate records, two independent researchers selected the articles by title and abstract, obeying the predefined inclusion and exclusion criteria. Two researchers independently selected the studies. In case of disagreement between the two researchers, a third researcher, an expert in the field, was consulted.

Then, the full texts were gathered for evaluation. The following data were extracted from the studies: authorship; year; place; number of participants; objective and design; sex; age group; characterization of data collection; and results obtained, considering the prevalence of parasitosis. In case of doubts regarding the results of each study, authors of publications included in the present systematic review were contacted for clarifications.

Methodological quality evaluation of the included studies

The methodological quality was analyzed individually and independently by the two referred researchers. Three criteria were evaluated, based on the Newcastle-Ottawa Scale (NOS) for cross-sectional studies[36]: (i) selection (items evaluated: sample representativeness, sample size, non-respondents and determination of exposure); (ii) comparability (control of confounding factors); and (iii) outcome (evaluation of results and statistical tests adopted). Item (i) provided a score between 0 and 5, item (ii) 0 and 2, and item (iii) between 0 and 3. The sum of the three items for each article, therefore, varied from 0 to 10 points. In this review, the studies were considered to be of high quality when they scored a value greater than or equal to five points, according to the previously published definition of the NOS evaluation[37].

RESULTS

Selected studies

The research strategy recovered 1,167 studies (scientific electronic databases and gray literature). After screening the title and abstract, 12 studies were selected for reading the full text, thus excluding 1,155 titles (13 by duplication and 1,142 because they did not fit the study question). Of these, the studies that met the eligibility criteria resulted in nine[38-46], included in this systematic review. The details of the selection process are illustrated in Figure 1.

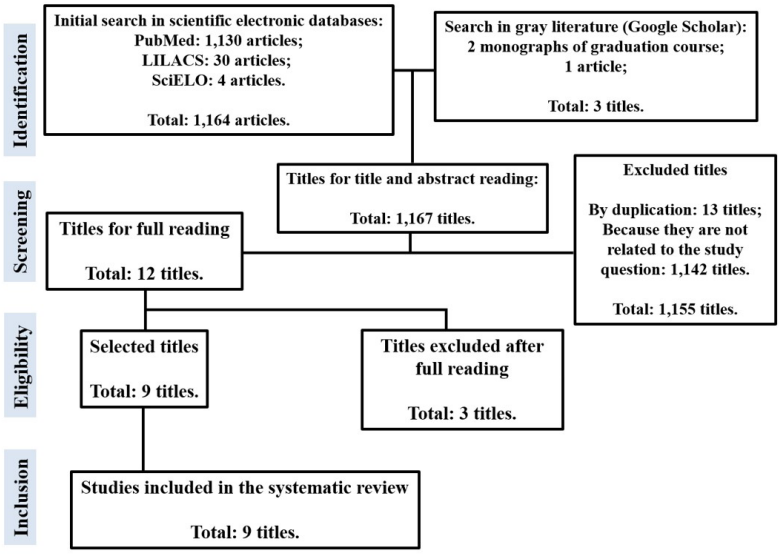

Figure 1. Flowchart of scientific articles selection in the databases for the systematic review on the prevalence of pediculosis by *Pediculus humanus capitis* in the state of Minas Gerais, in Brazil

Cad. Saúde Colet., 2023; 31(1):e30040425 | https://doi.org/10.1590/1414-462X202230040425

Main characteristics of the studies

Of the nine studies, six were carried out in the city of Uberlândia, two in Belo Horizonte, and one in Divinópolis, published between 1988 and 2019. The studies included participants sampled in barbershops, beauty salons, rural and urban municipal schools, elderly people's homes, long-term care facilities, early childhood education institutions, a public hospital, and a pediatric sector of a public hospital (Table 1).

Pediculosis prevalence and sociodemographic profile of the studies' participants

The prevalence in studies considering the total number of participants ranged from 1.4% to 57.4%. When sex was considered, the prevalence of infestation for *P. humanus capitis* ranged from 0 to 66.7% for males and 2.3% to 57.4% for females. As the studies presented different descriptions regarding infestation by groups, age group or age, the highest prevalences were found in: children with a percentage of 13.6% (study that describes only groups); age groups of 4-8 years (5.8%), 4-5 years (10. 3%), > 8 ≥ 10 years (16.2%), 10-12 years (45.3%), and 1-5 years (78.5%). Five studies classified the *P. humanus capitis* infestation according to the skin color/race of the participants, with individuals with white skin having 76.9% of the infestations, non-black skin ranging from 0.0% to 33.7%, brown skin 72.0%, and black skin individuals with infestations ranging from 1.4% to 40.3% (Table 2).

In one of the studies, the prevalence among students infested in schools located in the urban area ranged from 2.6% to 51.0%, and between 34% and 38.5% in schools in the rural area. In another study, the proportion of students affected by parasitosis in central schools ranged from 0.0% to 13.9%, and in schools in the periphery, from 0.0% to 18.2%. One of the studies showed a higher prevalence of parasitosis in people with low socioeconomic status (58.8%) and in another that 37.1% of hair samples containing the parasite came from barbershops or beauty salons frequented by people of low socioeconomic status. Schools that had students whose family income varied from ≥ 1 ≤ 3 minimum wages had an infestation of 12.6% in one of the studies (Table 2).

Pediculosis prevalence and hair characteristics

As for the length of the hair, three studies pointed to a greater infestation in the long hairs (variation from 16.0% to 79.5%) and three indicated in medium hair (variation from 9.0% to 15.7%). Hair color was reported in five studies, with dark being the most prevalent for parasitosis in three studies (variation from 2.9% to 36.6%) and light in only one study (10.5%). Capillary density infestation was described in three studies, with the predominant high (variation from 2.9% to 14.1%) in two and low (35.4%) in a third study. The thickness of the hair strand with the highest number of parasites was thin (variation from 3.5% to 13.4%) in two studies and thick (39.2%) in another study. Regarding the structure of the hair, in two studies, the wavy type was the one with the highest *P. humanus capitis* (variation from 4.3% to 44.7%) and the straight type was also mentioned in two studies (variation from 9.1% to 24.0%) as most infested. Only one study mentioned higher infestation occurrence in curly hair (7.1%). In one of the studies, 20.0% of the participants had anemia, 38.1% already had a history of infestation and 80.0% reported brushing their hair as the treatment used. One of the studies showed that 3.7% of those affected by parasitosis were not on school holidays (Table 2).

In three studies, the following types of hair were classified: type (straight, wavy or curly); color [light (blond and red) or dark (brown and black)]; hair thickness (thick or thin); capillary density considering 1 cm^2 of bounded scalp area (high or low); length [0 to 3 cm], medium (< 3 ~ 10 cm) and long (> 10 cm)]. Another study that lists only the length of hair strands considered short (up to 3 cm beyond the ear), medium (above 3 cm and below 10 cm beyond the ear) and long (more than 10 cm beyond the ear). In addition, two other studies considered for the capillary characterization of the participants' hair length: short (< 3 cm in length), medium (3 to 10 cm and length) and long (> 10 cm)]; hair color [dark (black or brown) or light (blond and red)]; and hair type (curly, wavy or straight).

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Table 1. Description of the authors, year, period, location, design, and objective of the studies selected for the systematic review on the prevalence of pediculosis by *Pediculus humanus capitis* in the state of Minas Gerais, in Brazil

Authors	Study period	Study location (city of Minas Gerais)	Study design (type)	Study objectives
Linardi et al.[38]*	October 1984 to April 1985	Barbershops and beauty salons (Belo Horizonte)	Cross-sectional study (article)	To determine a "rapid" prevalence of *Pediculus humanus capitis* in Belo Horizonte.
Linardi et al.[39]*	1985	Municipal schools (Belo Horizonte)	Cross-sectional study (article)	To determine the prevalence of *Pediculus humanus capitis* in schoolchildren in Belo Horizonte.
Borges and Mendes[40]*	November 1996 to March 2000	Day care centers, and urban and rural public schools (Uberlândia)	Cross-sectional study (article)	To determine whether factors such as age, gender, race, hair characteristics, as well as the location of the children's home (urban or rural areas) influence the distribution of lice in children and youth in Uberlândia.
Borges et al.[41]*	November 1999 to October 2000	Beauty salons, residences, and elderly people's homes (Uberlândia)	Cross-sectional study (article)	To determine the prevalence and monthly variation of pediculosis in different age groups in the population of Uberlândia.
Costa et al.[42]**	Not cited by the authors	Municipal Centers for Early Childhood Education (MCECE) (Divinópolis)	Cross-sectional study (article)	To identify the prevalence of head pediculosis among children in Municipal Centers for Early Childhood Education in Divinópolis, and to evaluate factors associated with the prevalence of pediculosis in this population.
Mendes et al.[43]*	September to November 2014	Early childhood education institutions (Uberlândia)	Cross-sectional study (article)	To determine the prevalence of pediculosis in preschoolers in Uberlândia.
Marinho et al.[44]*	August 2015 to July 2017	Pediatric sector of a public hospital (Uberlândia)	Cross-sectional study (article)	To determine the prevalence of pediculosis in children seen in a pediatric sector of a public hospital in Uberlândia.
Santos[45]**	November 2017 to September 2018	Public hospital (Uberlândia)	Cross-sectional study (monograph of graduation course)	To verify the prevalence of pediculosis in children treated at a hospital in Uberlândia. To evaluate the association of pediculosis with factors such as age, sex, age group, socioeconomic conditions, and hair characteristics. To verify knowledge about epidemiology, transmission, prevention, and control of pediculosis on the scalp of parents and/or guardians.
Figueira et al.[46]*	August 2017 to January 2018	Long-term care facilities for elderly adults (Uberlândia)	Cross-sectional study (article)	To determine the occurrence of head lice in these individuals, and analyze possible associations of the parasitosis with sex, ethnicity, age, and hair characteristics. The study also sought to verify the level of knowledge among elderly adults regarding aspects of the biology, epidemiology, and control of this ectoparasitosis.

*Selected studies from the search in the databases (PubMed, LILACS and SciELO); **Selected studies from the search in gray literature (Google Scholar)

Methodological quality evaluation of the included studies

The methodological quality evaluation included articles that had a sum of five points or more in the sum of the criteria. The average obtained in the evaluation of the quality of the titles was 7.0 (Table 3).

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Table 2. Description of the authors, year, main characteristics of the methodologies adopted, participants, main results, and prevalence of the parasitosis in the studies in the systematic review on the prevalence of pediculosis by *Pediculus humanus capitis* in the state of Minas Gerais, in Brazil

Authors	Methods	Sample and its characteristics	Local	Data regarding hair characteristics	Overall prevalence		Associated factors with *Pediculus humanus capitis* infestation
					n	%	
Linardi et al.[38]*	Samples of hair cut were collected and then the presence of the parasite was observed.	475 hair samples.	475 barbershops and beauty salons.	No	140	29.5	The highest prevalence (35.7%) was observed in barbershops with male clients ($p < 0.05$). Barber shops that charged lower prices [0.26-0.66 (low socioeconomic status)] for haircut had greater infestation (37.1%) ($p < 0.001$).
Linardi et al.[39]*	Questionnaire and inspections were carried out manually on the heads by a previously trained professional.	50,356 children and adolescents	105 public schools.	Yes	28,886	57.4	Low socioeconomic level ($p < 0.001$), educational level from 1 to 4 years ($p < 0.001$), female gender ($p < 0.001$), light skin color ($p < 0.001$), long hair ($p < 0.05$) and age group 1-5 years ($p < 0.001$).
Borges and Mendes[40]*	The individuals' heads were checked manually for the parasite encounter for three minutes, with special attention to the neck and behind the ears with the help of hair manipulation.	884 children and adolescents.	11 public institutions, including three-day care centers, four public urban schools and four public rural schools.	Yes	309	35.0	The highest prevalence rates were observed in black (40.3%; $p < 0.05$), female children (47.1%; $p < 0.05$), with long (52.6%; $p < 0.05$), dark (36.3%; $p < 0.05$), wavy hair (44.7%; $p < 0.05$).
Borges et al.[41]*	Study divided in three groups: - First group: samples of hair cut were collected and then the presence of the parasite was observed. - Second group: the individuals' heads were checked manually, and, after that, their hair was cut, taken to the laboratory, and examined. - Third group (elderly): the individuals' heads were examined.	416 hair samples.	Two beauty salons, participants' residences and three elderly people's homes.	No	31	7.5	The infestation rate among children up to 15 years old was significantly higher than the rate observed among older groups ($p = 0.013$). In the second group, the prevalence rate found using head inspection (20.6%) was seen to be significantly higher than the rate using cut hair (10.6%) ($p = 0.022$). There was difference between the rates found among children (24.2%) and among adults (10.6%) in the second group of people ($p = 0.045$).
Costa et al.[42]**	Questionnaire and inspections were carried out manually on the heads by a previously trained professional.	326 children.	Municipal Centers for Early Childhood Education.	Yes	50	15.3	The prevalence was higher in children with a history of pediculosis (58%; $p < 0.0001$), of those who used scavenging (32%; $p < 0.001$) and among girls (76%; $p < 0.0001$). Girls had 3.21 times the chance of presenting pediculosis when compared to boys.

*Selected studies from the search in the databases (PubMed, LILACS and SciELO); **Selected studies from the search in gray literature (Google Scholar). % = percentage. n = number. p = p value

Table 2. Continued...

Authors	Methods	Sample and its characteristics	Local	Data regarding hair characteristics	Overall prevalence		Associated factors with *Pediculus humanus capitis* infestation
					n	%	
Mendes et al.[43]*	Questionnaire and inspections were carried out manually on the heads by a previously trained professional, with special attention to the neck and behind the ears with the help of hair manipulation.	372 children.	Four preschools located in the central region and four others on the outskirts of the city.	Yes	28	7.5	The highest prevalence of infestation occurred in girls ($p < 0.005$). The influence of hair length on the prevalence of pediculosis showed a higher rate among children with long hair ($p < 0.005$). Children aged between 4-5 years were more affected than the others ($p < 0.05$). When comparing the rates verified for each school, regardless of location in the city, differences were observed between the prevalences ($p < 0.005$). The two highest prevalences observed (preschools V and III) were significantly different from the two lowest rates included in the comparison (preschools VI and II) ($p < 0.05$).
Marinho et al.[44]*	Questionnaire and inspections were carried out manually on the heads for three minutes by a previously trained professional, with special attention to the neck and behind the ears with the help of hair manipulation.	606 children.	Pediatric sector of a public hospital.	Yes	17	2.8	As for sex, girls had a higher prevalence ($p = 0.001$) and as for hair length, children with medium hair were the most affected ($p < 0.001$). Infestations occurred more frequently during school semesters ($p = 0.040$).
Santos[45]**	Questionnaire and inspections were carried out manually on the heads for three minutes by a previously trained professional, with special attention to the neck and behind the ears with the help of hair manipulation.	282 children.	Public hospital.	Yes	31	11.3	Female children ($p = 0.001$) with medium and long hair ($p = 0.001$) were more affected. It was observed that children with straight hair ($p = 0.025$) and high density ($p = 0.023$) had higher prevalence rates.
Figueira et al.[46]*	The individuals' heads were checked manually for the parasite encounter for three minutes, with special attention to the neck and behind the ears with the help of hair manipulation.	145 elderly.	Seven long-term facilities.	Yes	2	1.4	There was a higher occurrence in elderly black women, and the age group most affected was 60 to 75 years old. The highest occurrence was observed in elderly adults with medium length ($p = 0.000$), curly hair ($p = 0.019$). The facilities where the elderly women resided was privately run.

*Selected studies from the search in the databases (PubMed, LILACS and SciELO); **Selected studies from the search in gray literature (Google Scholar). % = percentage. n = number. p = p value

Table 3. Methodological quality evaluation of the scientific articles included in the systematic review: results obtained after using the Newcastle-Ottawa Scale for cross-sectional studies[36]

Studies	Criteria			Total (0 to 10)
	Selection (0 to 5 points)	Comparability (0 to 2)	Outcome (0 to 3)	
Linardi et al.[38]*	2	1	2	5
Linardi et al.[39]*	4	1	2	7
Borges and Mendes[40]*	4	1	2	7
Borges et al.[41]*	3	1	2	6
Costa et al.[42]**	4	1	2	7
Mendes et al.[43]*	3	1	2	6
Marinho et al.[44]*	5	1	3	9
Santos[45]**	5	1	3	9
Figueira et al.[46]*	3	1	3	7
Average				**7.0**

*Selected studies from the search in the databases (PubMed, LILACS and SciELO); **Selected studies from the search in gray literature (Google Scholar)

DISCUSSION

This systematic review gives an overview of the prevalence of pediculosis by *P. humanus capitis* and aspects related to the occurrence of parasitosis in the state of Minas Gerais, in Brazil. According to the search criteria established for conducting this systematic review, only studies available in the electronic databases and the gray literature were selected, which provided proven scientific evidence of the information obtained. The nine publications analyzed, from 1988 to 2019, refer to the municipalities of Uberlândia, Belo Horizonte, and Divinópolis. There was a total prevalence of parasite infestation ranging from 1.4% to 57.4%, in addition to different sociodemographic and physical-behavioral characteristics (concerning the individuals' hair) of parasitized people who frequent barbershops and beauty salons; students from rural and urban municipal schools, from early childhood education institutions, and daycare centers; residents of elderly homes; and patients from public hospitals.

The selected studies pointed out that the infestation showed variations in the prevalence rates of parasitosis among men and women. However, in seven studies, females obtained the highest proportions of infected people, in studies conducted in Uberlândia[40,43-46], Belo Horizonte[39] and Divinópolis[42]. Only in one of the studies that evaluated the presence of the parasite in hair samples, positivity was higher for males[38]. Studies conducted in the municipality of Manaus (state of Amazonas) showed greater infestation of the parasite in female hair, comprising 27.5%[47] and 3.0%[24]. The higher prevalence of infestations in females may be related to the predominance of medium to long hair among women, a cultural habit verified since childhood in the country[46]. Moreover, medium and long hair present a larger contact surface, facilitating transmission, especially among children while playing[44].

The studies addressed the prevalence of *P. humanus capitis* infestation in groups, age groups, or only by age. There was a prevalence of parasitosis in children aged 1 to 12 years old[38,40,42-45], although other studies also found the presence of head lice in young people, adults and the elderly population[41,46]. The most prevalent age groups mentioned in this review are justified by the fact that the studies developed in the state focus mainly on places with people of younger age groups. Agglomerations and prolonged sharing of utensils such as combs, hairbrushes, hats, barrettes, bed sheets, and towels, can facilitate the spread of head lice[48,49]. It is

known that nursing home facilities, schools, children's shelters, daycare centers, among others, are places that allow the grouping of people and, object sharing habits that can be present in all groups identified in the studies, considering that direct contact and fomite transmission, allow infestation[8,50]. Individuals from the same family, for example, siblings who share personal items like a comb, can facilitate the spread of *P. humanus capitis*[51].

The studies analyzed in this systematic review also referred to different classifications as to the skin color and or race of those affected. For this reason, we prefer to refer to this variable exactly as described by the authors (white, non-black, brown, and black)[38,39,43,45,46]. Given this condition, it was found that regardless of skin color or race, there was a variable degree of infestation among the participants. Studies conducted in the Northern region of Brazil have pointed out blacks[47] and non-blacks[24] as the groups most affected by parasitosis, with 22.1% and 3.4%, respectively. This divergence may be related to several factors related to lice infestation, such as different forms of hair (straight, wavy and curly, in addition to those with thin or thick hair, and hair with too much or too little volume) between different ethnic groups, variations in cultural habits and different socioeconomic conditions[24,48] or due to methodological differences between studies.

Regarding socioeconomic level, three of the nine studies pointed out that the majority of those affected by pediculosis of the head were at a level considered low[39], had family income up to 3 minimum wages[45] or frequenting barber shops and beauty salons considered to be of low socioeconomic status[38], by charging cheaper prices for the services offered. Population groups with varying socioeconomic levels can present significant differences in the prevalence of pediculosis, with those with less purchasing power being the most affected[50]. In the Northeast region of the country, a higher prevalence of individuals infested with head lice was observed in low-income communities[52].

In one of the studies included in the systematic review, students described as from urban and rural schools[41], as well as in a second study students from schools located in the central and peripheral regions[43], in the city of Uberlândia presented varying prevalences, considering the detailed classifications for the variable location of parasitosis, analyzed among educational institutions. Other studies have shown higher values of parasitosis in individuals from schools located in the rural zone of the municipality[49,53]. The higher prevalence of infestation in schoolchildren in rural areas is explained by some factors presented by their families, such as agglomerations of people living in small houses and lower levels of economic income[54,55]. A study showed that the same situation of high prevalence also occurs in Brazilian slums, which are not necessarily located in rural regions[52]. Such epidemiological similarity in different geographic regions can be explained by the fact that both are economically and politically disadvantaged, with lower levels of education, hygiene, healthcare, and more precarious housing.

In addition, one of the studies selected for the systematic review described that all children affected by parasitosis were not on school holidays[44]. The highest rates of pediculosis in schoolchildren are seen in the period of beginning or resumption of student activities, which are considered the main places of transmission by agglomeration, also due to the peculiar characteristics of the child population to remain in constant physical contact[56].

Long hair[39,40,43], dark hair[41,44,45], wavy hair[40,44], low capillary density[40], and people with hair strands considered thick[40], were cited with the highest proportions of *P. humanus capitis* infestation. However, the infestation was positive for other types of hair. This shows that specific characteristics of the threads can only facilitate the parasite's permanence in the individuals' heads since the literature points out that the beginning of the infestation is associated with direct contact with the parasitized person, and regardless of social class, sex, race or creed of this individual[57,58]. Other studies have also pointed out similarities in the occurrence of parasitosis in different hair characterizations[24,47,59]. These results reinforce the idea that any preventive work that may be done must encompass the community as a whole, regardless of the capillary characteristics they present, so that it has access to control strategies[48,60].

One of the studies, conducted in the municipality of Divinópolis[42] detailed that the target children of the study affected by parasitosis, had a previous history for the infestation, used hair

brushing as a treatment for pediculosis, and a small percentage has been identified with anemia. Infestations and reactions to arthropod bites in children are common reasons for presenting to pediatric health professionals[61]. They can result in secondary injuries due to scratches or serious emergent diseases, in addition to severe itching with associated sleep disorders, being a source of significant suffering for patients and family members, as is known in pediculosis by *P. humanus capitis*[62-64]. Despite progressing to more severe conditions, the course of head pediculosis is generally benign if management is timely[15].

As stated before, its management is crucial for a good prognosis, and it depends on different strategies, with some of them using low cost and multifaceted drugs, such as the ivermectin (IVM). In the state of Minas Gerais, IVM is considered an essential drug[65], which means it should be available at all times in adequate amounts, in the appropriate dosage forms, with assured quality and adequate information, and at a price the individual and the community can afford[66]. Recently, in midst of the COVID-19 pandemic, this same drug has received even more attention, and in the state of Minas Gerais, such as in other places, there has been a rush to drug stores where people are adopting self-medication and more concerningly, self-dosing, as IVM is sold without prescription[67]. Such fact can lead to the lack of this medication for the population that needs it, or even to promote an unwanted resistance of certain parasites due to its indiscriminate use. Therefore, studies that assess how pediculosis behaved before the current situation of excessive ivermectin consumption in the state of Minas Gerais are necessary.

In general, this systematic review describes important data on head pediculosis in municipalities of Minas Gerais. Although more epidemiological information about the disease in different regions of the state would enhance the assessment, the literature search was as comprehensive as possible, and the selection of sources aimed to identify all relevant and available data. However, this systematic review has limitations. The published data found by the research techniques adopted were reviewed, but possibly isolated records from some municipalities in the state of Minas Gerais may not have been noticed. Gray literature was used to minimize the non-inclusion of these findings. Furthermore, the absence of a standardized methodology to assess the different epidemiological aspects related to the infestation may hinder the data comparison.

CONCLUSIONS

This systematic review concluded that many epidemiological factors may co-operate in complex ways and influence the prevalence of head lice infestation in the state of Minas Gerais. Children during school period and black people with long, wavy, dark, and thick hair and low capillary density were the most affected by the disease. Low socioeconomic level and municipality were also related to higher prevalence rates. In conclusion, head louse infestation still represents an important health problem in the state of Minas Gerais, not only because of the ectoparasite's presence but also for important secondary complications caused by it. However, more studies that assess different populations and municipalities in the state are needed for more accurate data, since head lice infestation is a dynamic and complex process. Additionally, such studies should seek to use similar forms of data collection and analysis, enabling more accurate data comparison.

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