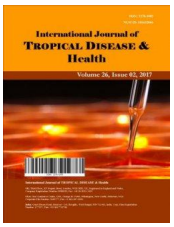

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Preventive Actions against *Pediculus capitis humanus* in Children of a Community Riverside's Metropolitan Region of Belém-Pará in Eastern Amazon

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Authors' contributions

This work was carried out in collaboration with all authors. Author DLC was the majority author of this manuscript since he carried out the research and wrote in his majority. Author VHAL was the second author, co-supervisor on pharmacy course completion work, and correspondent of the magazine, reviser of this work and updated its references. Author DSS was the third reviewer and translator. Author YMRP was a reviewer and assistant in bibliographical research. Authors FLFAMJ, RMS and MP managed the feasibility analyzes of the study and were scientific advisors and payers of this article. All authors read and approved the final manuscript.

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ABSTRACT

Pediculosis is a common pathology in poor populations of several cities. However, it is even more incidental and neglected in riverine populations. Based on this assumption, this study proposed the collection of data on this disease in these populations, as well as the treatment through kits and demystification of the general aspects of this disease. According to the results, 71% of the individuals that participated in this research presented pediculosis; 69% of the cases occurred in the female sex; and more often in an age group of individuals between 9 and 12 years of age; in addition, it was observed that, of the individuals in this study, 34% used chemical methods to treat, through products purchased in pharmacy; and, worryingly, 38% did not use any method of treatment. As a result, massive intervention of the pharmacist as primary health agent in these riverside populations is necessary, in order to clarify the risks of the non-treatment of this pathology, as well as to clarify the indications of the best methods, and against indications of orthodox and non-orthodox, and still work in health education in schools, where are the individuals most frequently affected by pediculosis and in family health programs, together with community health agents, in the homes of individuals affected by this parasite. In addition, the creation of a portal of contact and doubts between affected families and the basic health units of the region.

Keywords: Pediculosis; pharmacist; neglected populations; and riversider.

1. INTRODUCTION

The pediculosis (CID 10 - B85.0) corresponds to an infestation caused by an ectoparasite, popularly known as lice (*Pediculus capitis*). The disease is old, since it presents reports in mummies, but today it still afflicts the world population and is considered a public health problem [1].

According to the Brazilian Association of Pediculosis, the disease affects children from 4 to 12 years of age, regardless of hygiene conditions and social class [2]. Three species of lice can use the human being as host, they are: *Pediculus humanus corporis, Phthirus pubis, Pediculus humanus capitis*. Recent studies present some cases where, in addition to *Pediculus humanus corporis, P. humanus capitis* is also associated with disease transmission [3,4]. The lice eggs, known as nits, are clear and stick to the hair, but the lice are brownish-gray, measuring about 2.5 mm in length and are more difficult to see compared to nits [5].

There are indications that there has been an increase in the prevalence of lice infestation in the last ten years, and that the increase in the number of cases may be the result of heavy use of pediculicides (permethrin). Therefore, research has been carried out on new treatment strategies, such as pediculicides with physical performance or derivatives of essential oils from plants [6]. The child who is being parasitized has a drop in school performance and self-esteem. Transmission can occur through group activities, direct contact, or through games where the arthropod is transferred from one child to another [7].

Therefore, this work was justified by the need for greater attention regarding infestation of lice in children of riverine populations, since the disease makes the child feel ashamed, causing a drop in self-esteem, and affecting school performance, so the importance to do preventive and conscientious work on lice care, involving children and their families.

This study was designed in a cross-sectional and analytical form with the information of the community infected by Pediculus humanus capitis, in order to serve as a database for future research and public policies in this or adjacent communities.

2. OBJECTIVES

2.1 General Objective

To propose preventive actions against *Pediculus humanus capitis* in children of a community near the metropolitan area of Belém to know which groups require more vigilance and treatment.

2.2 Specific Objectives

- Propose educational measures for the awareness and eradication of lice.
- Creation of a guideline booklet for the prevention of pediculosis.

- Guide children and families about the ills that pediculosis can cause to health.

3. THEORETICAL REFERENCE

3.1 Historical Contextualization

The causative agent of pediculosis is among the various plagues that have reached Egypt, according to biblical records and hairs of mummies over 5000,000 years old [8,9]. Before the arrival of the Europeans in South America, there were already reports about the insect [10]. In northern Chile, about two thousand years ago, an infestation of lice in mummies has been reported and there are also reports in southern Peru [11].

In the northeast of Brazil, the oldest louse egg was found at an archaeological site, with approximately 8,000,000 years [11,12].

With the onset of human migrations around the world, these obligatory ectoparasites have managed to dissipate [13,14].

3.2 Epidemiology

For decades, research has shown that low-educated families are most affected. However, even if we believe that the infestation is exclusively related to the low socioeconomic level, current research is contradicting this [15].

A large part of the research on epidemiological studies involving lice had as object of study, children of school age, and it was possible to verify that the parasitic infestation of greater prevalence in these individuals is caused by *P. humanus capitis*, already in the world population, practically do not exist data on prevalence [6].

In the African continent, *Pediculus humanus capitis* was found with paws presenting structural differences that allowed a better fixation in the natives' hair type [16]. In Brazil, in Fortaleza, a study was carried out and published in a fishing village and in a favela 60 km away. This study focused on the prevalence of *Pediculus humanus capitis*. It was presented with the results, that 28.1% of the fishing community was parasitized with *Pediculus humanus capitis* and 43.4% of the population in the favela was also parasitized. According to the results, the most affected were female children aged 10-14 years [17].

In Turkey, a survey was carried out where a comparison was made between two neighboring villages with different socioeconomic backgrounds, showing that there is a connection with the size of the family group and the onset of pediculosis, and therefore there was a high prevalence when the number of relatives per inhabitant exceeded six people [18].

The prevalence of infestation in Brazil occurs between April and September [19]. Seasonality based on results presented in several studies is associated with climatic factors such as humidity and temperature [20,21].

A study was conducted in Germany to try to explain whether the parasite has a seasonal pattern, and it was possible to conclude that there is an increase in the incidence of infestation by *Pediculus humanus capitis* at the end of the summer. Social behaviors in the summer months may be the explanation, as children have more head-to-head contacts mainly during the summer holidays when compared to other times of the year. Another fact to be highlighted is that they increase the chances of the children meeting other children who already have the disease and when they start the school year, they end up taking the parasites to places where children attend, such as in schools and kindergartens [20].

3.3 The Filth Arthropod

About 600 million years ago, in the Precambrian, it is believed that the first arthropod arose. Since then, the members of the phylum have undergone evolutionary irradiation, and currently have the greatest diversity of species among living beings, having representatives such as: insects, crustaceans, myriapods and chelicerates, besides occupying numerous habitats around the world [22,23].

The lice, as shown in Fig. 1, belong to insects class and have three pairs of legs fixed to the abdomen, absence of wings, body divided into thoracic head and abdomen, and can be classified as hemimetaboles [24].

The insects colonized both aquatic and terrestrial niches, presenting the ability to survive in places where other living beings could not live [22,25].

It can be attributed to the great evolutionary success of this class such as: flight capacity, contributing to an increase in access to food,

access to adequate environmental conditions, dispersion and epicuticule of wax contributing to a decrease in water loss [22,26,27].

Fig. 1. Female of *P. humanus capitis*
Source:https://www.cdc.gov/dpdx/pediculosis/index.html [59]

3.4 The Taxonomy of Pediculus Humanus Capitis

The lice belong to the family peculiarity, order Phthiraptera, suborder Anoplura, which contemplates representatives very specific ectoparasites, that during the evolution were adapting to have as habitat, the surface of the body of the host. In this process, they acquired several morphological, functional and also structural adaptations [28,29,30]. These parasites, both female and male, and their nymph states, are considered to be hematophagous [31].

3.5 Pediculosis and the Species Pediculus Humanus Capitis

The human species can be host to 3 species of lice: Pediculus humanus corporis (located on the body), Pediculus humanus capitis (located on the head); and Phthirus pubis, located in the pubic region and popularly known as "boring", as shown in Fig. 2 [32].

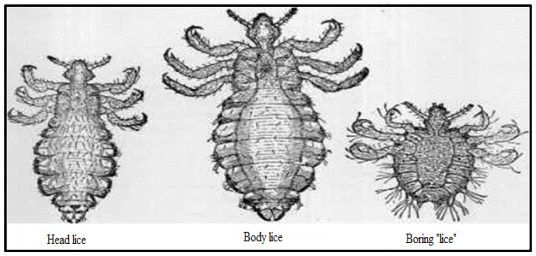


Fig. 2. Species of lice that parasitize man
Source:http://profjonatas.blogspot.com.br/2012/03/piolhos-insetos-que-parasitam-os-seres.html [60]

The infestation caused by *Pediculus humanus capitis* is called pediculosis [33]. *Pediculus humanus capitis* does not present other species that serve as host, being dependent on humans to survive [34]. It presents affinity for the scalp with humidity of approximately 70% and temperature close to 30º [35].

The louse is an apathetic insect that feeds on blood and has a life cycle that can last from 1 to 3 months, with the female being able to put between 7 and 10 eggs daily and during its life about 300 eggs [36].

The adult individual has an ovoid-shaped head, a pair of short antennae, a flat, elongated dorsum and a length of 2 to 3 mm. In addition, it has paws adapted for intense fixation in hair strands, opercula and a pair of lateral eyes [37].

The nits (eggs), usually hatch between 6 and 10 days, have yellow-white coloration, being the result of mating between male and female lice. They are incubated for an average of 6 to 9 days, and they guarantee the fixation in the hairs of their hosts, preferably near the nape and ears, due to a grayish substance, being able to be confused with the dandruff. Among the evolutionary stages of the parasite are egg stages (<1.0 mm in diameter) and nymphs, which undergo maturation in approximately 10 days [32,33].

3.6 Living Cycle of Footsteps and Combat Measures

Knowing the life cycle of lice (Fig. 3) is essential to better understand some aspects of treatment, because, as soon as the egg is hatched, the nymph searches for food (blood), several times a day, begins to pierce the skin of the scalp. The nymph undergoes moult after about 5 days, being thus denominated, molt of second stage. After the same number of days, another change occurs, being now called the third nymph stage. After becoming a third-stage nymph, she undergoes metamorphosis, becoming an adult: female or male [33].

One of the main causes of impetigo in populations of developing countries is scalp lice, which usually causes secondary infections, such as bacterial, staphylococci [38]. Although there is no scientific evidence, it is possible to suppose that *P. humanus capitis* may be a potential vector of *rickettsiae*) and other microorganisms [39]. Some characteristics observed in children who

are parasitized by lice are: sleep problems, pruritus due to anesthetics and anticoagulant enzymes inserted in the bite region, drop in school performance due to difficulty in concentration, and can also trigger anemia due to blood loss [40,41].

Although the literature available ensures that the infestation is linked to poor hygiene conditions, it is extremely important to note that anyone, regardless of color, race, social class and sex, has a chance of being infested by the insect. This fact can be explained due to the rapid and easy transmission between people [1], because it occurs due to the sharing of the same objects (clothing, caps, brushes, among others), a fact more common among girls than among school children. Being in this group, where it is possible to find the high rates of incidence and prevalence of the disease. There are measures to combat *P. humanus capitis* that cover chemical control, home and environmental education.

For the chemical control of pediculosis, a large choice of medicinal products, including products composed of pyrethroids and organophosphates, are available for the population, however, these medications can cause respiratory problems in patients and are not indicated for women who are breastfeeding or pregnant [42].

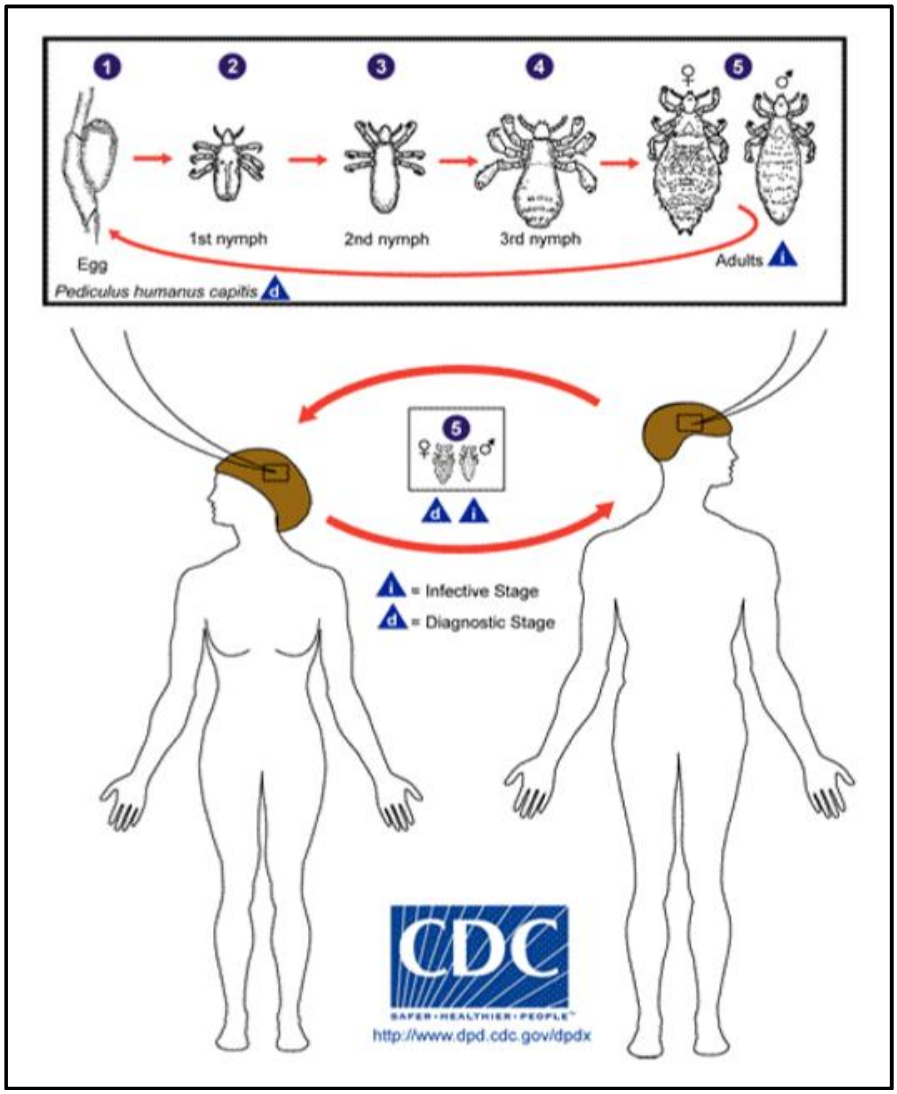


Fig. 3. Life cycle of *Pediculus humanus capitis*
Source:https://www.cdc.gov/dpdx/pediculosis/index.html [59]

The use of the fine comb continues to be the most effective way to combat the agent, since it can remove nymphs, adults and even some nits, being recommended in the scientific literature and inserted as topical treatment [32].

In the last 50 years, epidemiological studies, mainly in relation to school-age children, indicate that this disease has increased significantly [43].

3.7 Diagnosis and Clinical Manifestation

It is possible to identify the beginning of infestation by *P. humanus capitis* through a standard procedure that consists in measuring the distance of the egg fixed in the hair, in relation to the scalp, since it is known that the hair grows with speed of 0.4 mm per and the female of the parasite has the characteristic of depositing its eggs near the base of the hair, in this way it is possible to know the time in which the eggs were put [37].

In order to diagnose infestation by *Pediculus humanus capitis* it is necessary to find the live ectoparasite in the hair or it can be done using a thin comb, the latter being more effective than the visual examination [37,44].

A visual inspection when not accompanied by the use of the fine comb, presents less effectiveness since the insect can move quickly to avoid luminosity. Although they are smaller than the adult parasites, eggs are more easily found, especially in the post-auricular and occipital regions of the host [45,46]. The need for a differential diagnosis may occur at certain times because the scalp can be found remains of hair products, sand and even ephemeral cells desquamadas. Diagnosis in cases of doubt can be confirmed in several ways, including the use of microscopic examination of wires, combs with a magnifying glass, a microscope or a hand lens, thus establishing the correct diagnosis [47].

It is common for the host to be pruritus, which is caused by deposits of saliva and saliva on the scalp at the time of feeding, causing a hypersensitivity reaction. The discomfort that is generated as a consequence of pruritus is the cause of skin infections by bacteria, inattention, excoriations, sleep interferences, making them some of the most common manifestations [48].

3.8 Control and Prevention

According to Rey's guidelines [49] some prophylactic measures can be adopted against pediculosis, such as delimiting a hyphal perimeter of contact with infested clothes, people and personal objects; the adoption of ostensive treatment when in epidemic contingencies and drawn from protocols already validated and adopted by the Ministry of Health; besides covering in the preventive programs of health and sanitary education performances against pediculosis; and when in closed institutions, where pediculosis cases traditionally occur, treatment of the hosts and periodic evaluation of other members of the site could be adopted, as well as family members and caregivers.

3.9 Pediculosis and its Relationship with Other Diseases

As a vector for lice or fleas, Typhus (a disease caused by two species of bacteria: *Rickettsia typhi* and *Rickettsia prowazekii*) can be classified as Epidemic Typhus and Murine Typhus [50].

Epidemic Typhus has symptoms such as: myalgia, arthralgia, chills, high fever, headache, delirium and exanthema, which in the initial stage are light pink, but then change to red. Murine typhus has several symptoms, among them: very high fever (> 40º), arthralgia, back pain and headache. The use of antibiotics (chloramphenicol, tetracycline and doxycycline) would be the most effective option for the treatment of typhus, however if possible complications occur with the patient, the possible results would be: central nervous system damage, pneumonia, renal insufficiency and death. The use of oxygen and intravenous fluids may be necessary in some cases of endemic typhus infections [50].

3.9.1 Treatment

The Centers for Disease Control and Prevention (CDC), indicates disinfection with isopropyl alcohol or pediculicides and if it is not possible to use these two options, it is advisable to place the objects (hats, headphones, clothes, toys and sheets) in a plastic bag for a period of 2 weeks [51].

Topical pediculicides such as pyrethrins with piperonyl butoxide, lindane, permethrin and malathion have been recommended for treatment in a clinical report on pediculosis published by American Academy of Pediatrics (AAP), however, it is currently recommended that treatment with pyrethrin or 1% permethrin-based

products be used initially. In the United States, AAP has recommended malathion as a substitute for permethrin or pyrethrin in cases of treatment failure, but lindane has not been recommended because it poses a risk of seizures and is toxic to the central nervous system. In order to update the recommendations on pediculicides in 2010, the AAP published a report where it included the inclusion of benzyl alcohol, a pediculicide agent approved by the Food and Drug Administration (FDA) a year earlier [52].

In the literature, for the treatment of pediculosis, numerous methods are described with home-based formulations based on butter, oil, alcohol and petroleum, which expose the host to great risks. In order to verify the efficacy of these products, tests were performed [53], but the substance that presented an expressive mortality rate was only oil, while the other products presented only a decrease in egg fixation on the stem capillary, this thanks to its great viscosities facilitating the withdrawal with the fine comb. The treatment can be divided into two stages, where the first one aims at the death mainly of young and adult lice, in the subsequent application, between 7 and 14 days after the first, will occur the death of the parasites that will result from the hatching of the eggs that still exist.

Due to several researches showing flaws in chemical agents, more current methods of elimination of lice based on physical processes appeared, being extremely efficient in the elimination of the agents, canceling the occurrence of resistance and adverse effects of the chemicals.

3.9.2 Vaccination

A Research is being done on the digestive system of lice that will open new perspectives for future therapies [4].

The researchers' idea to end the use of insecticides was reinforced with the option to produce vaccines against parasites, since the use of chemicals does not present efficiency with extended time, as several cases of resistance occur [54]. In this study, some results will be presented. The first vaccine produced was used against the *Boophilus microplus* species (ticks) and did not show immediate action on the parasite. However, over a period of time between 70 and 90% of the tick population showed that the reproductive capacity was altered [54].

4. METHODOLOGY

4.1 Population and Type of Study

A cross-sectional and analytical study was carried out with 45 samples to identify the incidence of *Pediculus humanus capitis* infection in children from the communities of the Maracuja Hole located at 1 32'.03.0 `` S48º28`53.9``W (Fig. 4). five kilometers from Avenida Bernardo Sayão, and approximately an hour and thirty-two minutes from the municipality of Acará. These children were attended by the Luz da Amazônia program in partnership with the Biblica do Brasil Society, from August to November 2017, where the respective children's representatives signed the Free and Informed Consent Term to participate in the study.

4.3 Target Population

The target population of the study was the male and female children of the Furo do Maracujá community, enrolled in the Luz da Amazônia program, and the invitation to the children to participate in the study was later followed by an educational lecture on pediculosis.

4.4. Study Structuring

4.4.1 The samples

After the educational lecture, an invitation was made for those responsible to take their respective children to a predetermined room on the boat, where a questionnaire was filled out. After answering the questionnaire questions, the child's scalp was checked (Fig. 5) to confirm the information was given by the person in charge and a kit containing fine comb, vinegar, handmade soap and instructions for use was distributed (Figs. 6 and 7). The data were recorded, stored and taken to the laboratory for reassembly.

4.5 Criterion of Inclusion and Exclusion

Inclusion Criteria: children aged 1 to 15 enrolled in the Luz da Amazônia project, attended between August and November of 2017, with their respective parents who agreed to voluntarily participate in the study, signing the free and informed consent form, community residents.

Fig. 4. Location of the passion fruit hole
Source: Google maps

Fig. 5. Checking the scalp

Fig. 6. Items that are part of the kit

Exclusion Criteria: children under 1 and over 15 were excluded, who were not enrolled in the Luz da Amazônia project.

4.6 Ethical Aspects

Prior authorization was given to the participants through the Informed Consent Term (TCLE), signed by the responsible of the child.

4.7 Processing of Data

The data collected were tabulated and analyzes were performed using Microsoft Office Excel 2016.

Fig. 7. Kit delivered after infestation verification and confirmation

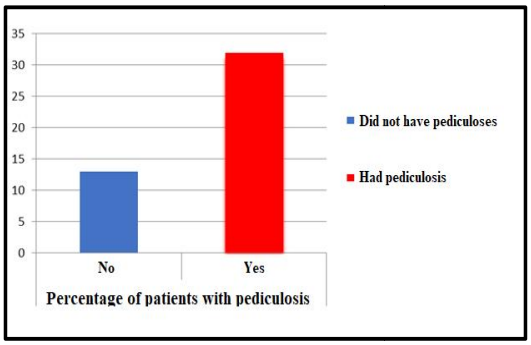
5. RESULTS

According to the results obtained, it was possible to verify that among all the children verified (n = 45), 32 presented pediculosis (71%) and 13 did not present (29%), which can be verified in Graph 1.

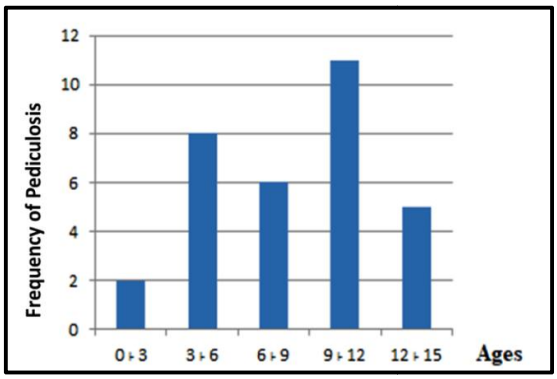
An important fact that can also be verified during the study was that the frequencies of pediculosis presented expressive values in the age range from 4 to 12 years, with the highest frequency occurring between 10 and 12 years (Graph 2).

Another data according to the Graph 3 on pediculosis distribution by gender, of the 45 samples, 69% of the cases affected female

members, however the male sex was affected by 31%.

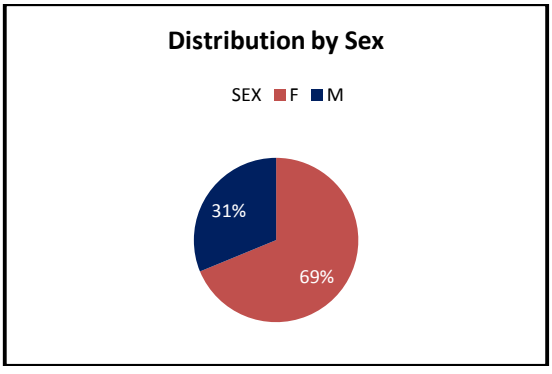


Graph 1. Percentage of pediculosis carriers in the community



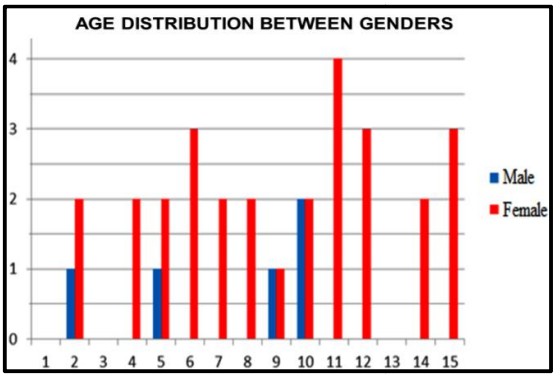
Graph 2. Frequency of pediculosis by age

Graph 4 shows that the age distribution between genders, where they presented relevant values at 6, 12 and 15 years, with a maximum value at 11.

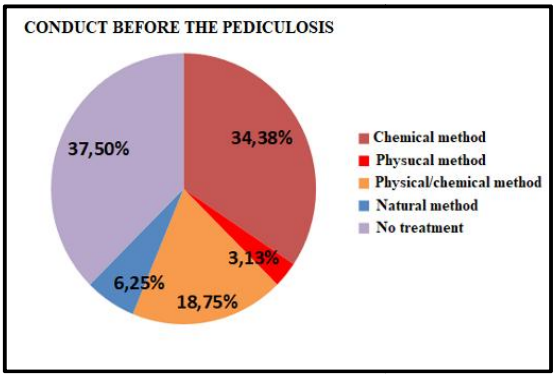


Graph 3. Distribution of pediculosis by sex

In relation to Graph 5, which shows the behavior before the pediculosis table, the methods were divided into physical method (use of fine comb) with 3% of use, natural method (use of vinegar, cachaça and shampoo of rue) with 6 %, chemical method (use of products purchased in pharmacy) with 34%, physical and chemical method (fine comb and pharmacy products) with 19% and the one with the highest value, people who did not use any of the other methods , with about 38%.



Graph 4. Age distribution between genders



Graph 5. Conduct in front of the pedicure

6. DISCUSSION

Of all the children verified (n = 45), 32 presented pediculosis (71%) and 13 did not present (29%), which can be verified in Graph 1.

In the work of Gabanni [55], conducted in the province of La Rioja, Argentina, evaluated 1,370 school-age children and verified that 22% presented signs of infestation by *Pediculus humanus capitis*, a smaller value when compared to Graph 1. Another that presented a lower value than the present study, was Catalá [50], who studied 181 children, showed that 45% had some degree of infestation by *Pediculus humanus capitis*, a value that is also opposed to that shown in Graph 1.

The frequencies of pediculosis presented expressive values in the age group from 4 to 12 years, with the highest frequency occurring between 10 and 12 years as shown in Graph 2.

According to Rupes et al. [56], in a study between October 2004 and February 2005, 531 children between 6 and 15 years of age from Olomouc and Zlín, located in the Czech Republic, were observed. 14.1% in this age group.

Rassami & Soonwera [57] presented similar results to those of Graph 2, since when they examined 3799 children in Bangkok they showed a higher incidence, about 23.32% in the age group of 5 to 12 years.

Similar results were found in Venezuelan students, where 28.8% of 327 individuals aged 6 to 15 years had the parasite, but the highest prevalence can be observed in students aged seven years) [58].

According to Catalá et al. [50] examined the heads of 131 children and the prevalence of parasite infestation in 6 to 11 residents of the province of La Rioja, Argentina, where it was found that 82 (45%) of the children had some degree of infestation by the parasite. This age range overlaps with what was expressed in Graph 2.

According to the Graph 3 on pediculosis distribution by sex, of the 45 samples, 69% of the cases involved female members, but the male sex was affected by 31%.

According to Catalá et al. [50], the male gender presents low susceptibility when compared to the female gender, which was also presented in Graph 3.

Normally, hair length is attributed to this fact, being of great importance at the time of the application of the control measures, as well as at the time of the contagion. In addition, factors such as the behavior of children, and hormonal changes that cause changes in the surface of the scalp may influence this result. The author also presented results where, contrary to the female gender, the male gender presented a fall in the prevalence when approaching puberty (10-11 years), which also reinforces with what was expressed in Graph 4.

Catalá et al. [50] show that the average prevalence of males is stable up to 9 years, decreasing in the following years. However, in Graph 4, the male gender presented variations, peaking at 10 years and disappearing later. Girls, on the other hand, were more affected until reaching a maximum value at 11 years, and at 6.12 and 15 years the second highest frequency occurred as shown in Graph 4.

With regard to treatment, according to Catalá et al. [50], the use of salt and vinegar corresponded to (31.1%), and shampoo use was the most used method (42.6%). In Fig. 5 salt use was not mentioned, however, the use of natural methods (vinegar, rue soap and cachaça) with 6%, and the most used method was the chemical method, with the product called Escabim (34%), being considered the best treatment against pediculosis.

An important fact related to the use of chemical methods (Graph 5) was that some of the children's leaders used extremely toxic products in their offspring and served as poison to kill other types of arthropods such as cockroaches and mosquitoes.

In addition, even those who used recommended chemical methods and pharmacy products did not know how to use properly and were unaware of the risks that could expose children.

Another point of extreme importance to be highlighted is the fact that 38% of the research participants do not do any type of treatment, thus showing the extreme importance of a pharmaceutical professional who together with health agencies can extend their actions to other places as schools, distributing kits and booklets for the population, so that they can direct these people to a correct treatment and remedy possible doubts of that community.

7. CONCLUSIONS

According to the results of the mentioned investigation, 71% of the individuals that participated in this research presented pediculosis; among these, the majority of cases occurred in females; and more often in an age group of individuals between 9 and 12 years of age; In addition, it was possible to observe that, of the individuals of this study, the second highest percentage used chemical methods to treat, through products purchased in pharmacy; and worryingly, the highest percentage did not use any method of treatment. Therefore, the presence of the pharmacist is essential to translate traditional and scientific knowledge into

a language in which people can understand and can feel benefited by this knowledge. This action also allows the experience and constant exchange of experiences essential for the formation of a pharmaceutical professional with the profile established by the National Curricular Guidelines, besides the study being a pilot that can be applied in other riverside communities.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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