

**PREVALENCE AND THE FACTORS ASSOCIATED
WITH PEDICULOSIS CAPITIS IN SCHOOLCHILDREN
IN THE CITY OF NITERÓI,
RIO DE JANEIRO STATE, BRAZIL**

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ABSTRACT

Pediculus capitis is an ectoparasitosis that is present worldwide, with highest prevalence among schoolchildren. This parasitosis has been correlated with socioeconomic factors and individual aspects of the host, such as sex and hair characteristics. In Brazil, it has been estimated that this disease occurs in about 30% of school-age children. Based on this, the aim of this study was to evaluate the prevalence of pediculosis among schoolchildren in the city of Niterói, in the State of Rio de Janeiro (RJ), besides analyzing the relationship between positivity and the characteristics of the participating individuals. The study included 244 students from the first to the fifth grades of elementary school who underwent a scalp aspiration procedure in order to diagnose parasitosis cases. Information regarding sex, self-declared skin color, hair length and color, and curl type was collected from each participant. Statistical analysis was performed using Fisher's exact test and logistic regression. The overall prevalence of pediculosis was 19.7%, and it was more frequent in females, with a statistically significant difference ($p < 0.001$). There were also statistically significant associations between positivity for infestation and the hair length ($p < 0.001$) and with the hair structure ($p = 0.019$). Being an afro-descendant, not being female and having dark hair, together, was a protective factor against pediculosis among schoolchildren. This study evidenced that the host's sex and physical characteristics showed direct relationships with lice infestation, although it was not possible to put forward a robust model for determining the presence of pediculosis. These results point to the notion that this ectoparasitosis is a multifactor disease.

KEY WORDS: *Pediculus capitis*; children; associated factors.

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INTRODUCTION

Pediculosis is a disease due to infestation by *Pediculus capitis*, known as head louse, and it mainly affects school-age children worldwide. In Brazil, where this disease is not notifiable, it has been estimated that 30% of school students have this parasitosis (Barbosa & Pinto, 2003), although the evidence for this only comes from occasional prevalence studies in schools (Borges & Mendes, 2002; Oliveira et al, 2017; Lustosa et al., 2020). Infestation by lice can cause itching on the scalp, which favors secondary infections by bacteria and fungi or myiasis, in addition to irritation and cognitive and psychosocial problems. The latter are due especially to the stigma of its association with poor hygiene habits (Catalá et al., 2005; Madke & Khopkar, 2012; Ozkan et al., 2012).

Certain host characteristics have been correlated with occurrences of pediculosis. Hair characteristics and skin color, for example, are some of the factors addressed in the literature (Bachok et al., 2006, Carzola et al., 2007; Devera et al, 2015; Molina-Garza & Galaviz-Silva, 2017). Female sex has been shown to be a risk factor in infestation by *P. capitis* (Bachok et al., 2006; Nazari & Sadijam, 2007; El-Khateeb et al., 2014; Costa et al., 2017). Thus, the aim of this study was to evaluate the prevalence of pediculosis among schoolchildren in the city of Niterói, RJ, and to make correlations between positivity and individuals' characteristics.

MATERIAL AND METHODS

This study was approved by the Research Ethics Committee of the School of Medicine of the Fluminense Federal University under report Nr. 3.472.323, in July 2019. A statistical analysis was performed to determine the sample size for the study, based on data provided by the Municipal Education Foundation of Niterói (FME, 2015) and the national prevalence estimate of 30% (Barbosa & Pinto, 2003). The minimum sample determined was 137 students and the maximum was 374, considering a confidence coefficient of 95%, with a maximum error of 0.058.

The study included 244 children (118 males and 126 females) from five municipal schools in Niterói who attended the first to fifth grades of elementary school and it was carried out from September 2019 to March 2020, evaluating one school at a time. The parents/ guardians of the students authorized their participation by signing a free and informed consent statement and the children themselves signed an assent form.

The lice collect was made by means of aspiration of the scalp, using a vacuum cleaner that had been adapted with a tissue filter (Lustosa et al., 2020). The material collected was packed into plastic containers and it was analyzed under a stereoscopic microscope at the Environmental Bioagents Laboratory

of the Fluminense Federal University, in order to diagnose the participants as positive or negative for active pediculosis. Individuals who presented any evolutionary form (closed nits, nymphs or adults) of *P. capitis* were considered positive. Although the aspiration of the scalp using a vacuum cleaner has been used, the most accurate method for the diagnosis of pediculosis is the observation of the head, since nits are not always removed from the hair strands by aspiration.

At the time of the aspiration, information was collected regarding the characteristics of the participating children: sex; self-declared skin color (black, brown, white or East Asian); hair length (short, medium or long); hair color (black, dark brown, light brown or blond); and hair structure (straight, wavy, loose curly or tight curly). For the variable of hair length, the hair up to the ear level was considered short, hair up to the shoulder level was considered medium-length and hair below the shoulder line was considered long. This information was individually recorded on a form for each participating child.

To investigate the association between positivity and host characteristics, Fisher's exact test was applied, taking the significance level to be 5%. For bivariate analysis, the variables that presented more than two categories were reorganized. The variables that had a p value lower than or equal to 0.25 were also tested through a stepwise forward estimation process in the logistic regression model (Bursac et al., 2008).

Based on the results from the model, odds ratios (OR) associated with the variables that remained in the model were estimated in order to analyze possible risk or protective factors regarding pediculosis. In this recategorization of the variables, the adjusted parameters were the following: hair length: short or not short; declared skin color: afro-descendants (self-declared brown and black individuals) or non-afro-descendants (white and East Asian); and hair color: light or not light. Because collinearity was observed between the variables of sex and hair length, it was not possible to use these two characteristics simultaneously in the construction of the logistic regression model. Thus, only the variable "sex" was inserted in the estimation process.

RESULTS

The prevalence of pediculosis on the scalp among the schoolchildren was 19.7%; the percentage of positive findings was higher among girls (79.2%), with a statistically significant difference (Table 1). Most of the students declared themselves as brown (40.2%) and the highest frequency of this pediculosis was found among children who self-declared as white (33.3%). Half of the students who considered themselves to be East Asian (n= 4) were parasitized (Table 1). There was no significant association between skin color and positivity (p= 0.071; Table 1).

Table 1. Pediculosis capitis results among schoolchildren and their association with sex, self-declared skin color and hair characteristics.

Variable	Categories (n= 244)	%	Positive (n= 48)	% (19,7)	p
Sex	Female (n= 126)	51.6	38	79.2	<0.001*
	Male (n= 118)	48.4	10	20.8	
Skin color	White (n= 61)	25.0	16	33.3	0.071
	Brown (n= 98)	40.2	15	31.3	
	Black (n= 63)	25.8	13	27.1	
	East Asian (n= 8)	3.3	4	8.3	
	Not declared (n= 14)	5.7	0	0.0	
Hair structure	Straight (n= 41)	16.8	10	20.8	0.019*
	Wavy (n= 35)	14.3	9	18.8	
	Loose curly (n= 45)	18.4	14	29.2	
	Tight curly (n= 123)	50.4	15	31.2	
Hair length	Short (n= 128)	52.5	12	25.0	<0.001*
	Medium (n= 29)	11.9	4	8.3	
	Long (n= 87)	35.6	32	66.7	
Hair color	Black (n= 102)	41.8	17	35.4	0.182
	Dark brown (n= 129)	52.9	31	64.6	
	Light brown (n= 10)	4.1	0	0.0	
	Blond (n= 3)	1.2	0	0.0	

Fisher's exact test: *statistical significance when $p \leq 0.05$.

Regarding hair characteristics, most of the students in this study had tight curly hair, and a higher percentage of these children were positive (31.2%), which was a statistically significant association ($p= 0.019$; Table 1). Most participants had short hair, and higher positivity was observed among long-haired schoolchildren (66.7%) with a statistically significant association ($p \leq 0.001$; Table 1). There was no statistically significant difference regarding hair color, but it was noted that children with darker hair had a higher frequency of positivity. Lighter hair colors occurred less frequently, and none of the light-haired schoolchildren were parasitized.

Table 2 shows the results from recategorization of the variables that presented p values lower than 0.25, into two categories per variable, for risk factor analysis using bivariate analysis and logistic regression.

It could be seen that, although nonsignificant, there seemed to be a tendency towards an association between hair color and positivity for pediculosis (p= 0.078), with a strict predominance of dark hair among positive individuals. Similarly, being female and having non-short hair were risk factors for pediculosis when analyzed separately (Table 2). However, sex and hair length showed high collinearity, so for logistic regression analysis, hair length was excluded.

Being an afro-descendant, male and having dark hair in association with the first two characteristics was a protective factor against pediculosis, from the results obtained in the logistic regression (Table 2). The variable of hair structure did not present a minimally significant p-value and, therefore, was not inserted in the analysis (p= 0.395).

Table 2. Association of pediculosis capitis with risk factors relating to sex, hair characteristics and self-declared skin color among schoolchildren.

Variables	Categories	Positive (n= 48)	p-value	Bivariate analysis OR (95% CI)	Logistic regression OR (95% CI)
Sex	*Female	38 (79.2%)	<0.001**	4.664 (2.200-9.886)	3.004 (1.560-5.786)***
	Male	10 (20.8%)		-	
Skin color	*Afro-descendant	28 (58.3%)	0.053	0.516 (0.266-0.999)	0.306 (0.160-0.586)***
	Non-afro-descendant	20 (41.7%)		-	
Hair structure	Straight	10 (20.8%)	0.395	-	-
	*Not straight	38 (79.2%)		0.714 (0.322-1.581)	
Hair length	Short	12 (25.0%)	<0.001**	-	NI
	*Not short	36 (75.0%)		4.259 (2.089-8.685)	
Hair color	Light	0 (0%)	0.078	-	-
	*Dark	48 (100%)		-	

Fisher's exact test: minimally significant p-value when ≤ 0.25 .

OR - odds ratio. CI - confidence interval. NI - variable not included in the final model. * Reference category. Bivariate analysis: statistical significance when $**p \leq 0.05$. Logistic regression: statistical significance when $***p \leq 0.05$.

A considerable positivity was observed among eight and nine-years-old children, in the second and third grade school with no statistically significant difference (Table 3).

Table 3. Pediculosis capitis results among schoolchildren and their association with age.

Age (years)	Positivity n= 48	%	Total of students n= 244	p
5	0	0	3	
6	8	19.5	41	
7	6	16.2	37	
8	11	25.6	43	
9	13	28.3	46	
10	7	15.9	44	
11	3	15.8	19	
12	0	0	7	0.679
13	0	0	4	

Fisher's Exact Test statistical significance when $p \leq 0.05$.

The evolutionary forms of *P. capitis* found in the samples were counted and analyzed in relation to the positivity and gender of the students. Most positive children had not only an evolutionary form of *P. capitis*, but also an association of them. Altogether, 126 evolutionary forms of lice were collected by aspiration, the most recovered being the mobile forms – adult and nymphs. It was also possible to detect nits through the scalp aspiration technique. Female children were the ones with the highest number of all evolutionary forms. Despite of this, on average, boys had a greater number of evolutionary forms, representing a greater overall parasite load (3.3 -33/10; Table 4).

Table 4. Results of the analysis of evolutionary forms of *Pediculus capitis* in schoolchildren from the city of Niterói, RJ, Brazil, recovered by the aspiration technique.

Schoolchildren sex	Adult	nymph	Nit	Total of evolutive forms	Media of evolutive forms
Male n= 10	13	18	2	33	3,3
Female n= 38	41	33	19	93	2,4
Total	54	51	21	126	

DISCUSSION

The prevalence of pediculosis among these schoolchildren in Niterói was 19.7%, which was lower than what was estimated for Brazil by Barbosa & Pinto (2003) and lower than what it was found in Nova Iguaçu, RJ, among children from four to 12 years old (37.07%; Oliveira et al., 2017). This lower prevalence was associated with the social stigma of parasitosis, which is related to lack of perception of this as a disease. Individuals who already knew that they were positive may have avoided to participate in this study, considering that the overall participation rate among the subjects was only 21.4% (244/ 1,140), which was comparatively lower than what it had been reported in other studies (Rukke et al., 2011; Devera et al., 2015).

The diagnosis by aspiration of the scalp allowed recovering the three evolutionary forms of *P. capitis* adult, nymphs and nits – however, mobile evolutionary forms were detected in greater numbers. This result is due to the fact that this technique is more effective for the diagnosis of active pediculosis. According to Lustosa et al. (2020), scalp aspiration is 2.74 to 7.87 times more effective for diagnosing active pediculosis compared to visual inspection. Catalá et al. (2004) pointed out that children with up to ten nits close to the scalp and without detection of mobile forms indicate recent infestation and low probability of active parasitosis.

Although we performed the quantification of the recovered evolutionary forms, in this study, the goal was to determine the prevalence of pediculosis from the diagnosis as positive or negative. The degree or severity of infestation was not addressed. Female children presented the highest number of all evolutionary forms; however, on average, the boys presented a larger number of evolutionary forms, representing a high overall parasite load (3.3; 33/ 10). This fact was not evidenced in the analyzed literature, and it may be related to the behavior of boys with bigger physical distance during routine activities, reducing the sharing of mobile forms of lice, maintaining, on average, superior parasite load.

In Niterói, girls showed a higher frequency of pediculosis, with a statistically significant difference, along with higher risk of infestation [OR= 4.664 (2.200-9.886); 95% CI], in line with other studies (Bachok et al., 2006; Nazari & Dadijam, 2007; Devera et al., 2015; Costa et al, 2017; Oliveira et al, 2017; Lustosa et al, 2020). In the literature, there is no consensus among different authors to explain this relationship, although it has been suggested that the main aspects to be considered is behavior, since girls have habits that bring them physically closer together than those of boys (Mohammed, 2019). Longer hair length was also a risk factor and it showed a strong association with sex, thus generating collinearity between these two characteristics. Gulgun et al. (2013) suggested that the predominance of long hair in girls may provide a reservoir for survival and reproduction of lice and that it was not possible to evaluate the influence of hair length on the prevalence of lice independently of sex, as also suggested by Ríos et al. (2008). On the other hand, Gutierrez et al. (2012) suspected that the difference was not only due to sex, but to long hair. They stratified the variable and found that the difference in prevalence between the sex disappeared. Other factors that modify the characteristics of the scalp, probably of hormonal nature, together with children's behavior, may explain the greater positivity among girls (Gutiérrez et al., 2012). Thus, it is important to consider that the higher positivity in this group may be associated with a set of factors linked to cultural, physiological and behavioral characteristics, and not with a single factor.

The characteristics of the hair were shown to have an association with infestation by lice. Some studies have also observed that higher proportions of individuals with dark hair were parasitized, but without any statistically significant association (Cazorla et al., 2007; Devera et al., 2015). In agreement with what it had been reported by other authors (Cazorla et al., 2007; Soultana et al., 2009; Molin-Garza & Galaviz-Silva, 2017), pediculosis was found to be more frequent among children with hair of longer length, which has a greater contact surface, and it is more laborious to inspect (Cazorla et al., 2007). It has also been suggested that longer strand length provide better development conditions for insects (Devera et al., 2015). In addition to length, the structure of the hair showed an association with positivity for infestation ($p= 0.019$). This was associated with differences in the format of the hair strands with distinct structures. While strands of loose curly hair have a more flattened or oval shape, which makes it difficult for the claws of the paws of lice to adapt to them, the cylindrical shape of strands of straight hair favors adjustment of the claws to the strand and makes parasitosis more feasible (Ko & Elston, 2004).

Based on the logistic regression results, self-declared skin color was the variable that showed greatest importance in differentiating positive and negative findings, such that being an afro descendant was a protective factor against infestation. There was an association between skin color, sex and hair color, such that dark hair led to a lower chance of being positive among afro-

descendants than among non-afro-descendants. According to a previous study conducted in the United States, African Americans have lower incidences of infestation, which can be explained by the format of the hair, such that these insects have difficulty in holding on to the strands (Ko & Elston, 2004).

Despite the association observed in this study, the small sample gave rise to lower reliability of the model, such that, even together, sex, hair color and skin color did not make it possible to establish a profile for identifying pediculosis. Positivity was not fully explained by these three characteristics and, therefore, it is important to study other factors that could impact its identification. Hence, lice infestation may be associated with a set of factors that are additional to those analyzed in this study, such as the habits and behavior of individuals, as well as cultural and socioeconomic conditions.

The risk factors for pediculosis were female sex and non-short hair, while the protective factors were to be an afro-descendant, in association with having dark hair and not being female. This study evidenced that the host's sex and physical characteristics showed direct relationship with lice infestation, although it was not possible to put forward a robust model to determine the presence of pediculosis. These results point to the notion that this ectoparasitosis is a multifactor disease.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest to disclose.

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