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Epidemiological Studies of Pediculus Humanus Capitis De Geer and Indicators of Infection on the Scalp and Mitigation Efforts

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Abstract: *Pediculus humanus capitis* is cosmopolitan, and is a common problem in children of school age. This study aims at determining the number of people infested head lice based on age, gender, education, socio-economic, way of life, the prevalence, the content of saliva and mitigation efforts. The design was observational and experimental studies with a sample of 663 people. The results show that 106 children in orphanages (18.7%), 20 children in elementary schools (50.0%), 17 patients in mental hospitals (30.9%) were attacked by head lice. Chi-square test shows a relationship between the length of the hair, shampooing material, frequency of shampooing, use of towel, use of hair comb, sleeping together, itching in the head, scalp irritation, and prevalence of lice on the head and in hair. Multivariate analysis with logistic regression test shows an association between the prevalence of adult lice with hair length, frequency of shampooing, use of hair comb and sleeping habits, and most closely related to the prevalence of head lice is the frequency of shampooing. Salivary gland protein per head louse is 3.2 µg/ml. Mitigation with magic chalk, VCO, and wash with shampoo every day for a week shows satisfactory result.

Keywords: Epidemiology, *Pediculus humanus* capitis, mitigation

I. INTRODUCTION

Pediculus humanus capitis/head louse is an obligate ectoparasite found on the scalp and hair and is transmitted by physical contact [1, 2, 3]. It is estimated that many Indonesian children are attacked by lice that suck the blood of the scalp. Although these insects do not cause serious health problems, the existence can be very annoying and irritating as it causes persistent itching in the head. Learning achievement of children can be threatened as it causes difficulty for the affected children to concentrate. Frequent scratching of the head is a major sign of the existence of *P. humanus capitis* [1, 2, 4].

P. h. capitis can be determined by studying the life cycle which begins with the laying of eggs attached to the hair. After 3-4 days, the eggs hatch into nymphs. Nymphs undergo three times shelling and grow into adult lice. Twenty-four hours after infestation, male and female mating would occur, and female insects will lay eggs as many as 7-10 eggs (nits) every day. *P. h. capitis* live up to 30 days and sustain by sucking human blood. *P. h. capitis* cannot live without blood within 15-20 hours. Nymphs and adults suck blood and in this process cause patients to suffer from itching, and thus would scratch their head. The legs of *P. h. capitis* are designed to grip the hair and can walk 2-3 cm per minute. *P. h. capitis* usually only live 1-2 days outside the head while eggs can survive up to 10 days [1, 2, 5].

Based on [6] incidence of *P. h. capitis* among children at Al-Alam is 21.2%. A high rate of head lice (40.3%) was found in girls aged 7-8 years. The proportion of head lice have also been found in children living in large families and those with low educational level of the parents (illiterate). *P. h. capitis* is also found in young people living in rural areas, having long hair, with poor head and hair hygiene [7].

The results of the study [3] concerning the epidemiological study of head lice (*Pediculus humanus capitis*) infestation among primary school students in rural areas of Sirjan Country, South of Iran, shows a that 20 of 1772 (1.12%) students have head lice. Head lice infestation rate is higher in girls than in boys. A difference of head lice infestation rate by gender is not statistically significant ($p > 0.05$). The relationship between the infestation of head lice categorized according to the frequency of hair wash is statistically significant ($p < 0.05$). The relationship of parent education shows significant role ($p < 0.05$). *Pediculosis* is a major health problem in many parts of the world including developing and undeveloped countries. Head lice infestation is higher in families where parents have low education levels, in a family house without any bathroom. Therefore, hiring health workers to educate families is an appropriate method to prevent *pediculosis* [3].

This study aims at determining the number of people infested with *P. h. cap*itis according to age, gender, education, socio-economic, way of life, the prevalence of head lice, and the content of saliva that causes infection of the scalp and control efforts in ten orphanages in North Sulawesi Province.

II. MATERIALS AND METHODS

This study was conducted in ten orphanages located in the province of North Sulawesi. The experiment was conducted from 24 January to 25 August, 2012. It constituted observational and experimental studies with cross sectional study design. Samples in this study amounted to 568 people. The data were obtained using a questionnaire to obtain the characteristics of respondents and head lice inspection using lice combs to get an idea of the adult head lice, nymphs and eggs.

Univariate analysis was used to look at the frequency distribution of the variables infested and non-infested with head lice, age, gender, education, socioeconomic status, and ways of life. The bivariate analysis Chi-Square used to prove the existence of the relationship between individual characteristics with the prevalence of adult fleas. Multivariate analysis using logistic regression test on six variables were adopted to determine which variables were most closely associated with the prevalence of head lice.

Examination of protein in the salivary glands of *P. h. capitis* by using micro BCA Protein (Bradford and Pierce BCA Protein Assay kit methods). Efforts of overcoming *P. h. capitis* were carried out by daily hair wash with shampoo for a week.

III. FINDINGS AND DISCUSSION

The age of respondents indicated that the frequency of the highest age was in the age group of 7-12 years amounting to 247 people (43.5%) and the lowest in the age group of 46-54 years amounting to 6 people (1.1%). Female respondents were 296 persons (52.1%) while male respondents were 272 persons (47.9%). Most respondents indicated an education of elementary level in 229 persons (40.3%) and the lowest being high school graduates of 2 persons (0.4%). The frequency of the socioeconomic status of the respondents was dominated by fatherless/ motherless children or 262 persons (46.1%) and the smallest number of constituting orphaned children of 64 persons (11.3%).

Judging by the way of life, respondents with short hair of 3 cm comprised 258 men (45.4%), while those with a hair length of 8 cm were 38 (6.7%) persons, respondents using soap to wash their hair of 412 persons (72.5%), while those using shampoo of 156 persons (27.5%). The frequency of daily shampooing was seen in 412 people (72.5%), a bigger number than those that wash their hair with shampoo once in 3 days comprising 156 persons (27.5%). By the use of towels, respondents who used mutual towels were 318 persons (56.0%), while those who individually used their own towels were 250 persons (44.0%). Respondents who shared mutual combs were 336 persons (59.2%), while those who individually used their own combs were 232 persons (40.8%). By the frequency of haircut, most comprised once in 1-3 months among 319 persons (56.2%) and the lowest frequency was once in 7-12 months found in 3 persons (0.5%). Respondents who slept alone comprised 301 persons (53.0%), while those who shared their sleeping area were 267 persons (47.0%). By the use of combs, respondents who shared the use of comb consisted of 336 persons (59.2%) and those who used their own combs were 232 persons (40.8%). The highest number of haircut frequency was once in 1-3 months found in 319 persons (56.2%) and the lowest was once in 7-12 months as practiced by 3 persons (0.5%). Respondents who slept alone were 301 persons (53.0%) and those who shared their sleeping area were 267 persons (47.0%). In general, caregivers did not find any head louse in 192 persons (33.8%), while those found with lice using special louse combs were 52 persons (9.2%).

The prevalence of adult head lice among children in orphanages was seen in 106 persons (18.7%), of average adult fleas (7.2%), and that of nymphs was seen in 106 persons (18.7%), average nymph (13.1%), and those with eggs were 106 persons (18.7), average louse eggs (98.3%).

Respondents who suffered from itching in the head were 106 persons (18.7%), irritation in the head were five persons (0.9%), red papules in the head were 2 persons (0.4%), pustules on the head were 2 persons (0.4%), and crusting in the head was 1 person (0.2%).

The age of respondents most heavily affected with head lice was in the range of 7-12 years old as seen in 69 persons (27.9%) and the lowest number was of the age range of 20-45 years as seen in 3 persons (6.3%). Female respondents consisted of 86 persons (29.1%), while male ones were 20 persons (7.4%). Elementary school level of education of respondents was indicated (28.8%) and the lowest rate was that of high school level (3.8%). Fatherless / motherless children accounted for 22.1%, and those from poor families constituted 14.5%.

Table 3.1 The relationship between the hair, the kind of shampoo used, the frequency of shampooing, the use of towel, the use of hair comb, the hair cut frequency, the sleeping habit, and the prevalence of adult fleas.

Variables	Those who have adult head lice		Those who do not have adult head lice		Total	
	n	%	n	%	n	%
Hair:						
- Short (3 cm)	5	1.9	253	98.1	258	100.0
- The length of 8 cm	22	57.9	16	42.1	38	100.0
- Shoulder length	78	42.9	104	57.1	182	100.0
- The length of hair over the back	1	1.1	89	98.9	90	100.0
Total	106	18.7	462	81,3	568	100.0
p	0.000					
Type of shampooing agent:						
- Shampoo	4	2.6	152	97.4	156	100.0
- Soap	102	24.8	310	75.2	412	100.0
Total	106	18.7	462	81.3	568	100.0
p	0.000					
The frequency of hair shampooing:						
- Everyday	102	24.8	310	75.2	412	100.0
- Once in 3 days	4	2.6	152	97.4	156	100.0
Total	106	18.7	462	81,3	568	100.0
p	0,000					
Use of hair comb:						
- Mutually shared	91	28.6	227	71.4	318	100.0
- Individually	15	6.0	235	94.0	250	100.0
Total	106	18.7	462	81,3	568	100.0
p	0.000					
Use of hair comb:						
- Mutually shared	96	28.6	240	71.4	336	100.0
- Individually	10	4.3	222	95.7	232	100.0
Total	106	18.7	462	81.3	568	100.0
p	0.000					
Haircut frequency:						
- 13 months	40	12.5	279	87.5	319	100.0
- 4 - 6 months	56	38.6	89	61.4	145	100.0
- 7 - 12 months			3	100.0	3	100.0
Never	10	9.9	91	90.1	101	100.0
Total	106	18.7	462	81.3	568	100.0
p	0.000					
Sleeping place:						
- Mutually shared	63	23.6	204	76.4	267	100.0
- Individually	43	14.3	258	85.7	301	100.0
Total	106	18.7	462	81.3	568	100.0
p	0.004					

Table 3.1 shows the number of lice found in many respondents who had long hair of 8 cm (57.9%), who used soap to wash their hair (24.8%), washed their hair every day (24.8%), used mutual towels with others (28.6%), used mutual combs (28.6%), cut their hair once in 4-6 months (38.6%), and shared their sleeping areas with others (23.6%). Thus using chi square analysis it was indicated that there was no relationship between the length of hair, the type of shampoo used, the frequency of shampooing, the use towels and combs, the hair cut frequency, and the habit of shared sleeping space and the prevalence of hair lice with $p < 0.005$.

Table 3.2 Correlation of events of itching of the head, scalp irritation, and the role of caregiver with the prevalence of adult fleas

Variables	People Affected with Adult Head Lice		People that are not Affected with Adult Head Lice		Total	
	n	%	n	n	n	%
Types of itchiness						
- Itchiness indicated	106	100.0			106	100.0
- No itchiness			462	100.0	462	100.0
Total	106	18.7	462	81.3	568	100.0
p	0.000					
Irritation of the head						
- Irritation	3	60.0	2	40.0	5	100.0
- No irritation	103	18.3	460	81.7	563	100.0
Total	106	18.7	462	81,3	568	100.0
p	0.047					
Caregiver role in orphanage						
- Comb lice and gnats every week	13	25.0	39	75.0	52	100.0
- Pick and comb out lice after shampooing	4	7.7	48	92.3	52	100.0
- Teach the benefits of the use of shampoo and louse comb	21	15.4	115	84.6	136	100.0
- Comb out lice and gnats	28	20.6	108	79.4	136	100.0
- No role indicated	40	20.8	152	79.2	192	100.0
Total	106	18.7	462	81,3	568	100.0
p	0.118					

Table 2 shows respondents who head lice and felt itchiness in the head, higher irritation (60%), and caregivers practicing hair combing and grooming every week (25%). Statistical test findings obtained using chi square p value <0.05 indicated a relationship between the incidence of itching in the head, irritation of the head, and the role of caregiver, and the prevalence of hair lice.

All respondents who had head lice and felt itchiness in the head, more likely experienced irritation (60%), and caregivers' combing and grooming every week (25%). Statistical test findings obtained using chi square p value <0.05 indicated that there was a relationship between the incidence of itching in the head, irritation of the head, and the role of caregiver, with the prevalence of hair lice.

Table 3.3 Factors mostly associated with the prevalence of adult fleas

Louse	B	Wald	Sig.	OR	95.0% C.I.for OR
Hair length	-1.627	43.098	0.000	0.197	0.121-0.319
Shampooing frequency	5.787	58.026	0.000	325.905	73.532-1444.461
Use of towel	-0.620	0.404	0.525	0.538	0.080-3.634
Use of comb	2.336	5.803	0.016	10.343	1.546-69.211
Hair cut frequency	-0.249	0.659	0.417	0.779	0.427-1.423
Sleeping habits	-0.886	5.664	0.017	0.412	0.199-0.855
Constant	-1.914	4.531	0.033	0.148	

Table 3.4 Protein Level

Amount of Salivary Gland	Absorbance	Amount of Protein
200	3.58	447.4
100	2.2	268.9
50	1.9	230.0

The results of the examination of the salivary gland of head lice per individual contain high levels of protein of head lice 3.2 μg/ml. As the head lice suck blood, they produce saliva that contains protein. This proteins causes allergic reactions that include itchiness and urge to scratch to relieve the itchiness. The scratching of the head results in irritation, red papules and lesions on the scalp.

Efforts of addressing head lice involved the use of shampoo for hair wash (costing Rp 500.00) every day for a week. Hair wash was conducted by using shampoo and rinsing with water and drying with towel. Hair was combed with a comb and a special lice comb to remove adult lice, nymphs and nits. This treatment is conducted every day for one week.

The interaction between the variables will determine the process and direction of the process of head lice infestation in the orphanages. Children infested with head lice were not only observed for the presence of *P. h. capitis*, but were particularly observed for the causal relationship of various factors and other elements. In epidemiology, the process of head lice infestations is primarily focused on the interaction between *P. h. capitis*, host/ humans and the environment that is conducive to the individuals and the society. These conditions

determine the incidence of head lice infestations [6]. Elements of the hosts and/or humans include age, gender, education, socioeconomic status, the role of caregiver, the way of life (the hair, the kind of shampooing used, the frequency of shampooing, the use of towel, the use of comb, the hair cut frequency, and the sleeping habit). Age of head lice infested children in the orphanages ranged between the ages of 7 and 12 years in 69 children (27.9%). This is consistent with the theory that *P. h. capitis* infestation is more prevalent in children and adolescents. Children are less able to maintain healthy scalp because this is a group of school-age group where more activities are performed together (peer group), thus transmission occurs more easily. Children's activities outside the homes/ orphanages also last longer, so the attention to personal hygiene would be more easily overlooked that allows head lice to thrive in scalp and hair [9].

Gender factor is one that can provide a descriptive variable difference in the number of head lice infestation. Girls are more easily infested than boys. This is consistent with the theory as girls have longer hair than boys. However, this study also found boys infested with head lice that seemed to be transferred by girls infested with head lice.

There was a greater number of primary school children infested with head lice compared to secondary school children. High school children showed better capability in maintain the cleanliness of their hair because in general teenagers have a better understanding than elementary school children. Their level of knowledge had an impact on the way they took care of themselves.

People who live in one place in large number facilitates the spread of head lice. The average children living in orphanages were fatherless/motherless, came from orphaned families, poor families, and broken homes, and were abandoned children. It is thus clear that orphanage children from poor families are in desperate need of funds for their daily life necessities, particularly to afford to buy shampoo. The socio-economic status affected the ability of orphanages in meeting the need for facilities and infrastructures necessary to maintain personal hygiene. The financial condition of orphanages did not quite affect the fulfilment of soap and shampoo. The orphanages inhabited by these children are institutions that provide child care, nurturing and guidance. As substitutes for families for the children, they also constitute temporary social welfare service facilities that enable the fulfillment of children's needs to be met. In order to meet the daily necessities of the children, orphanages rely on donations from donors.

Human head louse infestations in orphanages are marked by poor living habits, hair length of about 8 cm, daily shampooing using soap, joint use of towels and combs, haircut frequency of once in every 1-3 months, and the sharing of sleeping areas. Head lice are spread from person to person through physical contact or through combs, towels, and bed sheets. The elements mentioned above represent characteristic traits of the humans and/or hosts who play a role in the process of *P. h. capitis* infestation.

Environmental elements play a fairly important role in determining the process of interaction between humans and *P. h. capitis*. Theoretically, *P. h. capiti*s quickly spreads in crowded environments, such as orphanages, supported by poor hair hygiene conditions or infrequent cleaning of hair in females. Biological environment is very influential and holds an important role for *P. h. capitis* in the interaction with humans as the hosts with *P. h. capitis* causative agent. Judging by the aspect of the physical environment, facilities in eight orphanages were adequate whereas those at two orphanages were inadequate. Children at two orphanages had inadequate facilities and they had to adapt to poor conditions with only a single space being used for sleeping on the floor covered with mattresses. The number of occupants of such places would facilitate the spread of head lice like this. The social environment also plays a big influence. Another poor living condition in the orphanages that cause head lice infestation was the insufficient facilities available that made children share the use of towels and combs.

Head lice affect lower-class society or people who lead poor personal hygiene. Blood-sucking lice, *Anoplura*, that act more like humans and live in the hair near the nape of the head and ears. The life cycle occurs on human heads. The third phase of life of head lice (egg, nymph, adult) last for about 3 weeks. If head lice do not find their habitats in humans, they will die in a day or two days. Head lice are very small in size, about 2-3 mm long and they appear grasping the hair shaft near the scalp with specially shaped nails. Female mite live for about a month and produce 150 or more eggs (nits), approximately 10 eggs a day. The nit is yellowish-white and oval-shaped, firmly attached to the hair shaft base and takes one week to hatch. The factors that are closely related to *Pediculus humanus capitis* include a neighborhood or environment where *Pediculus humanus capitis* interact with children in orphanages (congested neighborhood). The characteristics of *Pediculus humanus capitis* includes the sucking of human blood 3-5 times per day. Human beings' reaction to *P. h. capitis* vary, but all normally feel itchiness in the head that causes head scratching to relieve it. The itchiness arises due to the effect of the saliva and excretion of head lice that are inserted into the skin while they suck the human's blood. Scratching causes scalp irritation, red papules and secondary infections (pustules and crusts) [1, 2, 5, 7, 10].

Head lice infestation was indicated as closely related to the character of the humans and that of the social groups in the orphanage. Another factor that was found closely related to the degree of infestation included among others, the nature of the infestation occurring in the orphanages, the nature of the environment

in which the process of infestation occurs, the cleanliness of the head and hair that was less noticeable in the orphanages, that helped *P. h. capitis* to thrive and breed, as well as the location and circumstances of the orphanages that cause *P. h. capitis* to infest humans.

IV. Conclusion

Children infested with head lice were of an average age of 7-12 years old, female, having primary school education, and of low socioeconomic level. The way of life of children in orphanages indicated with high infestation of head lice include children with hair length of 8 cm, frequency haircut of once in 1-3 months once cut, having a habit of daily hair wash with soap, using mutual towels and combs, and sharing sleeping areas. Children infested with head lice were indicated of experiencing itching, irritation of the scalp, red papules, pustules and crusting. Orphanages of high density were found to have occupants having high level of head lice infestation.

The average level of protein per head lice was 3.2 μg/ml. This protein causes allergic reactions that induce intense itching in the head and scratching of the head resulting in irritation, red papules, and lesions. Effective and efficient overcoming of head lice involved daily use of shampoo for a week.

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