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RECURRENT INFESTATION WITH PEDICULOSIS CAPITIS AMONG AGED 10-11 STUDENTS IN HULU LANGAT, SELANGOR

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ABSTRACT

Background: Recurrent Pediculosis capitis may lead to various physical, economical and psychological consequences. The aim of the study was to determine the level of recurrent Pediculosis capitis, identify the factors associated with the recurrence and its predictors.

Materials and Methods: The study used cross-sectional study design. Ten schools were included in the study. A total of 4,390 students from standard four and five were screened for Pediculosis capitis. Only 308 students diagnosed with Pediculosis capitis were included and treated. After 6-weeks, the recurrent infestation level was determined.

Result: The total level of recurrent infestation was 8.30%. Contact with person with lice infestation was associated with recurrent Pediculosis capitis ($\chi 2 = 3.557$, df =1, P = 0.050). Hair type ($\chi 2 = 4.388$, df =1, P = 0.036) and hair length ($\chi 2 = 4.225$, df =1, P = 0.040) showed significant association with recurrent Pediculosis capitis. Those with previous contact with an infested person had odds of 3.263 to have recurrent infestation at 6-weeks as compared to those without previous infestation (AOR=3.262, 95% CI = 1.138 – 9.356, P=0.028). The respondents with curly hair had the odds of 2.89 times higher than those with straight hair to have recurrent infestation at 6-weeks (AOR = 2.895, 95% CI = 1.155 -7.257, P = 0.023).

Conclusion: The total level of recurrent infestation was 8.30%. It is associated with contact with person with Pediculosis capitis, hair type and hair length. Recurrent Pediculosis capitis is still a public health problem and necessary intervention must be taken to prevent or reduce its occurrence.

Keywords: Recurrent infestation, re-infestation, Pediculosis capitis, primary school, Hulu Langat.

1.0 Introduction

Recurrent infestation with Pediculosis capitis has been one of major concerns following Pediculosis capitis infestation. A recurrent infestation is defined as no more than two adults or third instars lice removed from the individuals who had been free from infestation after the first successful treatment (Burgess, Brown & Lee, 2005).

Burgess et al. (2005) conducted a study on determining the efficacy of Dimethicone 4% and Phenotrine. The results showed that complete eradication of Pediculosis capitis occurred in 89 of 127 participants treated with Dimeticone (70%), and 94 of 125 (75%) of participants treated with Phenotrin (P = 0.005, CI = 6% -16%). Recurrent infestation occurred in six participants in the Dimeticone group and seven in the Phenothrin group. Cases of re-infestation were classified as treatment failures.

Recurrent infestation can be acquired from inadequate treatment or from other family members as reported by Burgress et al. (2007). Following their study in 2005, two years later, Burgess et al. (2007) conducted similar study to compare the efficacy of Dimeticone 4% with Malathion 0.05%. During this trial, they addressed the issue of re-infestation by enrolment of young siblings and offering treatment to non-participants. The results during examination after the treatment with Dimeticone showed 25 cures and 5 cases of re-infestation. In the Malathion group, 9 cases were cured and only 1 case of re-infestation.

A cross-sectional study was conducted in Iran by Dorodgar et al (2014). A total of 3,590 students involved in this study including 2,096 boys (58.4%) and 1,493 girls (41.6%). The overall prevalence of Pediculosis capitis was 0.47%. Fisher's exact test showed a significant association between the prevalence and previous history of infestation (P = 0.0001). Approximately, 65% of the cases of Pediculosis capitis were infested for the second time.

Recurrent infestation must be differentiated from resistant to treatment as their management are different. As reported by Hansen (2004), criteria for identifying resistance include the presence of live lice after 2 to 3 days of a properly applied anti-lice treatment or the presence of live lice after two correctly applied treatments. The ideal way to establish that treatment has failed is to examine the patient within a few days of product application but before potential re-exposure (Bailey & Porciv, 2004).

Pediculosis capitis unlike body lice are not known to cause significant health hazard (Elewski, 2005). However, complications may be derived from the parasitism of the human's head such as scratching, secondary bacterial infection of the scalp lesions caused by scratching, posterior neck adenopathy and even iron deficiency anaemia due to heavy and chronic infestation (Meister & Ochsendorf, 2016; Burke & Mir, 2011; Frankowski & Bocchini, 2010). As repeated infestation continues, the complications that arise may contribute to the worsening of physical complications such as impetigo and pyoderma (Bragg & Simon, 2017). Apart from that, Recurrent Pediculosis capitis may also lead to significant social and economic consequences.

As the consequence of itching, children may have difficulty sleeping. Subsequently, the child's may have sleep deprivation and impaired ability to concentrate in the classroom. This

can cause problems with school performance, leading to that child falling behind their peers. Some children may also suffer from teasing, because of scratching, and so have difficulty developing friendships (Kennedy, 2000). Over the ages, lice have become a symbol of filth, poverty and shame. Infected individuals are usually misunderstood as having inadequate personal hygiene, which leads to negative perceptions from others and subsequent psychological stress (Oh et al., 2010). Although recent epidemiological studies clearly demonstrate that lice infest children from all socio-economic classes; the stigma still exists (Mumcuoglu et al, 2006). Another consequence of recurrent infestation involves the social aspect of not only the children but also the parents and guardians from stigma, fear of transmission, and social isolation. It can be a cause of parental anxiety, social embarrassment, and unnecessary absenteeism from school (Nageswaramma, 2017).

Recurrent Pediculosis capitis can be very costly because of repeated treatments and time spent in eradication attempts. In the United States, with an estimated of 6 to 12 million infestations annually (CDC, 2013) it is estimated that $367 million of dollars were spent for the eradication of Pediculosis capitis over a decade ago (Hansen, 2004). Considering both direct costs of treatment and indirect costs due to education programs designed to reduce infestation, lost wages, and school or nursing home monitoring programs, the total economic impact of Pediculosis capitis is substantial.

The direct costs for the management of Pediculosis capitis include the expenses in buying pediculicides, lice combs and other treatments agents such as petroleum jelly, conditioner and olive oil. Most over-the-counter (OTC) products recommend two applications, approximately 7 to 10 days apart (Frankowski & Bocchini, 2010) to kill any nymphs that hatched from eggs that survived the first treatment. Based on the observation to local pharmacies, the packaging for most over-the-counter OTC) pediculicides is for twice application ranging from 60 to 80 ml per bottle. The price varies based on the main ingredients being used. Silicone-based pediculicide such as Dimethicone is sold at almost double the price of insecticides preparation (Malathion, Pyrethyroid, Permethrine). The price for a 75ml bottle of Dimethicone 4% ranged from RM 15 to RM 25.

2.0 Materials and Methods

The cross-sectional study was conducted among 10 government schools in Hulu Langat district, Selangor for duration of three months. The sample size used was calculated using the two population's proportion formula for hypothesis testing. The sample size was calculated to detect power of 80% with confidence interval of 95%. A total of 4,390 students were screened for the evidence of Pediculosis capitis, in which 308 students were included in the study. Inclusion criteria included consented to be involved in the study and available

throughout the study duration. Exclusion criteria included usage of pediculicide within one month prior to commencement of this study, presence of scalp lesions and children in the special education classes.

The students and family members with Pediculosis capitis were supplied with pediculicide, Dimeticone 4% gel in 70 ml bottles (LiceClear ® 4% lotion, Apex Pharmacy Sdn.Bhd.). A plastic lice comb was included in the packaging. The student was taught on the necessary

procedure of its application, as explained in the health education module. A handout was also given to the caregivers on the direction of its application.

Self-administered questionnaires on sociodemographic backgrounds and factors associated with Pediculosis capitis were given to the respondents. The reliability of the questionnaire was determined using Cronbach's alpha and the result obtained was 0.77 for the whole scale. After 2-weeks, the researcher re-examined the respondents for the evidence of Pediculosis capitis. The respondents who still had Pediculosis capitis were excluded from the study and referred to the Health Clinic. One month later (6-weeks from the screening), the respondents were re-examined for the evidence of recurrent infestation.

The Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA) version 20.1 was used for data analysis. Categorical variables were expressed as numbers and percentages, and analyzed using a chi-square test. All reported P values were made based on two-tailed tests. Differences were considered statistically significant at $P<0.05$. Logistic regression was used to determine the predictors of recurrent Pediculosis capitis.

3.0 Result

A total of 87 government primary schools were eligible to be included in this study. However, only 10 schools were selected through simple random sampling, with a total of 4,390 students. Only 4,344 students were examined. Non-respondents were those who were absent from the school on the day of data collection and those who were not given consent to be examined. The response rate at baseline for this study was 98.95 %. There were 308 students had Pediculosis capitis at screening, giving the overall prevalence of 7.09%. Two weeks after the application of pediculicides, the students were examined again for the presence of head lice. Eight students did not have successful treatment of Pediculosis capitis based on intent-to-treat. Therefore, they were dropped from the study protocol. The attrition rate was 2.60 %.

3.1 Sociodemographic and individual characteristics of the respondents

The socio-demographic and individual characteristics of the respondents are shown in Table 1 below. The respondents' socio-demographic characteristics were made up from the following: 149(48.4%) students aged 10-years old; 286 (94.2%) female students; 290 (94.2%) Malay ethnicity; 208 (57.5%) fathers with tertiary education, 213 (69.2%) mothers with tertiary education, 300 (97.4%) fathers who were employed and 213 (69.2%) mothers who were employed. As for the monthly household income, 203 (65.9%) students came from the family with income more than RM4,000 per month. In term of siblings, 89 (93.8%) students had four or less than four siblings, and 297 (96.6%) had less than ten family members living in the same household. A total of153 (49.7%) of the respondents had previous history of head lice infestation and 166 (53.9%) had history of contact with someone with head lice infestation. As for the hair characteristics, 229 (74.4%) had curly hair and 185 (60.1%) had long hair.

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Table 1: Socio-demographic and individual characteristics of the respondents

Variables	Frequency (n =291)	%
Age (years)		
10	149	48.4
11	159	51.6
Ethnicity		
Malay	290	94.2
Indian	15	4.9
Others	3	1.0
Gender		
Girl	286	92.9
Boy	22	7.1
Father's Education Level		
No formal education	4	1.3
Lower education	3	1.0
Secondary education	93	30.2
Tertiary education	208	57.5
Mother's Education Level		
No formal education	3	1.0
Lower education	3	1.0
Secondary education	89	28.9
Tertiary education	213	69.2
Father's Employment Status		
Employed	300	97.4
Unemployed	8	2.6
Mother's Employment Status		
Employed	213	69.2
Unemployed	95	30.8
Monthly Household Income		
RM 4000 or less	105	34.1
More than RM 4000	203	65.9
Number of Siblings		

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4 or less	*289*	93.8
More than 4	*19*	6.2
Number ofFamily Members Living in The Same Household		
10 or less	297	96.4
More than 10	11	3.6
Previous Lice		
Yes	153	49.7
No	155	50.3
Contact with someone infested		
Yes	166	53.9
No	142	46.1
Hair Type		
Straight	79	25.6
Curly	229	74.4
Hair Length		
Long	185	60.1
Short	123	39.9

3.2 Recurrent infestation level

After 6-weeks from screening, the recurrent infestation level was determined. Out of 300 students with successful treatment of head lice, 25 students were re-infested with Pediculosis capitis, giving the total level of recurrent infestation of 8.30%.

3.2.1 Factors associated with recurrent infestation

Chi-square analysis was conducted to examine the factors associated with recurrent infestation at 6-weeks after the screening. Table 2 shows that contact with person with lice infestation is associated with recurrent Pediculosis capitis ($\chi 2 = 3.557$, df =1, P = 0.050). Hair type ($\chi 2 = 4.388$, df =1, P = 0.036) and hair length ($\chi 2 = 4.225$, df =1, P = 0.040) show significant association with recurrent Pediculosis capitis.

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Table 2: Factors associated with recurrent infestation

Variables	Lice at 6-weeks (n=300)				χ^2 (df)	P-value
	Yes		No			
	Frequency	%	Frequency	%		
Age (years)						
10	11	7.7	132	92.3	0.147 (1)	0.701
11	14	8.9	143	91.1		
Ethnicity						
Malay	23	8.2	259	91.8	0.775 (2)	0.679
Indian	2	13.3	13	86.7		
Others	0	0	3	100.0		
Gender						
Male	1	4.5	21	95.5	0.446 (1)	0.504[a]
Female	24	8.6	254	91.4		
Father's Education Level						
No formal education	0	0	3	100.0	0.974 (3)	0.807
Lower education	0	0	3	100.0		
Secondary education	6	6.9	81	93.1		
Tertiary education	19	9.2	188	90.8		
Mother's Education Level						
No formal education	0	0	4	100.0	1.694 (3)	0.638
Lower education	0	0	3	100.0		
Secondary education	10	11.0	81	89.0		
Tertiary education	15	7.4	187	92.6		
Father's Employment Status						
Employed	23	7.9	269	92.1	2.989 (1)	0.084[a]
Unemployed	2	25.0	6	75.0		
Mother's Employment Status						
Employed	18	8.7	189	91.3	0.115 (1)	0.735[a]
Unemployed	7	7.5	86	92.5		
Monthly Household Income						
RM 4000 or less	8	7.8	94	92.2	0.049 (1)	0.825
More than RM 4000	17	8.6	181	91.4		
Number of Siblings						
3 or less	23	8.2	259	91.8	0.193 (1)	0.660[a]
More than 4	2	11.1	16	88.9		
Number of Family Members Living in The Same Household						
10 or less	23	8.0	266	92.0	1.450 (1)	0.229
More than 10	2	18.2	9	81.8		

Previous infestation						
Yes	10	6.7	140	93.3	1.091 (1)	0.296
No	15	10.0	135	90.0		
Contact with person with lice infestation						
Yes	7	5.1	131	94.9	3.557 (1)	0.050*
No	18	11.1	144	88.9		
Hair type						
Straight	11	13.9	68	86.1	4.388 (1)	0.036*
Curly	14	6.3	207	93.7		
Hair length						
Not beyond shoulder level	15	12.3	107	87.7	4.225(1)	0.040*
Beyond shoulder level	10	5.6	168	94.4		

Note: (χ^2)- Chi square; (^{a}) – Fischer exact test; (*)– Significant p< 0.05.

3.2.2 Predictors of recurrent infestation

Binary Logistic Regression was used as the statistical analysis to determine the predictors of recurrent Pediculosis capitis at 6-weeks post-intervention. From the bivariate analysis, variables which were significant at P<0.25 (father's employment status, hair length, previous infestation, contact with person with lice infestation, hair type) were included in the preliminary model. Both "Backward" and "Forward" stepwise likelihood ratio was tested to get the best model. The variable with P<0.05 was considered as the predictor for recurrent infestation at 6-weeks post-intervention, after adjusted for covariates.

As depicted in table 3, "Contact with someone infested" is a predictor for having recurrent infestation at 6-weeks. Those with previous contact with an infested person had odds of 3.263 as compared to those without previous infestation (AOR=3.262, 95% CI = 1.138 – 9.356, P=0.028). "Hair type" showed a significant predictor for recurrent infestation at 6-weeks, where the respondents with curly hair had the odds of 2.89 times higher than those with straight hair to have recurrent infestation at 6-weeks (AOR = 2.895, 95% CI = 1.155 -7.257, P = 0.023).

Table 3: Predictors for recurrent Pediculosis capitis at 6-weeks, adjusted by the covariates

Variables	**β**	**SE**	**Wald**	**AOR**	**95% CI**		**P-value**
					Lower	**Upper**	
Constant	-1.780	1.423	1.565	0.169			
Father's employment							
Employed	-1.154	0.911	1.605	0.315	0.053	1.881	0.205
Unemployed	1						
Number of family members							
10 or less	-0.303	1.114	0.079	0.731	0.082	6.489	0.779

More than 10	1						
Contact with someone infested							
Had previous contact	1.183	0.537	4.843	3.263	1.138	9.356	**0.028***
No previous contact	1						
Hair length							
Long	-0.861	0.467	3.402	0.423	0.169	1.055	0.065
Short	1						
Hair Type							
Curly	1.063	0.469	5.138	2.895	1.155	7.257	**0.023***
Straight	1						

Note: Overall classification, 92.6%; Hosmer and Lemeshow Test, P = 0.810; Nagelkerke R Square, 0.128; (*) Significant P-value <0.05.

4.0 Discussion

Recurrent infestation is an unruly condition after successful treatment of Pediculosis capitis. It may affect the psychology of the children and caregivers as they are being stigmatized of being 'dirty' even though many studies have proven that the level of cleanliness is not related to Pediculosis capitis. Being stigmatized, bullied and taunted by other students may have detrimental effects on the child's self-esteem. Parents also may experience the feeling of frustration as they have spent much effort, time and money to combat the parasite infestation. The parents may blame the children of not being able to take care of themselves from being re-infested with Pediculosis capitis. Subsequently, it may cause uneasiness in the parents-child relationship.

There are many contributory factors that could have led to recurrent Pediculosis capitis. One of the most principal factors is cross-infestation with family members who have lice. As stated by Ibarra et al. (2009), an infestation can persist for a long time if inspection and treatment are not synchronized. The study by Rukke et al (2011) recorded that children were three times more likely to have head lice if their household had previously experienced

pediculosis. More than one-third of the households with previous infestations had experienced head lice more than once. Recurrent infestation is not unexpected if a child is part of a group of interacting children in which simultaneously detecting and eradicating head lice are difficult.

Recurrent infestation could also be contributed by treatment failures due to several plausible causes. It might be due to improper use of the pediculicide. The pediculicide might not have been applied thoroughly all over the head, or the amount used was not sufficient. Non-compliance could also be the cause in which, the respondents failed to apply the pediculicide for the second time, seven days after the first application. They might also have failed to comply to the fine-tooth combing method as instructed.

Inappropriate usage of pediculicides may lead to various health and economic consequences. Non-pesticide pediculicides may not severely affect one's health, but overtreatment with pediculicide may lead to the issue of resistance. Resistance of head lice to some pediculicides has been reported to occur particularly in developed and developing countries where insecticides are readily available and used more widely. Resistance to malathion has been reported in Denmark, United Kingdom, France and Australia (Durand et al, 2012). Resistance pattern may vary between countries, between regions and even within a country as different insecticide have been used. Therefore, to determine the choice of treatment, the decision should depend on local resistance pattern. Unfortunately, the information on local resistance pattern is rarely available.

Most of the times, the diagnosis of Pediculosis capitis is made by non-physicians and they carry out self-treatment using widely available, safe and effective over-the-counter pediculicides. However, non-physicians may have the potential for misdiagnosis. Eggs & nits may be confused with dandruff, fibers, scabs, hair casts, droplets of hair spray, plugs of desquamated cells, or particles of dirt (Frankowski et al., 2010; CDC, 2013). Misdiagnosis may result in improper use of pediculicides leading to treatment failures. There is also raised concerns about unsafe use of these products, specifically, when no lice are present or when products are used excessively leading to toxicity or resistance to the pediculicide used (Burkhart & Burkhart, 2005). A related issue is the growing problem of resistance, which has been attributed to several causes, including pediculicide residue on the hair, exposure of lice to sub lethal doses, and inadequate concentration levels within products (Meinking et al., 2002).

Incorrect application of a treatment may create resistance pressure. After apparent product failure, re-treatment with the same product (or one with the same mechanism of action) may reinforce that selection and accelerate the emergence of resistance. Re-treatment of persistent lice infestations should be completed with a product different from any already used. Although recently introduced treatments have been found to be safe and effective, if used indiscriminately or excessively, the fate of these agents will be similar to that of the pyrethroids (Koch et al 2017).

Recurrent Pediculosis capitis and failure of over-the-counter pediculicides may expose the children to various treatment methods. In the search for effective treatments, parents or caregivers often use home remedies when commercial products and combing methods have failed or if they do not want to expose their children to pesticides or other chemicals (Gordon, 2007). These treatments range from commonly used ingredients such as mayonnaise to

resorting to more dangerous treatments such as the use of kerosene (AlBashtawy, 2012). There is little empirical evidence to support the efficacy of these methods or the frequency in which these methods are used (TakanoLee, Edman, Mullens, & Clark, 2004).

However, there was a study that examined the potential value of six purportedly effective home remedies conducted by Takano-Lee et al. (2004). The common home-remedies examined included vinegar, isopropyl alcohol, olive oil, mayonnaise, melted butter, and petroleum jelly. The study also examined the method to treat head louse infestations by drowning lice in water submersion. It was found out through that only petroleum jelly caused significant louse and eggs mortality, allowing only 6% to hatch. Unfortunately, none of the substances prevented lice from laying eggs. It was also recorded that killing lice by depriving

them of oxygen is inefficient as it was extremely difficult to drown lice, despite extended periods (i.e., 8 hour) of water submersion.

On the other hand, pesticide-based pediculicide may warrant lethal consequences due to its toxicity. As reported in a case report by Hamad et. al. (2016), organophosphate toxicity was diagnosed in a 7-year-old girl in Riyadh from the application of pediculicide containing Diazinon, classified as Class II (moderately hazardous pesticide) (WHO, 2008). The patient was known to have bronchial asthma on budesonide inhalation and salbutamol. She presented with vomiting, dizziness and altered level of consciousness. Her symptoms started 15 minutes after she applied Diazinon-60 ® (an organophosphorus compound, used for control of ectoparasites in animals) to her hair for treatment of lice. Scanning electron micrographs of scalp hair specimens revealed both viable and empty Pediculosis capitis nits.

5.0 Conclusion and recommendation

The total level of recurrent infestation was 8.30%. It is associated with contact with person with Pediculosis capitis, hair type and hair length. Recurrent Pediculosis capitis is still a public health problem and necessary intervention must be taken to prevent or reduce its occurrence. Screening for head lice shall be made mandatory at regular interval in each school. It can be incorporated in the Health Education sessions, at least once in two months. The 'Young Doctor Club' (Kelab Doktor Muda) must be mobilized further to enable them managing the problem of head lice in schools. They should be trained to diagnose head lice infestation including differentiating between active and inactive infestation. They can also monitor any treatment given to the infested student to ensure better treatment compliance.

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Declaration

Authors declare that this manuscript has never been published in any other journal.

Authors contribution

Author 1: Information gathering, preparation and drafting of manuscript
Author 2: Data Analysis and editing of manuscript
Author 3: Data Analysis and reviewing manuscript
Author 4: Data analysis
Author 5: Initiation of idea, review of manuscript and final editing

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