

Lindane Shampoo for Head Lice Treatment among Female Secondary School Students in Jeddah, Saudi Arabia: An Interventional Study

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Abstract

Background: We aimed to determine the prevalence of head lice infestation, effectiveness of over-the-counter treatment options, and the effectiveness and safety of lindane shampoo among female Saudi Arabian secondary school students.

Methods: This study was conducted in October-November 2016 in two secondary schools each from the northern and southern parts of Jeddah. Investigators completed a standardized questionnaire. Students' hair and scalps were examined manually for head lice or scalp lesions. Students with head lice infestation were asked to use 1% lindane shampoo.

Results: Of the 337 students examined, 106 (31%) were infested with live lice and eggs; 55% and 45% were from northern and southern schools, respectively ($P=0.02$). Among students who shared a comb and those who did not, the prevalence rates of head lice were 67% ($n=28$) and 33% ($n=14$), respectively. A history of head lice was more prevalent among students with positive head lice test results (49%) than among those with negative results (40%; $P<0.04$). A significantly lower number of students with head lice infestation had dark skin color (2/106; 1.9%) than light skin color. Moreover, 70/106 students used over-the-counter pyrethrin-containing pediculicide shampoos (22 [31%] responders, 48 [69%] non-responders). Furthermore, 93/106 (88%) responded to lindane shampoo whereas 13/106 (12%) did not ($P \leq 0.05$), with no neurotoxicity reported.

Interpretation: Pediculicide shampoo resistance is common among Saudi Arabian students, and lindane shampoo is a safe and effective treatment.

Keywords: Head lice; Student; Lindane; Pediculicide; Resistance

Introduction

Head lice are ectoparasites that live on human hosts by feeding on their blood, which can cause pruritus due to piercing of the skin. Head lice are transmitted to a new host only by close contact between individuals, making social contact the more likely route of transmission among school students. Such social contact includes sharing of combs, towels, and clothing, as well as direct head-to-head contact. Because head lice move easily from host to host, the lack of safe and effective repellents increases the risk of re-infestation.

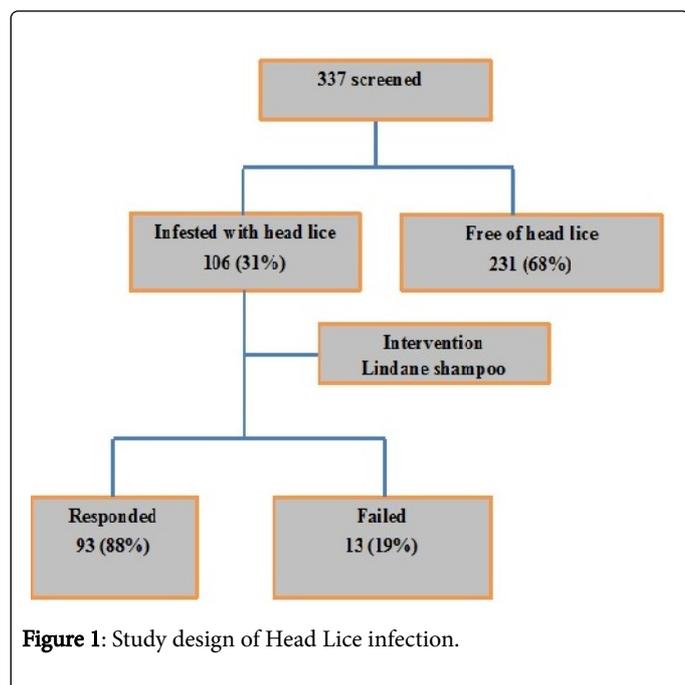
In one study conducted in Iran, the prevalence rate of head lice (*Pediculosis capitis*) infestation among school students was 27% [1]. Another cross-sectional study conducted from 2009 to 2010 in 1550 randomly selected primary-school children in Mafraq governorate, Jordan found the prevalence of *P. capitis* was 26.6%, with significant differences between girls (34.7%) and boys (19.6%), and between rural (31.2%) and urban (23.5%) residents. The study revealed that longer hair length, lack of bathing facilities, low frequency of hair-washing and bathing, and sharing of combs and scarves were significantly

associated with infestation ($p<0.001$) [2]. Another study conducted in Jazan, Saudi Arabia revealed a relationship between a family's level of education and lice infestation, with children of educated parents being less likely to have head lice [3]. Host-related factors linked to the prevalence of head lice include sex, age group, race, and type of hair. In recent years, resistance to insecticides has contributed to an increased prevalence of head lice [4]. Moreover, the incidence of head lice infestation is increasing primarily because of emerging treatment resistance [5]. Physicians are usually involved in the treatment of head lice after treatment failure for the second time, which could contribute to the emergence of resistance, as suggested by the results of efficiency studies showing that infested patients may treat themselves numerous times before seeking professional medical help [5,6]. Therefore, the aim of this study was to determine the prevalence of head lice infestation, the effectiveness of pediculicide treatments available over-the-counter, and the effectiveness and safety of lindane shampoo in treating head lice among Saudi Arabian female students.

Material and Methods

Approval for this study was obtained from the ethics committee of King Abdul-Aziz University Hospital and the Ministry of Education.

This interventional study was conducted in October and November 2016 in four secondary schools in the city of Jeddah: two schools from the north and two from the south of the city. A letter seeking official consent for the study was sent to the school health divisions. Verbal consent was obtained from each student before examination. A total of 337 female students aged 13 (\pm 2) years were examined. We included only female students (given that most male and female students are placed in separate schools in Saudi Arabia) with and without head lice. We excluded any students with a history of seizures or scalp lesions. Investigators completed a standardized questionnaire. Written consent for treatment was sent to parents of students with head lice. The Epi Info program (Epi7, CDC, Atlanta, GA, USA) was used to identify the sample size required for adequate statistical power, which for this study was 337 students. The study design is described in Figure 1.



Examination for the detection of head lice

The hair and scalp of each student was examined by hand for 3-5 m for the presence of any head lice or scalp lesions. At the end of each examination day, all the examined students with head lice and no scalp lesions were given a Klienze shampoo containing 1% gamma benzene hexachloride (lindane; manufactured by Gulf Care Factory for healthcare and cosmetics). Lindane, which has neurotoxic properties similar to those of dichloro-diphenyl-trichloroethane or DDT, causes fatal overstimulation of the ectoparasite's central nervous system [6,7]. The shampoo is approved by the Saudi Federal Safety Food and Medication Authority, and supplied for hospital use only. We instructed the students to apply the shampoo only once to avoid potential neurotoxicity, and showed them how to comb their hair during washing. Those who were positive for head lice were re-examined 2 weeks after treatment to detect the occurrence of any side effects and to examine the efficacy of the treatment provided.

Statistical analysis

Statistical analyses were performed using SPSS 21 software (SPSS, Chicago, IL, USA), and the chi-square test was used to compare

possible differences between groups, such as differences in efficacy rates, weekly frequency of hair-washing, history of having head lice, sharing a comb, skin color (light vs. dark skin color), and demographic data. Relative risk (RR) was calculated along with 95% confidence intervals (95% CIs) to assess the strength of the relationship between variables. Data are presented as means \pm standard deviations or as numbers of students (%). $P < 0.05$ was considered statistically significant.

Results

Baseline characteristics were not significantly different among students. The average student age \pm standard deviation was 13 \pm 2 y, the average weight was 49 \pm 15 kg, and the average height was 149 \pm 9 cm.

Of the 337 students examined, 106 (31%) were infested with live lice and eggs. As shown in Table 1, the number of head lice-infested students from the schools in the northern part of the city (59/106; 55%) was significantly greater than the number of head lice-infested students from schools in the southern part of the city (47/106; 45%; $P = 0.02$).

School name	Positive for head lice No. (%)	Negative for head lice No. (%)	Total No. (%)
North 1	40 (37)	44 (19)	84 (25)
North 2	19 (18)	66 (29)	85 (25)
South 1	25 (24)	59 (26)	84 (25)
South 2	22 (21)	62 (27)	84 (25)
Total	106 (31)	231 (69)	337 (100)

Table 1: Percentage of students infested with lice in each school.

Among students who shared a comb and those who did not, the prevalence rates of head lice were 67% ($n = 28$) and 33% ($n = 14$), respectively (RR: 2.5; 95% CI: 1.93–3.35; $P < 0.001$). Among students with positive head lice test results, the proportion of students with a history of head lice (52/106; 49%) was significantly higher than that among students with negative head lice test results (93/231; 40%; RR: 1.4; 95% CI: 1.7–2.5; < 0.04). Among students with positive head lice test results, the number of students with dark skin color (2/106; 1.9%) was significantly lower than that of students with light skin color (104/106; 98%; RR: 5.5; 95% CI: 1.3–23.7; $P = 0.007$; Table 2).

Out of the 106 students with head lice, 70 had used over-the-counter pediculicide shampoos containing pyrethrins. Among those 70 students, 22 (31%) responded and 48 (69%) failed to respond to this over-the counter shampoo treatment (RR: 2; 95% CI: 1.2–3.8; $P \leq 0.01$).

Regarding the effectiveness of the lindane anti-lice treatment, 93/106 (88%) students with head lice infestation tested negative for head lice 2 weeks after lindane treatment. No neurotoxic effects were observed in any of the students.

Characteristics	Positive for lice No (%) 106 (31)	Negative for lice No (%) 231 (68)	RR	95% CI	Pvalue*
Frequency of hair washing per week ≤ 3 days ≥ 3 days	36 (34) 70 (66)	110 (48) 121 (52)	1.0	0.35-1.0	0.01
Skin color Light Dark	104 (98) 2 (1.9)	209 (91) 22 (9)	5.5	1.3-23.7	0.007
History of having head lice Yes No	52 (49) 54 (51)	93 (40) 138 (60)	1.3	1.7–2.5	0.08
Sharing a comb Yes No	28 (26) 78 (74)	14 (6) 217 (74)	2.5	1.93-3.35	0.001
Number of uses of a comb in a day ≤ 1 ≥ 1	28 (26) 78 (73)	50 (22) 181 (68)	1.3	0.76-2.21	≤ 0.33
Number of previous lice infestations: ≤ 1 times ≥ 2 times	33 (31) 82 (77)	10 (4) 25 (11)	1.0	0.82-1.21	0.80

*Significance level ≤ 0.05

Table 2: Prevalence of head lice among secondary school students by student characteristics and hair care habits.

Discussion

In this study conducted in Saudi Arabian secondary school students, we investigated the prevalence of head lice infestation, the effectiveness of over-the-counter treatments, and the effectiveness and safety of lindane shampoo. Our results revealed that head lice infestation is negatively associated with dark skin color and positively associated with sharing a comb and showering less frequently. Moreover, resistance to over-the-counter pediculicide shampoo was common, and lindane shampoo was found to be a safe and effective head lice treatment.

In the present study, the overall prevalence of head lice infestation among female Saudi Arabian secondary school students from four schools was found to be 32%. The socioeconomic status of the population in the northern area of Jeddah is higher than that of the southern population. Surprisingly, however, the prevalence of head lice infestation was higher in students from the northern area, which contradicts the generally accepted hypothesis that head lice infestation generally occurs in lower socioeconomic groups [8]. Notably, schools in the north have a greater proportion of students with light skin color relative to those with dark skin color. Taken together with our finding that most students with head lice infestation were light-skinned, this indicates that light-skinned students have a higher risk of head lice infestation than dark-skinned students, which confirms the findings of other studies conducted in Africa [9,10]. However, it is still unclear why dark skin color imparts partial immunity or a protective effect against lice infestation.

The prevalence rate of head lice infestation among students who washed their hair ≥ 3 times per week was 31%. This result was similar to that of an Iranian study by Moosazadeh et al. in which the head lice infestation rate was found to be associated with a low frequency of bathing and also with sharing combs, as found in our study (Mahmood Moosazadeh). Moreover, a similar study conducted by Shayeghi et al. [11]. In Iranian school students showed that 49% of students with current head lice infestation had previously been infested with head lice, which may mean that those students had insufficient information about the mode of transmission of head lice; however, the failure of pediculicide shampoo is more likely. Our finding that 69% of students failed to respond to pediculicide-containing pyrethrin further suggests that lice are resistant to these pediculicide shampoos. The extensive use of pediculicides with a neurotoxic mode of action has led to the development and spread of resistant head lice populations worldwide [12-14]. In addition, the failure of current chemical treatments to kill lice embryos in eggs, the environmental and food safety concerns posed by these treatments, and their potential toxicity to users necessitate the development of safe alternative treatment methods that can effectively kill adult lice and eggs *via* new modes of action [15,16]. Other causes for the development of resistance to existing pediculicides include the persistence of pediculicide residue on hair, exposure of lice to sub-therapeutic concentrations, and inadequate concentration levels [5,6]. Numerous studies of the different types of head lice treatments have revealed that commercial pediculicides are ineffective in treating head lice infestations in students [12-14,17-19].

This study has some limitations. First, we did not perform genetic testing to confirm the presence of resistance-conferring genes or

genetic mutations in the lice, which we plan to investigate in future studies. Second, we examined 337 students from only four schools, which could have resulted in under- or over-estimation of resistance to over-the-counter treatments. Third, we only assessed head lice in female students. Hence, the prevalence of head lice in male students is unknown. This omission will be taken into consideration in future studies, which will examine a larger and more diverse population consisting of students of both sexes.

Conclusion

To our knowledge, this is the first study to assess head lice resistance and the effectiveness of lindane shampoo in Saudi Arabian students. Although lindane resistance is well documented in other parts of the world [20,21], we did not observe lindane resistance in this study, likely because of its restricted use as a second-line therapy that is only available for hospital use. Detailed scalp examination (to avoid any skin lesions that can increase the risk of neurotoxicity when using lindane shampoo) and the provision of formal instructions for lindane usage to the students resulted in the avoidance of neurotoxicities and adverse effects in all the students that used the lindane shampoo.

Head lice infestation is a common problem among schoolchildren in Saudi Arabia, where resistance to pediculicide shampoos is not uncommon. Our results suggest that lindane shampoo is a safe and effective treatment for head lice infestation. Further studies in a larger and more diverse population are needed to assess the effectiveness and safety of lindane and the resistance of head lice to over-the-counter treatments.

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Competing Interests

The authors declare that they have no competing interests.

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