

Local Solutions against Head Lice: A Comparative Survey in Nepalese Schools

Research Article

Volume 4 Issue 3- 2023

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Article History

Received: December 04, 2023 Accepted: December 08, 2023 Published: December 08, 2023

Abstract

Background: Infestation by the human head louse *Pediculus humanus var capitis* is one of the most common parasitic conditions among children worldwide. Availability of commercial products against head lice is often limited in low- and middle-income countries. Different versions of homemade anti-lice solutions were assessed and compared. In addition, differences in results between using a metal louse comb and a plastic one were also evaluated.

Method: In five schools of the Kathmandu Valley, 1,323 schoolchildren were screened for this study, designed as a comparative satisfaction survey. Theatre was used as a tool to encourage an open dialogue on this much-stigmatized topic.

Results: Out of 351 children affected by lice, 208 were included in the final analysis. In the group receiving the solution containing 5% of salt, vinegar, and a wetting agent, the proportion getting rid of head lice (parasite elimination-adults and nits) was 71,1% as compared to 56,8% with mustard oil (difference 14.4%, p-value=0,032). Among the two saline solutions tested, the one using 1% vinegar instead of 10% appeared just as effective, at less cost. Locally available plastic louse combs also appeared to be just as effective as the standard metal louse comb in eliminating head lice.

Conclusions: This research programme showed that a product made with natural ingredients can satisfactorily combat head lice. At the same time theatre as a tool to neutralize the stigma accompanying head lice infestation may have helped in implementing the anti-lice program.

Keywords: Pediculosis; Head lice infestation; School children; Saline solution; Mustard oil

Introduction

Infestation by the human head louse *Pediculus humanus var capitis* (Phthiraptera: Pediculidae) is one of the most common parasitic conditions among children worldwide. Transmission occurs mainly through direct contact and is thus highly influenced by the population

density of potential hosts. Households including many children living in densely populated spaces present a high prevalence of infestation, as do schools, refugee camps, jails, and orphanages [1]. Children between 3 and 14 years old are the most frequently affected, and after the age of four, girls tend to be more affected than boys (longer hair?),



even though infants, adults, and the elderly can be affected as well [2]. Although head lice may not be directly dependent on socio-economic status, they are particularly common in resource-poor communities in the developing world, linked with fewer financial resources, less access to information, and less availability of a pediculicide [3].

In Nepal, to the best of our knowledge, only one study has been conducted in Kathmandu schools. It showed a 38% prevalence of head lice infestation [4]. Children affected by this ectoparasite have poor sleep quality, show less attention in class, and are stigmatized by other schoolchildren [5]. Furthermore, only one synthetic treatment, called Mediker®, is available in Nepal, its active constituents are 20% camphor. This treatment was available only in big cities. In rural areas, inhabitants generally use mustard oil, also used for cooking. In low- and middle-income countries, commercial products against head lice are often unavailable, and when they exist, they are often prohibitively expensive [6]. Moreover, the efficacy of the synthetic insecticides like pyrethroids (permethrin and deltamethrin) and organophosphorus (malathion) is decreasing due to the development of resistance. Thus, today, there is a worldwide increase in head lice prevalence and a need to find new alternatives to tackle this parasite is growing [5,7].

In our approach of providing access to health care for everybody, including the underprivileged, we aim at validating locally available, safe and affordable solutions through clinical trials and satisfaction surveys. In this spirit of research, a previous pilot study conducted in Brazil evaluated the efficiency of a local remedy made of salt, vinegar, and water (5g of sodium chloride, 8mL of vinegar (5% acetic acid), 0.5mL of baby shampoo (as a wetting agent), 2 drops of lavender essential oil (to improve the fragrance), and enough water to make 100mL. By using this saline solution at home 4 times within 2 weeks (without using a louse comb), 55.2% of participants who had pedicu-

losis showed no signs of nits or adult lice after the treatment [8]. In the present study, we wanted to compare the traditional Nepalese mustard oil treatment with the more affordable saline solutions (in different versions, the aim being to improve the formula). At the same time, we wanted to compare the degree of efficacy between the locally available plastic lice comb and the standard (imported) metal lice comb.

Methods and Materials

Program Site and Population

A total of five schools from the Kathmandu Valley, Nepal, participated: four day-schools and one boarding school. Three of them were in the Lalitpur district and two in the Kavre district, where our local NGO partner, Environmental Camps for Conservation Awareness (ECCA), is active among low-income populations. All children in the schools and their families were eligible for the program.

Material and Intervention

Salt, vinegar (Paicho Synthetic Vinegar 4%, Manufacturer: Paicho), plastic anti-lice combs, and regular wide-tooth combs were purchased in the market of Patan, Nepal. Essential oil of *Cymbopogon winteranus* organic (popularly known as citronella), 100% pure, was bought in Aroma Garden shop, Thamel, Kathmandu, Nepal, and used to mask the odor of vinegar. Metal anti-lice combs with the narrowest interspace were purchased by internet from *Yangzhou Jianxin Brush-Making Company LTD*. The different treatments are presented in Table 1. Groups A and B applied a saline solution in their hair. The main difference was the type of wetting agent and amount of vinegar; both combed their hair with an anti-lice metal comb. Groups C and D applied mustard oil, and one group used an imported anti-lice metal comb while the other used a local anti-lice plastic comb.

Table 1: The difference in solution's composition and combs between the study groups.

Ingredients	Saline solution		Mustard oil	
	Group A	Group B	Group C	Group D
Salt	5g	5g	-	-
Vinegar ^a	1mL	10mL	-	-
Baby shampoo	0,5mL	-	-	-
Glycerin	-	5mL	-	-
Essential oil ^b	2 drops	2 drops	-	-
Water	99mL	85mL	-	-
Mustard oil	-	-	100mL	100mL
Metal anti-lice comb	x	x	x	
Plastic anti-lice comb				x

^a4% Acetic acid, ^bCitronella.

The treatment protocol was as follows: Apply the solution on dry hair until it became totally wet, leave for 1 hour, then comb with an anti-lice comb; wash as usual after a minimum of 24 hours. These steps were repeated twice in one-week interval for a total of three applications (D0, D7, D14). For mustard oil, the child was to be combed with a lice comb 5-10min. after the oil application, to follow as much as possible the traditional Nepalese procedure. In addition, all schoolchildren and their families were advised to carry out the following complementary procedures:

A. Wash all objects that had been in contact with affected hair 48 hours prior to treatment with hot soapy water or put them in a sealed plastic bag for two days.

B. Control the hair of all siblings on Day 0 and continue during the whole two weeks, treating them also if necessary.

Study Design

This study was designed as a satisfaction survey with a prospective, comparative design.

Eligibility

Schoolchildren were checked by visual inspection and, if infested by head lice, were included in the study. Any child presenting scalp wounds was excluded from the trial and sent for medical care.



Measurements

The head was examined visually and if no headlice detected, the wet-combing method was used, as it is considered to detect 3.5 times more headlice than visual inspection [9]. The treatment was defined as successful when no headlice (in the form of eggs, nymphs or adults) detected.

Group Division

For practical reasons and in order to obtain groups as homogenous as possible in terms of age, sex, and numbers, three small schools were attributed randomly to treatments, but all treatments were attributed in the larger school. The unit of division was the class. According to each school size and its recorded prevalence of head lice, and thus the number of participants of each treatment group, the fifth school treatment groups were then designed to homogenize each group in terms of age and numbers.

Sample Size

The sample was the whole population of affected subjects in all the study's schools. With an anticipated group size of at least 35 each, it would be possible to detect differences of at least 30% (between 55% and 85% success, a difference that, if observed, the study team deemed large enough to spread a recommendation), with a power of 80% and alpha 0,05.

Fieldwork Organization

We worked within a community-based approach where all students, teachers, parents, or caregivers were invited to participate in the program. In each school, a theatre play about the head lice life cycle, its related public health issues, and treatments was performed by each school's theatre team. After the theatre session, students were assessed and treated by the assigned treatment by trained staff. Each affected child received a package for treatment of their family, with instructions.

Data Collection

For each affected student, a satisfaction survey was filled in by the trained staff, on the overall degree of satisfaction and adverse effects. After the third application (on D16/17, called Control Day), each child's head was examined visually and, if no lice detected, by the more sensitive wet-combing method [2,5], following international guidelines for clinical trials with pediculicides [10]. The program occurred between May and June 2019.

Statistical Analysis

Data were entered in Excel tables, analyzed with Epi Info 7 and R version 3.6.2. Confidence Intervals (CI) were calculated for each group using the 95% exact Clopper-Pearson CIs. Differences between binomial variables were analyzed with Chi-square tests and associated 95% CIs calculated with Wald approximation. The final analysis of success rates was a 'completers analysis' using data from all affected schoolchildren who had available data at the Control Day.

Institutional Review Board Statement and Inform Consent

The study was conducted according to the guidelines of the revised Declaration of Helsinki (2013) and approved by each school authority. The Nepal Health Research Council (<https://nhrc.gov.np/>), responsible for issuing ethical approvals for Nepal, was contacted in 2019 for ethical approvals. It was responded that no ethical approval from the Nepal Committee was required for this study, as products were used in a usual manner as is the use of toilet lotion. Written informed consent has been obtained from the caregivers or parents; written information regarding the trial's objectives, procedures, and possible risks was given prior to the study. They were also informed that a child could withdraw from the study at any time and without penalty.

Results

A total of 1,323 students from five schools, including a boarding school, were screened in the program. It was found that 351 students (26,5%) had head lice. The prevalence of infestation was distributed as follows: Bal Vinod school (6-16 years old): 43,3% (52/120 students), Pushpanjali school (4-15 years old): 12,3% (91/740), Chantal Mauduit Academy (boarding school) (7-16 years old): 68,1% (109/160), Mahendra school (6-20 years old): 32,2% (59/183) and Janajyoti (3-16 years old): 33,3% (40/120). The first three schools are in the Lalitpur district, and the last two in the Kavre district. Out of the 351 affected schoolchildren, at the final Control Day (D16/17), 20 were lost to follow-up (other reasons, not related to the anti-lice program), and 123 could not be wet-combed for final examination because of lack of time (thus, only done by visual inspection); among them, 80 from a third whole saline group with the original solution, so the results presented in the final analysis exclude this group (Figure 1). Therefore, the final analysis was performed with 208 students, but data about adverse effects from 331 students was kept.

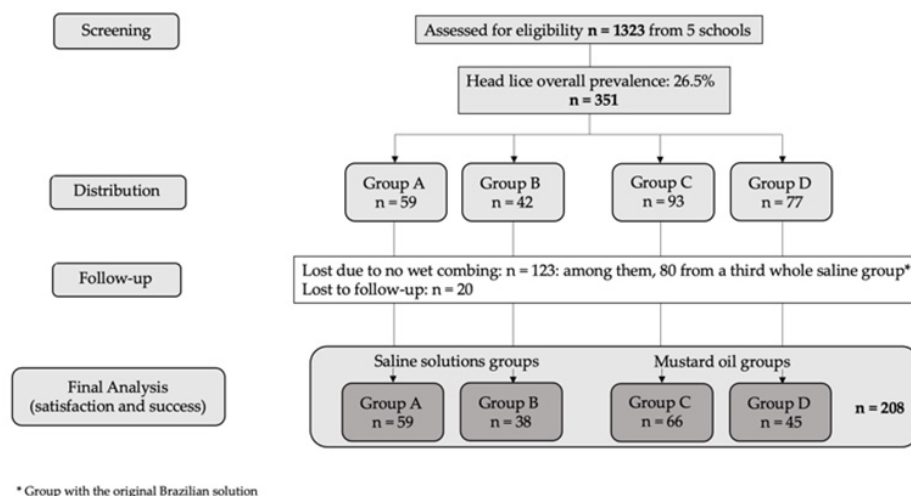


Figure 1: Participant's flow.



In the final analysis, the overall gender distribution among the 208 participants was 91,3% girls (190/208) and 8,7% boys (18/208). Of these 208 participants, 1,4% could not come at D7 and 2,4% at D14. The distribution of the groups was: group A-saline solution A applied to 59 students (age 6-20 years; mean age 11 years; 83% girls), group B-saline solution B applied to 38 students (2-16 years; mean age 10,5 years; 79% girls), group C-Mustard oil applied to 66 students (7-16 years; mean age 11,3 years; 100% girls) and group D-mustard oil applied to 45 students (5-14 years; mean age 10,5 years; 100% girls). Groups A, B, and C had hair combed with a metal anti-lice comb and group D with a plastic anti-lice comb. Table 2 summarizes the distribution of participants by intervention group.

Success rates obtained with saline solutions were similar with each other. Solution A: 71,2% (42/59 cured); (IC95% 57,9%-82,2%) and

solution B: 71,1% (27/38 cured); (IC 95% 54,1%-84,6%). With mustard oil, results were 59,1% (39/66 cured) (IC 95% 46,3%-71,1%) with metal anti-lice comb (group C) and 53,3% (24/45 cured) (IC 95% 38,0%-68,3%) with plastic anti-lice comb (Group D). Thus, with saline solutions, the proportion of children getting rid of head lice (parasite elimination - adults and nits) was 71,1% as compared to 56,8% with mustard oil (difference 14,4%, p-value=0,032). In (Table 3) are summarized the success rates for each intervention groups. Among all followed-up schoolchildren (n=331), the reported adverse effects were all transient and considered by the investigator as mild, mainly burning, and itching sensations. There was a slightly less adverse effects if the solution contained less vinegar (16,9% for solution A, versus 28,2% for solution B). Adverse effects for mustard oil groups (C and D) were like that of the solution A (14,7% and 15,5%, for C and D, respectively, versus 16,9%).

Table 2: Distribution of participants by intervention groups.

	Total (n=208)	Saline solution		Mustard oil	
		Group A (n=59) ^a	Group B (n=38) ^a	Group C (n = 66) ^a	Group D (n =45) ^b
Mean age-years		11(6-20)	10,5(2-16)	11,3(7-16)	10,5(5-14)
Sex: n (%)					
Girls	190(91,3)	49 (83)	30(79)	66(100)	45(100)
Boys	18(8,7)	10(17)	8(21)	-	-

^aMetal anti-lice comb, ^bPlastic anti-lice comb.

Table 3: The success rate of the intervention.

	Saline solution		Mustard oil	
	Group A (n=59)	Group B (n=38)	Group C (n=66)	Group D (n=45)
Cured, n	42	27	39	24
% [IC 95%]	71,2[57,9-82,2]	71,1[54,1-84,6]	59,1[46,3-71,1]	53,3[38,0-68,3]

Out of 331 students who answered the survey, 329 said they liked the program in general and some specified why: The reasons given most often were "because they got rid of head lice," seven students particularly liked the theatre, and 18 others mentioned the massage that was provided while applying the oil/solution. Not evaluated in the survey but stated orally, was the total satisfaction and enthusiasm of the teachers and the schools' directors. On their demand, the program was planned to be scaled up to other schools in Nepal in the future. Regarding the staff member's observations about saline solutions, most preferred the solution B containing glycerin, as it seemed to make untangling the hair easier.

Discussion

In this survey on head lice in Nepalese schools, the proportion of children getting rid of head lice with saline solutions was 71,1% as compared to 56,8% with mustard oil, with highly prevalent but mild and transient adverse events. Locally available plastic anti-lice combs and the standard metal anti-lice combs appeared to have similar effects on head lice elimination. Additionally, this is the first time to our knowledge that the efficacy of mustard oil has been clinically evaluated. Infestation rates were in accordance with that observed in 2004 by Poudel and Barker in schoolchildren of Kathmandu (38%) [4]. In one Iranian study [11], rates in schoolgirls were 23,4%, and in another, 67% [12]. In rural schools of India it reached up to 86% [13].

When comparing saline solutions with different wetting agents, glycerin (solution B) seems to be as efficient as baby shampoo (solution A). Unlike baby shampoo, glycerin consists of a single ingredient, can

be of plant origin, and helps to detangle the hair. Lower concentrations of vinegar (1%) seem to be as efficient as the original solution (10% vinegar) previously tested by our group in Brazil [8]. Keeping in mind that the final aim is to find a local and affordable solution, this means that either glycerin or baby shampoo can be used depending on local availability and price. Using 10 times less vinegar than in the original recipe reduces both cost and possible irritation when the scalp is wounded by scratching. Despite the heterogeneity between the groups making difficult a straightforward comparison, saline solutions appeared more efficient in eliminating head lice than mustard oil. The inherent effectiveness of the saline solution is also suggested when comparing the overall success rate of the saline solutions (71,1%) with the success rate of a study in rural Turkey (55,5%) that applied only the wet-combing method with the metal comb four times within two weeks [14] as a treatment method. This thus leads to a strong assumption that the saline solution contributes to eliminating head lice. The hypothesized mechanism of action suggested by other studies is desiccation of adult louse and perhaps eggs as well [15,16].

Regarding our findings about the comparison of plastic versus metal anti-lice combs, similar results were found elsewhere [14]. However, the effectiveness of a fine comb depends-in part-on the design and material they are built of [17]. *Cymbopogon winteranus*, citronella, was used in our study in tiny quantity to improve the odor of the solution. Other essential oils, e.g. lavender [8] can also be selected according to their local availability, price, their quality of being non-irritant on the skin, and their safety for children. Socially inclusive programs like this one are very rare in low-income settings [18]. As a result, without proper information and affordable treatment head lice infestations re-



main persistent. There is also a simple additional bonus: in general, the schoolchildren seemed to enjoy the anti-lice program very much, whether their head lice disappeared or not.

Theatre performances appeared to be an efficient tool to combat the shame and stigma surrounding the theme of head lice. None of the children or families refused to take part in the program, and most of them seemed rather enthusiastic about it. This method, known as the whole school/community approach, was applied successfully in the management of head lice in five studies [19]. This contrasts with reports of other programs where “being infested with head lice was regarded as a kind of disgrace for the family in the neighborhood and this turned out to be a huge obstacle” [14].

Limitations of the Study

A limitation of the study is that a high percentage of children could not be wet-combed after visual inspection. This reduced the total number of participants for the final analysis with the more sensitive detection method. The heterogeneity of the groups in terms of demographic data can be explained by the fact that, for practical reasons, each group was spread over a maximum of two schools, and these schools were very heterogeneous in terms of type (boarding school, rural and city schools), the number of schoolchildren, and head lice prevalence. In particular, the sex ratio was different, with mustard oil groups composed entirely of girls. However, including girls only for the analysis of the saline groups led to no major change in the success rate (68,4 % or 54/79 cured in girls only, rather than 71,1% or 69/97 cured for the whole group). The compliance/ adherence rate could not be estimated, as treatment material was brought into the schools and applied by trained staff. This makes it more difficult to generalize recommendations for use at home.

Conclusions

This survey showed that solutions containing 5% of salt and vinegar plus a wetting agent were associated with 71,1% headlice elimination as compared to 56,8% with mustard oil (difference 14.4%, p -value=0,032), with a similar rate of adverse effects, which were mild. It seems reasonable to use either glycerin or baby shampoo as a wetting agent, according to the local availability of the products. A solution with 1% vinegar instead of 10% seems to be just as effective, at a lower cost. The use of theatre as a tool to remove the stigma around head lice may have helped the implementation of the anti-lice program. These trials pointed out the feasibility of combatting head lice with safe, inexpensive natural ingredients, easily obtainable in almost any settings.

Funding

Antenna Foundation funded this program.

Acknowledgments

The authors would like to express their thanks to the children and families, school directors and teachers, the theatre director and the actors, to all ECCA volunteers, and Liesl Graz for English revision of the text.

Conflicts of Interest

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

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