Report

Head lice in pupils of a primary school in Australia and implications for control

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Abstract

Background Anecdotal reports suggest that head lice infestations are a common problem in school-aged children in Australia; however, only a few data are available. The present study aimed to determine the prevalence of infestation with head lice in children in an urban Australian school.

Methods All 735 pupils from grades preschool to five of a government-run primary school were invited to participate in the cross-sectional survey. Overall, 212 boys (46.5%) and 244 girls from 29 classes were examined. The main outcome measures were: (1) the detection of lice or eggs by visual examination of the child's head, and classification into 'not infested' and 'infested'; infested cases were further classified into 'active infestation' (lice or viable eggs found) or 'inactive infestation' (only unhatched eggs found); (2) for each child, a parent or guardian was asked to complete a standardized questionnaire.

Results Of the 456 children examined, 33.7% (95% confidence interval [CI] 26.9%, 40.4%) had evidence of infestation with head lice, 21.0% (95%-CI [15.2%, 26.8%]) with active infestation. The prevalence of infestation (active plus inactive) varied greatly between classes, ranging from zero to 72.2% (p < 0.001). Head lice were more prevalent in girls than boys (p < 0.001). Analysis of questionnaires showed that 47.7% (95%-CI [43.0%, 52.4%]) of the children had been infested with head lice in the previous 6 months. For children with active pediculosis capitis on examination, 14.0% (95%-CI [7.9%, 22.4%]) of parents or guardians had not noticed the infestation.

Conclusions In an urban primary school in Australia, head lice infestation was present at a hyperendemic level. Clustering by class indicated the classroom as a main source of infestation. Control strategies implemented in schools and including the education of teachers and parents need to be evaluated.

Introduction

Head lice, Pediculus humanus capitis, are a cause of worldwide concern, in particular for parents. Pediculosis capitis is known to be especially prevalent in school children, and studies performed in different countries suggest broadly varying infestation rates.1–8 Although infestation with head lice is known to be common in school children in Australia, only a few data are available. In a survey of 479 primary school students in Melbourne in 1985, the prevalence of pediculosis capitis was 6.9% at the beginning of the school term and 10% 3 months later at the end of the term.2 The prevalence in school children in Tasmania in the 1970s was found to be below 5%.8

For school children and their families, head lice have an impact in terms of the cost of treatments, days absent from school, time spent in eradication attempts, psychologic distress, and individual health.9 For schools and education departments, head lice are a common cause of complaint, and result in increased paperwork, time-consuming explanations, and in managing potential conflict with parents. Other parasitic infestations have been shown to affect cognitive function in children and to potentially decrease learning performance,10 but no studies appear to have been done on the effect of pediculosis capitis; however, clinical symptoms, such as pruritus and lymphadenopathy, which are likely to distract children's attentiveness, are frequently described in infested children.11

Infestation with head lice is usually detected by three types of evidence: itching and inflammation of the scalp and neck, sighting of lice, and detection of eggs attached to hair shafts. The clinical symptoms are suggestive of...
infection with head lice, but they are not diagnostic and have a low sensitivity. The eggs of head lice are laid within 1 cm of the scalp and are firmly bound to the shafts of hairs. Hatching occurs about 7 days after deposition, but most eggs remain in situ after the larvae have escaped. The empty egg shell (nit) can remain on the hair for many months, even after the infection has been eradicated. Consequently, although finding nits is evidence of past infection, it is not diagnostic of current infection. The threat of transmission to other people is only posed by active infection, which can be confirmed exclusively by finding lice, or viable unhatched eggs, on the hair shafts.

The present study provides data on the epidemiology of head lice in a primary school in Australia and comments on possible control strategies based in schools.

Materials and methods

Subjects

In June 1997, all 735 pupils of Crestmead State Primary School in Logan City, Queensland, Australia in the 29 classes from grades preschool to five were offered to participate in a survey for head lice. The school’s pupils were day pupils only and came from the surrounding suburbs in the south of Brisbane. The ethnicity of the participating students was predominantly Caucasian, and the community consisted largely of young families with limited financial resources. Only children with permission forms signed by a parent or guardian were examined.

Ethical approval was obtained from the James Cook University Ethics Committee (ethics approval number H613) and from the Department of Education, Queensland (reference number 39/97).

Physical examination and questionnaire

The hair and scalp were examined for head lice, eggs, or nits by six examiners all trained by R.S., and any questionable cases were examined by R.S. If any evidence of head lice was detected, the child was classified as infested with head lice. Treatment with a 1% permethrin formulation was applied, and after 20 min the hair was combed with a plastic fine tooth comb and the combings wiped onto paper tissue. The paper was immediately examined by one examiner (R.S.) using a dissecting microscope for the presence of lice, viable unhatched eggs, and hatched eggs. If lice or viable unhatched eggs were found in the combings, the infestation was classed as active. If only unhatched eggs and no evidence of lice were found in the combings, the infestation was classed as inactive. For each child, parents or guardians completed a brief standardized questionnaire on the occurrence of head lice during the past 6 months and recent treatments used.

Data analysis

Statistical analysis was performed with SPSS for Windows, release 6.1.3. As clustering within classes was strong, overall prevalence estimates and confidence intervals were adjusted using the mean of class prevalence means and the respective standard errors. Respective adjustments for clustering effects of prevalence apply also to gender comparisons. Exact or approximate 95% confidence intervals (95%-CI) are given as appropriate. The analysis of the effects of categorical variables on prevalence was performed using chi-squared tests and Fisher’s exact test. Spearman’s rank correlation coefficient (r) was used to examine the strength of correlation between the proportion of infested children and the proportion of examined children across classes. Clustering in classes was evaluated by utilizing chi-squared statistics for the comparison of proportions from several independent samples. Clustering effects in families were investigated using a binomial distribution and by comparing the calculated expected frequencies with the observed frequencies by means of chi-squared statistics with (number of children in family – 1) degrees of freedom. Throughout the analysis a significance level of 0.05 was used.

Results

From preschool to grade five, 456 pupils, 212 boys (46.5%) and 244 girls, out of the total enrolment of 735, were examined; a participation rate of 62.0%. Comparisons of the participating children with nonparticipants showed a slightly higher proportion of boys not being examined (52.7%) (p = 0.116). The proportion of examinations varied across grades with the highest proportion in grade two (74.4% examined) and the lowest in preschool (48.0% examined) (p = 0.001) (Table 1). Across classes, the proportion of infestation was found to be positively correlated with the proportion of children examined (active infestation: r = 0.41, p = 0.028; active and inactive infestation: r = 0.34, p = 0.074). There was no correlation between the proportion of inactive infestation and participation rate (r = 0.00, p = 0.951).

Of the 456 children examined, 33.7% (95%-CI = [26.9%, 40.4%]) had evidence of infestation with head lice either as nits alone (inactive infestation), or lice or viable, unhatched eggs (active infestation). Active infestation was detected in 21.0% (95%-CI = [15.2%, 26.8%]) of the total, or 65.8% (95%-CI = [56.4%, 71.3%]) of the 160 children showing evidence of current or past infestation with head lice. The prevalence of inactive infestation was 12.7% (95%-CI = [9.2%, 16.1%]). The above given prevalence estimates were adjusted for clustering effects in classes. The prevalence of infestation by grade ranged widely (Table 1); however, for classes within grades, the prevalence of infestation showed a much greater variation. For example, for classes in grade two, the prevalence of...
infestation ranged from 13.3% to 52.4% \((p = 0.041)\) and, for classes in grade three, from 0% to 72.2% \((p = 0.001)\), suggesting a class rather than an age effect. Tests of the null hypothesis of uniform distribution across classes were statistically significant for the prevalence of overall infestation (active and inactive) and of active infestation \((p < 0.001)\), supporting the alternative hypothesis of clustering within classes.

Head lice were more common in girls than boys, with active infestations prevalent in 26.9% \((95\%-CI = [19.5\%, 34.4\%])\) and 13.6% \((95\%-CI = [7.9\%, 19.3\%])\) respectively, and inactive infestations prevalent in 18.4% \((95\%-CI = [12.9\%, 24.0\%])\) and 5.9% \((95\%-CI = [2.3\%, 9.4\%])\) respectively. The above given prevalence estimates were adjusted for clustering effects in classes. The differences in prevalence were highly significant for gender \((p < 0.001)\). Analysis of the prevalence of infestation (active and inactive) across classes stratified by gender revealed for girls and boys significant clustering effects of infestation in classes \((p = 0.003)\) and \(p = 0.035\), respectively \((\text{Figs } 1 \text{ and } 2)\).

Overall, children from 323 families were examined. Of the 217 children with no other sibling in the school, 31.3% \((95\%-CI = [25.1\%, 37.5\%])\) showed a combined infestation (active or inactive) with head lice and 20.3% had an active infestation when examined. The combined infestation probability in families with one child was slightly smaller than the infestation probabilities in families with two \((39.2\%), \text{three} \((37.3\%), \text{and four} \((50\%)\) children being examined \((p = 0.288)\). For a total of 88 families, two children were examined, resulting in 40 \((45.5\%)\) families without infested children, 21 \((23.9\%)\) families where both children were infested, and 27 \((30.7\%)\) families with one child infested and the other not. The comparison of the observed frequencies with the expected frequencies as calculated using a binomial distribution showed that less families than expected had only one child infested (expected 40) and more families than expected had two children infested \((expected 11) \((p = 0.001)\). Of the 17 families with three children examined, two \((11.8\%)\) families were without any sign of infestation, 11 \((64.7\%)\) families had one infested child, and four \((23.5\%)\) families had two children with infestation. Comparison with expected frequencies as calculated using a binomial distribution showed no significant difference. There was only one family with four children of whom two were infested by head lice and two were not.

A total of 455 questionnaires were completed, including 12 questionnaires from parents or guardians who did not want their child examined. The proportion of returned questionnaires was 61.9% \((455/735)\) for the whole group, and 96.9% \((442/456)\) for the parents and guardians who agreed for their children to be examined. From the latter group, 47.7% \((95\%-CI = [43.0\%, 52.4\%])\) of children were reported as having been infested with head lice in the previous 6 months. Of the 154 children with a positive examination result, 80.5% \((95\%-CI = [74.2\%, 86.8\%])\) of parents or guardians were aware of the infestation (Table 2). Of the 100 children with active pediculosis capitis and a questionnaire completed, 14% \((95\%-CI = [7.9\%, 22.4\%])\) of parents or guardians had not noticed infestation with head lice in the previous 6 months. The failure of detection was higher for boys than girls, with values for active pediculosis capitis being 23.3% \((95\%-CI = [9.9\%, 42.3\%])\) and 10% \((95\%-CI = [4.1\%, 19.5\%])\) respectively \((p = 0.1138)\), and for combined active and inactive pediculosis capitis 32.6% \((95\%-CI = [19.1\%, 48.4\%])\) and 14.4% \((95\%-CI = [7.9\%, 20.9\%])\) respectively \((p = 0.022)\). All 211 parents or guardians who reported head lice in the previous 6 months attempted some form of treatment. The 12 children for whom questionnaires were completed, but permission to examine was denied, reported a frequency of pediculosis capitis of 41.7% \((95\%-CI = [15.2\%, 72.3\%])\) in the previous 6 months.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Total students in grade</th>
<th>Number (% examined)</th>
<th>Number with evidence of current or past infestation (prevalence)</th>
<th>Number with active infestation (prevalence)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preschool</td>
<td>100</td>
<td>48 (48.0%)</td>
<td>9 (18.8%)</td>
<td>1 (2.1%)</td>
</tr>
<tr>
<td>Grade 1</td>
<td>117</td>
<td>74 (63.3%)</td>
<td>22 (29.7%)</td>
<td>12 (16.2%)</td>
</tr>
<tr>
<td>Grade 2</td>
<td>143</td>
<td>106 (74.1%)</td>
<td>41 (38.7%)</td>
<td>24 (22.6%)</td>
</tr>
<tr>
<td>Grade 3</td>
<td>121</td>
<td>79 (65.3%)</td>
<td>27 (34.2%)</td>
<td>18 (22.8%)</td>
</tr>
<tr>
<td>Grade 4</td>
<td>123</td>
<td>76 (61.8%)</td>
<td>36 (47.4%)</td>
<td>29 (38.2)</td>
</tr>
<tr>
<td>Grade 5</td>
<td>131</td>
<td>73 (55.7%)</td>
<td>25 (34.2%)</td>
<td>18 (24.7%)</td>
</tr>
<tr>
<td>Total</td>
<td>735</td>
<td>456 (62.0%)</td>
<td>160 (35.1%)</td>
<td>102 (22.4%)</td>
</tr>
</tbody>
</table>

Table 1: Summary of participation and results of survey for head lice of grades preschool to five at a primary school in Logan City, Queensland, Australia.

Discussion

Infestation with head lice was very common in this urban primary school in Australia. In fact, the prevalence of active pediculosis capitis of 21.0% is the highest detected in any survey of school children in Australia. Schools in Australia and elsewhere in the world are experiencing epidemics of pediculosis capitis according to the National Pediculosis Association of the USA, which defines an epidemic as occurring when 5% or more of the student body are infested. The data from the questionnaire survey of parents and guardians provided additional evidence of the high incidence of infestation, as 30% of children without evidence of head lice infestation on examination were reported to have had pediculosis capitis in the previous 6 months.

The extremely high prevalence found in this survey may have been partly due to volunteer bias caused by children with head lice being more likely to be enrolled in the study, as parents whose children experienced head lice might be more willing to participate. This hypothesis was substantiated by the positive correlation between the proportion of infested children and the proportion of examined children per class. Therefore, for the most conservative estimate of the prevalence of pediculosis capitis (active and inactive),
Table 2  Current head lice status of children in primary school from examination, and relationship to infestation with head lice in previous 6 months as reported in questionnaire

<table>
<thead>
<tr>
<th>Result of questionnaire</th>
<th>Result of examination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No infestation</td>
</tr>
<tr>
<td>All children</td>
<td></td>
</tr>
<tr>
<td>No infestation</td>
<td>201 (69.8%)</td>
</tr>
<tr>
<td>Infestation</td>
<td>87 (30.2%)</td>
</tr>
<tr>
<td>Total</td>
<td>288</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
</tr>
<tr>
<td>No infestation</td>
<td>130 (79.3%)</td>
</tr>
<tr>
<td>Infestation</td>
<td>34 (20.7%)</td>
</tr>
<tr>
<td>Total</td>
<td>164</td>
</tr>
<tr>
<td>Girls</td>
<td></td>
</tr>
<tr>
<td>No infestation</td>
<td>71 (57.3%)</td>
</tr>
<tr>
<td>Infestation</td>
<td>53 (42.7%)</td>
</tr>
<tr>
<td>Total</td>
<td>124</td>
</tr>
</tbody>
</table>

The assumption could be made that all children who were not examined were not infested, leading to an estimated prevalence of 21.8%. Several points should be considered against this conservative estimate. Firstly, some parents may have misjudged the presence or absence of infestation, and indeed the questionnaire data suggest this. Secondly, correlation of infestation and participation was only found for active infestation, but not for inactive infestation which occurred in 12.7% of the examined pupils. An additional indication that the effect of volunteer bias may not have been large was that the reported incidence of pediculosis capitis in the 12 children who were not examined, but whose parents completed a questionnaire, was 42%, similar to the rate of the participants. Taking these considerations into account, the true prevalence of pediculosis capitis experienced in the school may be about 30%.

In the present survey, infestation with head lice, by examination and in questionnaire data, was twice as common in girls than in boys. Most previous studies have shown the prevalence to be higher in girls, a finding which is thought to be due to gender-related behavioral differences.1,2,12 Close contact between heads for boys tends to occur briefly in rough and tumble play, while for girls close head contact is often more intimate and prolonged. Hair length appears to be of indeterminate significance.5,12 Because we did not record hair length in this study, we are unable to comment on its relationship to prevalence.

The present study is only in part able to confirm results from previous studies showing that, if one member of a family is infested, other family members have a greater risk of infestation.12,17 This might be due to the fact that most of the children examined did not have siblings attending the same school in the grades examined, leaving only 106 families with more than one child observed. On the other hand, clustering by class was statistically significant and remained so after stratification by gender. This suggests that opportunities for transmission are prominent within the classroom, and that transmission outside the classroom might be less significant. An alternative explanation could be that children within classes tend to spend more time inside and outside the classroom with members of the same class than with children from other classes, hence giving a clustering effect based on class groupings.

The hypothesis that transmission at school is more likely in the classroom situation is consistent with the behavior of the head louse. Head lice have six legs, each with a claw adapted for grasping hair shafts, and they transfer to new hosts by grasping a hair from the new host with some claws while still hanging onto the hair shafts of the current host with other claws. Transfer is completed by releasing the claws holding the hair shafts of the old host. The key epidemiologic message is that most transfer is by intimate contact with the hair of the new host coming into contact with the hair of the old host.14,18

In schools, the opportunities for hair to hair contact are available both within the classroom and outside. Of classroom activities, group work would in theory be an ideal situation for the transfer of head lice. A study on head lice infestation in school children in the USA found that pupils who were permitted to sit or play on the floor or to work round small work tables generally had greater opportunities for head contact than children sitting at conventional desks, thereby increasing the risk to transfer head lice.17

The comparison of questionnaire data with the results of the examination revealed that parents or guardians were unaware of an active infestation in 10.0% of girls and 23.3% of boys. Previous studies suggest that parents may be unaware of how to detect infestation with head lice and may use techniques of low sensitivity.19,20 The greater
tendency for pediculosis capitis to be missed by parents or guardians of boys has not been reported previously and may be due to several reasons. Parents, particularly mothers, may examine the hair of girls more frequently and more thoroughly than that of boys; or girls may self-detect head lice more often than boys. The high rates of missed diagnoses of pediculosis capitis suggest that educational programs for parents are needed to increase the sensitivity of detection of head lice. A high compliance rate for such programs can be expected, because parents naturally regard pediculosis capitis as undesirable.

The control of head lice is a vexatious issue, particularly when insecticide resistance may be common. Parents and guardians frequently identify schools as the source of their child’s pediculosis capitis, and their intuitive assessment is supported by this study. Schools may have to consider that they need to play a more active role in the control of pediculosis capitis. Apart from the USA, where comprehensive pediculosis capitis screening programs for schools have been discussed for some time, only a few recent studies from other countries report successful programs implemented in schools. A study in Argentinian school children gave preference to massive, complete, and simultaneous treatment of the whole school as opposed to the treatment of single cases. In an epidemic situation, as described in the Argentinian school, school-wide examination and treatment programs may be justified, but if the prevalence of head lice is low, an anonymous questionnaire survey could be used to identify high risk classes which could then be examined and treated.

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References