**Aim:** To describe and investigate the relationship among the sun-related knowledge, attitudes and behaviours of New Zealand primary schoolchildren and consider the roles of sex and school year level.

**Methods:** A randomly selected, two-stage cluster sample of 488 children from 27 primary schools in five regions of New Zealand was surveyed regarding their sun-related knowledge, attitudes and behaviours. A scoring system was used to assign a knowledge, attitude and behaviour score to each child.

**Results:** Although knowledge increased with school year level, there was a decline in sun protective attitudes and behaviours. There was little variation in knowledge, attitudes and behaviour between boys and girls, but sex-year level interactions were found for knowledge and behaviour. When considering children’s knowledge, attitudes and behaviours simultaneously, knowledge was only significantly associated with behaviours when mediated by attitudes.

**Conclusions:** When targeting child sun protection and skin cancer prevention programmes, a focus on attitudes towards sun exposure and a suntan may prove beneficial in influencing sun-related behaviours.

**Key words:** attitudes; behaviours; children; knowledge; sun exposure; sun protection.

Skin cancer is the most common cancer in those economically developed countries with significant Caucasian populations. In New Zealand (NZ), melanoma incidence rates are among the highest in the world.1–3 Risk factors common to all skin cancers include red and blonde hair, light eye colour, fair skin colour, presence of nevi, family history of skin cancer and, the only known readily modifiable factor, excess and harmful sun exposure.4–6 Most skin cancers could potentially be avoided by preventing excess ultraviolet radiation exposure.7 Although the evidence is unclear as to whether childhood exposure is most important for the induction of skin cancer, however, childhood sunburn is associated with subsequent elevated melanoma risk.8 Thus, children have been identified as a key target group for skin cancer prevention efforts, both in NZ and internationally.9,10 Appropriately child sun protection should reduce subsequent skin cancer risk, but previous studies indicate that although children may know about this risk and be aware of the need for sun protection,11 this knowledge is not necessarily positively associated with protective attitudes and behaviours.12,13 Furthermore, sun protection and healthy sun behaviour tend to decrease during adolescence, particularly among girls.14 However, melanoma awareness, assessed from a measure of exposure to information on melanoma, predicted sun protection, indicating that this awareness may be related to protective behaviours.

Results from a 1997 study of NZ primary schoolchildren, 5–12 years, concluded that children as young as 5–6 years could describe the negative consequences of overexposure to the sun and could illustrate methods of sun protection.15 This knowledge is not necessarily positively associated with sun protective attitudes and behaviours.16 Furthermore, sun protection and healthy sun behaviour tend to decrease during adolescence, particularly among girls.17 However, melanoma awareness, assessed from a measure of exposure to information on melanoma, predicted sun protection, indicating that this awareness may be related to protective behaviours.
children, the older children would tend to be more knowledge-
able about sun-related issues, more likely to report pro-tan
attitudes and less likely to practice sun-safe usual behaviours.
Similarly, it was hypothesised that, compared with boys, girls
would tend to be more knowledgeable about sun-related issues,
more likely to report pro-tan attitudes and less likely to report
sun-safe usual behaviours.

Information on patterns of sun-related knowledge, attitudes
and behaviour of NZ primary schoolchildren has been sparse.
Accordingly, the first study aim was to document the prevalence
of sun-related knowledge, attitudes and behaviours that have
the potential to influence avoidance of excess sun exposure and
subsequent reduction of skin cancer risk. In addition, any sig-
nificant differences in these dimensions, according to sex and
school year level, which may assist in the design and timely
targeting of effective interventions, would be documented. The
second aim was to investigate the relations among the measures
of children’s sun-related knowledge, attitudes and behaviours.

Method
Sample

The study was cross-sectional in design and data collection
entailed the use of a self-completed questionnaire on sun-
related knowledge, attitudes and usual behaviours. Six state or
state integrated schools (i.e. schools with a special, often reli-
gious character which have been integrated into the state
system) were randomly selected, using the Ministry of Educa-
tion schools database as updated in April 2004, from eight
regions or centres of five provinces from which, for logistical
reasons, the study was conducted (Table 1). They were selected
because they provided sufficient latitudinal and rural–urban
differences and have been used similarly in two other stud-
ies.17,18 Two school year levels, Year 4 (Y4, modal age 8 years)
and Year 8 (Y8, modal age 12 years), were selected for the study
based on similar English and Australian studies,19,20 and known
psychological and behavioural differences between childhood
and preadolescence.21 Three schools from each province were
randomly selected per year level. Of the 2682 schools on the
Ministry of Education database on 22 January 2004, 2408
included Y4 and Y8 students. Schools with less than 10 children
were excluded and replaced with the next randomly selected
school. A single class, either Y4 or Y8, was randomly selected
from each school to take part.

Materials and measures

The student survey measures (Table 2) assessed sun-related
knowledge (11 questions), attitudes (three questions) and
behaviours (nine questions). Sun-related knowledge was
defined according to responses obtained to questions about
sunburn, skin cancer and means to prevent skin cancer, for
example, use of sunscreen. Sun-related attitudes towards a
suntan were defined according to children’s responses to ques-
tions about their desire to have a suntan (pro-tan attitudes) and
their perceptions of their family and friends’ beliefs about
having a suntan. Sun-related behaviour was defined according
to responses obtained to questions about getting a suntan, expe-
rience of sunburn and use of sun protective measures. Demo-
graphic data including sex, age and self-identified ethnicity were
also collected using the student questionnaire. The questions
asked were similar to those used in a national survey adminis-
tered to the general public over four consecutive summer weeks
in 1999 and a survey administered to NZ secondary schoolchil-
dren.22,17 Amendments were made (after the pilot study was
carried out in four additional schools) to ensure that age-
appropriate language was used and any questions found to be

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Sample characteristics by region or centre (from the north of the North Island to the south of the South Island) and school year level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region/Centre</td>
<td>Year level</td>
</tr>
<tr>
<td>North Island</td>
<td></td>
</tr>
<tr>
<td>Auckland Region</td>
<td>Y4</td>
</tr>
<tr>
<td></td>
<td>Y8</td>
</tr>
<tr>
<td>Waikato Region</td>
<td>Y4</td>
</tr>
<tr>
<td></td>
<td>Y8</td>
</tr>
<tr>
<td>Wellington/Hutt Valley Region</td>
<td>Y4</td>
</tr>
<tr>
<td></td>
<td>Y8</td>
</tr>
<tr>
<td>Masterton Centre</td>
<td>Y8</td>
</tr>
<tr>
<td>South Island</td>
<td></td>
</tr>
<tr>
<td>Canterbury Region</td>
<td>Y4</td>
</tr>
<tr>
<td></td>
<td>Y8</td>
</tr>
<tr>
<td>Ashburton Centre</td>
<td>Y4</td>
</tr>
<tr>
<td>Otago and Southland Region</td>
<td>Y4</td>
</tr>
<tr>
<td></td>
<td>Y8</td>
</tr>
<tr>
<td>Total</td>
<td>Y4</td>
</tr>
<tr>
<td></td>
<td>Y8</td>
</tr>
</tbody>
</table>

NA, not applicable.
Table 2 Main effects of students’ sex and school year level on key outcomes (adjusted ORs)

<table>
<thead>
<tr>
<th>Variable</th>
<th>All students</th>
<th>Y4 male</th>
<th>Y4 female</th>
<th>Y8 male</th>
<th>Y8 female</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>488</td>
<td>111</td>
<td>103</td>
<td>123</td>
<td>151</td>
</tr>
<tr>
<td>All OR (95% CI)</td>
<td>0.8 (0.5-1.2)</td>
<td>0.8 (0.6-1.1)</td>
<td>0.6 (0.3-1.0)</td>
<td>2.0 (1.4-2.9)</td>
<td>1.8 (1.2-2.7)</td>
</tr>
<tr>
<td>Sex OR (95% CI)</td>
<td>0.8 (0.5-1.2)</td>
<td>0.3 (0.2-0.4)</td>
<td>0.5 (0.3-0.8)</td>
<td>0.6 (0.4-1.0)</td>
<td>0.8 (0.5-1.3)</td>
</tr>
<tr>
<td>Year OR (95% CI)</td>
<td>0.8 (0.5-1.2)</td>
<td>0.7 (0.4-1.0)</td>
<td>0.8 (0.5-1.3)</td>
<td>2.0 (1.4-2.9)</td>
<td>1.8 (1.2-2.7)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe to get sunburnt once or twice a year</td>
<td>24.2</td>
<td>21.4</td>
<td>25.9</td>
<td>27.8</td>
<td>22.2</td>
</tr>
<tr>
<td>Things you can do to not get skin cancer:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avoid getting sunburnt</td>
<td>63.9</td>
<td>58.6</td>
<td>65.9</td>
<td>66.7</td>
<td>60.9</td>
</tr>
<tr>
<td>Cover up with clothing</td>
<td>38.2</td>
<td>33.7</td>
<td>41.7</td>
<td>47.2</td>
<td>39.8</td>
</tr>
<tr>
<td>Eat sunscreen</td>
<td>9.6</td>
<td>10.7</td>
<td>13.8</td>
<td>16.1</td>
<td>9.9</td>
</tr>
<tr>
<td>Go to a sunbed clinic</td>
<td>1.6</td>
<td>1.2</td>
<td>2.5</td>
<td>2.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Use sunglasses</td>
<td>2.4</td>
<td>2.1</td>
<td>2.5</td>
<td>2.1</td>
<td>1.3</td>
</tr>
<tr>
<td>Skin cancer</td>
<td>0.8</td>
<td>0.7</td>
<td>1.3</td>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Melanoma</td>
<td>0.4</td>
<td>0.4</td>
<td>1.2</td>
<td>0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>Sunburn</td>
<td>2.0</td>
<td>1.7</td>
<td>2.9</td>
<td>2.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Sun sensitivity</td>
<td>0.4</td>
<td>0.4</td>
<td>0.8</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>Sunburn index</td>
<td>0.4</td>
<td>0.4</td>
<td>0.8</td>
<td>0.6</td>
<td>0.3</td>
</tr>
</tbody>
</table>

* P < 0.05; ** P < 0.01; *** P < 0.001. Reference groups: boys; all Y4 children. The P values for year level and sex are for differences in adjusted means. CI, confidence interval; OR, odds ratio; UVI, Ultraviolet Index; Y4, Year 4; Y8, Year 8.

References:

inappropriate (e.g. on sun bed use) were removed. The face and content validity of the student knowledge, attitude and behaviour items were established from the relevant literature.15,23,24 Knowledge items were scored as either 0 or 1. A score of 1 was allocated for either agreement with a factually correct statement or disagreement with a factually incorrect statement. A score of 0 was allocated for either disagreement with a factually correct statement or agreement with a factually incorrect statement. Attitude items were scored as either 1 for disagreement or 0 for agreement with pro-tan statements.23 A non-committal response was interpreted as an indication of hesitation or reluctance to agree with the statement, so a half-point was awarded if the child answered that they were ‘unsure’. Pro-tan behavioural items were scored either as 0 for ‘yes’ or 1 for ‘no’, according to whether or not they were reported for the recall period. Sun protective behavioural items were scored as either 0 for ‘never’ or ‘sometimes’, or 1 for ‘most of the time’ or ‘always’. Records with missing values were neither awarded any points nor classified as correct.

**Procedures**

Ethical approval for the project was obtained from the University of Otago Human Ethics Committee (Ref No. 04/028). The student survey was conducted as part of a larger study to measure children’s sun exposure. The fourth and first terms (October 2004 to April 2005) were selected as the most desirable times to measure sun exposure, because ambient UV radiation levels are then at their highest.26 Approximately 6 weeks prior to survey administration, information sheets and consent forms were distributed to class teachers for parents or guardians. One of two researchers was present for 1 week at each school to administer the student survey to consenting children. Researchers gave only general instructions to assist questionnaire completion and, for Y4 children, the survey was also presented via an overhead projector and each question read aloud to overcome any limitations in reading skills.

**Statistical procedures**

All analyses were carried out using SAS 9.1.2 (SAS Institute Inc., Cary, NC). Differences in responses to individual questions were assessed by year level, sex and year level–sex interaction using PROC GLIMMIX to implement logistic regression models with a random school effect used to account for cluster effects within schools. Differences in knowledge, attitude and behavioural scores were assessed by year level, sex and year level–sex interaction using PROC MIXED to implement linear mixed models with a random school effect. In both cases, denominator degrees of freedom were determined using the Kenward-Rogers method. Because children’s attitudes and behaviours may be substantially influenced by their peers, it was decided to assess differences between year levels rather than age groups. Knowledge, attitude and behaviours scores were calculated as the sum of ‘correct’ or desirable responses. For the path models, PROC CALIS was used to implement structural equation modelling to test specified casual relationships among children’s sun-related knowledge, attitudes and behaviours. This model entails the application of hypothesised relations among variables, specified in terms of the variances and covariances of variables, fitted to an observed covariance matrix.27 The stratified nature of the sample was not considered in the analyses nor were weights used as the focus was on associations rather than prevalence. Marginal and conditional residuals were examined for all models to ensure that model assumptions were sufficiently satisfied.28

**Results**

Overall, 27 schools out of the original 30 selected participated in the study, representing 90% participation of invited schools. Details of population strata by region are presented in Table 1. Of the 667 eligible children, 488 (214 Y4, 274 Y8; 234 male, 254 female) completed the student survey, representing a 73% participation rate. For the representativeness of our sample in relation to children in Y4 and Y8 nationally, we considered school decile and ethnicity as indicators. School decile in NZ is a measure of the socioeconomic status of the community around the school. Decile 1 schools are from low socioeconomic communities, whereas decile 10 schools have the lowest proportions of these students. The sample for the present study was representative of the national school decile distribution for decile 2 (7%), decile 3 (7%), decile 4 (15%), decile 6 (15%), decile 7 (11%), decile 8 (11%) and decile 10 (15%), except for deciles 1 and 5 of which our sample contained 1 and 0 schools, respectively. However, the observed proportions of low decile (1–3), medium decile (4–7) and high decile (8–10) schools were not significantly different from those of all NZ schools (Fisher’s exact test \( P = 0.412 \)).

Self-identified Maori (the indigenous peoples of NZ) represented 23.3% of the sample, 9.0% reported other Pacific ethnicities and 67.7% identified with NZ European and other ethnicities. From data obtained from Statistics New Zealand for the 2001 census, these percentages were similar for the general NZ population of the respective modal ages 8 and 12 years for whom 22.0% were self-identified Maori, 7.7% reported Pacific Island ethnicities and 67.3% identified with NZ European and other ethnicities (Pearson chi-square test \( P = 0.65 \)).

The results for measures of children’s sun-related knowledge, attitudes and behaviours are presented in Table 2. Overall, many students believed that avoiding getting sunburnt (63.9%) and using sunscreen (81.9%) were ways to prevent skin cancer. Approximately two-thirds of all students had got a suntan (61.8%) and got sunburnt (63.7%) the previous summer, while half of all children had used sunscreen (51.4%) and worn a hat or cap (49.4%) to prevent themselves from getting sunburnt. Two comparisons are presented; one used boys as the reference group and the other all Y4 children. In the assessment of the influence of year level, for example, an odds ratio of >1 suggests that Y8 children were more likely to agree with a statement than Y4 children, but less likely to do so if the odds ratio is <1. Mean scores for children’s sun protection knowledge, attitudes and behaviours are presented in Table 3. Y8 children had significantly poorer scores for sun protective behaviour. For NZ European children only, the observed patterns were similar to those found for all ethnicities combined, except a tendency for NZ European boys to have higher mean sun protective behaviour scores (3.5) than NZ European girls (3.1). Where there was
a statistically significant interaction, there was evidence that the sex (year) effects differed between years (sexes). It should be noted that the presented differences are from overall tests of difference between the sexes and years (i.e. adjusted differences, see footnotes to Tables 2 and 3). The nature of these interactions can be seen from inspecting the percentages/mean scores in the Tables.

An initial model (Fig. 1) postulating a direct link between knowledge and behaviour found that this path was not statistically significant ($t = 1.46$) and that model fit could be improved by its removal (Wald test, $P = 0.1429$). Final model fit was more than satisfactory (goodness of fit index $= 0.9971 > 0.9$; adjusted goodness of fit index $= 0.9825 > 0.9$; and chi-square $P$ value $= 0.1434 > 0.05$). Children’s sun-related knowledge, attitudes and behaviours were all correlated, but the association between knowledge and behaviours was mediated by attitudes.

**Discussion**

Children’s relatively high sun-related knowledge scores suggested that, generally, they had a good knowledge of issues related to sun protection and skin cancer. This is consistent with previous studies.\(^{14,15,29}\) However, more than half of all Y4 children and three-quarters of Y8 children reported having been sunburnt last summer, even though a large proportion of children agreed that avoiding sunburn was a good way to reduce skin cancer risk. Despite reporting current knowledge that sunburn is unhealthy, during the previous summer, children either did not know how best to protect themselves from getting sunburnt or did not apply the knowledge they had in the way that would be most protective.
sunburnt, did not place sufficient value on their health to alter their behaviour or experienced a lack of social and environmental support for protective practices. Whatever the combination of factors, many children had experienced sunburn.

Our findings confirm earlier research and support the hypothesis that children’s sun protection knowledge and behaviours are related to year level, such that knowledge increased while behaviours deteriorated among the older age group (Y8). Our findings do not support the hypothesis that, overall, children’s knowledge, attitudes and behaviours scores are related to sex, when that dimension is considered in isolation. However, significant sex–year level interactions were identified for knowledge and behaviour, such that knowledge declined with age for boys, but increased with age for girls. Conversely, protective behaviour scores declined with age for girls, but increased with age for boys. Overall, this pattern is in contrast to a Queensland study which found that several potential barriers to the use of sun protection, for example, the desire to be tanned, the perceived attitudes of peer groups and difficulties with the use of specific sun protection measures, were significantly more prominent among boys than girls.21 The most likely reason for this was the age difference between the two samples, where the Queensland study included older children in Grades 7, 9 and 11, typically ages 12, 14, and 16, respectively.

The patterns of scores for sun protective knowledge, attitudes and behaviours among NZ European children (the ethnic group potentially at greatest risk of skin damage from excessive exposure to UV radiation) were similar to those found for all ethnicities, except a tendency for NZ European boys to have higher sun protective behaviour scores than NZ European girls. While this difference is limited, it should be considered when any intervention that targets specific ethnic groups is considered.

The strongest association with age in Table 2, the perception that going to a sun bed clinic helps provide protection against skin cancer, reflects a widespread lack of understanding about that issue among the younger children. The second strongest association, the actual wearing of broad-brimmed hats, bucket hats or a cap with flaps indicated that older children were far less likely than younger children to wear these types of hats. Part of the SunSmart schools’ policy is the ‘no hat, no play’, or ‘no hat, play in the shade’ guideline.30 It is unclear why older children report that they are less likely to wear either the most protective type of hat, or any hat, compared with younger children, when they are supposedly subject to the same set of rules in place at school. It could be that these types of hats are less attractive among older children and younger children are easier for teachers and care givers to supervise.

Despite having the highest knowledge score, Y8 girls scored the lowest attitude scores, consistent with findings among adolescent girls.14 Our results suggest that the older girls knew more about sun protection and skin cancer compared with younger children, but that this knowledge was not translated into healthy sun exposure attitudes. Overall, children’s knowledge was only associated with behaviour through their attitudes, but not directly with their behaviours. Previous interventions designed to improve children’s sun protection have successfully used education-based programmes to increase knowledge, but have not necessarily produced sustained changes in behavioural intentions or protective behaviours.51,52 Improvements in knowledge that are not reinforced by positive changes in attitudes may not be able to sustain behaviour change. ‘Kidskin’, a non-randomised, school-based sun protection intervention trial in Perth, Western Australia, aimed to determine the extent to which such a programme could reduce children’s sun exposure.52 This multi-component intervention included a specially designed curriculum, but at the end of the 4-year programme and 2 years thereafter, there was little evidence of any favourable effect. The results from the cross-sectional study reported here remain within the context of association rather than causality, and so do not provide strong evidence that a change in attitudes could be expected to lead to a change in behaviour. Nevertheless, the results of a previous study which used the theory of planned behaviour tend to confirm that changes in attitudes can affect behaviour.53

Some possible study limitations include the reliance on self-report of usual behaviour that is strongly contextually linked. However, previous studies have shown that children are reasonably good at self-reporting, including their usual sun-related behaviour.14–17 The survey was part of a larger sun exposure study and some children declined to participate because of the perceived cumbersomeness of other study tasks. In addition, the sample was not randomly selected from the national population and, therefore, the findings are not necessarily representative of that population. Nevertheless, the sample from the five regions surveyed was characteristic of NZ primary schoolchildren.

The most important insight gained through the present study was that attitudes towards sun exposure and obtaining a suntan should be specifically targeted in sun protection and skin cancer prevention programmes aimed at children, because these attitudes tend to mediate the association between knowledge and behaviours. This finding is of major relevance in the formation of sun protection programmes aimed at children, and suggests that, so long as sun-related knowledge is in place, once pro-tan attitudes are reversed, there is a reasonable expectation that the frequency of sun protective behaviours will increase.

Acknowledgements

Special thanks are due to the Cancer Society of New Zealand (NZ) divisional health promotion staff, school principals, teachers and children who participated and made this project possible. G Bodeker, V Hammond, H Shiona, R McKenzie, M Kotkamp, M Allen, N Huston and J Jopson are acknowledged for their contribution to the project. The project was initiated and undertaken by the Social and Behavioural Research in Cancer Group and funded by a project grant from the Cancer Society of NZ Inc. The views expressed are not necessarily those of the Cancer Society of NZ Inc. During the preparation of this paper, Dr Reeder and the Social and Behavioural Research in Cancer Group received funding from the Cancer Society of NZ Inc. and the University of Otago. Associate Professor Cox received support from the Director’s Cancer Research Trust. Ms Wright received support from the National Research Foundation of South Africa, the National Institute of Water and Atmospheric Research and an International PhD scholarship from the University of Otago.
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