Effect of a School-based Sun-Protection Intervention on the Development of Melanocytic Nevi in Children

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"Kidskin" was a 5-year (1995–1999), school-based intervention trial among first-grade children in Perth, Western Australia. It aimed to assess whether a sun-protection intervention could protect against nevus development on the trunk, face, and arms. Included were a control group, a "moderate intervention" group, and a "high intervention" group. Control schools taught the standard health curriculum, while intervention schools received a specially designed sun-protection curriculum over 4 years. The high intervention group also received program materials over summer vacations when sun exposure was likely to be highest and were offered low-cost sun-protective swimwear. After adjustment for baseline nevus counts and potential confounding, nevus counts on all body sites were slightly lower in both intervention groups relative to the control group at follow-up, although the differences were not statistically significant and the high intervention was no more protective. Children in the moderate and high intervention groups, respectively, had fewer nevi on the back (6%, 95% confidence interval (CI): 0, 12; 4%, 95% CI: –3, 11), chest (boys) (5%, 95% CI: –4, 13; 3%, 95% CI: –8, 14), face (11%, 95% CI: 0, 21; 9%, 95% CI: –6, 21), and arms (8%, 95% CI: –1, 17; 3%, 95% CI: –10, 14). Am J Epidemiol 2002;155:739–45.

Prevention of skin cancer, particularly melanoma, is a priority among White populations living in countries with high levels of solar radiation. Exposure to sunlight is the main cause of melanoma (1, 2), and childhood exposure is particularly important (3). Although programs encouraging sun protection in children exist (4, 5), levels of exposure remain high (6–11).

Melanocytic nevi are suitable intermediate endpoints to evaluate childhood sun-protection interventions; they are strongly related to history of sun exposure (12–15) and to risk of melanoma (16), and they are common in children (12, 17, 18). Nevi have been used to evaluate two previous interventions. The Vancouver Moles Cohort Study involved 309 White children (154 aged 6 or 7 years and 155 aged 9 or 10 years) at six schools, who were individually randomized into an intervention or control group. Children in the intervention group received free sun-protection factor 30 sunscreen at the beginning of summer each year from 1993 through 1995, and their parents were instructed to apply it when the children were to be out in the sun for at least 30 minutes. The average number of new nevi that developed over the 3-year period was higher in the control group than in the intervention group, 28.0 versus 24.0 (p = 0.048), while reported sun exposure was similar in the two groups (19). The other study was a community-based trial—the Cancer Action in Rural Towns study—conducted in 10 matched pairs of towns in New South Wales, Australia, between 1994 and 1998 (20). It aimed to improve sun-protection practices, knowledge, and attitudes. Workplaces, schools, retailers, and sporting organizations participated over 3 years. In 1995, a year after the intervention began, the backs of 592 children living in 11 towns were photographed. In 1998, 311 of these children—then aged 8–12 years—were rephotographed. No significant differences were found between intervention and control towns with regard to the development of nevi (R. Burton, Anti-cancer Council of Victoria, Australia, personal communication, 2000).

This paper describes the main results of the Kidskin study. This Western Australian school-based sun-protection intervention commenced in 1995.

MATERIALS AND METHODS

Study design

The study design has been described previously (21). Briefly, the study involved a cohort of children who commenced school in 1995 at age 5 or 6 years. The study was a nonrandomized, community intervention trial with schools as the units of intervention. Three groups were included: a control group of 14 schools, a “moderate intervention” group of 11 schools, and a “high intervention” group of eight schools. Schools were not randomly assigned to treat-
ment groups because of concerns about contamination and because costs were reduced by designating schools closest to the center of Perth as eligible for the high intervention group. Schools located farthest from the center of Perth were designated as control group clusters. Schools were randomly selected from within clusters, after stratification by social disadvantage (21).

The study was designed to have 85 percent power ($\alpha = 0.05$, two-sided test) to detect a 25 percent reduction in exposure when controls were compared with the high intervention group (21), although the data on which these calculations were based (especially the variance in number of nevi) were not ideal. We estimated that a 25 percent reduction in exposure would equate to an 8 percent difference in the mean number of nevi at the end of the study.

Control schools taught the standard Western Australian health education curriculum (22). Moderate and high intervention schools taught a specially designed sun-protection curriculum over 4 consecutive years (1995–1998). Children were encouraged to reduce their sun exposure by staying indoors during the middle of the day and by protecting themselves when outdoors by staying in the shade and wearing sun-protective clothing, hats, and sunscreen. Children in the high intervention group were also sent program materials over the summer vacation, when sun exposure is likely to be highest, and were offered low-cost sun-protective swimwear.

The study was approved by human research ethics committees at the University of Western Australia and at Curtin University of Technology. Parents of all subjects provided their written informed consent.

Outcomes

The main outcome was the number of nevi on the back at the end of the study. The back is a common site for nevi (18) and melanoma (23), and nevi on this site are relatively easy to count (24). Other outcomes included the number of nevi on the face, arms, and, for boys, the chest; levels of suntan on the back and forearms at the end of summer; and sun-related behavior during the summer vacation.

Data collection

Nevi were counted in winter to minimize confusion with freckling. Observers were trained according to the International Agency for Research on Cancer protocol for identifying and recording nevi (25). Under bright light, the observers counted the number of nevi on each child’s face and arms. Slides of each child’s back—and boys’ chests—were taken by using professional photographic equipment. Anatomic landmarks were marked on children’s skin, so that the areas on which nevi were to be counted later could be identified on the slides. The shoulders were excluded because they are often freckled, which makes nevus counting difficult.

The slides taken of each child’s trunk in 1995 and 1999 were projected side by side onto a whiteboard. An experienced observer, blind to study group, identified and marked all preexisting and new nevi on the 1999 slide by referring to the 1995 slide. Nevii that had disappeared from the later slide were also marked, and any excisions were noted. The observer also indicated whether factors such as freckling or poor slide quality made counting difficult.

In 1999, nevi on randomly selected pairs of slides were counted twice by the same observer so that intrarater reliability could be estimated; a dermatologist also counted nevi from randomly selected pairs of slides. Each time nevi on the face and arms were counted, randomly selected children were assessed twice—either by the same observer or two different observers—at least 15 minutes apart.

The level of freckling on the face and arms was estimated whenever nevi were counted, and freckling on the shoulders was assessed when the two slides of the back were compared. The shoulders tend to be more freckly than the back and therefore provide a better indication of a child’s tendency to freckle. Winter freckling on the face, arms, and shoulders was scored between 0 (none) and 10 (very heavy) according to a series of diagrams showing variations in distribution and density of freckling on each of these sites (12).

As a measure of suntan, skin reflectance was measured on the back and right forearm at the end of the second and fourth (final) summers by using a spectrophotometer. As a measure of constitutional skin color, reflectance was measured on the right upper inner arm during the baseline winter. Questionnaires on outdoor activity were completed by parents before the intervention began in 1995 and at the end of the summer vacation at the midpoint (1997) and end (1999) of the study. Questions were asked about time spent outdoors and the proportion of time children wore a hat or sunscreen, stayed in the shade, or had their back covered by clothing at each locale. A composite index of overall, effective sun exposure was also derived from information about the amount of time children spent outdoors and the level of sun protection they used (26).

More favorable results in the two intervention groups with respect to these outcomes midway through the study (1997) have been described previously (26, 27). After taking account of baseline differences, children who participated in the Kidskin program were consistently more sun protected at follow-up than those in the control group. Children in the high exposure group had the most favorable behaviors, the control group the least favorable behaviors, and the moderate group intermediate behaviors. The behaviors most affected were reducing time spent outdoors during the middle of the day, covering the back with clothing and swimsuits, and seeking shade (27). Consistent with these results, the 1997 sun exposure index suggested a 25 percent difference in overall effective sun exposure between children in the high intervention group and controls, while the measured level of suntan on the back and, to a lesser extent, the forearm was lower in children in the intervention groups (26).

Data analysis

The generalized linear mixed model (the SAS System Proc MIXED procedure (28)) was used to compare 1999 nevus counts among the three groups, while taking account of group assignment by school and adjusting for potential confounding. Nevus counts were considered separately for
individual body sites because of the different methods used to
count nevi on the trunk compared with the arms and face.
The number of nevi present on each body site at follow-up
was lognormally distributed, after a constant (1.0) was
added to allow for subjects with no nevi. These analyses
produced adjusted geometric means for each study group,
the ratio of the adjusted means in the moderate and high
intervention groups to that in the control group, and a 95
percent confidence interval for these ratios. Adjustment
was made for the logged baseline nevus count on the same site,
observer and month of observation in each year, parental
education, tendency to sunburn, southern European ethnicity,
sex, hair color, inner arm (winter) skin reflectance, and
an interaction term involving month of observation in each
year. In preliminary analyses, each outcome variable—(log)
nevi on the back, chest, face, and arms—was regressed on
the nevus count for the same site at baseline. This regression
was conducted to determine the form of the baseline nevus
variable that was the best predictor of the final counts, and
it was undertaken without knowledge of intervention group.
In each case, the logged form of the baseline site-specific
nevus count produced the highest adjusted $R^2$ value and was
therefore selected for inclusion in the final model. The deci-
sion to retain confounding variables in the model was based
on a backward selection process (29).

The level of winter freckling on each site was treated as a
continuous outcome, and means for each group were esti-
mated as described above by using the generalized linear
mixed model (28). Intraclass correlation coefficients, as
measures of inter- and intrarater reliability for nevus counts,
were calculated by using one-way analysis of variance (30).

**RESULTS**

Of the 33 schools originally selected for the study in 1995,
28 agreed to participate. Five replacement schools were ran-
domly selected from the same cluster and level of social dis-
advantage as the schools that declined to take part; all of these
replacement schools participated. Consent was obtained for
1,776 (70 percent) of the 2,529 year 1 children invited to par-
ticipate; 1,623 were of European ethnicity. Non-European
children were excluded because melanoma and other skin
cancers are rare among those ethnic groups (31).

Of the 1,623 study participants, 1,615 were examined in
1995, and 1,455 were still living in Perth and were available
for follow-up assessment in 1999. Either a back or chest
slide was missing for 19 (1.3 percent) subjects. The slides
for another 19 children (three in the high exposure group,
eight in the moderate exposure group, and eight in the con-
trol group) were rated impossible to count because of freck-
ling or other skin blemishes. Among the remaining 1,417
children, information on at least one confounding variable
was missing for 19, leaving 1,398 eligible for inclusion in
data analyses. All 1,455 children reexamined in 1999 had a
nevus count for the face, and 1,454 had a count for the arms.
Information on potential confounding variables was missing
for 23 (1.6 percent) children, leaving 1,432 and 1,431 chil-
dren to be included in the analysis of nevi on the face and
arms, respectively.

Hair and eye color, the propensity to burn, and the abili-
ty to tan were evenly distributed among the three study
Groups at the beginning of the study, as was sex (table 1).
Southern European ethnicity was more prevalent in the
high intervention group and less so in the control group.
Despite stratification by index of social disadvantage in
the school selection process, parental education differed sub-
stantially across groups (table 1).

To determine whether children lost to follow-up were
similar to those still available for testing, baseline nevus

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control group (n = 629)</th>
<th>Moderate intervention group (n = 416)</th>
<th>High intervention group (n = 353)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>52.1</td>
<td>55.0</td>
<td>50.4</td>
</tr>
<tr>
<td>Female</td>
<td>47.9</td>
<td>45.0</td>
<td>49.6</td>
</tr>
<tr>
<td>Hair color</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black or dark brown</td>
<td>33.7</td>
<td>35.8</td>
<td>39.7</td>
</tr>
<tr>
<td>Light brown</td>
<td>32.5</td>
<td>34.1</td>
<td>33.1</td>
</tr>
<tr>
<td>Blonde or fair</td>
<td>30.6</td>
<td>27.9</td>
<td>23.8</td>
</tr>
<tr>
<td>Red or auburn</td>
<td>3.2</td>
<td>2.2</td>
<td>3.4</td>
</tr>
<tr>
<td>Eye color</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown</td>
<td>21.7</td>
<td>20.9</td>
<td>25.5</td>
</tr>
<tr>
<td>Hazel</td>
<td>25.6</td>
<td>23.1</td>
<td>21.0</td>
</tr>
<tr>
<td>Blue</td>
<td>51.7</td>
<td>53.8</td>
<td>51.6</td>
</tr>
<tr>
<td>Green</td>
<td>1.0</td>
<td>2.2</td>
<td>2.0</td>
</tr>
<tr>
<td>Propensity to burn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe with blisters</td>
<td>13.3</td>
<td>11.5</td>
<td>9.9</td>
</tr>
<tr>
<td>Painful burn</td>
<td>40.8</td>
<td>47.1</td>
<td>43.6</td>
</tr>
<tr>
<td>Mild burn</td>
<td>40.8</td>
<td>38.2</td>
<td>40.2</td>
</tr>
<tr>
<td>Not burn at all</td>
<td>5.1</td>
<td>3.1</td>
<td>6.2</td>
</tr>
<tr>
<td>Ability to tan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very tanned</td>
<td>37.9</td>
<td>33.7</td>
<td>32.0</td>
</tr>
<tr>
<td>Moderate tan</td>
<td>40.8</td>
<td>42.3</td>
<td>45.9</td>
</tr>
<tr>
<td>Lightly tanned</td>
<td>19.0</td>
<td>20.7</td>
<td>20.1</td>
</tr>
<tr>
<td>No tan at all</td>
<td>2.2</td>
<td>3.4</td>
<td>2.0</td>
</tr>
<tr>
<td>Southern European ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>5.4</td>
<td>10.6</td>
<td>14.7</td>
</tr>
<tr>
<td>No</td>
<td>94.6</td>
<td>89.4</td>
<td>85.3</td>
</tr>
<tr>
<td>Parental education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tertiary</td>
<td>25.2</td>
<td>45.2</td>
<td>48.7</td>
</tr>
<tr>
<td>Nontertiary</td>
<td>74.8</td>
<td>54.8</td>
<td>51.3</td>
</tr>
</tbody>
</table>

* Percentage of children in each category.
units for month of photography, the means on the natural scale were not. After square-root transformation and adjustment.

Counts for the back were compared in these subsets of children. This analysis was undertaken for 813 randomly selected children whose slides were examined soon after data collection in 1995 (so that baseline equivalence among the study groups could be assessed (21)). Of these children, 738 were available for follow-up assessment in 1999 and 75 were not. After square-root transformation and adjustment for month of photography, the means on the natural scale were 3.3 and 3.7 (p = 0.3), respectively, indicating that the difference was small and not statistically significant.

Winter freckling ratings on the face and arms were similar among the groups, both at baseline and follow-up. Furthermore, freckling ratings were generally low, particularly on the arms (table 3). Freckling on the shoulders was assessed when the 1995 and 1999 slides of the back were compared, even though nevus counts on the back were restricted to an area below the shoulders. The amount of freckling on this site was low at both baseline and follow-up; more than 90 percent of children in each group had a rating of 0 or 1 out of 10 at the end of the study. The means in the three groups were similar at baseline, although, at follow-up, children in the control group appeared to have slightly more freckling on this site than children in the high intervention group (table 3).

The adjusted mean nevus counts in each group in 1995 and 1999 are shown in table 4. There were small differences among the three groups just before the Kidskin intervention was implemented; children in the moderate intervention group had slightly higher counts for the face and arms and a lower count for the back. After adjustment, the nevus counts at follow-up in 1999 were 3–11 percent lower in the two intervention groups than in the control group for all body sites, although the differences were not statistically significant (table 4). In each case, the adjusted counts were lower in the moderate than in the high intervention group. Confidence intervals around all estimates were narrow and were consistent with weak associations at most. No significant statistical interactions were found between treatment group and any other variable, including baseline nevus count or freckling level.

The intraclass correlation coefficients for the reproducibility of nevus counts were high, both within and between observers (table 5). Furthermore, the mean difference between the counts of the observer and the dermatologist was low (−0.4 (95 percent confidence interval: −0.9, 0.07)), and there was no obvious relation between the value of the mean and the agreement between observers (data not shown).

### DISCUSSION

On average, children who received the Kidskin intervention had fewer nevi on all body sites at the end of the study than children in the control group, after adjustment for potential confounding variables. They had approximately 5 percent fewer nevi on the back and 3–11 percent fewer nevi on other body sites. None of these weak associations was statistically significant.

The confidence intervals for nevi on all body sites were narrow and were compatible with only small protective effects of the intervention. For example, the confidence intervals for the main outcome—nevus on the back—effectively ruled out reductions of more than 12 percent in the mean number of nevi in the high intervention group relative to the control group.

The Kidskin program involved delivery of a wide range of classroom- and home-based activities to promote and reinforce positive sun-related behavior in children over 4 consecutive years. As such, to our knowledge it is the

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**TABLE 2.** Mean body surface area, by group at baseline and follow-up, in children included in the analysis of nevi on the back, Kidskin study, Perth, Western Australia, 1995–1999

<table>
<thead>
<tr>
<th>Year</th>
<th>Control group (n = 629)</th>
<th>Moderate intervention group (n = 416)</th>
<th>High intervention group (n = 353)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>0.84 (0.09)†</td>
<td>0.84 (0.09)</td>
<td>0.85 (0.08)</td>
</tr>
<tr>
<td>1999</td>
<td>1.17 (0.15)</td>
<td>1.16 (0.14)</td>
<td>1.19 (0.14)</td>
</tr>
</tbody>
</table>

* In square meters.
† Numbers in parentheses, standard deviations.

**TABLE 3.** Mean winter freckling ratings at baseline and follow-up among children in the Kidskin study, Perth, Western Australia, 1995–1999

<table>
<thead>
<tr>
<th>Year and site</th>
<th>Control group Mean (95% CI†)</th>
<th>Moderate intervention group Mean (95% CI)</th>
<th>High intervention group Mean (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Face†</td>
<td>2.5 (2.3, 2.7)</td>
<td>2.3 (2.1, 2.6)</td>
<td>2.3 (2.0, 2.6)</td>
</tr>
<tr>
<td>Arms†</td>
<td>1.2 (1.1, 1.4)</td>
<td>1.0 (0.8, 1.2)</td>
<td>1.2 (0.9, 1.4)</td>
</tr>
<tr>
<td>Shoulders‡</td>
<td>0.1 (0.07, 0.15)</td>
<td>0.05 (0.0, 0.1)</td>
<td>0.1 (0.0, 0.14)</td>
</tr>
<tr>
<td>1999</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Face†</td>
<td>3.7 (3.4, 4.0)</td>
<td>3.7 (3.4, 4.1)</td>
<td>3.8 (3.4, 4.2)</td>
</tr>
<tr>
<td>Arms†</td>
<td>2.3 (2.1, 2.5)</td>
<td>2.2 (2.0, 2.4)</td>
<td>2.3 (2.1, 2.5)</td>
</tr>
<tr>
<td>Shoulders‡</td>
<td>0.6 (0.5, 0.7)</td>
<td>0.4 (0.3, 0.6)</td>
<td>0.4 (0.2, 0.6)</td>
</tr>
</tbody>
</table>

* CI, confidence interval.
† Adjusted for month of observation and observer.
‡ Adjusted for month of observation.
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largest, most comprehensive and most intensive sun-protection intervention to be undertaken and evaluated to date. Midway through the study in 1997, the two intervention groups had lower levels of suntan and reported sun exposure than the control group (26, 27). Therefore, a greater impact on the development of nevi might have been anticipated.

Overall, the results have a high degree of validity. The rates of follow-up were excellent, and missing data were relatively rare. Accurate and reliable measurement of all outcome and predictor variables was emphasized by using established methods, and reproducibility within and between observers was high. Every effort was made to minimize nondifferential measurement error and eliminate differential error, including blinding of observers. Therefore, any error in the nevus counts was likely to be nondifferential, with a loss of precision (for error in final counts) or attenuation of the association (for error in baseline counts) the most likely consequences. Importantly, the level of freckling on the arms and face was similar in the three groups on both occasions that nevi were counted. The amount of freckling on the shoulders was similar among the

<table>
<thead>
<tr>
<th>Site</th>
<th>Control group</th>
<th>Moderate intervention group</th>
<th>High intervention group</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Value</td>
<td>No.</td>
<td>Value</td>
</tr>
<tr>
<td>Back (n = 1,398)</td>
<td>629</td>
<td>416</td>
<td>353</td>
<td></td>
</tr>
<tr>
<td>Adjusted mean 1995*†</td>
<td>4.0</td>
<td>3.6</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td>Adjusted mean 1999‡</td>
<td>7.3</td>
<td>6.8</td>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td>Ratio of means (95% CI)[§¶]</td>
<td>0.94 (0.88, 1.00)</td>
<td>0.96 (0.89, 1.03)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest (boys only, n = 731)</td>
<td>328</td>
<td>227</td>
<td>176</td>
<td></td>
</tr>
<tr>
<td>Adjusted mean 1995†</td>
<td>3.3</td>
<td>3.4</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Adjusted mean 1999‡</td>
<td>6.3</td>
<td>6.0</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>Ratio of means (95% CI)[¶]</td>
<td>0.95 (0.87, 1.04)</td>
<td>0.97 (0.86, 1.08)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Face (n = 1,432)</td>
<td>646</td>
<td>430</td>
<td>356</td>
<td></td>
</tr>
<tr>
<td>Adjusted mean 1995#</td>
<td>4.2</td>
<td>4.4</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>Adjusted mean 1999**</td>
<td>6.0</td>
<td>5.4</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Ratio of means (95% CI)[¶]</td>
<td>0.89 (0.79, 1.00)</td>
<td>0.91 (0.79, 1.06)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arms (n = 1,431)</td>
<td>646</td>
<td>429</td>
<td>356</td>
<td></td>
</tr>
<tr>
<td>Adjusted mean 1995#</td>
<td>9.2</td>
<td>9.8</td>
<td>8.9</td>
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<tr>
<td>Adjusted mean 1999**</td>
<td>14.1</td>
<td>13.0</td>
<td>13.7</td>
<td></td>
</tr>
<tr>
<td>Ratio of means (95% CI)[¶]</td>
<td>0.92 (0.83, 1.01)</td>
<td>0.97 (0.86, 1.10)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* All adjusted means are geometric means of “nevi + 1.”
† Adjusted for month of observation.
‡ Adjusted for sex, tendency to sunburn, southern European ethnicity, parental education, hair color, inner arm reflectance, baseline nevus count, month of observation in each year, and month95 × month99.
§ CI, confidence interval.
¶ Group mean divided by control group mean.
# Adjusted for month of observation and observer.
** Adjusted for sex, tendency to sunburn, southern European ethnicity, parental education, hair color, inner arm reflectance, baseline nevus count, observer in each year, month of observation in each year, and month95 × month99.

TABLE 4. Mean nevus counts on each body site at baseline and follow-up among children in the Kidskin study, Perth, Western Australia, 1995–1999

TABLE 5. Reproducibility of nevus counts at baseline and follow-up, Kidskin study, Perth, Western Australia, 1995–1999

<table>
<thead>
<tr>
<th>Year</th>
<th>Site</th>
<th>Control group</th>
<th>Moderate intervention group</th>
<th>High intervention group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trunk</td>
<td>Intraclass correlation coefficient (95% CI)[*]</td>
<td>Face</td>
<td>Intraclass correlation coefficient (95% CI)</td>
</tr>
<tr>
<td>1995</td>
<td></td>
<td>No.</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intrarater</td>
<td>124</td>
<td>8</td>
<td>0.98 (0.97, 0.99)</td>
</tr>
<tr>
<td></td>
<td>Interrater</td>
<td>152</td>
<td>9</td>
<td>0.86 (0.81, 0.90)</td>
</tr>
<tr>
<td>1999</td>
<td>Intrarater</td>
<td>62</td>
<td>4</td>
<td>0.93 (0.88, 0.96)</td>
</tr>
<tr>
<td></td>
<td>Interrater</td>
<td>58</td>
<td>4</td>
<td>0.82 (0.87, 0.95)</td>
</tr>
</tbody>
</table>

* CI, confidence interval.

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three groups at baseline, while at follow-up it was slightly higher in the control group. These small differences were unlikely to have affected the results, as freckling levels were generally very low and the shoulders were excluded from the area on which nevi were counted.

Bias from the nonrandomized design is possible (21). To minimize this potential problem, we adjusted for all individual-level variables considered, a priori, to be predictive of the outcomes, even when baseline differences between the groups were small. Residual confounding is unlikely to have biased the study results in a way that would have altered our conclusions. The between-group differences in these variables at baseline suggest that children in the high intervention group were less likely to develop nevi than children in other groups. Thus, if these factors had not been fully accounted for, the effect of the intervention would (if anything) have been overestimated.

Another area of concern relates to the potential for bias resulting from the differential recall and social desirability (32) associated with parent-reported information about their children’s sun-protection behavior. Such bias may have produced an overestimation of the favorable effect of the Kidskin intervention on these behaviors among children who received it. This overestimation, in turn, may have led to the more favorable reported behaviors (26, 27) in these children not being accompanied by a similar effect on nevi. However, the deeper suntan measured objectively in the control group children compared with those in the two intervention groups at follow-up in 1997 (26) suggests that there were genuine differences in behavior among the groups.

There are several possible explanations for the apparent discrepancy between the lack of intervention effect on nevus development and the relatively favorable sun-protection behaviors reported previously (26, 27). Firstly, the participants may have been too old at recruitment for the Kidskin intervention to have a major impact on the development of nevi. However, the Vancouver Moles Cohort Study reported a protective effect of their intervention in children older than those in the Kidskin study; half of that study’s participants were aged 6–7 years and half were aged 9–10 years at recruitment (19).

Secondly, it is possible that not enough time had elapsed for behavior change to protect against nevus development. The Kidskin intervention was first implemented during the final school term of 1995, just prior to the summer vacation in December 1995–January 1996. Thus, the earliest possible impact of the intervention on sun-protection behavior would have occurred at that time, 3.5 years before nevi were recounted at the end of the study. Significant differences among the groups with respect to sun-related behavior and suntan were observed in 1997 (26, 27). Even if behavior did not change until then, there was still a 2.5-year time lag before nevi were recounted in 1999. Since the Kidskin intervention began, two other research groups have published results that suggest a 2-year induction time between sun exposure and nevus development in children. A joint Australian–United Kingdom study compared rates of nevus development in children of similar ethnicity in Townsville, Queensland, Australia, and Glasgow, Scotland, from birth to age 3 years (33). The proportions of children who had any nevi at age 1, 2, and 3 years, and the nevus counts at each age, were significantly higher in Australian children. The second study is the Vancouver Moles Cohort Study, in which children were issued free sunscreen over 3 consecutive summers (19). These data suggest that there was sufficient time to observe an effect on nevi in the Kidskin study.

Thirdly, although the Kidskin intervention appeared to have had a positive effect on sun-protection behavior by 1997 (26, 27) and again in 1999 (unpublished data), it is possible that other behaviors relevant to the development of nevi remained similar among the groups, thereby accounting for the apparent lack of effect on nevi. For example, childhood sunburn may be related to the development of nevi (13, 14, 34, 35). Sunburn generally occurs after intermittent or unaccustomed intense sun exposure. The Kidskin program aimed not only to reduce the number of episodes of sun exposure but also to increase the level of protection during any given episode. Information on sunburn was collected in the 1997 and 1999 questionnaires; children in the two intervention groups were reported to have had less frequent and less severe sunburns than those in the control group (unpublished data). However, in the absence of baseline data on sunburn, these results may have been due to pre-existing differences. Nevertheless, it seems likely that the better sun-protection behavior reported in the two intervention groups at follow-up would have been associated with less sunburn.

Fourthly, nevi may not be a particularly sensitive indicator of sun exposure. Few data are available on the dose-response relation between sun exposure and the development of nevi in children, and those that exist are discrepant. The biggest differences in the prevalence of nevi (among children of the same age and ethnic background) have been observed in studies comparing children in Australia and the United Kingdom (33, 36) or comparing children living at very different latitudes within Australia (15). On the other hand, in studies conducted within single communities, the associations observed between the prevalence of nevi in childhood and various measures of sun exposure have been relatively weak (12, 34, 35). These results suggest that, in any given geographic location, relatively subtle differences in sun exposure have only a weak effect on nevus development. Thus, the effect of the Kidskin intervention on sun exposure may simply have been insufficient to impact the development of nevi.

Finally, in Australia, there is a high level of community awareness about the importance of sun protection. Thus, the associated “contamination” of the control group would have made the children in that group more similar to children in the intervention groups—with respect to sun-related behavior—than would otherwise have been the case. Such contamination would have limited the potential for improvement in sun-protection behavior among children who received the Kidskin intervention, relative to the children in the control group, and thereby have limited the potential for the program to affect nevus development.

The fact that the high-level intervention did not have a greater protective effect on the development of nevi than the moderate level of intervention is difficult to explain, given
that children in the former group had less sun exposure. In any event, it casts doubt on the benefit of the additional components of the high-level intervention, particularly given their extra cost.

The use of nevi to evaluate sun-protection intervention trials may not be cost effective in Australia, given that nevi may be sensitive to only relatively large differences in sun exposure. Such trials may produce only marginal improvements in behavior in a population already exposed to 20 years of campaigns about preventing skin cancer.

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