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Recalling our day in the sun: comparing long-term recall of childhood sun exposure with prospectively collected parent-reported data†

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To examine the impact of sun exposure on human health, accurate measures of past sun exposure are required. We investigated how young adults' recall of childhood sun-related behaviours compares with parent-reported measures collected during childhood. The Kidskin-Young Adult Myopia Study (KYAMS) is a follow-up of the Kidskin Study, a sun-protection intervention study conducted from 1995–2001. KYAMS participants, aged 25–30 years, reported time in sun, and use of hats and sunscreen, for each year from ages 5–26 years (n = 244). Using weighted kappa, we assessed agreement between these data and corresponding variables derived from the Kidskin Study parent questionnaires completed when KYAMS participants were aged 6–12 years. Ordinal logistic regression was used to test the association between self-reported sun-behaviours and corresponding parent-reported data. We found slight agreement between self-reported and parent-reported data for all sun-behaviour measures except hat use at 12 years. KYAMS recall of time in sun at 8–12 years was not associated with Kidskin Study parent-reported responses after adjustment for current time in sun. Recall of higher hat and sunscreen use was associated with higher parent-reported hat and sunscreen use (OR[hat] = 1.37, 95% CI: 1.16, 1.62; OR[sunscreen] = 1.23, 95% CI: 1.03, 1.48). However, KYAMS self-reported data were unable to predict corresponding parent-reported responses. Group data from retrospective recall of sun-related behaviours may be of limited value in studying the relationship between sun exposure and health outcomes; however, individual data are likely of little use.

Introduction

The sun plays a fundamental role in our health. Diseases such as melanoma, multiple sclerosis, pterygium and myopia have all been linked with excessive or insufficient past sun exposure.[1–4] Childhood appears to be a key period in which sun exposure can modify long-term risk of certain health conditions. For example, high amounts of childhood sun exposure or time spent outdoors have been associated with increased risk of melanoma[5,6] and pterygium[4] (a fibrovascular growth on the eye studies) and decreased risk of multiple sclerosis[7] and myopia.[8,9] Research into or predictions of an individuals' current or future risk of a certain sun exposure-related condition, such as melanoma or pterygium, may therefore depend upon retrospective recall of sun exposure or sun protection behaviours. Indeed, some of the aforementioned studies[4,7] as well as case-control studies of melanoma[10,11] relied on retrospective recall of sun exposure, despite the lack of validation of these data against childhood-specific measures of sun exposure.

One of the challenges in testing the links between sun exposure and disease, particularly for childhood sun exposure in relation to adult diseases, is accurate measurement of past sun exposure. There are a number of objective measures of current sun exposure such as electronic and polysulphone dosimeters.[12–15] However, objective measures of long-term past sun exposure assess only cumulative exposure over the lifetime, *e.g.* silicone skin casts provide a measure of cumulative actinic skin damage.[16,17] Importantly, these methods cannot detect variations in the amount of sun exposure received at specific ages or over particular time frames, such as childhood, which may be of interest for some disease outcomes, *e.g.* myopia, multiple sclerosis.[9] Additionally, these objective measures of cumulative exposure are influenced by

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other factors such as age or skin type, which can limit their utility, and are typically measured for one body site, such as the wrist, which may not be relevant to the research question.[12,15]

Self-reported measures of sun exposure, ranging from diaries to questionnaires completed during particular times of life, may circumvent some of the limitations of objective measures of cumulative sun exposure. Short-term recall (*e.g.* weeks to months) of sun exposure has been shown to correlate with objective measures of short-term sun exposure, such as serum 25-hydroxyvitamin D (25[OH]D) concentration.[13,16,18]

Few studies have examined the validity of self-reported sun exposure over the longer term, *e.g.* 5+ years prior. King and colleagues found that participants overestimated time spent outdoors over the previous 12-month period compared to a sun diary completed throughout the year. However, this group also found that the rank correlation (Spearman) was better (ρ = 0.35 to ρ = 0.56), indicating that while participants overestimated their sun exposure, ranking of participants was preserved to some extent.[19] Sun calendars that ask participants to recall time in sun and sun-protection behaviours for each year of life from early childhood (*e.g.* 5 years) have been previously used for long-term retrospective assessment of sun exposure.[16,20] Using such a sun calendar, time in the sun in summer over the last year and over the last 3 years was correlated with serum 25[OH]D concentration (r = 0.22 and r = 0.23, respectively).[16] Additionally, self-reported cumulative lifetime sun exposure has been found to be correlated with actinic skin damage.[16,17,21,22] However, it is not clear whether long-term recall of sun exposure provides an adequate measure to explore effects of sun exposure at specific ages, rather than the cumulative total. If such measures were accurate, they could provide information on particular ages of susceptibility to the adverse or beneficial effects of sun exposure.

Here we aimed to assess the extent to which young adults' recall of their summertime sun exposure and use of sun-protection measures at 6, 8, 10 and 12 years of age agreed with parent-reported data collected at those same ages, and whether these self-reported responses could be used to predict an individual's childhood sun exposure or sun protection use.

Materials and methods

Participants

Participants of the Kidskin Young Adult Myopia Study (KYAMS) who participated before January 2019 were included in this study. The KYAMS has been underway since 2015 and details of the study have been published elsewhere.[23] Briefly, the KYAMS is a follow-up of the Kidskin Study and aims to investigate the relationship between a childhood sun-protection intervention and long-term risk of myopia. The Kidskin Study was a school-based intervention trial that aimed to reduce sun exposure in primary school children and assess whether they subsequently developed fewer melanocytic nevi. The Kidskin Study was conducted between 1995 and 2001 in Perth, Australia and enrolled 1776 children attending their first year of school in 1995 (age 5–6 years) at 33 participating schools.[24] Schools were assigned to one of three groups: high intervention, moderate intervention and control, involving different levels of intensity of classroom lessons, out-of-school activities and swimwear intended to reduce sun exposure.[24] The KYAMS uses prior contact details, social media, word of mouth and Australian Electoral Roll information to recruit participants of the Kidskin Study to undergo an eye examination and provide information on past and current sun exposure.

The Kidskin Study questionnaires

During the Kidskin Study, a parent or guardian of each Kidskin Study participant was invited to complete a questionnaire on their child's time in sun and use of sun-protection measures such as sunscreen, hat, and shade over the previous summer holidays when the child was aged approximately 6, 8, 10 and 12 years. The data collected included the amount of time spent outdoors at the beach, the pool, or around the house or neighbourhood as well as the proportion of time their child was in the shade, using sunscreen or wearing a hat at each of these venues. Possible responses to these questions are described in the ESI.† As data on shade use were not collected in the KYAMS, these data were not included in the analysis.

The questionnaires were modified slightly over the course of the Kidskin Study. The 1995 and 1997 questionnaires recorded time spent outdoors between 8 am and 4 pm whereas the 1999 and 2001 questionnaires covered time spent outdoors between 8 am and 5 pm. The amount of time spent outdoors when outside around the house or neighbourhood was not reported in 1995, and for 1997 was for between 11 am and 5 pm, compared to 8 am to 5 pm at the 1999 and 2001 follow-ups. We therefore did not calculate time outdoors for 1995 but used time in sun data from the remaining years in this analysis. Data collected between 1995 and 2001 are referred to as "Kidskin Study" or "parent" data. For this analysis, parent-reported data are treated as gold-standard measures of childhood sun exposure of Kidskin Study participants. Previous work from the Kidskin Study showed that a sun index – a composite measure of sun exposure and sun-protection use derived from the parent questionnaires – had good test-retest reliability.[25] Furthermore, the parent-reported sun index was correlated with measured suntan (r = −0.17, p < 0.001),[25] and parent-reported time outdoors between 11 am and 2 pm was associated with the number of melanocytic naevi on the back at age 12 years in the Kidskin Study.[26]

The KYAMS questionnaire

KYAMS participants are asked to complete a questionnaire and a sun calendar. The sun calendar was introduced after KYAMS recruitment had begun; those who had already participated were retrospectively asked to complete the sun calendar and later sent a reminder. The questionnaire includes questions on demographics (age, sex, education, ethnicity), current time spent outdoors in summer, number of sunburns and skin type and response to sun exposure. From a range of hair and skin colour images, participants are asked to select a colour that most closely matched their own.

The sun calendar is based on and similar to that used and validated in a previous study.[16] On the sun calendar, participants are asked to complete, for every year of life since 1994 (approximately age 5 years), their place of residence, amount of leisure time in the sun on an average summer day, proportion of time wearing a hat with brim or visor, and proportion of time wearing sunscreen. Categories for time spent outdoors questions are "less than half an hour", "half to one hour", "1–2 hours", "2–3 hours", "3–4 hours", "more than 4 hours". For use of sunscreen or hat the categories are "never", "less than half of the time", "half of the time", "more than half of the time", "all of the time". These data are referred to as "KYAMS" or "offspring" data.

Data analysis

Parent data from the Kidskin Study were used to calculate parent-reported time in sun during the summer holidays at ages 8, 10 and 12 years and the proportion of time outdoors spent wearing a hat or sunscreen at ages 6, 8, 10 and 12 years. These estimates were then classified into categories matching the KYAMS sun calendar data. A detailed description of the methods used to derive these variables is included in the ESI.†

Statistical analysis

The statistical analysis broadly comprised of three parts: (1) testing agreement between offspring-reported and parent-reported responses, (2) modelling univariate and multivariate associations between parent-reported responses and offspring-reported responses and (3) testing the extent to which offspring-reported responses predicted parent-reported responses.

Statistical analysis was carried out using R statistical software version 3.5.1 (R Foundation for Statistical Software, Vienna, Austria). The Pearson chi square test was used to compare characteristics of the participants. We used a weighted kappa statistic to test the agreement between the offspring self-reported responses and the matching parent-reported variables at each age. The weighted kappa assesses the amount of agreement between two variables while accounting for agreement expected by chance and is equivalent to the intraclass correlation under certain conditions.[27] The weights account for the spacing between groups. The weighted kappa and a 95% confidence interval were calculated for each of 1995 (excluding time outdoors), 1997, 1999, 2001 and for an average of all years. The following criteria were used to qualify the level of agreement,<0 = poor, 0–0.2 = slight, 0.21–0.4 = fair, 0.41–0.6 = moderate, 0.61–0.8 = substantial, 0.81–1 = almost perfect.[28]

We used ordinal logistic regression to analyse the association between Kidskin Study parent-reported time in sun, hat use or sunscreen use (outcomes) with offspring recall response for the same variable (predictors). KYAMS questionnaire data were used as covariates. Ordinal regression was chosen due to the ordinal nature of the outcomes and to enable adjustment for potential confounders that could influence ability to recall past sun exposure and sun protection behaviours. Rather than construct a model for each follow-up year separately, we included data from all follow-ups in a single regression model using a generalised estimating equation approach to account for within-subject correlation. These models therefore provide an analysis of overall recall of sun exposure behaviours at 6, 8, 10 and 12 years and enabled us to more precisely identify relevant covariates. We used the R package 'repolr' to fit the models as it has been shown to return appropriate parameter estimates and tests the assumption of proportional odds.[29] The odds ratios (OR) reported from ordinal logistic regression represent the odds of being above *vs.* below the *i*th category (*i.e.* OR > 1 represents greater odds of being in a higher category and OR < 1 represents lower odds of being in a higher category). As there were low numbers of KYAMS participants in the lowest category of time in sun, categories one and two ('less than $\frac{1}{2}$ an hour' and '$\frac{1}{2}$ to 1 hour') for both Kidskin Study and KYAMS data were collapsed together for ordinal regression. Sex and covariates with $p < 0.10$ were included in the multivariate analysis. We also constructed a separate model adjusting for current self-reported time spent outdoors in summer to investigate whether KYAMS participants are using current time outdoors as a proxy for past time outdoors.

Finally, we evaluated whether a combination of offspring responses, sex and covariates from the KYAMS could be used to predict Kidskin Study parent-reported responses. Ordinal logistic regression was used to fit the prediction model with categorical parent-response as the outcome. Separate prediction models were constructed for time spent outdoors, hat use and sunscreen use. A randomly selected 80% of the data were used to fit the prediction model. The remaining 20% of the data were used to test the performance of the prediction model by calculating percent agreement and weighted kappa between the predicted parent-reported response and the actual parent-response.

Results

Participants

A total of 301 individuals (mean age 27.5 [range 25.3–30.0] years) participated in the KYAMS between May 2015 and January 2019. Of these, one participant had no Kidskin Study parent data and was excluded from further analysis. KYAMS sun calendar data were available for 244 (81.3%) participants. Table 1 shows the baseline characteristics of the KYAMS participants. Females and those in the high- and moderate-intervention groups are overrepresented in the KYAMS compared to the Kidskin Study baseline ($p < 0.001$ and $p = 0.005$, respectively) (ESI Table S1†). Individual offspring sun calendar responses tended to be more similar across ages than the parent-reported data (Kappa = 0.6–0.96 *vs.* Kappa = 0.1–0.40, respectively) (ESI Table S2†). On average, KYAMS participants recalled higher time outdoors than parents at ages 8, 10 and 12 years (median category: 2–3 hours *vs.* 1–2 hours for all).

Table 1 Characteristics of the KYAMS participants

Variable	Number	%
Age at KYAMS (years)		
25	11	3.7%
26	119	39.7%
27	46	15.3%
28	94	31.3%
29	30	10.0%
Sex		
Male	115	38.3%
Female	185	61.7%
Ancestry[a]		
European	246	86.3%
Non-European	39	13.7%
Highest education completed		
Primary or secondary school[b]	46	16.3%
TAFE[c]/technical college	86	30.4%
University – undergraduate	112	39.6%
University – postgraduate	39	13.8%
Tendency to sunburn after 30 min		
Severe sunburn with blistering	11	4.3%
Have painful sunburn	68	26.6%
Get mildly burnt	129	50.4%
Not get sunburnt at all	48	18.8%
Number of painful sunburns		
Never	8	2.8%
Once	25	8.7%
2–10 times	199	69.6%
More than 10 times	54	18.9%
Tanning after sun exposure		
Very tanned	53	20.8%
Moderately tanned	98	38.4%
Lightly tanned	87	34.1%
No suntan at all	17	6.7%
Hair colour		
Black	18	7.0%
Dark brown	151	59.0%
Mousey blond	62	24.2%
Light blond	12	4.7%
Red	13	5.1%
Skin colour		
Olive	23	9.0%
Olive-medium	43	16.8%
Medium-fair	85	33.2%
Fair	105	41.0%

[a] Those reporting both parents of only English, Celtic, Northern European, Eastern European or Mediterranean European background were considered as having a European background. [b] Only two people reported a highest completed level of education below secondary school; this group was combined with the secondary school education group. [c] Technical and further education.

Table 2 Agreement between Kidskin parent-reported responses and KYAMS participant long-term recall of time spent outdoors in the sun, and the proportion of outdoors time that they wore a hat or sunscreen

	Observed agreement	Expected agreement	Weighted Kappa[a]	95% CI
Age 6				
Proportion of time spent wearing hat	35.2%	28.4%	0.14	0.05, 0.23
Proportion of time spent wearing sunscreen	34.5%	27.7%	0.14	0.05, 0.23
Age 8				
Time spent outdoors in sun	23.3%	21.5%	0.11	0.02, 0.21
Proportion of time spent wearing hat	32.5%	27.6%	0.11	0.02, 0.20
Proportion of time spent wearing sunscreen	32.7%	26.2%	0.19	0.10, 0.28
Age 10				
Time spent outdoors in sun	22.5%	21.4%	0.10	0.01, 0.20
Proportion of time spent wearing hat	32.1%	27.3%	0.10	0.01, 0.19
Proportion of time spent wearing sunscreen	31.5%	26.5%	0.17	0.08, 0.26
Age 12				
Time spent outdoors in sun	25.0%	20.7%	0.16	0.07, 0.26
Proportion of time spent wearing hat	26.7%	23.3%	0.05	−0.04, 0.14
Proportion of time spent wearing sunscreen	26.1%	22.3%	0.16	0.07, 0.25
Average of all years				
Time spent outdoors in sun	20.9%	24.1%	0.16	0.07, 0.25
Proportion of time spent wearing hat	34.0%	34.3%	0.05	−0.04, 0.14
Proportion of time spent wearing sunscreen	38.8%	31.0%	0.20	0.11, 0.29

[a] Weights were equal to the numeric values assigned to each KYAMS sun-calendar category (*i.e.* 0.25, 0.75, 1.5, 2.5, 3.5 and 5 for time in sun and 0, 0.25, 0.5, 0.75 and 1 for hat or sunscreen use).

Agreement between parent-reported and long-term recall measures

The observed agreement, expected agreement, weighted kappa and its 95% confidence interval for each survey year and for an average of all survey years of the Kidskin Study are shown in Table 2. The best agreement between parent and offspring data was for sunscreen use. Time in sun showed slight agreement at all ages, with best agreement at age 12 years and when all years were averaged. Slight agreement was also found for hat wearing. However, this agreement weakened at each successive follow-up and was not significantly better than chance at age 12 years or when all responses were averaged.

Predictors of Kidskin Study parent-reported response

After adjustment for sex, age at Kidskin Study follow-up and hair colour, increasing KYAMS self-reported time in sun at age 8, 10 or 12 years was associated with increasing parent-reported time in sun at those ages (OR = 1.31, 95% CI: 1.12, 1.53) (Table 3). However, after adjusting for quartiles of KYAMS self-reported current time in sun in summer, this association was no longer significant (OR = 1.17, 95% CI: 0.99, 1.37), whereas quartiles of self-reported current time in sun remained significantly associated with parent-reported responses (OR = 1.38, 95% CI: 1.15, 1.66). Increasing category of KYAMS self-reported hat and sunscreen use were also associated with increasing Kidskin Study parent-reported responses after adjustment for covariates (Table 3). Covariates in the hat use model were sex, tendency to sunburn and highest level of education. Covariates in the sunscreen model

Table 3 Results of generalised estimating equation ordinal logistic regression models analysing the association between Kidskin Study parent-reported responses and KYAMS long-term recall of time spent in the sun, and the proportion of outdoors time that they wore a hat or sunscreen

	Time in sun OR (95% CI)	Hat wear OR (95% CI)	Sunscreen use OR (95% CI)
Increasing KYAMS self-reported category	1.31 (1.12, 1.53)	1.37 (1.16, 1.62)	1.23 (1.03, 1.48)
Sex			
Female	Reference	Reference	Reference
Male	1.56 (1.04, 2.35)	2.36 (1.56, 3.58)	0.76 (0.49, 1.18)
Age at Kidskin Study follow-up	0.93 (0.85, 1.01)	NA	0.89 (0.84, 0.94)
Decreasing tendency to sunburn	NA	0.77 (0.59, 1.01)	0.67 (0.52, 0.88)
Hair colour			
Black	Reference	NA	NA
Dark brown	2.85 (1.60, 6.38)	NA	NA
Mousey blond	3.82 (1.60, 9.15)	NA	NA
Light blond	5.94 (2.01, 17.60)	NA	NA
Red	3.67 (1.32, 10.19)	NA	NA
Highest level of education			
Primary or secondary school	NA	Reference	NA
TAFE/technical college	NA	1.41 (0.75, 2.64)	NA
University – undergraduate	NA	1.10 (0.60, 2.01)	NA
University – postgraduate	NA	2.17 (1.01, 4.63)	NA

were sex, tendency to sunburn and age at Kidskin Study follow-up. The proportional odds assumption was not rejected in any of the final ordinal regression models (all $p > 0.05$).

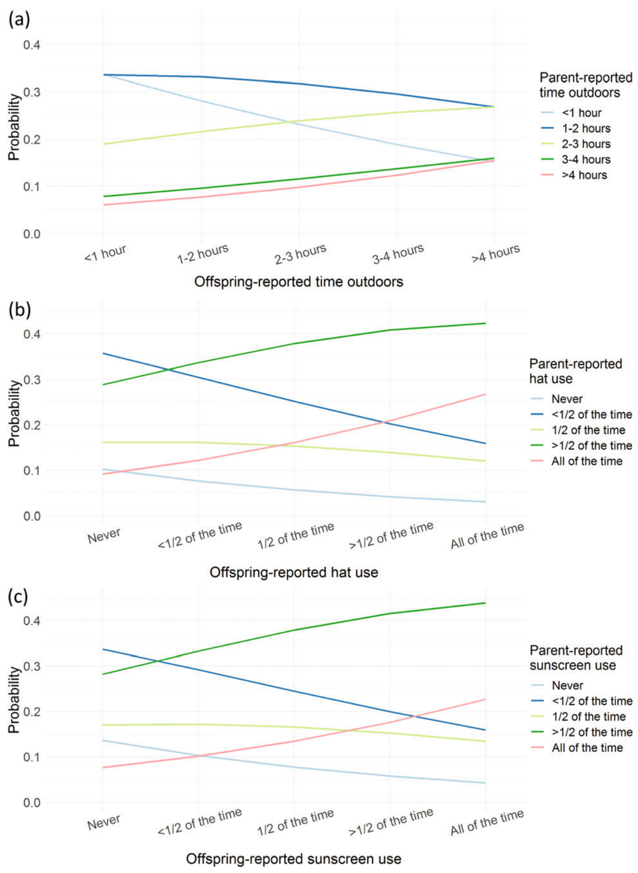

Fig. 1 Predicted probabilities of being in each of the parent-reported sun-behaviour groups based on self-reported response for time spent outdoors (a), proportion of time spent wearing a hat (b) and proportion of time spent wearing sunscreen (c). Probabilities are derived from ordinal logistic regression models without adjusting for covariates.

Table 4 Performance of prediction models – agreement between predicted and actual parent-reported time spent in the sun, proportion of time wearing hat and proportion of time wearing sunscreen

	Observed agreement	Expected agreement	Weighted kappa	95% CI
Childhood time in sun[a]	32.23%	28.32%	0.09	0.01, 0.16
Current time in sun[b]	32.56%	27.11%	0.08	−0.02, 0.17
Time wearing hat[c]	38.15%	37.18%	0.04	−0.04, 0.13
Time wearing sunscreen[d]	39.43%	36.79%	0.04	−0.06, 0.14

[a] Variables in model: self-reported time in sun at age 8, 10 and 12 years, age at Kidskin Study follow-up, sex, hair colour. [b] Variables in model: current self-reported quartiles of time spent outside in summer, age at Kidskin Study follow-up, sex, hair colour. [c] Variables in model: self-reported hat use, sex, tendency to sunburn, highest level of education. [d] Variables in model: self-reported time in sun, age at Kidskin Study follow-up, sex, tendency to sunburn.

Fig. 1 graphically represents the value of offspring-reported time outdoors, hat use and sunscreen use in predicting parent-reported responses.

Performance of the prediction models

The performance of the prediction models as evaluated by agreement between actual and predicted parent-reported time in sun, hat use and sunscreen use is shown in Table 4. Predicted parent-reported hat use and sunscreen use did not have better than chance agreement with actual parent-reported hat use and sunscreen use. Predicted parent-reported time in sun had slight agreement with actual parent-reported time in sun; however, the overall performance of the prediction model was relatively poor.

Discussion

Childhood sun exposure has been found to be a key life-period in determining risk of future sun exposure-related conditions such as melanoma or multiple sclerosis.[7,30] Objective, cumulative measures of sun exposure such as actinic skin damage are insensitive to fluctuations in sun exposure across the life period. For example, measures of actinic skin damage would theoretically be unable to differentiate an individual who had high sun exposure in childhood and low sun exposure in early adulthood from someone who had low sun exposure in childhood and high sun exposure in early adulthood. However, a case-control study suggests that the latter individual has 3 times the odds of developing multiple sclerosis compared to the former.[7]

We investigated whether recall of sun exposure may be useful in investigating the effects of childhood sun exposure on later health outcomes. In this study, young adults' long-term recall of sun exposure and sun-protection behaviours during specific years of childhood, and averaged over this period, had only slight agreement with parent-reported data collected during childhood. Additionally, offspring long-term recall of sun exposure and sun-protection behaviours had little utility in predicting parent responses reported at the time, even after adjustment for relevant covariates. Therefore, use of long-term self-reported data recalling sun-related behaviours from 15 to 20 years ago (between ages 6 and 12) in lieu of prospectively collected parent-reported data collected would be of limited value in the KYAMS.

Long-term recall of time in sun at ages 8, 10 and 12 years was not significantly associated with parent-reported responses after adjustment for current self-reported time in sun. Indeed, offspring's current time in sun was associated with parent-reported time in sun, indicating that (a) people maintain time in sun behaviours from childhood to young adulthood, as has previously been noted,[20] and (b) that young adults' recall of their time spent in sun during childhood is based to some extent on their current time spent outdoors. The latter point could potentially be explained by anchoring bias, in which individuals use some prior value as a starting point (anchor) to estimate an uncertain value resulting in estimates that are typically biased toward the anchor.[31] In surveys of farmers, recall of data (*e.g.* income) in the previous two years was shown to be heavily reliant on recall of current data.[32] Thus, current data was used as an anchor to recall past data. It is possible that KYAMS participants used current time spent outdoors as an anchor from which they estimated past time outdoors and estimates were therefore biased towards current time spent outdoors. Questions that encourage participants to use memorable childhood events to guide estimates may mitigate some of this bias.[10,16] Our results suggest that self-reported current time in sun is potentially more useful than long-term recall for assessing childhood time outdoors, but current time in sun data would be entirely insensitive to changes in sun exposure over the life-course, which is often the aim when asking participants to recall long-term sun exposure. Interestingly, long-term recall of greater hat and sunscreen use at ages 6, 8, 10 and 12 years were associated with increasing parent-reported response for the same variables even after adjustment for current hat and sunscreen use. Thus, participants are able to recall their past hat and sunscreen use to some extent. Unfortunately, the long-term self-reported offspring data were not accurate enough to be useful in predicting parent-reported time in sun, hat use or sunscreen use responses. Hence it is unlikely that other studies that lack data on actual sun-related behaviours during childhood will be able to estimate these retrospectively.

These findings have important implications for the design of future studies on the effects of sun exposure on health and the interpretation of past studies using retrospective recall of sun exposure as an explanatory variable. Studies have reported associations between long-term recall of past sun exposure and skin cancer,[10,11,33] pterygium[4] and multiple sclerosis.[7] despite validation of these questionnaires against cumulative objective measures of sun exposure; our findings suggest these results should be interpreted with caution as recall of childhood sun exposure may be inaccurate or more reflective of recent sun exposure. Many studies use interview techniques to elicit recall of sun exposure,[4,7,10,11,33] which may be a better method for measuring past sun exposure, but how well these estimates reflect actual sun exposure at the time is not known.[25,26]

This study has some limitations. First, Kidskin Study parent-reported time spent outdoors was treated as the gold-standard measure of childhood sun-related behaviours, but this data may itself be limited and subject to error. The Kidskin Study parent-reported data has the advantage of being collected close to the time the relevant behaviours occurred, but it is also subject to reporting errors such as parents' lack of awareness of their child's activities, particularly as the child gets older. The unmasked design of the Kidskin Study could also have introduced a social desirability bias, where parents of offspring in the intervention groups may under-report sun exposure because they feel this is more socially desirable. We think it unlikely that such bias affected offspring in the KYAMS as examiners were masked to intervention group and participants had only very few recollections of the Kidskin Study and were often unaware that some schools were in control or intervention arms or indeed that only select schools in Perth participated in the study. Second, the Kidskin Study sun-related behaviour variables were computed from a number of categorical variables, potentially resulting in some loss of information and there were minor changes to the wording of questionnaires between follow-ups. The latter could explain why these measures at ages 6, 8, 10 and 12 years were less similar in the Kidskin Study when compared to the KYAMS (ESI Table 2†).[25,26] It is because of the limitations and potential error in Kidskin Study parent-reported data that we deliberately avoided the terms 'accuracy' or 'validation' in this study. Despite this, sun index data derived from the same questionnaire has been shown to be internally valid and have good test-retest reliability,[25,26] and there is some evidence that parents are aware of their child's time spent outside over the short-term.[34] Therefore, while parent-reported measures of sun exposure and sun protection in this study may not be entirely accurate, we believe they are a valid measure to compare against. Third, the questionnaires used to collect data on time in sun, hat use and sunscreen use in the Kidskin Study and KYAMS were quite different. The approach taken in our study may therefore not be the best method for comparing responses between retrospective recall and prospective parent-reported data. It wasn't feasible to ask KYAMS participants to complete the same questionnaires as their parents for each age investigated (approximately 50 pages total). We therefore used the Kidskin Study parent data to derive sun-behaviour variables that were similar to those collected in the KYAMS sun calendar, which has been used previously for retrospective recall of sun exposure.[16,20] Third, the KYAMS sample was not entirely representative of the Kidskin Study cohort having a higher proportion of females and individuals in the high or moderate intervention groups when compared to the baseline Kidskin Study sample. There is therefore some potential for attrition bias and our findings may not be widely generalizable.

Conclusions

Agreement between young adults' long-term recall of their childhood sun-related behaviours and parent-reported data collected at the time was slight or consistent with chance findings. KYAMS young adult self-reported sun-related behaviours were associated with corresponding Kidskin Study parent-reported data. This indicates that grouped data on long-term retrospective recall of sun-related behaviours had some value when investigating associations with later health outcomes. Yet, we found that such data could not be usefully applied to predict individual behaviours reported at the time. These findings have implications for the design of studies assessing the long-term impact of sun exposure on human health.

Conflicts of interest

The are no conflicts to declare.

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