**Appearance-based interventions to reduce UV**

**exposure: A systematic review**

Purpose. As a majority of skin cancer cases are behaviourally preventable, it is crucial

to develop effective strategies to reduce UV exposure. Health-focused interventions

have not proved to be sufficiently effective, and it has been suggested that people might

be more susceptible to information about the negative effects of the sun on their

appearance.

Method. This systematic review of 30 separate papers, reporting 33 individual studies

published between 2005 and 2017, assesses the overall effectiveness of appearance

interventions on participants’ UV exposure and sun protection behaviour.

Results. Appearance-based interventions have positive effects on sun exposure and sun

protection, immediately after the intervention as well as up to 12 months afterwards. The

meta-analysis found a medium effect size on sun protection intentions for interventions

which combined UV photography and photoageing information: r+ = .424; k = 3,

N = 319, CI = 0.279–0.568, p = .023.

Conclusions. This review provides a current perspective on the effectiveness of

appearance-based interventions to reduce UV exposure, and also highlights methodological

issues. It recommends that practitioners administer a UV photo intervention in

combination with photoageing information to reduce UV exposure. Furthermore, the

review specifically recommends that future research focuses on the use of theoretical

constructs to enhance photoageing information and is conducted with older participants

and in countries where people have less opportunity for sun exposure.

**Statement of contribution**

What is already known on this subject?

* Appearance-focused interventions may in some cases be more effective than health-focused interventions in reducing UV exposure, as the underlying motivations for tanning are associated with appearance concerns.
* Previous reviews and meta-analyses have indicated that appearance-focused interventions such as photoageing and UV photo are associated with positive effects in reducing UV exposure and/or increasing sun protection.
* Previous reviews identified methodological issues with research on this topic, which included limited a priori power calculations and a general lack of long-term follow-ups.

Deaths from skin cancer are an increasing problem around the world; the World Health

Organization(WHO, 2018) reports that up to 2 million new cases occur globally each year.

In the United Kingdom, non-melanoma skin cancers are by far the most common type of

cancer with around 102,000 new cases diagnosed annually (Cancer Research UK, 2016).

There is an established link between ultraviolet (UV) radiation exposure and all types of

skin cancer; this includes intentional (e.g., indoor and outdoor tanning) and incidental

exposure (WHO, 2016). It is estimated that UV radiation causes 86% of malignant

melanoma cases in the United Kingdom(Cancer Research UK, 2016). Thus, skin cancer is

to a large degree behaviourally preventable, meaning that developing strategies to reduce

UV exposure could be effective in limiting new incidences (Jackson & Aiken, 2006).

Although the health-related costs of UV exposure and the benefits of sun protection are

relatively well known (Miles, Waller, Hiom, & Swanston, 2005), interventions that

highlight these consequences are not sufficiently effective (Mahler, Kulik, Gerrard, &

Gibbons, 2006). A possible reason for this is that tanning behaviour is primarily motivated

by a desire to improve appearance, and, as such, it is perhaps less responsive to health

warnings (McWhirter & Hoffman-Goetz, 2015). Research on both men and women

suggests that focusing on the appearance-related costs of UV exposure is effective in

reducing UV exposure (Grogan & Loosemore, 2015). A review by Dodd and Forshaw

(2010) found that appearance-based interventions were generally successful in improving

UV-protective behaviours (e.g., sun protection use), but only moderately successful in

altering behaviours relating to UV exposure. Another systematic review by McWhirter and

Hoffman-Goetz (2015) found that visual images, for example UV photography (i.e.,

showing participants current level of UV damage to their skin), were successful in

promoting sun protection and reducing UV exposure.

This study is modelled on the Williams, Grogan, Clark-Carter, and Buckley (2013a)

review and meta-analysis, which focused on the efficacy of appearance-based interventions

to reduce UV exposure. Williams, et al. (2013a) found an overall positive impact of

appearance-based interventions on reducing UV exposure, and the meta-analysis

indicated that UV photo (i.e., demonstrating actual UV damage to a participant’s face)

and/or photoageing information (i.e., providing participants with information about the

ageing effect of the sun) had a significant effect on sun protection intentions and future

indoor tanning behaviour. The authors identified a number of problems with the data set,

including limited long-term follow-ups, homogeneity of settings, and limited a priori

power analysis. This study aims to provide an updated review of the literature, which is

considered relevant as the last data search was executed over 5 years ago. This is

particularly important as research into appearance-focused interventions has developed

significantly since this time, for instance by including novel techniques such as facial

morphing (a type of intervention demonstrating potential future UV damage, by morphing a current image of the person using a specialized software). This study also

includes a larger meta-analysis.

1. Do appearance-based interventions reduce UV exposure immediately after the

intervention and/or long-term?

2. What does new research (i.e., the studies not included in the Williams et al.,

2013a paper) add to current understanding of the efficacy of appearance-related

interventions to reduce UV exposure, and has the quality of research improved?

**Method**

Protocol and registration

A review protocol was not used; however, the review has been reported in accordance

with the PRISMA guidelines. See Appendix S1 for the PRISMA checklist.

Eligibility criteria

Eligibility criteria were identical to Williams, et al. (2013a). Studies included an

appearance-based intervention, either in isolation (i.e., assessing scores before and

after the intervention) or in comparison with another intervention (or control

condition), and were required to adopt a pre-test and post-test design, but not

necessarily randomized controlled trials (RCTs). Correlational studies were not

included. An appearance-based intervention was defined as an intervention that

highlighted negative effects of UV exposure on appearance, such as UV photography

or photoageing information. Furthermore, studies had to assess the effects of the

intervention on sun-seeking and/or sun-protective behaviours or intentions. Sunseeking

behaviours were defined as behaviour that increased UV exposure and

included spending time in the sun or using indoor tanning booths; sun-protective

behaviours were defined as behaviour intended to decrease UV exposure, such as sun

lotion use or protective clothing. Finally, studies were required to administer a posttest

measure to assess the effectiveness of the intervention.

Information sources

The primary source of articles was Web of Knowledge (Science Citation Index Expanded,

Social Sciences Citation Index, Arts & Humanities Citation Index, Conference Proceedings

Citation Index – Science and Social Science, Emerging Sources Citation Index); in

addition to this, seven other electronic databases (CINAHL, ZETOC, PsycARTICLES,

PsycINFO, MEDLINE, OVID, and Proquest theses) were accessed to search for studies. To

ensure the searched databases provided a relevant literature base, it was confirmed that

the list of studies included in the Williams, et al. (2013a) paper was found. An ancestry

search, that is, identifying references that cited the identified papers, was also carried out

to identify any missing studies.

Search

This study used the same search terms as Williams, et al. (2013a), to ensure consistency:

‘(sun\*OR UV) AND (appearance OR age spots OR photoaging OR damage OR wrinkles)

AND (skin cancer OR melanoma OR health) AND intervention\*AND (sunscreen OR

protect\*OR tan\* OR expos\*OR prevent\*OR behav\*)’, and included studies conducted 1January 2005–16 May 2017. The search was conducted by the first author. 2005was used

as a starting point as research up until this point was sufficiently covered in previous

reviews.

Study selection and data collection process

Eligibility assessment was performed by the first author (see PRISMA flow chart in

Appendix) but agreed upon by all authors. A total of 170 records were identified through

database searches, and a total of 532 records were identified through the ancestry search,

yielding a total of 701 screened records. Following this, 655 records were excluded based

on irrelevancy and duplicity, leaving a total of 46 papers to be examined. In addition, six

studies were excluded because the intervention focused on health consequences of UV

exposure (Cheng, Guan, Cao, Liu, & Zhai, 2011; Dykstra, 2007; Hernandez et al., 2014;

Lazovich et al., 2013; Olson, Gaffney, Starr, & Dietrich, 2008 [included in the Williams,

et al. (2013a) review]; Thomas et al., 2011), three due to not examining relevant research

questions (Cox et al., 2009; Hillhouse, Turrisi, Stapleton, & Robinson, 2010; Walsh, Stock,

Peterson, & Gerrard, 2014), and seven for not containing an intervention (Cheetham &

Ogden, 2016; Hillhouse et al., 2016; Noar et al., 2015; Pagoto et al., 2009; Taylor,

Westbrook, & Chang, 2016; Welch, Chang, & Taylor, 2016; Williams et al., 2013). To

identify potential, prominent authors in this field were contacted (e.g., authors of the

Williams et al., 2013a) and asked whether they had any unpublished material.

Additionally, ProQuest theses was searched for unpublished material. An extraction

table was designed based on the main elements reported in the Williams, et al. (2013a)

study. Data were extracted by the first author, with 10% checked blind (i.e., independently

extracted by another member of the team and then compared to the data extraction

conducted by the first author) by the sixth author during April–May 2017. Due to the high

level of agreement (88%), the remainder of the data were checked non-blind by the same

author, with agreement of 94%. Any disagreements were resolved by discussion. All

papers were further checked and agreed upon by the second author. The final review

includes 30 separate articles (33 independent studies, as some articles reported more than

one study); 18 of these papers (20 individual studies) were not included in the Williams,

et al. (2013a) article. Information extracted from the studies included participant

characteristics, study location and settings; intervention characteristics, outcome

measures, and which, if any, theoretical constructs were utilized to inform the

intervention; and methodological issues.

A formal tool was not utilized to assess methodological bias, but the first author

assessed risk of bias in each study by examining the methodology (i.e., study design,

proposed analyses, type of intervention, comparison groups), randomization process,

quality of the outcome measures (e.g., Cronbach’s alpha), and research funding. No

studies were deemed to be biased, aside from the Bae, Bae, Wang, and Gilchrest

(2017) paper, as it was neither controlled nor randomized and did not compare the

intervention with a control condition. However, this risk of bias did not adversely

impact the meta-analysis, as it was excluded due to lack of sufficient details for effect

size calculation, and was therefore only commented on in the systematic review. In

addition, small-study bias and publication bias were assessed utilizing Egger’s

regression (Egger, Davey-Smith, Schneider, and Minder, 1997) and trim and fill

analyses (Duval & Tweedie, 2000). This was reviewed and agreed upon by the

second and last authors. In sum, the main outcomes of interest included sun-seeking behaviours and intentions (i.e., indoor and outdoor tanning), and sun-protective

behaviours and intentions (i.e., use of protective clothing or suntan lotion).

Meta-analytical strategy

The meta-analysis employed a random effects model. All but one of the studies included in

the review were also included in the meta-analysis. Bae et al. (2017) was not included

as the main author declined a request for additional data to facilitate effect size

calculations. Three studies (Mahler, Kulik, Gerrard, & Gibbons, 2007, 2013; Mahler et al.,

2006) included separate UV photo and photoageing information components (with the

same participants) and hence were added as two separate studies under the two relevant

interventions. Studies were categorized according to the type of appearance intervention,

creating four separate data sets: interventions with UV photo, photoageing information,

UV photo in combination with photoageing information, and interventions that could not

be classified as either, for instance facial morphing or group discussions. Due to the

heterogeneous nature of the final category, it was not possible to further distinguish

between these interventions. The process of categorization into types of interventions

enabled the inclusion of the same participants in separate analyses. In addition, studies

described in Gibbons, Gerrard, Lane, Mahler, & Kulik (2005) were originally analysed as

one by that paper’s authors, resulting in a total of 34 independent studies included in the

meta-analysis. For each of these studies, correlation coefficient r was calculated to assess

the relationship between the appearance-based intervention and the outcome variable,

which was classified as sun protection or UV exposure. Following Cohen’s (1992)

recommendations, r = .10 was taken to represent a ‘small’ effect size, r = .30 a ‘medium’

effect size, and r = .50 a ‘large’ effect size. Long-term (i.e., any follow-up longer than

immediately following the intervention, ranging from 1 week to 6 months) effects of the

interventions are commented on in the systematic paper review as there were not enough

studies with similar levels of follow-ups to include this as a moderator analysis.

Where studies contained two (or more) conditions, the appearance-focused condition

was defined as the one with the strongest focus on appearance, and the control condition

contained, where possible, active element (e.g., another intervention, as compared to a

passive control being waitlist only). Where studies contained more than one appearance focused intervention, these were compared separately to a control condition, creating

separate effect sizes. Where studies lacked relevant statistics, authors were contacted to

provide additional information that could facilitate the effect size calculations. All authors

except one (Bae et al., 2017) responded with the requested information (Christensen,

Champion, & Wagner, 2014; Cornelis, Cauberghe, & De Pelsmacker, 2014; Gibbons,

et al., 2005; Hevey et al., 2010; Mahler, Beckerley, &Vogel, 2010;Mahler, Kulik, Gerrard,

& Gibbons, 2010; Morris, Cooper, Goldenberg, Arndt, & Gibbons, 2014; Sontag & Noar,

2017; Stapleton, Turrisi, Hillhouse, Robinson, & Abar, 2010). These authors were also

asked about any unpublished material they might have. As the majority of the studies

included a follow-up immediately after the intervention, where possible, this point in time

was used to calculate effect sizes to ensure homogeneity of the data. For studies that did

not have an immediate follow-up (N = 7), or did not report sufficient data for this point,

effect sizes were calculated for the nearest available time following the intervention.

The meta-analysis assessed the effectiveness of the intervention on four specific

outcome variables: sun-protective intentions, sun-protective behaviour, UV exposure

intentions, and UV exposure. In addition, effectiveness was also assessed as a weighted

mean for multiple outcome variables, henceforth referred to as a combined outcome variable. If multiple outcomes were measured for one of the categories above, for

example, both sun exposure and sun lotion were measured to examine sun-protective

behaviour, an overall effect size was calculated as the weighted mean of these measures.

Random effect sizes were computed using SPSS version 22 and the macros developed by

Wilson (2005). Effect sizes were weighted by sample, with a 95% confidence interval, and

an estimate of heterogeneity. Publication bias and small-study bias were also assessed

(Duval & Tweedie, 2000; Egger et al., 1997).

**Results**

Descriptive features of the studies

Participants and settings

Across all samples, there were 7,348 participants, with sample sizes ranging from 50 to

965 participants. Twelve studies specifically targeted females, whereas four studies

targeted males. The remainder had a mixed-gender participant group. Twelve studies

based their sample size on power calculations. The majority of the studies included

participants aged between 16 and 35 years. Participants were predominately White.

Seven studies targeted a risk group such as indoor tanners or highway workers. A majority

(75.8%) of the interventions were implemented in a research facility or University setting,

with the remainder (24.2%) being administered online or in a community setting (e.g., a

public beach).

Appearance-based interventions

The most common type of intervention (N = 17) was UV photography, either in isolation or

Combined with information about photoageing. Three of the UV photo studies (Mahler et al.,

2006, 2007, 2013) administered two separate interventions on UV photo and photoageing.

The second most common type of intervention (N = 7) was photoageing information. The

remainder of the studies utilized alternative types of interventions, such as discussing and

challenging the tanned ideal, manipulating media images, or implementing facial morphing.

Twenty-one of the studies based their interventions fully or in part on theory. See Table S1 for full details of the theoretical basis and critical points for each of the studies.

Measures employed

All studies administered post-intervention measures to assess the effect of an

appearance-based intervention on UV exposure intentions and/or behaviours. All but

one (Bae et al., 2017) of the studies compared this to a control condition (passive

control in six of the studies). All of the papers utilized some form of self-report

measure to assess intervention efficacy. An alternative method to assess behavioural

efficacy of the intervention examines skin colour. It involves the use of a skin

reflectance spectrophotometer which, when based on hue lightness and saturation

on various skin sites, can indicate level of UV exposure (Mahler et al., 2006). This

technique was utilized by four studies.

Descriptive results from systematic review

Table 1 provides a summary of the overall pattern of findings. Table S2 provides a detailed

description of the individual studies, including intervention design and findings. Overall, a

majority (N = 29) of the studies reported that an appearance-focused intervention had apositive effect on reducing UV exposure and/or increasing sun protection. Interestingly,

four of the studies that reported positive findings only found this effect when examining a

particular participant group or combination of conditions; Cornelis et al. (2014) found

that an appearance intervention decreased intentions to tan when the argument against

tanning was two-sided, but not when it was one-sided; Stapleton et al. (2010) found that

their intervention decreased indoor tanning frequency among a subgroup of tanners with

previously low knowledge of the health or appearance costs of tanning; and Walsh and

Stock (2012) found than UV photo increased sun protection willingness among masculine

men. Finally, Morris et al. (2014) found that UV photo had a positive effect on sun

protection intentions only when participants were primed with mortality.

For the studies including a longer (i.e., longer than immediately following the

intervention) follow-up, the findings were generally positive. Up until a month after the

intervention, participants reduced indoor and outdoor sunbathing frequency and

increased use of sun protection (Chait, Thompson, & Jacobsen, 2015; Gibbons, et al.,

2005). These effects were evident for up to 6 months, including reduced intentions to tan

and increased intentions to use sun protection (Hillhouse, Turrisi, Stapleton, &Robinson,

2008; Jackson & Aiken, 2006).

Three studies did not find an effect of the appearance-based intervention on the main

measured outcome; Christensen et al. (2014) found that participants in the UV photo

condition did not progress in UV-protective stages of change long term, and the health oriented intervention was significantly more effective in increasing immediate sunprotective

intentions; and Hevey et al. (2010) found no significant difference between a

health and appearance-framed message on intentions to use sunscreen and sunbeds.

Similarly, Sontag and Noar (2017) reported no difference between a health and

appearance-framed message on UV exposure intentions.

Pertaining to the second research question regarding the contribution of the 20 studies

published since 2012 (i.e., those not included in Williams et al., 2013a), there was a

similar selection of interventions, apart from the inclusion of two studies utilizing facial

morphing (Owen, Grogan, Clark-Carter, &Buckley, 2016; Williams, Grogan, Clark-Carter,

& Buckley, 2013b). This technique had positive results on participants’ sun protection

intentions and behaviour when compared to a health literature intervention. Moreover,

three of the four studies specifically targeting a male population were found in this

sample. Although most research is still conducted on a female sample, this suggests that

research into UV exposure is increasingly considering men’s motivation to tan and their

barriers to sun protection. The majority of these studies reported modest results or

positive findings confined to a particular combination of conditions (e.g., mortality

priming or two-sided arguments). This suggests that appearance-focused interventions to

reduce UV exposure may need to consider drawing on other aspects of behaviour change

or persuasion theory to enhance efficacy.

Results of meta-analysis

Table 2 presents the summary of the meta-analyses results (with combined effect sizes),

and Figure 1 plots effect sizes and standard errors. The meta-analysis was carried out on

four subsets categorized according to the type of intervention utilized; this is because

some participants took part in more than one intervention, and thus, it was not possible to

analyse the sample as one.

Ten studies (Christensen et al., 2014; Dwyer, 2014; Heckman et al., 2013; Mahler

et al., 2013, 2006, 2007; Morris et al., 2014; Pagoto, Schneider, Oleski, Bodenlos, & Ma, 2010; Walsh & Stock, 2012) examined the effectiveness of UV photo on the combined

outcome variable, and on sun-protective intentions specifically. For the overall effect of

this intervention on all outcomes, the effect size was small, r+ = .19; k = 10, N = 1,564,

95% CI: 0.084–0.296, p < .001. The effect size on sun-protective intentions only was alsosmall r+ = .165; k = 8, N = 1,251, 95% CI: 0.036–0.295, p = .012. Effect sizes were

heterogeneous, Q(9) = 35.38, p < .001.

Four studies (Mahler et al., 2006, 2007, 2013; Tuong & Armstrong, 2014) examined

the effectiveness of photoageing information on sun-protective behaviour and intentions

combined, and sun-protective intentions separately. For the overall effects of photoageing

on all of the above outcome variables, the combined effect size was medium r+ = .327;

k = 4, N = 836, 95% CI: 0.206–0.447, p < .001. On sun protection intentions only, the

effect size was small r+ = .272; k = 3, N = 813, 95% CI = 0.203–0.341, p = .039. Effect

sizes were heterogeneous, Q(9) = 7.65, p = .054, using Higgins, Thompson, Deeks, and

Altman’s (2003) proposed significance level of .10.

Six studies (Gibbons et al., 2005; Mahler, Kulik, Butler, Gerrard, & Gibbons, 2008;

Mahler et al., 2005; Mahler, Kulik, et al., 2010; Sontag & Noar, 2017; Stock et al., 2009)

examined the effectiveness of UV photography combined with photoageing information

on a combination of three outcome variables: sun-protective behaviour and intentions, UV

exposure, and sun-protective intentions separately. For the effectiveness of this

intervention on the above outcome variables, the combined effect size was small,

r+ = .261; k = 6, N = 918, 95% CI = 0.047–0.475, p = .017. The combined effect size on

sun protection intentions only was medium, r+ = .424; k = 3, N = 319, 95% CI = 0.279–

0.568, p = .023. Effect sizes were heterogeneous, Q(13) = 54.89, p < .001.

Fourteen studies (Chait et al. 2015; Cooper, Goldenberg, & Arndt, 2014; Cornelis

et al., 2014; Heckman, Handorf, Darlow, Ritterband, & Manne, 2017; Hevey et al., 2010;

Hillhouse et al., 2008, 2017; Jackson & Aiken, 2006; Mahler, Beckerley, et al., 2010;

Mahler, Kulik, et al., 2010; Owen et al., 2016; Stapleton et al., 2010, 2015; Williams

et al., 2013b) examined the effectiveness of interventions not classed as either of the

above on a combination of all of the outcome variables, as well as sun protection

intentions, UV exposure, and UV exposure intentions separately. For the effects of these

interventions on the above outcome variables, the combined effect size was small,

r+ = .191; k = 14, N = 3,895, 95% CI = 0.117–0.265, p < .001. On UV exposure

intentions only, the combined effect size was small, r+ = .235; k = 7, N = 1,798, 95%

CI = 0.133–0.371,p < .001.On actual UV exposure, the effect size was small, r+ = .1542,

k = 6, N = 1,878, 95% CI = 0.007–0.302, p = .040. Finally, the effect on sun protection

intentions was small but non-significant, r+ = .223;k = 5, N = 773, 95% CI = \_0.015 to

0.461, p = .067. Effect sizes were heterogeneous, Q(6) = 26.67, p < .001.

Summary of risk of bias scores

As only two unpublished studies were included in the analysis, it was not possible to assess

publication bias by directly comparing effect sizes of published and unpublished studies.

Thus, a trim and fill analysis was performed (Duval & Tweedie, 2000) using STATA version

11 (StataCorp, 2009). Results revealed that there was no bias in interventions utilizing UV

photo, photoageing information, or interventions classed as neither. It did, however,

reveal a publication bias in interventions utilizing UV photo in combination with

photoageing information, filling three studies, rendering the results non-significant,

p = .410. To ensure the meta-analytical effect sizes were not adversely impacted by

underpowered studies from relatively small samples, an Egger’s regression was also

performed (Egger et al., 1997) using STATA version 11 (StataCorp, 2009). Results

revealed no small-study bias in any of intervention types. Discussion

Summary of evidence

The current study provides a valuable contribution to the existing literature, as it includes

20 individual articles (consisting of 22 independent studies) published between 2012 and

2017 that were not included in Williams et al. (2013a), providing an updated examination

and analysis of current directions within research on appearance-based interventions.

Furthermore, as the meta-analysis contains more individual studies, it represents a more

reliable reflection of the effectiveness of these interventions. Additionally, the current

review includes two unpublished papers, a factor that goes some way towards

counteracting publication bias.

Appearance-based interventions were generally successful in reducing UV exposure,

supporting the findings reported by Williams et al. (2013a). The inclusion in the current

review of research utilizing facial morphing indicates that this could be an effective

intervention for behaviour change. However, three studies did not find an effect of

appearance-based intervention when compared to a health-based intervention, which

was not identified by Williams et al. (2013a). One observation made in the current review

is that two of these studies used active rather than passive control. This therefore calls for

further investigation.

The results of the meta-analyses indicate that appearance-based interventions were

associated with a small positive effect on intentions and behaviours. The largest effect

sizes were associated with UV photography combined with photoageing information.

These results may indicate that providing individuals with two sources of information –

visual and descriptive – with subjective and objective focus could be an effective way to

influence UV-related behaviours. The component of photoageing information can also be

manipulated according to theory, which may be beneficial, as it could enhance health

interventions with theoretical constructs. For instance, Mahler et al. (2005) utilized

Theory of Alternative Behaviours (Jaccard, 1981) by aiming to alter participants’

perceptions of UV exposure and providing an alternative to tanning (sunless tanning

products). Other effective theoretical constructs in this sample included Social Comparison

Theory (Festinger, 1957) and Theory of Planned Behaviour (Cialdini, Kallgren, &

Reno, 1991). As these interventions appeared to be effective in reducing UV exposure and

increasing sun protection among students as well as the general public, it is likely they

could be widely implemented. However, due to the issue of publication bias in this

sample, it is difficult to draw definitive conclusions. Future research could benefit from

investigating this issue further, to determine whether two sources of information could

increase the effectiveness of appearance-focused interventions in reducing UV exposure.

There are a number of things to consider when interpreting the results of the meta analysis.

The most common outcome variable was sun-protective intentions, which limits

the conclusions that can be drawn on other variables. Given the relatively small number of

studies, it was not possible to include follow-up length as a mediator in the analysis, and it

is therefore difficult to determine whether the techniques used would have long-term

effect on behaviour, as well as immediate effect on intentions. Considerable variability of

research methodologies (e.g., control group conditions and inclusion/exclusion of darker

skin tones) and reporting style (e.g., inclusion of baseline comparisons and non-significant

variables) between the studies makes it difficult to directly compare results between the

studies. Furthermore, there was a wide span of effect sizes in the subset of the metaanalysis

which included any intervention that did not utilize UV photo or photoageing

information. This suggests that some of these interventions are more effective than others and should be further investigated in future research. Lastly, the meta-analysis identified a

publication bias among studies utilizing UV photo in combination with photoageing

information. We would therefore encourage researchers and journals alike to consider

null results for publication.

Sample limitations and recommendations for future research

While skin cancer incident rates do not differ significantly between genders (Skin Cancer

Foundation, 2016), there was an overwhelming majority of female participants. Given that

the current review identified only four studies of male participants, future research would

benefit from including men in the study population, particularly as men also value a

tanned appearance (Cancer Research UK, 2016; Day, Wilson, Hutchinson, & Roberts,

2016). As men may perceive tanning and appearance norms in different terms than

women, such as reluctance to engage in practices regarded as feminine (Grogan, 2016),

future appearance interventions with men may need to consider the role of masculinity.

Moreover, study samples were overwhelmingly young (16–35 years); as age increases,

the risks of skin damage build-up, so it therefore seems relevant to include an older

population in future studies (Cancer Research UK, 2016). Most participants were White;

as populations with darker skin are by no means immune to skin cancer, future research

would benefit from more ethnically diverse samples (Skin Cancer Foundation, 2016).

Finally, some studies included a sample where a large number of participants had

experienced skin cancer themselves, or known a family member to do so (Mahler et al.,

2013), whereas others did not include this as a variable in the analyses; this is a factor that

could skew results and should be considered in future studies.

The majority of the studies were conducted in the United States, raising concerns

about generalizability of findings to other areas; they were also conducted in locations

with high level of sun exposure (such as Florida), and it might therefore be difficult to

predict whether interventions are effective in countries with fewer days of sun.

Qualitative research has indicated that people living in locations with fewer hours of sun

(such as the United Kingdom) associate UV exposure with leisure time and holidays; this

may affect the effectiveness of an intervention to impact motivations to reduce UV

exposure among these participants (Persson, Benn, Dhingra, & Grogan, 2017).

Twelve studies based their sample size on a priori power calculations, with the

remaining studies stating a lack of power, or not specifying power calculations. This is

problematic, as a potential lack of power in a majority of the examined studies may limit the

conclusions that can be drawn from their results, as it can over- or underestimate the effect of

the intervention, particularly in combination with publication bias (Charles, Giraudeau,

Dechartres, Baron, & Ravaud, 2009; Minarik et al., 2016). It is therefore recommended that

future research consistently include a priori power calculations, as well as comparing any

intervention with an active, rather than a passive, control condition.

Conclusions

This review and meta-analysis provide a valuable perspective on current research on

appearance-based interventions to reduce UV exposure. The findings suggest that

appearance-based interventions are associated with small positive effects on reducing

sun-seeking behaviours and/or increasing sun-protective behaviours. These results were

generally supported by a meta-analysis. With the previously discussed high levels of skin

cancer rates across western Europe and the United States, this would suggest that implementation of these interventions could have scope to prevent skin cancer in a large

number of people.

We recommend that practitioners who are looking to increase sun protection

intentions administer UV photo in combination with photoageing information, as this was

associated with the largest effect size. These interventions could be administered to men

and women alike, over a wide age span, and they appear to be effective when

implemented in a clinical and/or research setting.

A number of methodological issues may limit the conclusions that can be drawn from

the results. However, within the current context, this review contributes significantly to

the existing body of research into appearance-based interventions to reduce UV exposure

and recommends that future research consistently employ a rigorous methodology (e.g.,

inclusion of power calculations) and focus on more varied outcomes and a diverse sample

population from a wider array of cultures. As motivations for UV exposure might differ in

populations living in locations with less opportunities for sun exposure, this review

specifically recommends that additional future research on the effectiveness of

appearance-focused interventions is conducted in places such as the United Kingdom

and northern Europe.

Conflict of interest

All authors declare no conflict of interest.

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