The effectiveness of public health interventions in reducing sunbed use and rates of skin cancer

An evidence review

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Research. Evidence. Action.

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Abbreviations

Abbreviation	Explanation
AOR	adjusted odds ratio
BASE	Bielefeld Academic Search Engine
CDSR	Cochrane Database of Systematic Reviews
CENTRAL	Cochrane Central Register of Controlled Trials
CI	confidence interval
CINAHL	Cumulative Index to Nursing and Allied Health Literature
DANS	Data Archiving and Networked Services
ERIC	Education Resources Information Center
GRADE	Grading of Recommendations Assessment, Development, and Evaluation
HRB	Health Research Board
HSE	Health Service Executive
IARC	International Agency for Research on Cancer
LILACS	Latin American and Caribbean Health Sciences Literature
MeSH	Medical Subject Headings
NCCP	National Cancer Control Programme
NCRI	National Cancer Registry Ireland
NEHS	National Environmental Health Service
NHLBI	National Heart, Lung, and Blood Institute
OR	odds ratio
PICOS	population, intervention, comparator, outcomes, and study design
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses
RCT	randomised controlled trial
ROBINS-I	Risk Of Bias In Non-randomized Studies – of Interventions
RoB 2	Risk of Bias 2
SciELO	Scientific Electronic Library Online
SCCP	Scientific Committee on Consumer Products
SCHEER	Scientific Committee on Health, Environmental and Emerging Risks
SD	standard deviation
SMD	standardised mean difference
SWiM	Synthesis Without Meta-analysis
TRoPHI	Trials Register of Promoting Health Interventions

Abbreviation	Explanation
UV	ultraviolet
UVR	ultraviolet radiation
USA	United States of America
WHO	World Health Organization

Glossary of terms

Term	Definition
artificial tanning	Artificial tanning is the act of using a device that emits ultraviolet radiation (UVR) to produce a cosmetic tan [1].
baseline or design-related heterogeneity	Baseline or design-related heterogeneity arises when the population or research design of studies differs across studies. It can be reduced *a priori* by setting up a suitable population, intervention, comparator, and outcomes framework that determines which types of populations and designs are eligible for meta-analysis [2].
bias	Bias is a systematic overestimation or underestimation of an association in research. There are many types of bias, such as selection, recall, observer, and interviewer bias. Bias is minimised through good study design and implementation [3].
blinding	Blinding is a method used in research to ensure that the people involved in a research study – participants, clinicians, and researchers – do not know which participants are assigned to each study group, or which participants experienced the exposure or outcome of interest. Blinding is used in order to ensure that knowledge of the type of exposure, treatment, or diagnosis does not affect a participant's response to the treatment, a healthcare provider's behaviour, or an interviewer's approach to data collection.
carcinogen	A carcinogen is a substance or agent that is capable of causing cancer in living tissue [1].
causality	Causality is the relation of cause and effect. The Bradford Hill criteria for causality are: strength of association or effect size; consistency of findings across studies (known as reproducibility); biological credibility (plausibility); specificity (other explanations); a temporal relationship (exposure occurred before the outcome) and biological gradient known as a dose–response relationship; coherence (consistent with other lines of evidence); and analogy (similar agents act similarly).
chance	Chance is sampling variability that can give rise to a particular result. It is the 'luck of the draw'. It is an unsystematic overestimation or underestimation of the cause-and-effect relationship. The probability value (*p*-value) measures the probability or likelihood that an observed result occurred by chance alone.
cohort study	A cohort study is a form of longitudinal (analytic observational) epidemiological study in which a group of subjects, called a cohort, is followed over a period of time, and data relating to predetermined exposures and outcomes are collected on two or more occasions over this time period. The incidence (number of new cases) of the outcome(s) of interest is calculated in the exposed people and compared with the incidence in the non-exposed people. The data for the cohort can be collected either by following the participants into the future (prospective study) or by asking them about their

Term	Definition
	past (retrospective study). Cohort studies contribute to causality or disease aetiology and provide, at best, moderate-quality evidence.
confidence interval	A confidence interval is the range of values (for example, proportions) in which the true value is likely to be found with a degree of certainty (by convention, a 95% degree); that is, the range of values will include the true value 95% of the time.
confounding	Confounding is when a factor has an association with the exposure and can independently cause the outcome or disease. It can overestimate or underestimate an effect of interest or association. A confounding variable (also called a confounding factor or confounder) is a variable that has a relationship with both the exposure and the outcome variable. Confounding is controlled for by restricting the study population, matching the study population (for age, sex, geography, and/or socioeconomic factors), randomly selecting the study population, undertaking a stratification in the analysis (for example, by age, sex, geography, and/or socioeconomic factors), and performing regression analysis.
cross-sectional survey	A cross-sectional survey or prevalence survey is a descriptive epidemiological study in which the presence or absence of both the exposure and outcome is assessed at the same point in time. This study type is vulnerable to the problem of which came first: the exposure or the outcome (likened to 'the chicken or the egg'), as both exposure and outcome data are collected at the same point in time. These types of studies are often used to assess the prevalence of acute or chronic conditions; to inform health planning and evaluation; or to formulate a theory. It can be difficult to control for factors that may be related to the exposure and outcome in cross-sectional surveys, so they cannot be used to determine causality. They are sometimes included in the hierarchy of evidence and are considered to provide very low-quality evidence.
hierarchy of evidence	The hierarchy of evidence for primary epidemiological studies is, from highest to lowest quality: randomised controlled trials, non-randomised trials, longitudinal cohort studies, case-control studies, and cross-sectional surveys. Ecological or correlational studies are not usually in the hierarchy of evidence, as their role is to suggest rather than prove causal relationships.
I^2	The I^2 statistic is the approximate proportion of total variability in point estimates that can be attributed to heterogeneity. Its value depends on the precision of included studies as well as their sample sizes, such that as studies increase in sample size, the I^2 tends towards 100%. It is commonly classified as follows: I^2 = 25%: low heterogeneity I^2 = 50%: moderate heterogeneity I^2 = 75%: substantial heterogeneity [4].

Term	Definition
irradiance	Irradiance is the amount of ultraviolet radiant power received by a surface per unit area, usually expressed in watts per square metre (W/m^2) [1].
Mantel-Haenszel odds ratio	The Mantel-Haenszel formula allows the calculation of an overall, unconfounded (adjusted) effect estimate of a given exposure for a specific outcome by combining (pooling) stratum-specific odds ratios (ORs) or relative risks (RRs).
mean difference	The mean difference or difference in means is a standard statistic that measures the absolute difference between the mean value in two groups in an epidemiological study. It estimates the amount by which the exposure or intervention changes the outcome on average compared with the control.
melanoma	Melanoma is the most serious type of skin cancer, arising from atypical melanocytes (cells that produce melanin/skin pigment) in the skin [1].
melanocytes	Melanocytes are epidermal cells that produce melanin [1].
non-melanoma skin cancers	This refers to all types of skin cancers that are not melanoma, such as basal cell carcinoma and squamous cell carcinoma [1].
ocular melanoma	Ocular melanoma is a type of cancer that develops in or around the eye in the cells that produce pigment [1].
odds ratio (OR)	An OR is a statistic that quantifies the strength of the association between two events, A and B. The OR is defined as the ratio of the odds of A in the presence of B and the odds of A in the absence of B, or equivalently (due to symmetry), the ratio of the odds of B in the presence of A and the odds of B in the absence of A.
outlier	There are several ways to define the effect of a study as an outlier. In this review, outlier studies were classified as those wherein the confidence interval did not overlap with the confidence interval of the pooled effect. The idea behind this method is as follows: (1) Studies with a high sampling error are expected to deviate substantially from the pooled effect. However, because the confidence interval of such studies will also be large, this increases the likelihood that the confidence intervals will overlap with that of the pooled effect. (2) If a study has a low standard error and still (unexpectedly) deviates substantially from the pooled effect, there is a good chance that the confidence intervals will not overlap, and that the study is classified as an outlier [5].
randomised controlled trial (RCT)	An RCT is an analytic interventional epidemiological study in which subjects are randomly assigned to one of at least two groups. The first group is the experimental group, which receives the intervention of interest, and the other group is the comparison or control group, which receives an alternative treatment (such as current conventional therapy or a placebo). The two groups are then followed up on to see if there are any differences between

Term	Definition
	them with respect to the outcome(s) of interest. RCTs are the most stringent study design for evaluating the effect of an intervention on an outcome.
RCT – parallel design	A parallel RCT is a type of RCT where the participants are randomly allocated to either one or more intervention groups or a control group, and all of the participants in each group only receive one treatment for the entirety of the study. The researcher measures and compares the outcomes in the groups at the end of the study.
RCT – cluster design	A cluster RCT is a type of RCT where the unit of randomisation is not at the individual level but at the group level (such as in a school, clinic, or geographical area), and these groups are assigned to either one or more intervention groups or a control group. This study design is often used to evaluate a new standard of care, guideline, or other practice-, hospital-, or system-wide change that can affect patient outcomes. Cluster RCTs are helpful when there is a high risk of contamination, such as when members of the group that was not randomised to treatment could learn about and adopt parts of the intervention (e.g. in school or care home settings).
relative risk or risk ratio	The relative risk or risk ratio is the ratio of the probability of an outcome in an exposed (or intervention) group relative to the probability of the outcome in an unexposed (or control) group, and it compares the incidence of the outcome in the exposed group with the incidence of the outcome in the unexposed group.
standard deviation	The standard deviation is a summary measure of the differences of each observation from the mean within a normal distribution. It measures the amount of variation or dispersion within a set of normally distributed values. A low standard deviation indicates that the values tend to be close to the mean of the set of values, while a high standard deviation indicates that the values are spread out over a wider range. For a normal distribution, around 68.0% of scores are within 1 standard deviation of the mean; around 95.0% of scores are within 2 standard deviations of the mean; and around 99.7% of scores are within 3 standard deviations of the mean.
standard error	Standard error is a measure of the statistical accuracy of an estimate (equal to the standard deviation) of the theoretical distribution of a large population of such estimates.
statistical heterogeneity	Statistical heterogeneity is a quantifiable property that is influenced by the spread and precision of the effect size estimates included in a meta-analysis. Baseline heterogeneity can lead to statistical heterogeneity (for example, if effects differ between included populations) but does not have to. It is possible for a meta-analysis to display high statistical heterogeneity even if the included studies themselves are virtually identical [6].
sunbed	A sunbed is an electrically powered appliance or installation that emits UVR which is intended to produce tanning for cosmetic purposes [1].

Term	Definition
τ2	This is a point estimate of the among-study variance of true effects. It quantifies the variance of the true effect sizes underlying the data. Its value is insensitive to the number of studies and their precision [6].
ultraviolet radiation (UVR)	UVR is a type of radiation that is produced by the sun and some artificial sources, such as sunbeds. UVR covers the wavelength range of 100–400 nanometres (nm) and is divided into three bands: ultraviolet A (UVA) (315–400 nm), ultraviolet B (UVB) (280–315 nm), and ultraviolet C (UVC) (100–280 nm). All three bands are classified as carcinogenic to humans [1].
ultraviolet index (UVI)	The UVI is a measure of the level of UVR. The values of the index range from 0 upward; the higher the UVI, the greater the potential for damage to the skin and eyes, and the less time it takes for harm to occur [1].
wavelength	Wavelength is the distance between identical points on two successive crests of an electromagnetic wave [1].

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Executive summary

Introduction

Background

The chief environmental cause of skin cancer is ultraviolet radiation (UVR). UVR exposure comes mainly from the sun, but between 1980 and 2010, there was an increase in the use of artificial sources of UVR for cosmetic purposes. Skin cancer is the most common cancer in Ireland, with an average of 11,358 new cases of both melanoma and non-melanoma skin cancer diagnosed each year during the period 2020–2022. The purpose of this review is to provide an evidence base on the effectiveness of the public health interventions outlined by the World Health Organization (WHO), and implemented in Ireland and internationally, for reducing sunbed use and rates of skin cancer. The type of sunbed use examined in this review is use not prescribed or recommended by a medical practitioner. The main target audience for the evidence review is policy-makers at the Department of Health in Ireland, who are considering the development or revision of regulations relating to sunbed use.

Research question

The research question answered was:

- How effective are public health interventions in reducing sunbed use and the rates of skin cancer?

Methods

The approach we used for this review comprises a systematic review and meta-analysis of primary quantitative studies to synthesise evidence on the effectiveness of public health interventions in reducing sunbed use and the rates of skin cancer. The methods used in this review follow best research practice and are divided into five stages: identifying research evidence; screening search results; extracting data; conducting methodological quality and risk of bias assessments; and creating a synthesis incorporating the certainty of evidence.

In order to identify the evidence, our primary literature searches (conducted between 26 July and 2 August 2024) were based around the research question and eligibility criteria, and included a range of biomedical, clinical, and social databases (n=11); search engines (n=3); preprint resources (n=2); and trial registries (n=1). Supplemental searches, which we conducted between 11 and 25 November 2024, included forward and backward citation searching of papers that were included in data extraction; forward and backward citation chasing of the WHO's 2017 report, *Artificial tanning devices: Public health interventions to manage sunbeds*; and follow-up of relevant trial protocols and conference abstracts identified during results screening. Final searches for this review included two biomedical databases, two general search engines, one academic search engine, a grey literature resource, and non-exhaustive searches of relevant websites.

We imported our primary, supplemental, and final search results into Eppi-Reviewer. We double-screened our primary search results on title and abstract using EPPI-Reviewer's priority screening machine learning mode, guided by our eligibility criteria. We also used double-screening for the full-text screening stage of the results screening process. Conflicts in double-screening were resolved by discussion or referral to a third reviewer where necessary.

Data from each included study were extracted using a bespoke piloted data extraction form by one reviewer and validated by another for accuracy and comprehensiveness. We resolved disagreements by

discussion or referral to a third reviewer where necessary. Data extracted included publication, study, and intervention details; measures of effect; confounding variables; and other relevant information.

One reviewer conducted the methodological quality and risk of bias assessments independently and another validated these assessments for accuracy. Conflicts were resolved by discussion or referral to a third reviewer where necessary. We assessed the methodological quality and risk of bias of each study using relevant standards: the National Heart, Lung, and Blood Institute (NHLBI) quality appraisal tool for controlled interventions, the NHLBI quality appraisal tool for observational cohort and cross-sectional studies, the NHLBI quality appraisal tool for before-and-after (pre-post) studies with no control group, the Risk Of Bias In Non-randomized Studies – of Interventions (ROBINS-I) tool for non-randomised studies, and the Cochrane Risk of Bias 2 (RoB 2) tool for parallel randomised controlled trials (RCTs) and cluster RCTs.

Descriptive data on study characteristics are documented in tables and the results are presented by intervention type: education interventions are discussed first, followed by regulation interventions. For each outcome, we completed an assessment of the feasibility of meta-analysis following published guidance and found that it was not appropriate to proceed with meta-analysis for some of our outcomes. Therefore, we have presented a narrative synthesis for such outcomes, and completed pairwise meta-analysis for the remaining outcomes: mean frequency of sunbed use (education interventions), mean likelihood sunbed use intentions (education interventions), and prevalence of sunbed users (regulation interventions). We assessed the quality or certainty of evidence for each outcome using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) system, and each outcome was scored as having high-, moderate-, low-, or very low-certainty evidence.

Findings

Of the 4,472 citations screened from our primary searches, we included 36 papers that had an eligible study design, 5 of which were modelling papers that we subsequently excluded (as we had an adequate number of empirical studies for analysis). Of the 3,675 citations screened from supplemental and final searches, we included a further 3 papers for data extraction. The review includes 34 full-text studies in the final analysis: 25 papers that evaluated education interventions on sunbed users and 9 papers that evaluated regulation interventions.

Education interventions

The primary designs of the studies on education interventions included 14 RCTs (reported on in 15 papers), 3 cluster RCTs, 5 before-and-after studies, and 2 cross-sectional survey papers (1 study). The primary studies were completed in the United States of America (USA) (20 papers) and Europe (5 papers), and the papers were published between 1995 and 2024.

The systematic review participants included adolescents, young women, parents, non-medical skincare professionals, and high-risk patients. The educational themes were sunbed use, skin damage, and health risks. The interventions were delivered through a variety of formats. In-person or face-to-face education was delivered in seven papers; workbooks, flyers, and/or pamphlets were used in another seven papers; social media was used in four papers; web platforms or websites were used in five papers; and a multicomponent education intervention was used in two linked papers. Comparators in the included studies comprised participants not receiving the interventions (12 papers), waitlist participants (3 papers), unrelated educational interventions (3 papers), and no intervention at baseline (7 papers). Study outcomes were broadly categorised into sunbed use (22 papers) and intentions to use a sunbed (11 papers); 8 papers measured both outcomes. No papers assessed skin cancer rates.

The methodological quality assessment for the 18 RCTs indicated that 2 were high-quality trials, 1 was of moderate quality, and the remaining 15 were low-quality trials. The quality assessment for the five before-and-after studies and the two cross-sectional survey papers indicated that they were all low-quality studies.

The overall risk of bias for the 12 RCTs reporting on sunbed use was assessed as 'low' for 1 paper, 'some concerns' for 4 papers, and 'high' for 7 papers. The overall risk of bias for the 10 RCTs reporting on sunbed use intentions was assessed as 'low' for 1 paper, 'some concerns' for 2 papers, and 'high' for 7 papers. The overall risk of bias assessments for the three cluster RCTs reporting on sunbed use indicated a high risk of bias for all. The overall risk of bias assessments for the two cluster RCTs reporting on sunbed use intentions indicated a high risk of bias for both. Risk of bias assessments for the five before-and-after studies reporting on sunbed use denoted that all studies had a critical risk of bias, while the two cross-sectional survey studies had a serious risk of bias.

Outcome one: Sunbed use

Six papers that evaluated education interventions and reported on the frequency of sunbed use (a continuous measure) were pooled into a meta-analysis. The results of the pairwise random effects meta-analysis indicated a standardised mean difference (SMD) of 0.15 (95% confidence interval (CI): −0.64 to 0.94; I^2: 91.4%; certainty of evidence: very low; 6 papers) in favour of the control, indicating a higher frequency of sunbed use in the intervention group, although the difference was not statistically significant (p>0.05). The GRADE certainty of evidence ranking for the sunbed use outcome was very low. There was substantial heterogeneity between the findings of the included studies, as indicated by the I^2 (and its 95% CIs), which measures the variability in point estimates. The study that was the highest contributor to the overall heterogeneity included frequent sunbed tanners.

Outcome two: Sunbed use intentions

Five papers that evaluated education interventions and reported on likelihood of sunbed use intentions were pooled into a meta-analysis, and the results of the pairwise random effects meta-analysis indicated a SMD of −0.24 (95% CI: −0.42 to −0.05; I^2: 48.4%; certainty of evidence: very low; 5 papers) in favour of the intervention, which indicated lower sunbed use intentions, and this finding was statistically significant (p<0.05). The GRADE certainty of evidence ranking for the pairwise meta-analysis results on sunbed use intentions was very low. There was moderate heterogeneity between the findings of the included studies, as indicated by the I^2. The type of education intervention delivered appeared to contribute to the overall heterogeneity.

Regulation interventions

All nine primary papers on regulation interventions were cross-sectional surveys. The primary studies were completed in the USA (6 papers), Canada (1 paper), Ireland (1 paper), and Norway (1 paper), and were published between 2009 and 2020.

The cross-sectional surveys included adolescent participants (eight papers) and adult participants (one paper). At least one-half of the participants were women/girls in the five papers that reported a gender breakdown. We employed the WHO's framework document (*Artificial tanning devices: Public health interventions to manage sunbeds*) in order to identify and classify the interventions. The nine papers examined the effects of regulation interventions that restricted access to sunbeds; specifically, two papers evaluated the prohibition of unsupervised artificial tanning services, and eight papers investigated setting an age limit on sunbed use. The comparator for all nine papers was no intervention at baseline. Both papers examining the prohibition of unsupervised artificial tanning services assessed sunbed use

only. Of the eight papers examining setting an age limit on sunbed use, all eight assessed sunbed use and only one assessed sunbed use intentions. No papers assessed skin cancer rates.

The methodological quality assessment for all nine cross-sectional surveys indicated that five were of low quality and four were of moderate quality. All nine cross-sectional surveys had a serious risk of bias.

Outcome one: Sunbed use

Five papers that reported on sunbed use as a dichotomous (yes or no) measure were pooled into a pairwise random effects meta-analysis. The results of the meta-analysis indicated an odds ratio (OR) of 0.74 (95% CI: 0.38–1.45; I^2: 97%; certainty of evidence: very low; 5 papers) in favour of the intervention, indicating 26% lower odds of sunbed use after the age ban was introduced compared with no intervention at baseline, but the effect was not statistically significant (p>0.05). The GRADE certainty of evidence ranking for this outcome was very low. There was substantial heterogeneity between the findings of the included studies, as indicated by the I^2, which measures the variability in point estimates.

Outcome two: Sunbed use intentions

Only one paper assessing regulation interventions reported on sunbed use intentions, and it indicated that the odds of sunbed use intentions among adolescents in 2017 following the introduction of an age ban compared with a baseline control in 2013 did not decrease significantly (OR: 0.85; 95% CI: 0.64–1.13; p>0.05). The GRADE certainty of evidence ranking for the sunbed use intentions outcome for regulation interventions was very low.

Conclusion

This evidence review synthesised 34 papers on studies that aimed to reduce sunbed use and sunbed use intentions; 25 papers evaluated education interventions and 9 papers assessed regulation interventions.

There was very low-certainty evidence that education interventions did not statistically significantly decrease sunbed use in the intervention compared with the control groups in the pairwise random effects meta-analysis.

There was also very low-certainty evidence that regulation interventions did not statistically significantly decrease sunbed use in the intervention groups compared with baseline in the pairwise random effects meta-analysis.

Education interventions did statistically significantly reduce sunbed use intentions in favour of the interventions compared with the control groups in the pairwise random effects meta-analysis, but the certainty of evidence was again very low.

The only regulation intervention study reporting on sunbed use intentions found that the regulation in place did not indicate a statistically significant change compared with baseline, and the certainty of evidence was very low.

Our synthesis of the evidence on sunbed education and regulation interventions highlights the need for a combined intervention approach that leverages each of these strategies for the control of sunbed use. Both education and regulation interventions showed an inclination towards statistical significance for decreased sunbed use in many individual studies, and this decline was statistically significant for pooled education interventions assessing sunbed use intentions; thus, it appears that a combination of regulation and education interventions is necessary for a more robust outcome in favour of the intervention. Progression of Irish policy on sunbed use is justified if both education and regulatory approaches are considered and consolidated in any prospective interventions, as has been done with the control of tobacco and alcohol use.

1 Introduction

1.1 Background

The chief environmental cause of skin cancer is ultraviolet radiation (UVR) [7]. UVR exposure comes mainly from the sun, but between 1980 and 2010, there was an increase in the use of artificial sources of UVR for cosmetic purposes [1]. The use of these devices – such as sunbeds, stand-up tanning booths, and facial tanners (all referred to as 'sunbeds' in this review) – is increasing the incidence of skin cancer and decreasing the age of first occurrence [8–10].

The UVR from a sunbed is distributed into two bands based on wavelength – ultraviolet A (UVA) (315–400 nanometres (nm)) and ultraviolet B (UVB) (280–315 nm) – and has the same physical characteristics as the UVR exposure from the sun [1]. Many sunbeds predominantly emit UVA light, with much higher irradiance compared with the sun, as well as some UVB light [11,12]. Sunbeds are designed to provide a tan rapidly and, in order to achieve this, emit UVR at high intensity. Most tanning beds in Europe emit UVR at levels equivalent to midday tropical sun [11,12], but some of the more powerful tanning beds may emit UVR with an intensity equivalent to an 'extreme' ultraviolet (UV) index (>11), and with UVA intensities well above anything experienced in nature [12–15]. Please see Figure 1 for a breakdown of the UV index by the Health Service Executive's (HSE's) National Cancer Control Programme (NCCP).

When preparing policies and proposals related to consumer safety, health, and the environment, the European Commission relies on independent scientific committees to provide it with sound scientific advice and draw its attention to new and emerging problems [16]. In 2006, the Scientific Committee on Consumer Products (SCCP) provided an opinion on the biological effects of UVR from sunbeds. It stated that using sunbeds was likely to increase the risk of malignant melanoma of the skin and possibly ocular melanoma. It recommended that young people aged under 18 years avoid sunbeds [17].

A few years later, in 2009, the International Agency for Research on Cancer (IARC) classified the use of UV-emitting tanning devices as a Group 1 carcinogen to humans [18]. Combined analysis of more than 20 epidemiological studies shows that the risk of cutaneous melanoma is increased by 75% when the use of tanning devices starts before the age of 30 years. There is also sufficient evidence of an increased risk of ocular melanoma associated with the use of tanning devices. Studies in experimental animals support these conclusions and demonstrate that UVR (both UVA and UVB) is carcinogenic to humans [18]. These findings reinforce current recommendations by the World Health Organization (WHO) to avoid sunbeds and tanning parlours [1,19].

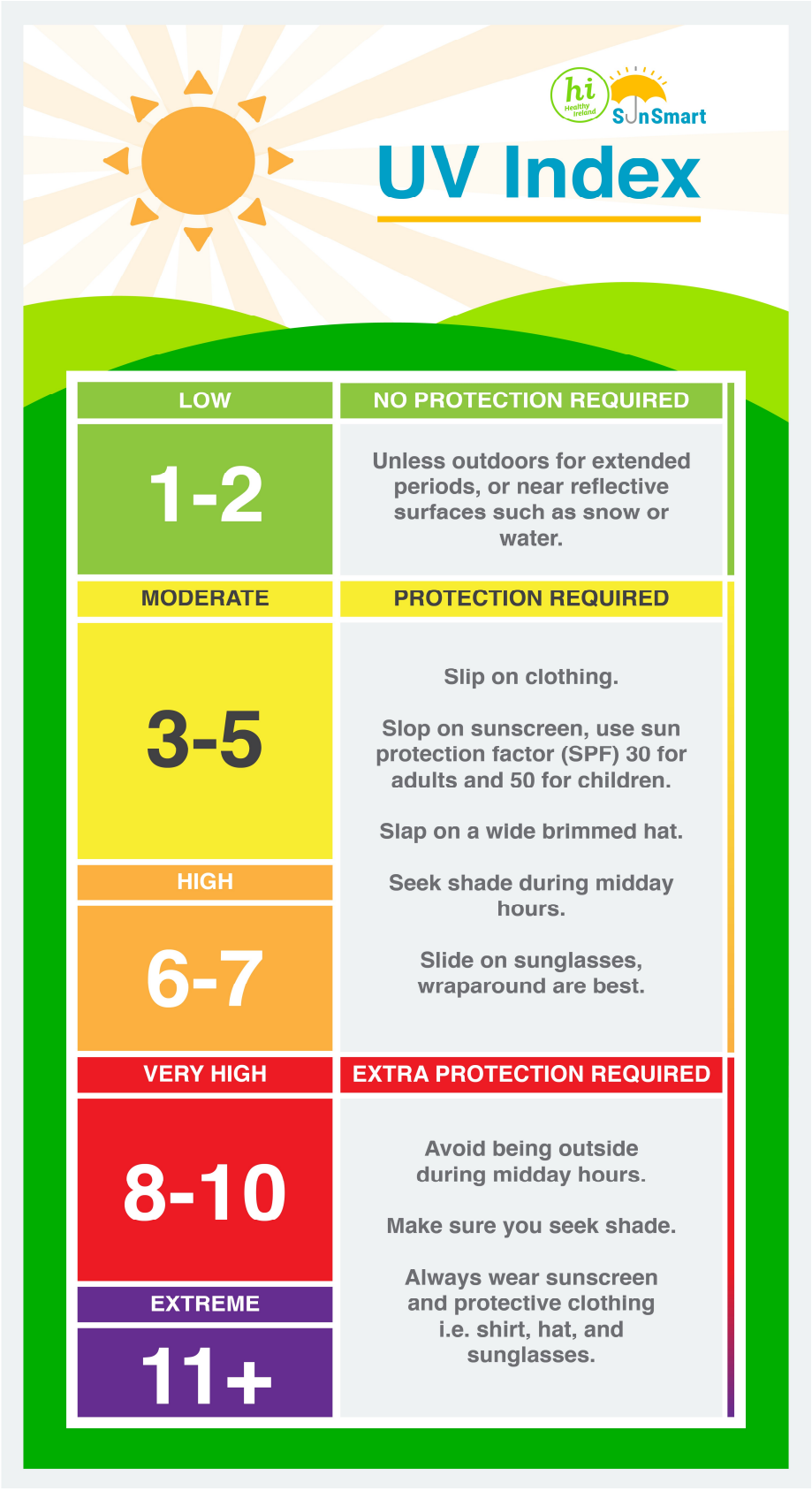

Figure 1: HSE–NCCP SunSmart UV Index Advice

Source: MET Éireann, 2024 [20]

In light of new evidence, the European Commission asked the Scientific Committee on Health, Environmental and Emerging Risks (SCHEER) to update the previous opinion on this topic. In 2016, the SCHEER echoed the sentiments of the previous opinion, stating that UVR is a complete carcinogen, both as an initiator and a promoter (both are needed for cancer to fully develop) [21]. As evidence shows that exposure to UVR from sunbeds causes cancer, and because of the nature of skin cancer induction, safe limits cannot be set for UV irradiance from sunbeds. The SCHEER states that sunbeds cannot be used without endangering human health even if they are used following existing precautions, such as using them for only short durations, wearing glasses, etc. The bottom line is that using them even once can elevate someone's risk for developing skin cancer, and the only safe way to use them is not to use them at all [21].

In 2017, the WHO outlined some policy options that may be considered by legislators and regulatory authorities to manage sunbed use in the document titled *Artificial tanning devices: Public health interventions to manage sunbeds* [1]. In each case, the intervention has been implemented in at least one WHO country or member state.

These interventions are categorised into two domains [1]:

1. promoting education strategies
2. regulating sunbed use.

The second domain, regulating sunbed use, is further divided into four main subcategories, each with its own elements:

1. banning sunbeds:
    a) banning all artificial tanning services
    b) banning the hire and sale of sunbeds for domestic use
2. restricting access to sunbeds:
    a) prohibiting unsupervised artificial tanning services
    b) setting an age limit on sunbed use
    c) preventing the use of sunbeds by 'high-risk' individuals
3. managing sunbed operations:
    a) conducting surveillance and licensing of tanning establishments
    b) controlling UV exposure
    c) requiring eye protection
    d) training sunbed operators
    e) taxing tanning sessions
4. prescribing risk communication:
    a) requiring the provision of information
    b) banning the marketing and promotion of sunbeds
    c) requiring the display of warning notices
5. ensuring compliance and enforcement.

The interventions described under each of these subcategories are listed in Figure 2.

Figure 2: Regulatory options to reduce the health risks from sunbeds

Source: WHO, 2017 [1]

The substantial burden of UVR-induced skin cancers extends beyond individual health impacts to create significant strain on healthcare systems. The high incidence of these cancers creates substantial demands on healthcare access and resources, while the tendency for patients to develop multiple primary tumours compounds treatment complexity and costs. Additionally, the economic burden encompasses not only primary treatment, but also ongoing secondary prevention measures and the substantial costs associated with treating metastatic disease. International modelling studies project that effective sunbed regulation could yield billions in healthcare savings through prevention of these cancers and their associated treatment costs [22,23].

1.2 Irish landscape

Skin cancer is the most common cancer in Ireland, with an average of 11,358 new cases of both melanoma and non-melanoma skin cancer diagnosed each year during the period 2020–2022 [24,25]. The number of people being diagnosed with skin cancer in Ireland is rising rapidly. National Cancer Registry Ireland (NCRI) projections suggest that the average number of cases diagnosed each year may double between 2015 and 2045 [24].

Ireland's Department of Health recognises that deliberate exposure to UVR for cosmetic purposes, in the form of sunbeds, is increasing the rates of the major types of skin cancer. In order to help battle this rise in skin cancer rates, the Public Health (Sunbeds) Act 2014 was enacted in Ireland in June 2014. The Act is enforced by the HSE and the National Environmental Health Service (NEHS) [26]. The primary objectives of the Act are to protect those aged under 18 years from the risk of skin cancer, and to regulate sunbed use for those aged 18 years and over in order to reduce their likelihood of developing skin cancer, premature ageing, causing damage to their eyes, and being exposed to other health risks.

Phase one of the Act commenced in July 2014 with the prohibition of the use of sunbeds by those aged under 18 years on sunbed premises. It also prohibited the sale or hire of sunbeds to people aged under 18 years. Phase two, which commenced in March 2015, introduced comprehensive measures to protect public health, including [26]:

- the prohibition of unsupervised use of sunbeds in sunbed premises

- the requirement that clients use protective eyewear
- a prohibition on certain marketing practices
- a prohibition on health claims
- a requirement for warning signs on sunbed premises and social media sites
- a requirement that sunbed businesses provide health information to potential clients
- notification to the HSE of the operation of existing sunbed business.

These measures fall within the scope of the WHO's public health interventions identified in the document titled *Artificial tanning devices: Public health interventions to manage sunbeds* [1], which were outlined in Section 1.1 and Figure 1 of this evidence review.

1.3 Systematic review literature

We identified four existing systematic reviews that evaluated education and regulation interventions measuring sunbed outcomes.

Sandhu *et al.* (2016) examined the effects of multicomponent community-wide interventions and mass media interventions alone in order to determine their effectiveness in reducing UVR exposure in a systematic review of the literature, and included two studies that examined the effect of these interventions on sunbed outcomes [27]. The first primary study examined the effect of a multicomponent community-wide intervention and reported a 4.0% decrease in sunbed use (95% confidence interval (CI): 2.5–5.5%). The second primary study examined the effect of a mass media intervention alone and reported a decrease in sunbed use (odds ratio: 0.61; 95% CI: 0.54–0.69), as well as a decrease in the proportion of teens who started using sunbeds in early adolescence (aged 13 years: from 13% to 8%, $p<0.001$; aged 13–15 years: from 75% to 65%, $p<0.001$) [27].

Sheeran *et al.* (2020) estimated the size of intervention effects on indoor tanning and determined which intervention strategies maximise behaviour change in a systematic review of 32 studies on indoor tanning [28]. The authors concluded that the effects of interventions were not significantly different from zero for indoor tanning (including sunbed use and intention to use sunbeds) ($d+$: −0.011; 95% CI: −0.096 to 0.074). In addition, the authors reported that individually delivered interventions that promoted alternatives to tanning were associated with larger effect sizes for sunbed outcomes [28]. Despite this, the definitiveness of characteristics associated with larger effect sizes may warrant further investigation. This is because the approach that Sheeran *et al.* followed [28] relied on a comparison of existing studies (as opposed to direct comparisons within trials); thus, it remains unclear whether the characteristics compared were mutually exclusive in each study, and if not, how confounding intervention characteristics were controlled for in the systematic review.

Asai *et al.* (2021) used a systematic review approach to examine the effect of interventions aimed at post-secondary school young adults on college and university campuses on skin cancer awareness, photoprotection, and change in UV-exposure-related behaviour. The authors reported that loss-framed messages (such as early ageing and skin damage as a result of sunbed use) appear to decrease intentions to use a sunbed [29]. The findings of this review with respect to sunbeds are based on 10 studies [29].

Rodriguez-Acevedo *et al.* (2020) used a systematic review approach to examine changes in the international prevalence of indoor tanning (or sunbed use) among teenagers and adults after artificial tanning devices were classified as carcinogenic by the IARC in 2009 [30]. The authors identified 43 prevalence studies, published between 2010 and 2018, that reported on the prevalence of indoor tanning exposure. The authors concluded that the prevalence of sunbed use among teenagers for the period

2013–2018 was 6.5% (95% CI: 3.3–10.6), 70% lower than the 22.0% (95% CI: 17.2–26.8) prevalence for 2007–2012. The prevalence of sunbed use in adults was 10.4% (95% CI: 5.7–16.3) for the period 2013–2018, a decrease of 35.0% from 18.2% for the period 2007–2012. The authors attribute a portion of these decreases to the IARC statement [30].

1.4 Purpose of this review

The purpose of this review is to provide an evidence base on the effectiveness of the public health interventions outlined by the WHO, and implemented in Ireland and internationally, for reducing sunbed use and rates of skin cancer.

The main target audience is policy-makers at the Department of Health who are considering the development or revision of regulations relating to sunbed use. This review addresses artificial tanning sunbeds used for cosmetic purposes only, and it is not intended to cover the use of UV therapy devices for medical purposes under the guidance of a trained medical practitioner.

1.5 Research question

With the above information in mind, the Department of Health and the Health Research Board (HRB) have agreed the following research question:

- How effective are public health interventions in reducing sunbed use and the rates of skin cancer?

2 Methods

2.1 Review design

For this evidence review, we employed a systematic review and meta-analysis of primary quantitative studies to examine the evidence base for public health interventions aimed at reducing sunbed use and skin cancer rates. We prepared and registered a protocol on PROSPERO (Protocol number CRD42024573467) [31]. This systematic review has been reported according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) criteria (Appendix A) [32].

2.2 Eligibility criteria

The eligibility criteria for this systematic review are set out in Table 1. Inclusion and exclusion criteria were based on population, intervention, comparator, outcomes, and study design (PICOS). The population of interest was individuals who use sunbeds for cosmetic purposes. Non-sunbed users who use UV therapy devices for medical purposes were excluded. The interventions of interest were those identified by the WHO in *Artificial tanning devices: Public health interventions to manage sunbeds* [1], which were outlined in Section 1.1 and Figure 1 of this evidence review. The study design inclusion criteria were set to take account of the paucity of experimental studies, as indicated by the scoping searches. Studies were required to include at least one outcome of interest in order to be eligible for consideration. We did not apply any limits for the domains of date, language, or location.

Table 1: Inclusion and exclusion criteria using PICOS and other relevant criteria

PICOS domain	Inclusion criteria	Exclusion criteria
Population	Users of artificial tanning devices for cosmetic purposes Artificial tanning devices that emit UVR, including sunbeds, stand-up tanning booths, and facial tanners, all of which will be referred to as 'sunbeds' in this document	Non-sunbed users UV therapy devices when these are used for medical purposes under the guidance of a trained medical practitioner
Intervention	Public health interventions, as outlined in the WHO publication *Artificial tanning devices: Public health interventions to manage sunbeds* [1]: • promoting education strategies • regulating sunbed use (see Section 1.1)	Public health interventions not detailed in the WHO publication *Artificial tanning devices: Public health interventions to manage sunbeds* [1]
Comparator	Non-sunbed users No intervention Unrelated alternative interventions	–
Outcomes	Sunbed use or sunbed use intentions Rates of melanoma (including ocular melanoma) or estimated rates Rates of non-melanoma skin cancers or estimated rates Rates of pterygium (a raised, fleshy growth on the eye's conjunctiva)	–
Study design	Randomised controlled trials Controlled clinical trials Non-randomised trials Retrospective/prospective cohort studies Case-control studies Cross-sectional surveys Modelling studies	Case studies Opinion pieces or editorials Qualitative studies Reviews Conference abstracts Conference posters Trial protocols
Date	No limit	–
Language	No limit	–
Location	No limit	–

2.3 Identifying research evidence

2.3.1 Search approach

The information searches for this evidence review were designed to prioritise sensitivity and recall rather than specificity and precision. The purpose was to capture as much relevant information as possible, at the cost of also including some irrelevant material [33]. The sensitivity of the search was balanced with the logistical requirements of the review, including both the time frame provided and the staff available. We used a comprehensive approach to guide the information retrieval stage of this review, including the use of a wide range of search resources and methods. We carried out searches of clinical, allied health, and social care databases; registries; preprint repositories; and other grey literature sources. We also employed supplemental search methods such as citation searching and protocol follow-up.

The formal search plan for this evidence review, as outlined in the review protocol [31], included three stages:

1. The first stage comprised searches of relevant bibliographic databases and grey literature resources, which were carried out and documented.
2. The second stage involved supplementary searches, including forward and backward citation searching.
3. We carried out a final set of searches in a limited number of databases a few months after the first stage in order to capture any relevant material that had been published since we conducted the initial searches.

In practice, the first stage of literature searching was carried out during July and August 2024, and the second and third stages of the search process (supplemental searches and final searches) were amalgamated into a single stage and carried out between 11 and 25 November 2024.

2.3.2 Search concepts

The search process was built around the requirements of the research question. While the primary concept for this review comprised interventions (for example, educational or regulatory interventions) that are intended to reduce sunbed use, the literature search was designed around the concept of sunbeds themselves rather than specific interventions. The reason why we took such a broad approach was that the terminology for these interventions is not standardised or consistent across all resources used, and so, from a technical search point of view, was not always included in titles, abstracts, or other searchable fields of the databases searched. Simply put, a database search cannot capture a relevant journal article if the relevant terms used in that article are not included in the searchable fields of the database. After we carried out the scoping searches, it became clear that the screening process would be a more effective filter for relevant studies than searching for the combination of terms for sunbeds and our interventions of interest.

As stated, the primary concept for the search was that of sunbeds or indoor tanning. Synonyms for this concept included, but were not limited to, the following: ‘sunbed’, ‘sunlamp’, ‘solarium’, ‘indoor tanning’, ‘tanning salon’, ‘tanning facilities’, and ‘non-solar tanning’. The full search strategies (showing all synonyms used) and Preferred Reporting Items for Systematic reviews and Meta-Analyses literature search extension (PRISMA-S) are available in Appendix B. The topic of sunless tanning products includes creams, tablets, and spray-on tans (all of which were beyond the scope of this evidence review), but it can also include sunbeds; therefore, after testing in searches, terms relating to sunless tanning products were included in the final search terms. The search term ‘collarium’ and the plural ‘collaria’ were both tested but were omitted from the final search because including this terminology returned only confounding results (e.g. references to the collarium of a mushroom, the plant bug genus *Collaria*, or the slime mould *Collaria arcyrionema*). We also included some non-English-language terms we believed to be relevant in order to maximise the likelihood of capturing non-English-language research, but these terms were very broad and were not as specific as required. Some non-English terms in languages that do not use a Latin alphabet that we considered relevant were included, for example, “تخت آفتابی”, “سالن برنزه”, “لامپ برنزه کننده”, “صالون تسمير”, “מכון שיזוף”, “曬黑沙龍”, “日焼けサロン”, and “σολάριουμ”. Not all databases were able to resolve these terms or relate them to searchable text. The most comprehensive search strategies were possible with bibliographic databases such as EBSCO MEDLINE, Ovid Embase, and EBSCO Cumulative Index to Nursing and Allied Health Literature (CINAHL), while only short and simple searches were possible with other resources such as search engines, as these resources are not designed for systematic searching.

We did not use outcomes or treatment indications as search concepts in order to capture as much relevant research as possible [34]. Chapter 4 of the *Cochrane Handbook for Systematic Reviews of Interventions* states, per Frandsen et al. (2020), that searching on all aspects of the review question is usually unnecessary and potentially undesirable [33,35], as aspects of the question (such as outcomes or comparators) may not be adequately indexed in the database's searchable fields [33] and thus would not be captured in the search but would result in relevant research being excluded.

We did not employ any search limits for date, age, or geographical region. While a language limit was not used to restrict the search results to the English language only, the majority of the research published within the databases and resources that we searched was in the English language. We also included some non-English-language research databases in the search with the aim of capturing research in other languages.

2.3.3 Search strategies

We constructed the initial search strategy in EBSCO MEDLINE using Medical Subject Headings (MeSH) thesaurus terms and keywords (or 'free' natural language terms). We used the MeSH Browser and PubMed PubReMiner tool to source relevant MeSH terms [36,37]. We examined the titles, abstract terms, and author/subject index terms of relevant papers for relevancy and potential inclusion. For each concept, we constructed search blocks using relevant terms. We used Boolean operators ('and', 'or', and 'not') to combine search blocks in MEDLINE.

We translated the EBSCO MEDLINE search strategy for use in other databases and we employed database thesaurus terms (also known as controlled vocabulary) where available. For example, we used MeSH terms while searching the Cochrane Library. For search resources that do not allow complex, structured searches, we used abbreviated searches. A second information specialist (AF) peer-reviewed the MEDLINE search strategy in line with best practice [38].

2.3.4 Search resources

In order to capture relevant research, we used a broad range of search resources, such as biomedical, clinical, social, and public health literature databases; systematic review resources; grey literature resources; search engines; preprint repositories; and protocol resources. We included search resources that index non-English-language research, as well as search resources known to include research from countries where sunbed bans have been implemented, specifically Australia, Brazil, and Iran.

As some of the interventions of interest have a legislative basis, we initially scope-searched legal databases prior to carrying out the formal searches in order to establish whether relevant research would be found there. Similarly, as educational interventions were relevant to the review, we scope-searched the Education Resources Information Center (ERIC) database (which is sponsored by the Institute of Educational Sciences of the U.S. Department of Education). We found that including legal databases and ERIC in the formal searches did not offer any benefits in addition to the inclusion of the clinical and social databases, so, after scoping, these were not used.

As noted in Section 2.3.1, we carried out a final set of searches at the same time that the supplemental searches were carried out in order to capture any newly published relevant reviews. The resources examined for these final searches included MEDLINE; the Cochrane Library, including the Cochrane Database of Systematic Reviews (CDSR) and the Cochrane Central Register of Controlled Trials (CENTRAL); and Google Scholar. The final list of resources used is outlined in Table 2, and an expanded list of resources with numbers of results and dates of searches is presented in Appendix B. The databases used for the searches, including MEDLINE, Embase, and CENTRAL, align with those suggested by the *Cochrane Handbook for Systematic Reviews of Interventions* [33]. The search strategies and methods that have been

described here were implemented in line with PRISMA-S, the reporting guideline for literature searches [39].

Table 2: Literature search resources

Type of search platform	Name of search platform or resource
Primary searches	
Biomedical/clinical/social and public health literature databases	EBSCO MEDLINE
	EBSCO CINAHL
	EBSCO SocINDEX with Full Text
	Epistemonikos (primary studies limit)
	EPPI-Centre Trials Register of Promoting Health Interventions (TRoPHI)
	Virtual Health Library (VHL) Regional Portal databases, including Latin American and Caribbean Health Sciences Literature (LILACS)
	Informit
	Ovid Embase
	Scientific Electronic Library Online (SciELO)
	Scientific Information Database (Iran)
	Cochrane Library (including the CDSR and CENTRAL databases)
Search engines	DuckDuckGo
	Google (first 200 results for each search)
	Google Scholar (first 200 results for each search)
Preprint resources	Research Square
	medRxiv and bioRxiv (combined search interface)
Trial resources	ClinicalTrials.gov
Supplemental searches	
Citation searching	Forward citation searching of research papers selected to be included from the screening process
	Backward citation searching of research papers selected to be included from the screening process
	Follow-up of trial protocols and conference abstracts identified in the screening process
	Forward and backward citation searching of references to the WHO (2017) report *Artificial tanning devices: Public health interventions to manage sunbeds* [1]
	WHO report citations (via Google Scholar)
Updated database and search engine searches	DuckDuckGo
	Bielefeld Academic Search Engine (BASE)
	EBSCO MEDLINE
	Google Scholar
	Cochrane Library (including the CDSR and CENTRAL databases)
Grey literature and other resources	OpenGrey via Data Archiving and Networked Services (DANS)
	Non-exhaustive searches of relevant websites

We included search engines in the primary search in order to assist in the retrieval of studies that were published outside of indexed journals [40,41]. These are frequently used as supplemental search resources, but it was helpful to incorporate them at the primary search stage, as the results could then be deduplicated with the results from the searches of bibliographic databases. Search engines have been shown to be of some use when searching for research published in non-traditional formats. Although they can often be useful, there are disadvantages to the use of search engines, including a lack of transparency and reproducibility. For example, citation counts from Google Scholar are useful but typically not completely accurate – they can be expected to include duplicates and errors and may not always detect

citations from reports or non-traditional publications. The algorithms on which search engines operate are also typically not made public, and many factors (such as the geographic location of the searcher) can affect the results retrieved [40–42]. We included several of these resources (which use different algorithms and web-crawling systems) with the aim of reducing the effect of bias in the individual search engines.

2.3.5 Supplementary search strategies

We supplemented the primary database searches by forward and backward citation screening a set of research papers included from the full-text screening stage of the database searches. Backward citation searching (reference chasing or 'snowballing') and forward citation searching (citation chasing) have previously been shown to be helpful when carrying out searches for systematic reviews [43]. We used Google Scholar to retrieve citations of included research papers, and we used the Dimensions AI database to retrieve reference lists from research papers where possible. We included the references and citations of the WHO's 2017 report *Artificial tanning devices: Public health interventions to manage sunbeds* [1] as part of the citation searching process. We also searched grey literature sources (OpenGrey and a selection of relevant websites) as supplemental sources.

We carried out an updated search in selected search resources (EBSCO MEDLINE; the Cochrane Library, including the CDSR and CENTRAL databases; the search engines DuckDuckGo and Google Scholar; and BASE) after these supplemental searches were completed in order to update the search results.

As per PRISMA-S reporting requirements, we note here that we did not contact authors, experts, manufacturers, or others as part of the search process [39].

2.3.6 Study screening and selection

We managed data for the results screening process in Eppi-Reviewer [44,45]. We deduplicated the results from the search in EndNote X9 and then uploaded these to Eppi-Reviewer. We double-screened these results at title and abstract level using a broad set of inclusion and exclusion criteria (see Table 2 and Table 3). The screening codes we used were based broadly on the PICOS criteria. We added a code for 'exclude on relevant poster, conference abstract, or trial protocol'. We considered these items as excluded studies, but retained them in order to follow up the citations for related published studies during our supplemental search. We also used a code for 'exclude on relevant systematic review', as these items could then be followed up for relevant comparable research for the review discussion.

We did not use an 'exclude on duplicate' code during the title and abstract screening process; rather, the references coded for inclusion were screened separately for duplicates after the title and abstract screening process. We used this approach for several reasons: at the title and abstract screening stage, the citation details are often incomplete and could result in items being coded as duplicates in error; in addition, we used a machine learning screening method that did not present the references in a list that we could sort by title, author name, or other method, so checking for duplicates was not a simple task and would take extra time, whereas excluding on any other code could be decided quickly and simply based on the information in the reference in question without comparing it to potential duplicates. We did not use 'exclude on comparator' as a screening code for title and abstract screening, as the comparators are often not described in enough detail to make accurate screening decisions based on the available titles and abstracts. Disagreements on screening verdicts were captured within the Eppi-Reviewer screening mechanism and resolved through discussion.

Table 3: Screening codes

Title and abstract screening codes

INCLUDE on title and abstract
EXCLUDE on population
EXCLUDE on intervention
EXCLUDE on outcome
EXCLUDE on primary study design
EXCLUDE on relevant poster, conference abstract, or trial protocol
EXCLUDE on relevant systematic review
Full-text additional or changed screening codes
INCLUDE on full text
EXCLUDE on comparator (full-text only)

We used EPPI-Reviewer's priority screening machine-learning mode in order to expedite the screening process at the title and abstract screening stage [46]. In this mode, the EPPI-Reviewer algorithm detects patterns during the initial training period of the screening process, and then presents the items that have been calculated as highly relevant to the screeners early in the screening process. This system uses machine-learning/text-mining to build a model based on which terms and phrases occur in records coded as 'included' and 'excluded'. The system iteratively analyses the records that have been screened - initially at intervals of every 25 records, and then less frequently, for example every 100 records, as the model develops. At each analytic stage, it reanalyses the remaining records for screening and assigns them a predictive score on likelihood of relevance for inclusion. It then generates a set of records and presents them by likelihood of inclusion. This allows the screeners to process the records most likely to be included early in the screening process and leave the vast majority of the potential excludes to the latter part of the screening process [47].

The priority screening process offers a range of modes to reconcile differences in coding verdicts for double-screened records, including:

- Multiple: no auto-completion,
- Multiple: auto-complete (code-level),
- Multiple: auto-complete (inclusion/exclusion level),and
- Multiple: autocomplete (safety first).

The reconciliation mode chosen for this review was Multiple: auto-complete (inclusion/exclusion level). This mode presents any records to the screeners for discussion and reconciliation where the screening code differs between screeners, i.e. one screener assigns an include code and the second screener assigns an exclude code. A decision is made between the two screeners and the third arbitrator on whether that record should then be included or excluded. The code chosen at the end of discussion and reconciliation is final for that record and are completed and locked in. The completed and locked in records are not presented again to the screeners. All records in title and abstract screening were double screened and none were auto completed. The settings chosen for priority screening in this review are shown in Figure 3. Priority screening can be used only once in the screening process for a review, and was not used for full text screening or title and abstract screening of the supplemental search results.

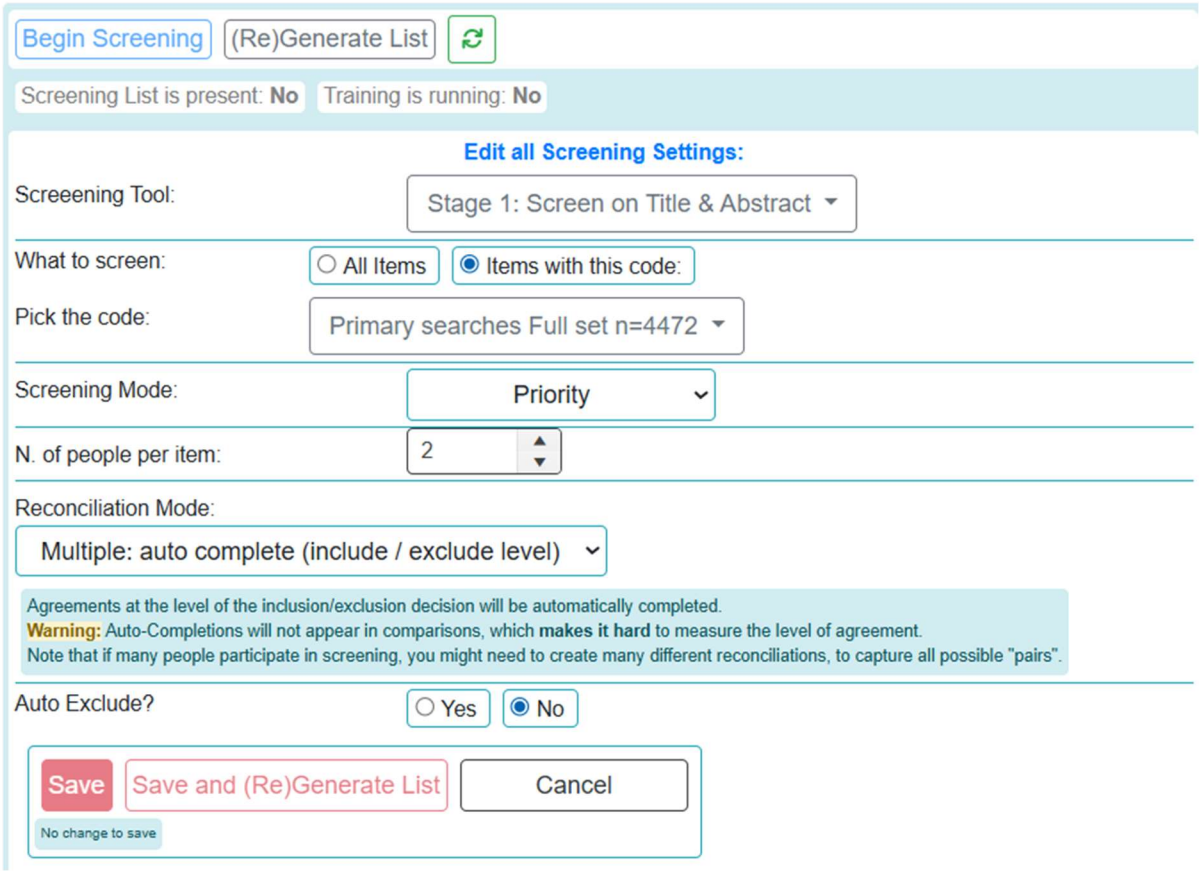

Figure 3 EPPI-Reviewer priority screening settings

We carried out full-text screening of research papers on the results included from the title and abstract screening stage. We used the 'exclude on comparator code' at the full-text screening stage. After full-text screening, any research papers that did not meet the exclusion criteria were considered for inclusion. We included research papers that were included from this screening process in a forward and backward citation searching process. Research papers retrieved from this process were screened using the same screening criteria as the first set of results. The citation details of papers excluded at the full-text screening stage, with their exclusion codes, are listed in Appendix C.

2.4 Data extraction

We extracted data using standardised bespoke electronic data extraction forms that we piloted on a small sample of papers and adapted as necessary (Appendix D). In order to minimise bias and errors, data extraction was performed by one reviewer and checked by a second (TM and DM). Disagreements were resolved through discussion or referral to a third reviewer where necessary. Data that were extracted include:

- **Publication details**: title, first author, year of publication
- **Study details:** country, study design, funders, study setting(s), target population, comparator(s)
- **Intervention:** aim, intervention type (in line with the WHO framework, mode of delivery, duration, outcome(s)
- **Measure of effect:** time points measured, outcome definition, unit of measurement, upper and lower limits, outcome/tool validation, assumed risk estimate, power, number of missing participants, unit of analysis, statistical methods used

- **Other information:** key conclusions of study authors, correspondence required for further study information (from whom, what, and when).

2.4.1 Confounding domains

During literature scoping and full-text reading, we identified three possible confounding variables and two co-interventions that could be associated with the intervention and could independently prevent or cause the outcomes (in this case, change in sunbed use, sunbed use intentions, and rates of skin cancer):

- confounding variables include:
  - age
  - sex
  - race/ethnicity
- co-interventions include:
  - ongoing education interventions
  - pre-existing regulations.

We documented the confounders controlled for in each paper and used these data to answer the quality assessment question. Depending on study design and data availability, we accounted for confounding variables in our meta-analysis using subgroup and stratified analyses.

2.5 Methodological quality assessment

In order to minimise bias and errors, two reviewers independently assessed the methodological quality of the included studies. Discrepancies were resolved through discussion or referral to a third reviewer where necessary. The methodological quality assessments were used to describe the main strengths and limitations of the included studies. We did not use the methodological quality assessments as a reason for study exclusion.

As highlighted in Section 2.2, a range of study designs were included in this systematic review. Consequently, a range of quality assessment tools were required for different study types. We assessed the methodological quality of randomised controlled trials (RCTs) and non-randomised intervention studies using the National Heart, Lung, and Blood Institute (NHLBI) quality appraisal tool for controlled interventions. For cross-sectional studies, we assessed methodological quality using the NHLBI quality appraisal tool for observational cohort and cross-sectional studies. We assessed the methodological quality of before-and-after studies using the NHLBI quality appraisal tool for before-and-after (pre-post) studies with no control group. These tools are available on the NHLBI website [48].

For each paper, we calculated an overall quality rating using a bespoke system, based on essential criteria for each type of study [3]. For RCTs and non-randomised intervention studies, cross-sectional studies, and before-and-after studies, we selected and scored five items from the respective NHLBI tool as outlined in Table 4,Table 5, and Table 6. The items chosen identified the aspects of the studies that were most likely to introduce bias to the results through unrepresentative sampling (a proxy for effect of assignment or exposure), sample size (a proxy for ability to detect true differences in outcomes), loss to follow-up (a proxy for missing outcome data and for complete reporting of outcomes and experiences), and confounding (a proxy for randomisation). The criteria were chosen to mimic risk of bias.

Table 4: Overall quality rating calculation for RCTs and non-randomised intervention studies using the NHLBI quality appraisal tool for controlled interventions

Item	Scoring
2. Was the method of randomisation adequate (i.e. use of randomly generated assignment)?	Yes: 1.0 No: 0.0
3. Was the treatment allocation concealed (so that assignments could not be predicted)?	Yes: 1.0 No: 0.0
6. Were the groups similar at baseline on important characteristics that could affect outcomes (e.g. demographics, risk factors, co-morbid conditions)?	Yes: 1.0 No: 0.0
7. Was the overall drop-out rate from the study at endpoint 20% or lower of the number allocated to treatment?	Yes: 1.0 No: 0.0
12. Did the authors report that the sample size was sufficiently large to be able to detect a difference in the main outcome between groups with at least 80% power?	Yes: 1.0 No: 0.0

Note: Responses of 'Not reported', 'Cannot determine', and 'Not applicable' were scored 0.0 for each item.

Table 5: Overall quality rating calculation for cross-sectional survey studies using the NHLBI quality appraisal tool for observational cohort and cross-sectional studies

Item	Scoring
3. Was the participation rate of eligible persons at least 50% and was an appropriate target population clearly defined per the research question and did the cases adequately represent the cases that arose in the target population?	Yes: 1.0 No: 0.0
4A. Were all the subjects selected or recruited from the same or similar populations (including the same time period)?	Yes: 0.5 No: 0.0
4B. Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	Yes: 0.5 No: 0.0
5A. Was a sample size justification, power description, and effect estimates provided?	Yes: 0.5 No: 0.0
5B. Was a description of variance provided?	Yes: 0.5 No: 0.0
13. Was loss to follow-up after baseline 20% or less?	Yes: 1.0 No: 0.0
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	Extensive: 1.0 Partial: 0.5 Some: 0.0 None: 0.0

Note: Responses of 'Not reported', 'Cannot determine', and 'Not applicable' were scored 0.0 for each item. For item 14, key potential confounding variables were identified based on established risk factors for the condition under consideration (see Section 2.4.1); while some papers controlled for a large number of variables in their models, only these key confounding variables were considered for item 14. The scoring system for item 14 was:

0.0 = No control for confounders

0.0 = Some control for one of the confounding variables or co-interventions

0.5 = Partial control for two or more of the confounding variables or co-interventions

1.0 = Extensive (must have controlled for each of the confounding variables and co-interventions)

Table 6: Overall quality rating calculation for before-and-after studies using the NHLBI quality appraisal tool for before-and-after (pre-post) studies with no control group

Item	Scoring
2. Were eligibility/selection criteria for the study population prespecified and clearly described?	Yes: 1.0 No: 0.0
3. Were the participants in the study representative of those who would be eligible for the test/service/intervention in the general or clinical population of interest?	Yes: 1.0 No: 0.0
5. Was the sample size sufficiently large to provide confidence in the findings?	Yes: 1.0 No: 0.0
8. Were the people assessing the outcomes blinded to the participants' exposures/interventions?	Yes: 1.0 No: 0.0
9A.Was the loss to follow-up after baseline 20% or less?	Yes: 0.5 No: 0.0
9B. Were those lost to follow-up accounted for in the analysis?	Yes: 0.5 No: 0.0

Note: Responses of 'Not reported', 'Cannot determine', and 'Not applicable' were scored 0.0 for each item.

For each paper reporting on RCTs and non-randomised intervention studies, cross-sectional survey studies, or before-and-after studies, the scores were summed (for a total score ranging from 0.0 to 5.0). Papers scoring less than 3.0 were rated low quality, papers scoring 3.0 were rated moderate quality, and papers scoring 3.5 or more were rated high quality. As many studies were cross-sectional in nature (point-in-time surveys) and scored 0.0 on item 13 of the NHLBI quality appraisal tool for observational cohort and cross-sectional studies (loss to follow-up not applicable), the maximum possible score for papers reporting on these types of studies was effectively capped at 4.0; for this reason, the threshold for 'high quality' was set at 3.5 rather than 4.0 in order to allow more effective differentiation of papers at the upper end of the range of scores.

2.6 Risk of bias assessment

In order to minimise bias and errors, two reviewers independently assessed the risk of bias of the included studies (TM and DM). Disagreements were resolved through discussion or referral to a third reviewer where necessary.

Two independent reviewers assessed the risk of bias of RCTs using the Cochrane Risk of Bias 2 (RoB 2) tool that is available on the Cochrane Methods website [49,50]. This tool evaluates several domains, including bias arising from the randomisation process, deviations from the intended interventions, missing outcome data, measurement of the outcome, and selection of the reported result. Each domain was rated as having a low risk of bias, some concerns of bias, or a high risk of bias, and an overall risk of bias judgement was made for each study.

Two independent reviewers assessed the risk of bias of non-randomised studies using the Risk Of Bias In Non-randomized Studies – of Interventions (ROBINS-I) tool [51]. This tool addresses bias in seven domains: bias due to confounding, selection of participants, classification of interventions, deviations from intended interventions, missing data, measurement of outcomes, and selection of the reported result. The reviewers rated each domain as having a low, moderate, serious, or critical risk of bias, and an overall judgement was made for each study outcome.

The results of the risk of bias assessment are presented in figures and discussed in the narrative synthesis, providing transparency about the quality of the included studies and the confidence in the findings of this systematic review.

2.7 Meta-analysis feasibility assessment

A meta-analysis feasibility assessment is a stepwise framework that ensures that the underlying assumptions in extracted data are systematically explored and that the risks (and benefits) of pooling and comparing intervention effects are identified. For each outcome of interest, we completed an assessment of the feasibility of meta-analysis following published guidance [52]. We first grouped papers by intervention group (i.e. education or regulation) and then by outcome (i.e. sunbed use or sunbed use intentions). Following this, for each group of papers, we assessed comparability on the following variables:

- **Outcome measures:** Outcomes derived from raw data (e.g. mean sunbed use) had to provide the same data, or data that could be transformed into a usable standardised format, in order for us to complete a meta-analysis (e.g. standard errors were converted to standard deviations (SDs)). Precalculated, heterogeneous effect estimates were also considered feasible where these could be converted to standardised mean differences (SMDs) [53]. The outcome follow-up period (e.g. 1 month or 6 months post-intervention) was used to inform subgroup analysis in order to distinguish between short-term and long-term intervention effects.
- **Study design:** In line with recommended practice [54], where an outcome was studied by both clinical trial and observational study designs, we sought to separate clinical trial and observational data for the purpose of meta-analysis. Consequently, in order for meta-analysis to be feasible, we required three studies of the same broad study design (i.e. clinical trial or observational design). Where a study design was inappropriately employed to test an intervention, it was excluded from the meta-analysis.
- **Population:** Population age, gender, and race/ethnicity were considered as part of the feasibility assessment. Population characteristics were not only used to exclude studies from meta-analysis but also to inform decisions on stratification, as well as subgroup and sensitivity analysis.
- **Intervention:** Within the main intervention groups of education and regulation, interventions were further subclassified by mode of education delivery and degree of regulatory restriction. These subclassifications were used to inform subgroup and sensitivity analysis.
- **Extent of control for confounding:** The main confounding variables were gender, age, and race/ethnicity. Confounding was considered for observational designs whereby analyses were stratified by sex and age; adjusted proportions were employed if appropriate.
- **Number of studies contributing outcome data:** We required three studies in order for the outcome to be feasible for meta-analysis.
- **Study quality/risk of bias:** This domain was used to inform subgroup analysis.

2.8 Data synthesis

Where feasible, we quantitatively synthesised the data using meta-analytic methods for the research question. When meta-analysis was not feasible, we used a narrative approach following the Synthesis Without Meta-analysis (SWiM) guidelines [55].

We considered network meta-analysis – a statistical technique for the comparison of three or more treatments in a single analysis by combining direct and indirect evidence in a single network [56] – in order to compare outcomes within and across education and regulatory intervention categories. We determined that network meta-analysis was not feasible due to heterogeneity in the study designs employed to study regulation (observational designs) and education (clinical trial and observational

designs) intervention studies. In addition, there were insufficient numbers of studies with which to undertake a network meta-analysis of the education intervention subcategories.

We conducted a pairwise meta-analysis separately for education and regulation interventions. The pairwise meta-analysis approach for each individual study outcome was guided by the *Cochrane Handbook for Systematic Reviews of Interventions* [54]. We performed analyses in R version 4.4.3 using the meta, metafor, and tidyverse R packages [57–61].

We ran a series of meta-analysis models in order to pool the following:

- The difference in the average sunbed use between groups receiving an education intervention and no education intervention using clinical trial data (with the SMD derived from raw study data or from precalculated pooled estimates)
- The difference in the average sunbed use intention between groups receiving an education intervention and no education intervention using clinical trial data (with the SMD derived from raw study data)
- The difference in the proportion of sunbed users between groups where age restriction legislation is in place and where there is no age restriction legislation in place (with the odds ratio (OR) derived from raw study data).

There were insufficient education intervention data to pool the average sunbed use or average intended sunbed use in observational studies. There were also insufficient data to pool binary outcome data such as odds of sunbed use. There were insufficient 'partial restriction' (i.e. parental consent) regulation intervention data to pool as part of the meta-analysis for regulation interventions. We contacted four study authors requesting the missing data we required for inclusion in the meta-analysis and received the requested data from one study author.

Based on the results of the feasibility assessment for meta-analysis, we anticipated considerable between-study heterogeneity for all feasible meta-analysis models and therefore used a random effects model to pool effect sizes for each model [62]. The random effects meta-analysis model considers both study sample size and the estimate of between-study variation (i.e. study heterogeneity) when weighting study effects [62]. We estimated the random effects model using the restricted maximum likelihood estimator for differences in the average sunbed use and sunbed use intentions given its robust performance in continuous outcome data [63]. Given its utility for binary effect size data, we employed the Paule-Mandel procedure in order to estimate the difference in the proportion of sunbed users between groups where age restriction legislation is in place and where there is no age restriction legislation in place. We used Knapp-Hartung adjustments [64] to calculate the confidence interval around the pooled effect. Several studies showed that applying a Knapp-Hartung adjustment can reduce the chance of false positives, especially when the number of studies is small [65,66]. For all meta-analysis models of continuous outcome data, we carried out sensitivity analysis using the Sidik-Jonkman τ^2 estimation method. We computed meta-analytic SMDs for continuous outcomes and ORs for binary outcomes, and expressed each with 95% confidence intervals and prediction intervals where computable. Outlier studies, defined as those wherein the confidence interval does not overlap with the confidence interval of the pooled effect of the meta-analysis, were identified using the 'find.outliers' function in R [5] and were removed. We have presented the results of the meta-analyses in forest plots.

Specific subgroup analyses were planned *a priori* in order to test specific hypotheses, describing why some types of studies produce lower or higher effects than others. Subgroups of interest were study risk of bias, participant age (i.e. younger versus older than 25 years), intervention type (i.e. mode of education delivery and degree of regulatory restriction), and outcome follow-up period (i.e. intervention effects in

the short, medium, and longer term). Analyses were stratified by sex given differences in tanning behaviour between males and females [30].

We assessed heterogeneity between studies using the I^2 statistic with corresponding 95% confidence intervals (CIs) and with prediction intervals. Reporting both of these statistics rather than a single one provides a more reliable indication of any potential heterogeneity in the data [6]. Higgins and Thompson's I^2 statistic is defined as the percentage of variability in the effect sizes that is not caused by sampling error [6,54], and a prediction interval is a statistical estimate that provides a range within which a future observation is expected to fall given the data that have already been observed [6]. Higgins and Thompson's I^2 statistic is interpreted using the thresholds of 25%, 50%, and 75% indicating low, moderate, and substantial heterogeneity, respectively. Publication bias is assessed with statistical tests for funnel plot asymmetry, such as Egger's test, if 10 or more studies are included in a meta-analysis.

When meta-analysis was not feasible due to factors such as an insufficient number of studies, high heterogeneity, or significant differences in study designs, populations, interventions, or outcomes, we adopted a narrative synthesis approach following SWiM guidelines [55]. We systematically extracted the data for narrative synthesis, focusing on study characteristics, key findings, and contextual factors such as setting, population, and intervention details. We grouped studies by relevant characteristics such as population demographics, type of intervention and comparator, outcomes measured, and study design.

We prepared detailed tables summarising the key characteristics and findings of the included studies. A structured narrative synthesis describes the range of findings within each group, discussing the consistency of findings across studies and identifying key patterns and themes. This approach ensures a comprehensive and transparent assessment of the available evidence, regardless of the feasibility of quantitative synthesis.

2.9 Certainty of evidence

We assessed the certainty of evidence for each eligible primary outcome (sunbed use and sunbed use intentions), including publication bias, using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) system. The GRADE system indicates the quality of evidence and strength of the recommendations [67]. While the methodological quality assessment and risk of bias assessment processes described in Sections 2.5 and 2.6 rated the quality of individual studies, we applied the GRADE approach to appraise the quality of evidence for eligible primary outcomes across the studies, in line with best practice [67].

Under the GRADE system, we determined the initial certainty of the evidence based on study design. Well-designed RCTs provide a high degree of certainty, and well-designed observational studies provide a moderate or low degree of certainty depending on the study design (longitudinal cohort study, case-control study, or cross-sectional survey). The level of certainty was thus adjusted upwards or downwards based on study design. Ultimately, the body of evidence related to each outcome received one of four grades – high, moderate, low, or very low – reflecting the level of certainty we have that the true effect is similar to, or substantially different from, the estimate of the effect.

The quality of the evidence was thereafter downgraded considering five criteria (risk of bias, inconsistency, indirectness, imprecision, and publication bias), and for outcomes where the five criteria were met, the quality of the evidence was upgraded based on three criteria (large effect, dose–response gradient, and opposing bias and confounders). Thus, each outcome started with 10 points and deductions of 0, 1, or 2 points were made for each of the five downgrading criteria. However, if all five criteria were met, an additional 1 or 2 points were supplemented for large effect, and 1 point for dose–response and/or opposing bias and confounders. The reasons for downgrading were:

1. risk of bias, which takes account of study design considering the hierarchy of evidence and the methodological quality of the study
2. inconsistency, which considers both clinical and statistical heterogeneity that cannot be controlled for in the analysis
3. indirectness, which considers the comparator intervention and whether it is the current gold standard or it is being used as a proxy; indirectness also considers the population, intervention, and outcome
4. imprecision, which takes account of the size of the variance and the optimal effect size, and is closely related to sample size and the number of events of interest
5. publication bias, which is a systematic underestimation or overestimation of the underlying beneficial or harmful effect due to the selective publication of studies.

The decision to upgrade should only be made on rare occasions and should only be made after full consideration and in the context of reasons to downgrade. If serious limitations are present in any of the five downgrade areas, then upgrading should not be applied. The reasons for upgrading were:

1. large or exceptionally large estimates of the magnitude of an intervention or exposure effect
2. the presence of a dose–response gradient, which may increase certainty in the findings of observational studies
3. where all plausible residual confounding from observational studies may be working to increase or decrease the demonstrated effect, if no effect was observed.

2.10 Deviations from the protocol

We documented all deviations from our published protocol.

During the preliminary scoping search phase, we included modelling studies in order to fill an expected shortfall in the availability of empirical data. However, at the data extraction stage, we identified sufficient evidence from observational and experimental studies to address the research objectives. We therefore excluded modelling studies in order to maintain methodological consistency across the included studies.

We added sunbed use intentions to our outcomes, as this was a specific and common measure in the included studies. In addition, we added unrelated alternative interventions to our controls so as to maximise our number of controls.

3 Findings

3.1 Introduction

In order to address the Department of Health's research question regarding the effectiveness of public health interventions in reducing sunbed use and skin cancer rates, our systematic review utilised the WHO's framework document titled *Artificial tanning devices: Public health interventions to manage sunbeds* [1]. This document outlines various policy options for legislators and regulatory authorities to manage sunbed use, each of which has been implemented in at least one WHO country or member state. Our review set out to systematically evaluate the evidence for these interventions and their impact on both sunbed use and subsequent skin cancer rates.

These interventions are categorised into two domains [1]:

1. promoting education strategies
2. regulating sunbed use.

The evidence will be presented separately for these two outcome categories.

First, we will describe the overall search and screening results in Section 3.2. Then we will present the study characteristics, methodological quality, risk of bias, and findings for the education interventions in Section 3.3, followed by regulation interventions in Section 3.3.5.5.

It is important to note from the outset, that no studies were found that addressed skin cancer rates or pterygium as an outcome. For all papers examined, study outcomes were broadly categorised into sunbed use and sunbed use intentions.

3.2 Search and screening results

Primary, supplemental and final searches search results were imported to Eppi-Reviewer. Of 4,472 records from primary searches double-screened on title and abstract using priority screening mode between 8 August and 16 September 2024, 175 papers were included for full-text screening. The priority screening progress curve is shown in Figure 4. These 175 records were separately screened for duplicates as part of the title and abstract screening, resulting in 172 records available for full-text screening.

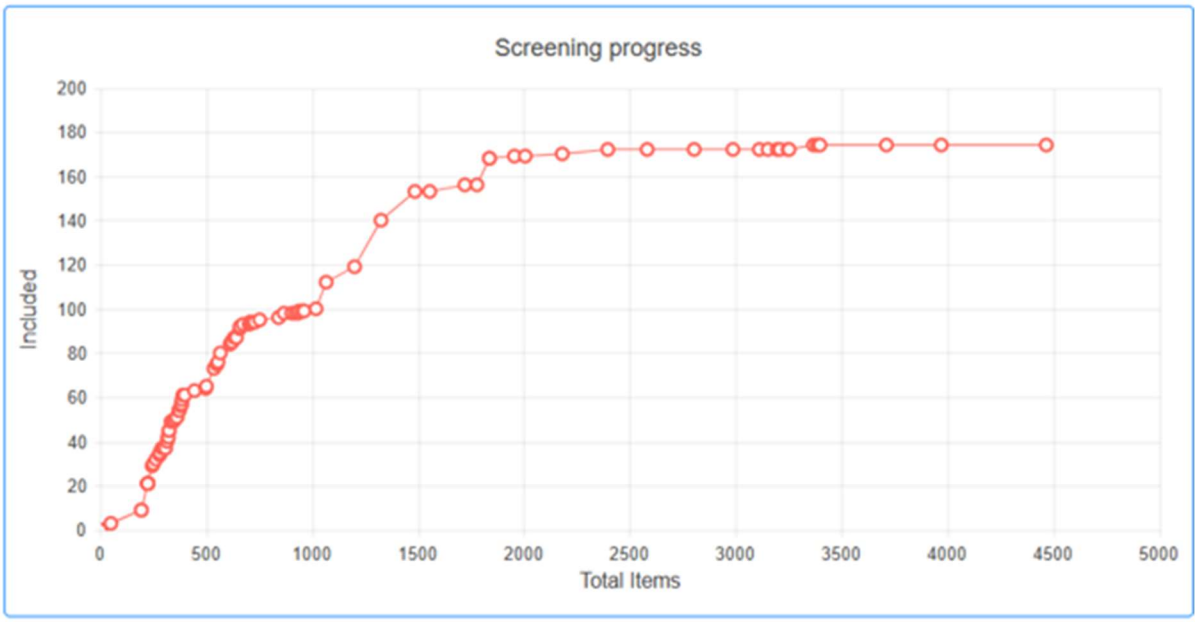

Figure 4 EPPI-Reviewer priority screening graph for title and abstract screening

From full text screening of primary search results, 31 records were selected for inclusion in the evidence synthesis, as per the PRISMA flow chart (Figure 5). From the supplemental and final search records, 3,675 records were screened on title and abstract, resulting in 25 records available for full-text screening. Of these records, 3 were selected for inclusion in the evidence synthesis. The review included 34 full text papers in the final analysis: 25 papers that evaluated education interventions on sunbed users and 9 papers that evaluated regulation interventions.

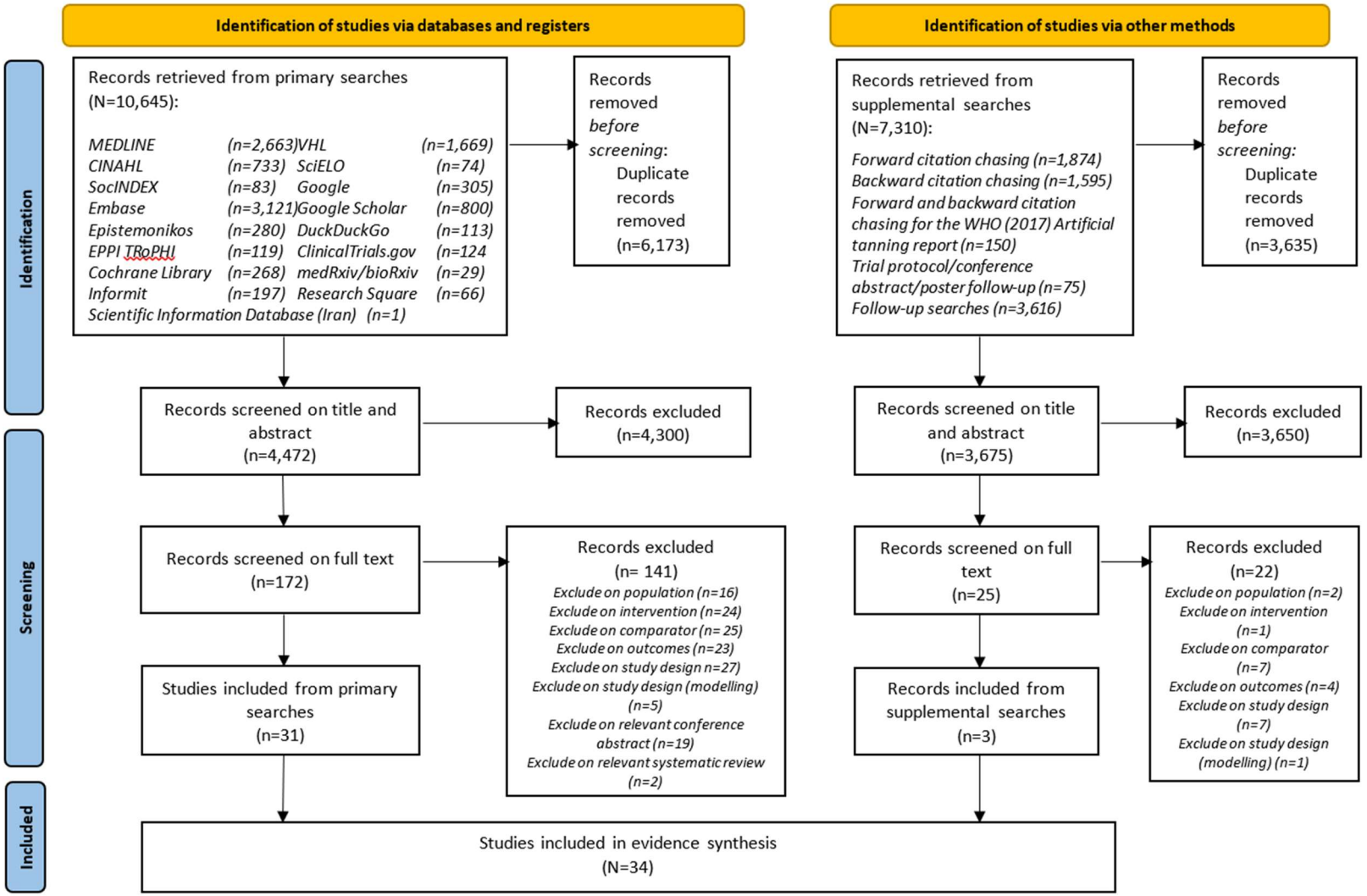

Figure 5 PRISMA flow chart

Source: Page *et al.*, 2021 [32]

3.3 Education interventions

3.3.1 Search and screening results for education interventions

The HRB identified 25 papers that assessed education interventions [68–92]. The 25 papers presented 23 unique studies: 1 RCT reported initial and long-term findings that were published as 2 separate papers [71,72], and the only 2 cross-sectional survey papers were both linked to the same intervention and population, but the surveys were conducted at different points in time [81,82].

3.3.2 Study characteristics for education interventions

3.3.2.1 Study designs

We identified 25 papers encompassing 23 studies that assessed the effect of education in various formats on the use of sunbeds or the intention to use sunbeds, and these are summarised in Table 7. The individual papers were published between 1995 and 2024 [85,92]. The effectiveness of the 23 interventions was evaluated through an array of study designs: 2 two-arm cluster RCTs [68,86], 1 three-arm cluster RCT [74], 11 two-arm RCTs [69–72,77–79,83,87,89,90], 3 three-arm RCTs [73,75,76], 1 four-arm RCT [80], 2 cross-sectional surveys [81,82], and 5 before-and-after studies [84,85,88,91,92].

3.3.2.2 Study population

The education interventions were based in various western countries: Denmark [68,81,82], the United States of America (USA) [69–80,83–85,87–91], Italy [86], and Hungary [92]. Analytic sample sizes in the various papers ranged from 16 participants [88] to 37,766 participants [82] in a nationally representative study.

The target audiences of the education interventions were as follows: adolescent students [68,86,91], adolescent girls [78], both adolescents and young adults [81,82], young women [69,73–75,77,79,87–90], young adults [76,80], mothers of adolescent daughters [71,72], mothers of adolescents of any gender [70], parents and their adolescent children [83], non-medical skincare professionals [84], patients with non-melanoma skin cancer and their helpers [85], and kidney transplant patients [92].

The proportion of women participants ranged from 38% in Tari *et al*.'s research [92] to 100% in 13 papers [69–75,77–79,85,87–90]. Ng *et al*. [84] did not indicate the sex or gender distribution in their research.

Seventeen of the research papers featured participants who were adolescents or young adults aged 25 years and under [68,69,73–80,83,86–91], while 5 papers featured adults aged 40 years and over who were mothers or parents of adolescents [70–72] or were skin cancer or kidney transplant patients [85,92]. The two Køster *et al.* papers [81,82] included a broad age range of participants (aged 15–64 years) because these were national cross-sectional studies. Ng *et al.* [84] did not indicate the age of participants in their paper.

3.3.2.3 Study interventions on education

The education interventions were delivered through a variety of formats. Face-to-face or in-person education was delivered in seven papers. In their study, Aarestrup *et al.* [68] delivered a teacher-led intervention to discourage sunbed use among adolescent pupils within a curriculum that spanned from three to nine classroom lessons. The teachers delivered an e-magazine teaching resource with instructions that cautioned on sunbed use. In Stanganelli *et al.*'s research [86], an expert dermatologist or trained biologist delivered interactive face-to-face education on skin cancer and associated risk factors (such as sunbeds) to adolescent students. The education, resources, and activities were rolled out over a 3-month period. In-person education was also key to the intervention by Cho *et al.* (2018) [74], which was delivered to young women from university sororities in a single 60- to 75-minute session. The education

featured a media analysis and media production module in order to counter negative influences on perceptions and practices related to health and beauty with an emphasis on sunbed use. The media production element was delivered as two separate intervention arms: The counter-argument intervention arm encouraged participants to provide a counter-logic to the media's harmful influence on sunbed use, while the counter-story intervention arm encouraged recollection of an instance when media content affected the participants' perceptions about tanning and appearance.

The study by Ng *et al.* [84] included a face-to-face presentation discussing sunbed use and melanoma that was delivered to non-medical skincare professionals, including aestheticians, cosmetologists, and massage therapists. The professionals were also given take-home flyers featuring the same content as the presentation, which they reviewed over a 1-month period. In Robinson and Rademaker's study [85], doctors and nurses provided in-person education on skin cancer and the role of sunbeds to non-melanoma skin cancer patients over a 6-month period. A copy of the written material was also provided to the patients, which they were asked to share and discuss with their helpers. The in-person education in Tari *et al.*'s [92] study was provided to kidney transplant patients due to their increased risk of skin tumours. Medical personnel provided education on the topic of adequate sun protection and sunbed avoidance during a 1-hour session. The paper by Swindler *et al*. [91] assessed a standardised 45-minute educational lecture that was delivered to high school students. The lecture was presented by a fourth-year medical student and elaborated on skin protection and the effects of ultraviolet radiation (UVR) damage.

Another mode of intervention delivery was the use of written formats – including workbooks, flyers, and pamphlets – in seven papers. The study by Abar *et al.* [69] provided booklets on sunbed use to young women who were university students. The booklets featured information on alternative appearance-enhancement strategies, such as sunless tanning, in a bid to discourage sunbed tanning. Participants were given a 1-month period to review the booklets. Written messages were also provided in the study by Greene and Brinn [75], which warned women college students about the dangers of sunbeds and sun exposure. The intervention consisted of two modes that were delivered as separate arms, with information presented as either statistical evidence about the risks of using sunbeds or as narrative messaging that illustrated the same argument through a story. The intervention by Hillhouse and Turrisi [77] also provided educational workbooks to women university students for perusal over a 2-week period. The workbooks outlined the appearance-damaging effects of sunbeds, provided guidelines, and offered alternatives. The same intervention was featured in a subsequent study by Hillhouse *et al*. (2008) [79], in which a booklet with the same educational themes was provided to women university students for review over a 1-month period.

One intervention by Stapleton *et al*. (2010) [89] featured educational booklets on various aspects of sunbed use, including the damaging effects of ultraviolet (UV) exposure and indoor tanning guidelines that emphasise tanning cessation. The population of interest was undergraduate women, and they were given 6 months to review the intervention material. Conversely, Lazovich *et al.*'s study [83] provided educational pamphlets and postcards on sunbed-related themes to parents and teenagers, with a 6-week period allotted for them to explore the material. Baker's study [70] targeted mothers of teenage daughters. A parents' handbook on skin cancer and exposure to UVR was supplied, and the book also highlighted strategies that the mothers could use to improve communication with their daughters.

Four papers leveraged social media in their education interventions. The study by Buller *et al*. (reported in two papers [71,72]) included social media posts delivered over a 12-month period to mothers of adolescent daughters. The posts provided information on the risks of sunbed use, state policy regulations, permissiveness towards daughters, and behavioural alternatives. In comparison, an intervention by Stapleton *et al*. (2018) [88] utilised a secret invitation-only social media group for young women. The

material was delivered over a 4-week period via daily group posts that, in an attempt to reduce potential resistance, conveyed intervention content that generally focused on body image and women's experiences rather than directly addressing sunbed use. Kim *et al*. [80] delivered a digital dating game with social media features (such as interaction and messaging) that was directed at young people. The simulated environment of the dating game provided players with the opportunity to obtain knowledge about the risks of using sunbeds through their interaction with other game avatars over a 30-day period. While the digital dating game was the primary intervention arm, other active intervention arms in Kim *et al.*'s study included a health website that featured educational content on sunbed use, and a health brochure that featured stories about the negative consequences of sunbed use.

Web platforms and websites were another avenue for education interventions, and they were employed in five papers. Cho *et al*. (2020) [73] adapted their previous in-person intervention [74] for delivery via a website. The intervention was delivered over a single session that was about 38 minutes in duration and retained the core theme of media literacy on sunbed use; the education session also explored the role of social media in the lives of young women at university. The intervention components comprised media analysis, as well as subsequent media production, which was delivered as two separate arms. Young women in the first media production arm were asked to develop a counter-argument to the role of media in sunbed use, while those in the second media production arm were asked to recall a story pertinent to the same theme. Heckman *et al.*'s research study [76] employed an interactive and tailored website over a 12-week period that was aimed at young adults who were at risk of skin cancer. The tailored website was delivered as the first intervention arm and focused on sunbed tanning risks and protective behaviours. The second intervention arm was allocated to the Skin Cancer Foundation website, which featured a multimedia section on the topic of skin cancer prevention.

Hillhouse *et al*. (2017) [78] used a website that provided information that was designed to reduce sunbed tanning motivation and increase willingness to adopt sunless tanning by highlighting poignant themes such as healthy skin in fashion and beauty. Adolescent girls were included in the research and given 6 months to review the website. In one web-based intervention, Stapleton *et al*. (2022) [90] utilised assessment questions and personalised feedback on sunbed tanning among young women. The intervention spanned a period of 4 weeks and aimed to enhance the participants' readiness to change. Conversely, an earlier web-based intervention by Stapleton *et al.* (2015) [87] adopted a cognitive behavioural approach to guiding reflection and restructuring beliefs related to the personal and social value of tanning. The educational intervention was delivered to young women over a 6-week period.

Two of the included papers reported on a large-scale national multicomponent education intervention on the theme of sunbed use and skin damage that was delivered across social media, magazines, radio, and television [81,82]. Despite public availability, the intervention primarily targeted young people aged 15–25 years over a 10-year campaign period. This intervention design was distinct from the others because of its multicomponent aspect, which leveraged social media, traditional media, and the Internet.

3.3.2.4 Study comparators

The comparators in the included studies comprised participants who were not receiving interventions [69,73,75–77,79,80,83,89], waitlist participants [70,87,90], non-intervention groups (for cluster RCTs) [68,74,86], unrelated educational interventions [71,72,78], and non-intervention baseline participant characteristics [81,82,84,85,88,91,92].

3.3.2.5 Study outcomes

Study outcomes were broadly categorised into sunbed use and sunbed use intentions. Twenty-two of the papers reported the effects of the interventions on sunbed use [68–77,79,81,82,84–92], 12 papers

reported on sunbed use intentions [68,70–75,77–80,83], and 9 papers reported on both outcomes [68,70–75,77,79]. Sunbed use was evaluated in a number of ways: using a 'yes' or 'no' answer to the question [68,71–74,76,81,82,84,86,92], by frequency of sunbed use [69,70,75,77,79,87–90], as a scale measuring sunbed use [85], and as a categorical measure with various options for sunbed use [91]. Sunbed use intentions were measured with a 'yes' or 'no' answer [68,83] or via a likelihood, Likert, or intention scale [70–75,77–80]. None of the papers assessed skin cancer rates.

Table 7: Summary of study characteristics for studies examining education interventions

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
IN-PERSON OR FACE-TO-FACE EDUCATION										
Aarestrup *et al.* (2014) [68]	Denmark	Cluster RCT	The intervention entailed the use of an e-magazine teaching resource that was delivered in intervention schools. The objective of the intervention was to discourage sunbed use among pupils by changing their knowledge and attitudes. A teacher led the sessions using a guide that included facts and instructions.	Schools with no intervention	Adolescent pupils	3–9 lessons (mean: 5.6 lessons per class)	Sunbed use (yes/no) in the past 6 months; sunbed use intentions (yes/no)	Total: 3,635 Analytic: 2,351	Age range: 14–18 years	50.60%
Stanganelli *et al.* (2016) [86]	Italy	Cluster RCT	The educational intervention consisted of an interactive 2-hour meeting with students and teachers and led by an expert dermatologist or trained biologist on the topics of skin cancer, associated risk factors, and protective behaviours. Following the education session, resource material was distributed. Additional student activities entailed the creation of educational materials, drawings, videos, and graphic projects. In order to incentivise participation, an award was given for the best presentation on the importance of primary skin cancer prevention.	Schools with no intervention	Adolescent students	3 months	Sun lamp use (yes/no)	Total and analytic: 3,042	Age range: 13–20 years	54.6%
Ng *et al.* (2012) [84]	USA	Before-and-after study	An oral presentation was delivered to non-medical skincare professionals with accompanying PowerPoint slides delineating the link between sunbed use	No intervention at baseline	Non-medical skincare professionals (aestheticians	1 month	Tanning bed usage (yes/no)	Total: 253 Analytic: 183	Not reported	Not reported

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
			and melanoma. The session covered different modes of melanoma prevention and encouraged the practitioners to share their knowledge on the link between sunbeds and melanoma with their clients. At the end of the presentation, educational flyers with the same content as the presentation were distributed to participants.		, cosmetologists, and massage therapists)					
Robinson and Rademaker (1995) [85]	USA	Before-and-after study	Doctors and nurses provided an educational intervention on skin cancer protection to non-melanoma skin cancer patients. Each patient was asked to provide their helper with a copy of the written material and to discuss it with them. The written material focused on the skin's response to sun exposure, the risk of skin cancer, and recommended sun protection steps. The theme of sun protection included information on sunbed tanning. Two brochures from the American Cancer Society were also provided to the patients.	No intervention at baseline	Patients with non-melanoma skin cancer and their helpers	6 months	Scale measuring the frequency of tanning device use in the past year (scale 1–5)	Total: 200 patients and 200 helpers Analytic: 178 patients and 178 helpers	Age range: 42–74 years for patients and 27–65 years for helpers	Patients: 53.4% Helpers: 68.2%
Tari *et al.* (2024) [92]	Hungary	Before-and-after study	An in-person education training session was provided to a group of kidney transplant patients on their increased risk of skin tumours, appropriate self-examination, adequate sun protection, and sunbathing habits that increase their	No intervention at baseline	Kidney transplant patients	1-hour session	Tanning bed use (yes/no)	Total: 221 Analytic: 176	Mean age: 55.1 years	38%

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
			skin tumour risk (such as sunbed tanning). The 1-hour training session was conducted once; however, patients were consistently reminded of the importance of sun protection and skin self-examination during periodic dermatological visits.							
Swindler *et al.* (2007) [91]	USA	Before-and-after study	A fourth-year medical student presented a standardised educational lecture on skin protection and UVR damage to high school pupils. The programme consisted of a 45-minute presentation on the risks of sun exposure, its contribution to skin cancer, and its impact on premature ageing. Time was allowed for questions afterwards.	No intervention at baseline	High school pupils	45 minutes	Tanning bed use (never, just for special occasions, or >15 times per year)	Total: 589 Analytic: 517	Age range: 15–16 years	52.8%
Cho *et al.* (2018) [74]	USA	Three-arm cluster RCT	The in-person education intervention was delivered to sororities. The first four sections focused on media analysis, and the fifth was dedicated to media production. The media analysis sections provided an overview of media influences on perceptions and practices related to health and beauty (including tanning), and advocacy against sunbed tanning behaviour and melanoma. The media production section comprised argument and story production modules. The argument module (delivered as arm	Sororities with no intervention	Young women from university sororities	60–75 minutes	Indoor tanning (yes/no) in the past month; indoor tanning intentions in the next 2 months (continuous 7-point	Total and analytic: 247	Mean age: 20.2 years	100%

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
			1) encouraged participants to counter the media's harmful influence on young women's appearance-related behaviour, including tanning. In the story module (delivered as arm 2), participants were asked to describe a time when the media changed the way that they felt about their appearance, including tanning, and reflect on this.				likelihood scale)			
WORKBOOKS, FLYERS, AND PAMPHLETS FOR EDUCATION										
Abar *et al.* (2010) [69]	USA	RCT	An educational booklet on sunbed tanning was provided that featured three appearance-enhancement alternatives: exercise, clothing, and sunless tanning. Booklet sections highlighted the history of tanning, provided an analysis of current tanning norms, described the effects of UVR on skin (focusing on sunbed tanning), and provided sunbed tanning guidelines but with an emphasis on abstinence.	No intervention controls	University students who were women and who had tanned indoors or who had above-average tanning intentions	1 month	Indoor tanning frequency per month (continuous)	Total: 430 Analytic: 379	19.2 years	100%
Greene and Brinn (2003) [75]	USA	Three-arm RCT	There were two written message flyer intervention conditions that focused on problems associated with sunbed tanning, sunbeds, and sun exposure. The statistical message (delivered as arm 1) provided statistical proof of the risks of using tanning beds. The narrative message (delivered as arm 2)	No intervention controls	College students who were women	20 minutes	Indoor tanning frequency in the last month (continuous); indoor tanning	Total: 145 Analytic: 141	Mean age: 21.4 years	100%

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
			demonstrated the risks of using tanning beds via a story. The statistical and narrative messages contained identical arguments (in quality and number) and sources, but they were presented in different evidence formats.				intentions (continuous 5-point responses)			
Hillhouse and Turrisi (2002) [77]	USA	RCT	The educational workbook was 11 pages long and the aim was to provide information on the appearance-damaging effects of sunbed tanning, provide sunbed tanning guidelines, and offer tanning alternatives. The workbook promoted a harm-reduction philosophy that encouraged participants to give up sunbed tanning altogether. Where tanning abstinence was not attainable, participants were encouraged to tan less often or take safety precautions when doing so.	No intervention controls	University students who were women and who tanned	2 weeks	Indoor tanning frequency in the last 2 months (continuous); indoor tanning intentions (continuous 7-point Likert scale)	Total: 147 Analytic: 106	Mean age: 20.8 years	100%
Hillhouse *et al.* (2008) [79]	USA	RCT	The educational booklet highlighted three appearance-enhancement alternatives in place of sunbed tanning: exercise, clothing, and sunless tanning. Booklet sections also elaborated on the history of tanning in terms of tanning norms, the role of media, the effects of UVR on the skin, and the impact of sunbed tanning. The education provided	No intervention controls	University students who were women and who tanned	1 month	Indoor tanning frequency in the last 3 months (continuous); indoor tanning intentions (continuous 7-	Total: 430 Analytic: 412	Mean age: 18.6 years	100%

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
			sunbed tanning guidelines but emphasised tanning abstinence.				point Likert scale)			
Stapleton *et al.* (2010) [89]	USA	RCT	An educational booklet on various aspects of the sunbed tanning experience was provided. Booklet subsections elaborated on tanning norms in the context of tanning history, the damaging effects of UV exposure, sunbed tanning guidelines that emphasised tanning cessation, harm-reduction techniques for non-abstainers, and alternative appearance-enhancement approaches in place of tanning.	No intervention controls	Undergraduates who were women and who had tanned indoors or who had that intention	6 months	Number of indoor tanning sessions in the past 3 months (continuous)	Total and analytic: 362	Mean age: 18.2 years	100%
Lazovich *et al.* (2013) [83]	USA	RCT	The intervention consisted of educational pamphlets and postcards for parents and teenagers on sunbed tanning. The core content covered health risks, common misperceptions, parental influence on teenager behaviour, sunbed tanning industry tactics, and strategies for communication with teenagers. The postcards aimed at teenagers were embedded in the parents' pamphlets. The pamphlets and postcards included information on websites where parents and teenagers could learn more, view videos, and access resources.	No intervention controls	Parents and their teenage children	6 weeks	Intention to tan indoors soon (yes/no); intention to tan indoors in the next 12 months (yes/no)	Total: 97 teenagers and 118 parents Analytic: 70 teenagers and 111 parents	Age range: 15–16 years	72.2%

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
Baker (2013) [70]	USA	RCT	The educational handbook aimed at parents provided information on skin cancer and exposure to UVR. The first three sections focused on informing mothers about the developmental changes in their teenage daughters, building a strong mother–daughter relationship, and strategies that mothers could use in order to improve communication with their daughters. The final two sections provided detailed discussions on skin cancer with a focus on evidence linking the early use of sunbeds to melanoma development.	No intervention waitlist	Mothers of teenage daughters	1 month	Tanning bed/device use in the past 3 months (continuous) Intentions to indoor tan in the future (7-point Likert scale)	Total: 69 Analytic: 42	Mean age: 45.4 years	100%
SOCIAL MEDIA EDUCATION INTERVENTIONS										
Buller *et al.* (2021) and Buller *et al.* (2022) [71,72]	USA	RCT	The social media intervention was based on social cognitive theory, transportation theory, and diffusion of innovations theory. The social media posts were designed to increase awareness of local state sunbed tanning policy; provide knowledge of the risks; improve mothers' self-efficacy in resisting their daughters' sunbed tanning requests; encourage modelling of tanning avoidance; promote behavioural alternatives; and enhance sun safety.	Social media educational intervention on prescription drug misuse	Mothers of daughters aged 14–17 years	12 months	Indoor tanning (yes/no); indoor tanning intentions (continuous 7-point likelihood scale)	Total and analytic: 869	Mean age: 43.1 years	100%

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
Stapleton *et al.* (2018) [88]	USA	Before-and-after study	The intervention consisted of a secret invitation-only Facebook group. Secret group activities were not publicly accessible to other Facebook users. All intervention content was delivered via daily group posts. The goals of the dissonance-based Facebook intervention were to raise awareness of and promote reflection on sociocultural and media influences on body image and risky behaviours; encourage participants to speak out against idealistic thinking and endorse counter-perspectives by commenting on the group Facebook page; and promote body acceptance. The researchers commented on and liked posts in order to encourage participation. Posts generally focused on body image and women's experiences rather than directly addressing sunbed tanning in a bid to reduce potential resistance from tanners.	No intervention at baseline	Young women who used Facebook	4 weeks	Number of indoor tanning sessions in the past month (continuous)	Total: 17 Analytic: 16	Mean age: 20.8 years	100%
Kim *et al.* (2021) [80]	USA	Four-arm RCT	A digital dating game was used as a tool to prevent sunbed tanning among young adults. The game's health content was developed specifically to influence sunbed tanning beliefs by emphasising the negative consequences (physical, mental, and social harms), the erroneous	No intervention	Youth who were residents in the USA	30 days	Intentions to tan indoors (7-point scale from 1 (strongly disagree) to 7	Total: 576 Analytic: 501	Mean age: 21 years	52%

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
			injunctive normative beliefs on sunbed tanning, misperceptions about the prevalence of sunbed tanning among peers, and autonomy over the ability to manage sunbed tanning. In the game, each player was given a 30-day trial where participants exchanged messages with potential dates and made consequential choices that determined the direction of their future conversations and relationships. Through the dating game's simulated environment, players could safely obtain knowledge on sunbed tanning risks through interaction with other game avatars. Participants also learned about the short- and long-term consequences of sunbed tanning through the actions they took within the game. The second intervention arm was a health website that presented educational content on sunbed tanning, while the third intervention arm was a health brochure that featured stories on the negative consequences of sunbed tanning.				(strongly agree))			
WEB-BASED EDUCATION INTERVENTIONS										
Cho *et al.* (2020) [73]	USA	Three-arm RCT	This web-based intervention adapted the content of a previously developed and evaluated media literacy intervention on	No intervention controls	Young women from a university	38 minutes	Indoor tanning (yes/no) in	Total and analytic: 518	Mean age: 20.1 years	100%

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
			sunbed tanning [74]. The intervention addressed the role of social media, including Instagram. The first four intervention sections were on media analysis, and the fifth was on media production. The first four sections were identical between the two intervention arms. The final section was devoted to either counter-argument or story production on the topic of sunbed tanning. Participants were given brief instructions, followed by an example of either a counter-argument (delivered as arm 1) or a story (delivered as arm 2); those in the counter-argument arm were asked to develop and upload their own counter-argument onto the web platform.		who tanned or had intentions to tan		the past month; indoor tanning intentions in the next month (continuous 5-point likelihood scale)			
Heckman *et al.* (2016) [76]	USA	Three-arm RCT	The intervention website (delivered as arm 1) was interactive, tailored, and delivered through multiple media formats (text, audio/video, and images). Modules covered tanning and sunbed tanning, the associated risks, and protective behaviours. Each of the 12 modules was expected to take about 10 minutes and focused on encouraging behaviour change. The Skin Cancer Foundation website was delivered as arm	No intervention	Young adults at moderate to high risk of skin cancer	12 modules that were 10 minutes each (for arm 1) reviewed over a maximum of 12 weeks	Indoor tanning (yes/no) in the past month	Total and analytic: 965	Mean age: 21.8 years	66.10%

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
			2. The Skin Cancer Foundation website was selected because it is a high-quality multimedia website on the topic of skin cancer prevention.							
Hillhouse *et al.* (2017) [78]	USA	RCT	Participants accessed a website that was designed to reduce sunbed tanning motivation and increase their willingness to use sunless tanning alternatives. The website covered themes on the role of healthy skin in fashion and beauty, among celebrities, and in UV tanning avoidance, as well as peer relationships within the scope of sunbed tanning. Links pertinent to sunbed tanning, health, and tanning alternatives were also provided.	Website on alcohol prevention intervention	Adolescent girls who tanned or had intentions to tan	6 months	Index of intention to indoor tan (from definitely do not intend (1) to definitely do intend (7))	Total and analytic: 443	Mean age: 15.2 years	100%
Stapleton *et al.* (2022) [90]	USA	RCT	The web-based intervention on sunbed tanning spanned 29 web pages with assessment questions and personalised feedback. The intervention was primarily text-based, with some graphics. Educational content supported participants in monitoring recent tanning behaviour and provided skills-based behaviour change content. The goals of the intervention were to enhance participants' readiness to change by exploring ambivalence, bolstering commitment to change, and encouraging the consideration and uptake of	No intervention waitlist	Young women who used sunbeds regularly	4 weeks	Number of indoor tanning sessions in the past 2 months (continuous)	Total: 54 Analytic: 53	Mean age: 22.6 years	100%

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
			alternative ways to obtain sunbed tanning benefits while reducing the risks.							
Stapleton *et al.* (2015) [87]	USA	RCT	The web-based intervention guided participants through content on sunbed tanning beliefs and behaviours. The intervention adopted a cognitive-behavioural approach in the reflection on and restructuring of beliefs related to the personal and social value of tanning. Content highlighted the role of media and peer experiences in shaping sunbed tanning beliefs, which can lead to body dissatisfaction. Restructuring these beliefs involved thought exercises through the introduction of evidence against sunbed tanning. The intervention also provided counter-perspectives to beliefs about the idealisation of a tanned appearance in the media and among peers. Intervention participants who indicated a desire to change their sunbed tanning behaviour were supported in creating a change goal and plan. The plan included the consideration of obstacles and strategies for overcoming these obstacles. Participants were also encouraged to consider alternative appearance-modification behaviours that could be substituted for sunbed tanning.	No intervention waitlist	Young women who indoor tanned	6 weeks	Tanning bed or booth use in the past 6 weeks (continuous)	Total: 187 Analytic: 159	Mean age: 19.8 years	100%

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
NATIONAL MULTICOMPONENT INTERVENTIONS										
Køster *et al.* (2011) and Køster *et al.* (2018) [81,82]	Denmark	Cross-sectional survey	An anti-sunbed campaign was launched across social media (MySpace, YouTube, and Facebook), magazines, radio, and television. Highlights included a pocket movie competition, a viral video clip on YouTube, and a music video that made links between sunbed use and skin damage; these were widely accessible across the Internet and on youth-oriented television music programmes.	No intervention at baseline	Primarily young people aged 15–25 years	2011: 2 years 2018: 10 years	2011: sunbed use within the past 12 months (recent use and non-recent use) 2018: sunbed use within the past 12 months (yes/no)	2011 Total: 14,514 Analytic: 13,229 2018 Total: 37,766 Analytic: 37,562	Age range 2011: 15–59 years Age range 2018: 15–64 years	2011: 54.1% 2018: 51.2%

3.3.3 Study quality for education interventions

The methodological quality assessment for the RCTs in Table 8 indicates that out of the 18 RCT papers, 2 were high quality [71,90], 1 was of moderate quality [72], and all the other papers were low quality [68–70,73–80,83,86,87,89]. The RCTs generally omitted information on the randomisation procedure and treatment allocation concealment, which contributed to the low-quality ratings. Full quality assessment results are presented in Appendix E.

The assessment for the cross-sectional survey studies in Table 9 indicates that both papers (from the same study) were rated as low quality [81,82]. Primary areas of concern were insufficient or a lack of information on the participation rate, as well as the absence of sample size justification, power description, and effect estimates (Appendix E).

All five of the before-and-after studies were assigned low-quality ratings (Table 10) [84,85,88,91,92]. Persistent areas of concern were in relation to the sample size used, a lack of blinding for outcome assessors, and not accounting for losses to follow-up in subsequent analyses (Appendix E).

Table 8: Summary of methodological quality assessment ratings for RCTs

Author	Year	Country	Study design	Q2: Randomisation adequate	Q3: Treatment allocation concealed	Q6: Groups similar at baseline	Q7: Drop-out rate	Q12: Sample size	Total score	Rating
Aarestrup *et al.* [68]	2014	Denmark	Cluster RCT	Not reported	Not reported	Yes	No	Not reported	1	Low
Abar *et al.* [69]	2010	USA	RCT	Not reported	Not reported	Yes	Not reported	Not reported	1	Low
Buller *et al.* [71]	2021	USA	RCT	Yes	Yes	Yes	No	Yes	4	High
Buller *et al.* [72]	2022	USA	RCT	Not reported	Yes	Yes	No	Yes	3	Moderate
Cho *et al.* [74]	2018	USA	Three-arm cluster RCT	Not reported	Not reported	Yes	Cannot determine	No	1	Low
Cho *et al.* [73]	2020	USA	Three-arm RCT	Not reported	Not reported	Yes	No	Not reported	1	Low
Greene and Brinn [75]	2003	USA	Three-arm RCT	Cannot determine	Cannot determine	Not reported	Yes	Not reported	1	Low
Heckman *et al.* [76]	2016	USA	Three-arm RCT	Yes	Cannot determine	Yes	No	No	2	Low
Hillhouse and Turrisi [77]	2002	USA	RCT	Not reported	Not reported	Yes	No	Not reported	1	Low
Hillhouse *et al.* [79]	2008	USA	RCT	Not reported	Not reported	Yes	Yes	Not reported	2	Low
Hillhouse *et al.* [78]	2017	USA	RCT	Not reported	Not reported	Yes	Yes	Not reported	2	Low
Lazovich *et al.* [83]	2013	USA	RCT	Not reported	Not reported	Cannot determine	Cannot determine	No	0	Low

Author	Year	Country	Study design	Q2: Randomisation adequate	Q3: Treatment allocation concealed	Q6: Groups similar at baseline	Q7: Drop-out rate	Q12: Sample size	Total score	Rating
Stanganelli *et al.* [86]	2016	Italy	Cluster RCT	Not reported	Not reported	Not reported	Yes	Not reported	1	Low
Stapleton *et al.* [89]	2010	USA	RCT	Not reported	Not reported	Yes	Yes	No	2	Low
Stapleton *et al.* [90]	2022	USA	RCT	Yes	Yes	No	Yes	Yes	4	High
Stapleton *et al.* [87]	2015	USA	RCT	Not reported	Not reported	Yes	Yes	Not reported	2	Low
Baker [70]	2013	USA	RCT	Not reported	Not reported	Yes	No	No	1	Low
Kim *et al.* [80]	2021	USA	Four-arm RCT	Not reported	Not reported	Not reported	Yes	Not reported	1	Low

Table 9: Summary of methodological quality assessment ratings for cross-sectional survey studies

Author	Year	Country	Study design	Q3: Eligible population and participation rate†	Q4A: Similar population recruitment	Q4B: Prespecified inclusion and exclusion criteria	Q5A: Sample size justification	Q5B: Variance	Q13: Loss to follow-up	Q14: Adjusted for confounding	Total score	Rating
Køster *et al.* [81]	2011	Denmark	Cross-sectional survey	No	Yes	Yes	No	Yes	Not applicable	Extensive	2.5	Low
Køster *et al.* [82]	2018	Denmark	Cross-sectional survey	Cannot determine	Yes	Yes	No	Yes	Not applicable	Extensive	2.5	Low

Table 10: Summary of methodological quality assessment ratings for before-and-after studies

Author	Year	Country	Study design	Q2: Eligibility/ selection criteria	Q3: Representative participants	Q5: Sample size sufficient	Q8: Outcome assessors blind	9A: Loss to follow-up	9B: Lost to follow-up in analysis	Total score	Rating
Ng *et al.* [84]	2012	USA	Before-and-after study	No	No	Not reported	No	No	No	0	Low
Robinson and Rademaker [85]	1995	USA	Before-and-after study	No	No	Not reported	No	Yes	No	0.5	Low
Stapleton *et al.* [88]	2018	USA	Before-and-after study	No	Yes	No	No	Yes	No	1.5	Low
Tari *et al.* [92]	2024	Hungary	Before-and-after study	Yes	No	Not reported	No	No	No	1	Low
Swindler *et al.* [91]	2007	USA	Before-and-after study	Yes	Yes	Not reported	No	Yes	No	2.5	Low

3.3.4 Study risk of bias for education interventions

Figure 6 presents the risk of bias assessment for RCTs reporting on sunbed use [93], and only 1 of the 12 papers had a low risk of bias [71]. The remaining RCTs revealed some concerns of bias in four papers [72,75,76,90] and a high risk of bias in seven papers [69,70,73,77,79,87,89]. The domains primarily contributing to the high overall risk of bias were the randomisation process, deviations from the intended interventions, and the measurement of outcomes; generally, information pertaining to these domains was not reported or was insufficiently reported in the papers.

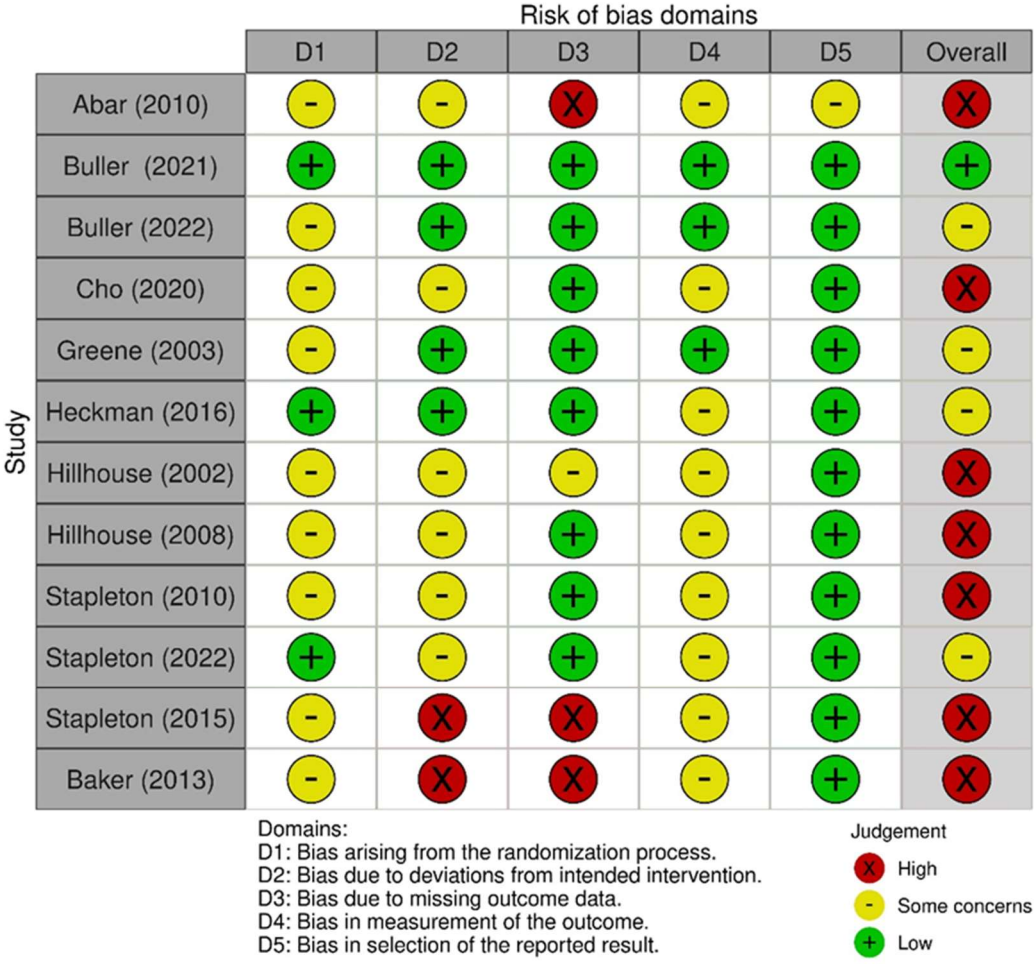

Figure 6: Risk of bias assessment using Risk of Bias 2 (RoB 2) for education intervention RCT studies reporting on the sunbed use outcome

Source: McGuinness and Higgins, 2020 [93]

Figure 7 presents the risk of bias assessment for RCTs reporting on sunbed use intentions. The overall risk of bias was low for one paper [71], displayed some concerns for two papers [72,75], and high for seven papers [70,73,77–80,83]. The risk in bias was mainly a consequence of bias arising from randomisation, deviations from intended interventions, and outcome measurement, largely due to missing or insufficient

information provision.

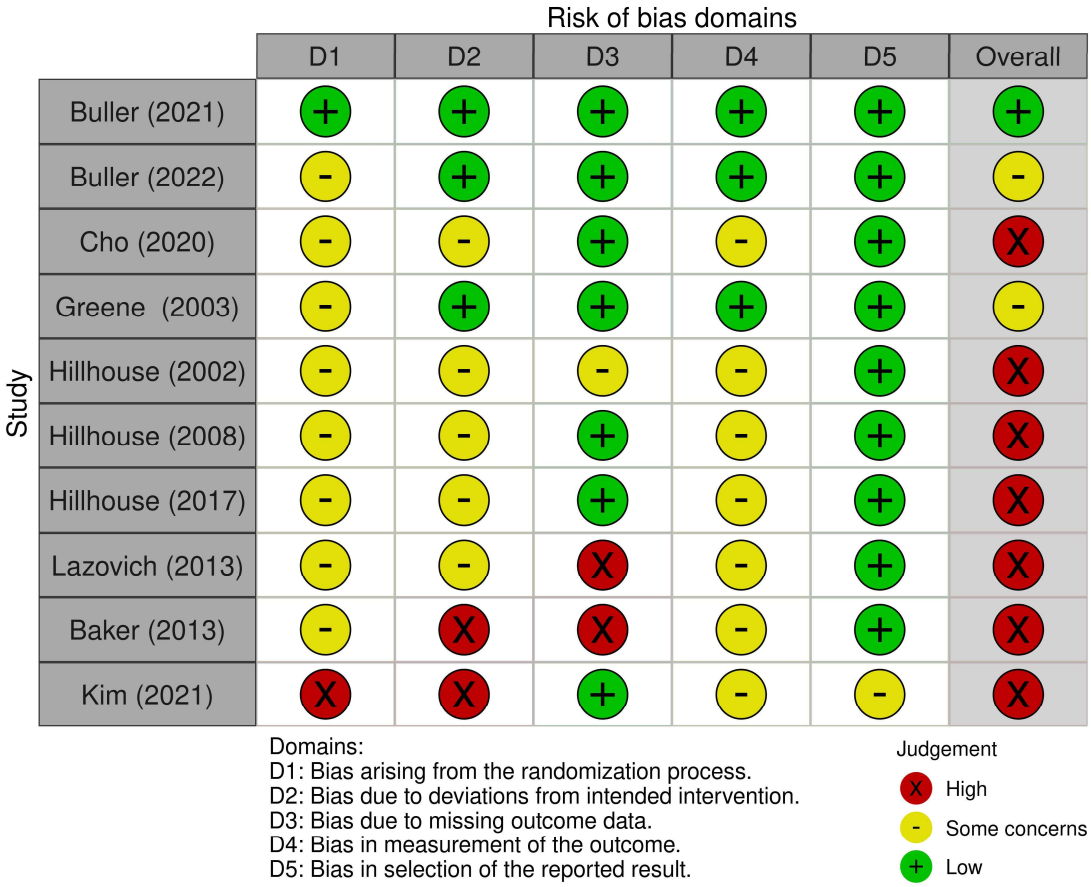

Figure 7: Risk of bias assessment using RoB 2 for education intervention RCT studies reporting on the sunbed use intentions outcome

Source: McGuinness and Higgins, 2020 [93]

Figure 8 presents the risk of bias assessment for three cluster RCTs reporting on sunbed use. All the cluster RCTs reporting on sunbed use indicated a high risk of bias, with the major domains of concern being the randomisation process, deviations from the intended intervention, and the measurement of outcomes [68,74,86]. The results were chiefly due to missing or incomplete information relevant to the domains of concern.

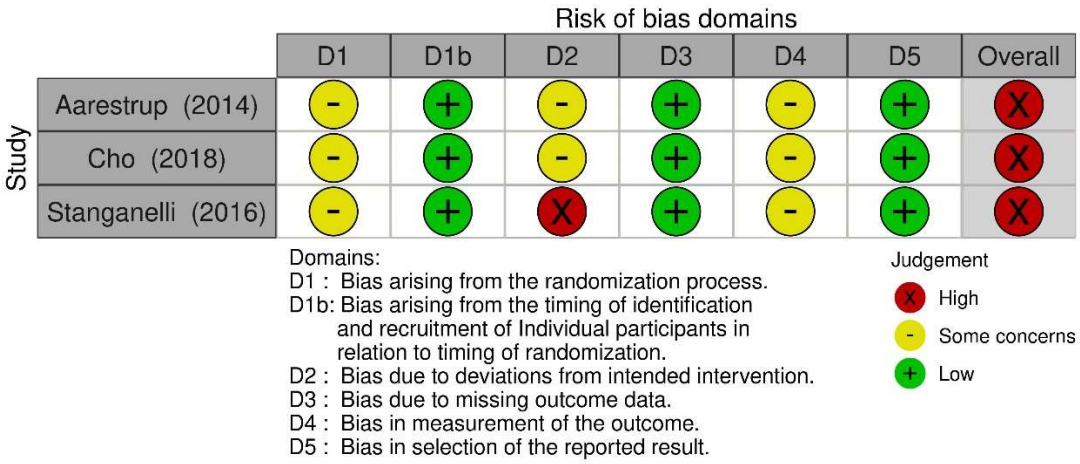

Figure 8: Risk of bias assessment using RoB 2 for cluster RCTs for education intervention cluster RCT studies reporting on the sunbed use outcome

Source: McGuinness and Higgins, 2020 [93]

The risk of bias assessment for the two cluster RCTs reporting on sunbed use intentions is presented in Figure 9. Both cluster RCTs reporting on sunbed use intentions had a high risk of bias. Bias arising from randomisation, deviations from the intended intervention, missing outcome data, and the measurement of outcomes contributed to the overall high risk of bias [68,74]. The risk of bias rating was affected by no or incomplete reporting in the domains of concern.

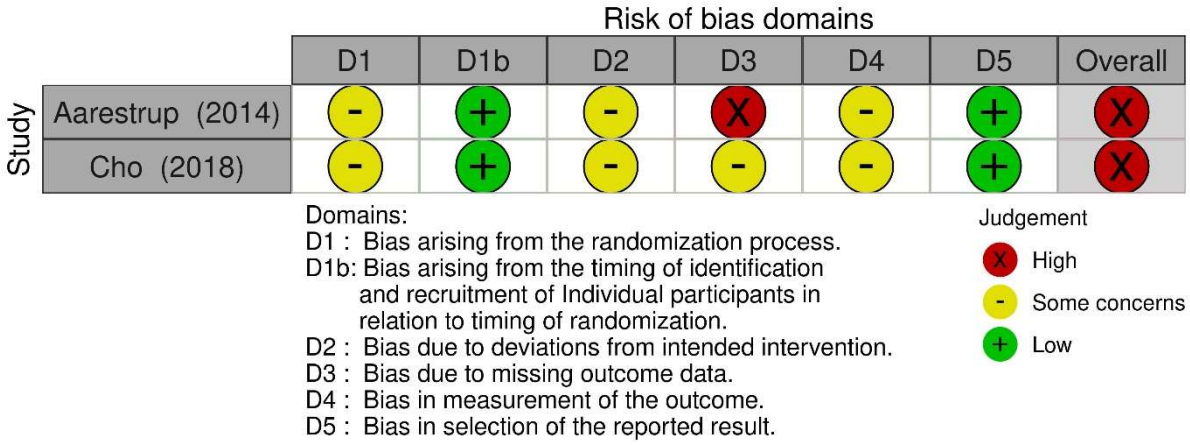

Figure 9: Risk of bias assessment using RoB 2 for cluster RCTs for education intervention cluster RCT studies reporting on the sunbed use intentions outcome

Source: McGuinness and Higgins, 2020 [93]

The risk of bias assessment for cross-sectional survey studies and before-and-after studies reporting on sunbed use is presented in Figure 10. The risk of bias assessment found that the five before-and-after studies had a critical risk of bias [84,85,88,91,92], while the two cross-sectional survey studies had a serious risk of bias [81,82]. The critical and serious risk of bias scores were chiefly a product of uncontrolled confounding. Incomplete reporting on outcome measurement and selection of the reported result also negatively influenced the risk of bias scores.

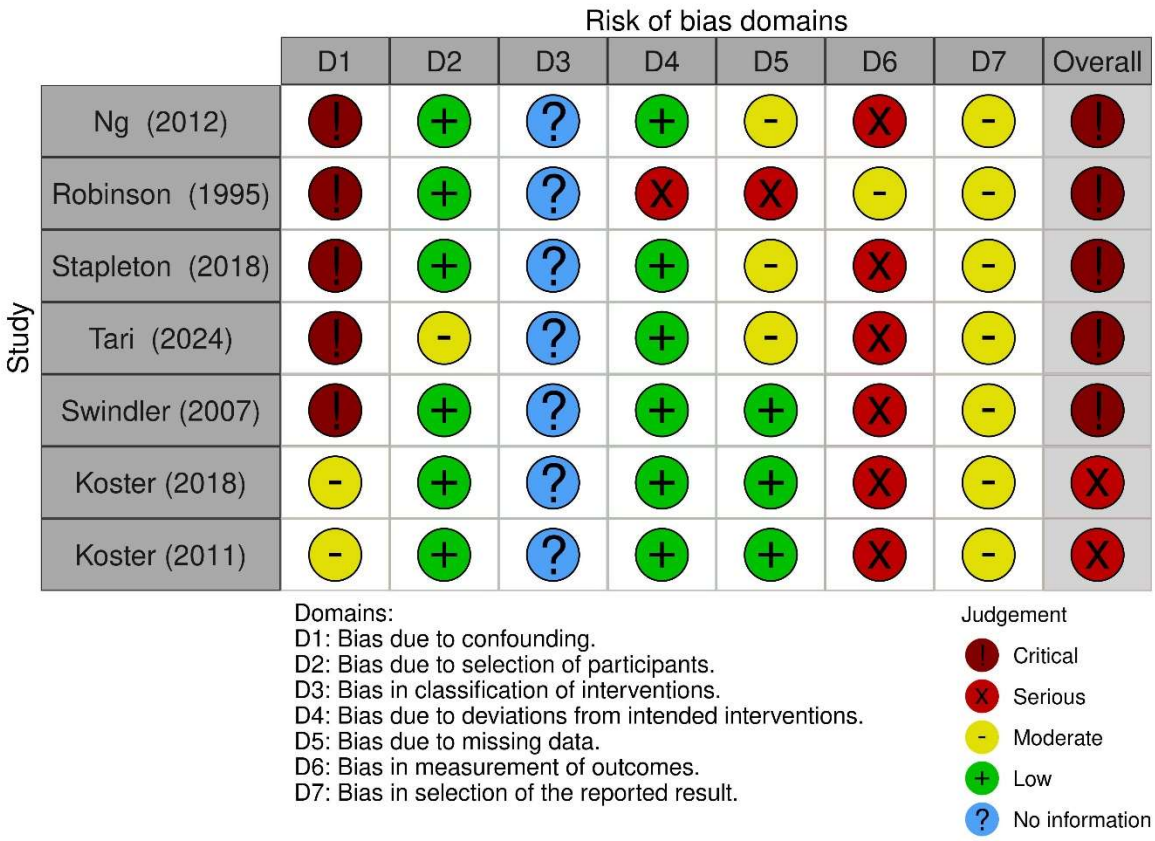

Figure 10: Risk of bias assessment using Risk Of Bias In Non-randomized Studies – of Interventions (ROBINS-I) for education intervention cross-sectional and before-and-after studies reporting on the sunbed use outcome

Source: McGuinness and Higgins, 2020 [93]

3.3.5 Study findings for education interventions

3.3.5.1 Feasibility assessment for meta-analysis

We completed a feasibility assessment in order to determine if we should perform a meta-analysis for the effect of education interventions on sunbed use and sunbed use intentions. Twenty-two of the papers reported the effects of the education interventions on sunbed use [68–77,79,81,82,84–92].

Sunbed use was evaluated as a dichotomous (yes or no) answer in 11 papers [68,71–74,76,81,82,84,86,92]. Nine of these 11 papers could not be pooled in a meta-analysis because of incomplete outcome data [71,72], incomplete data on participants in each arm [73,74], incomplete data on adjustments due to cluster RCT design [68,86], an incomparable population who were kidney transplant recipients [92], and an incomparable intervention due to the multicomponent design [81,82]. This left 2 out of the 11 papers that were suitable for pairwise meta-analysis, but these papers could not be pooled into a pairwise meta-analysis because the requisite minimum number of papers for such an analysis is three [76,84].

Frequency of sunbed use was reported in nine papers [69,70,75,77,79,87–90]; of these, three were excluded from the meta-analysis due to incomplete data on outcomes [69], incomplete data on participants in each arm [77], and differing study design [88]. This resulted in the pooling of six papers that reported on frequency of sunbed use in a pairwise meta-analysis [70,75,79,87,89,90].

Two papers utilised ordinal scales in order to assess sunbed use; these were also excluded from the meta-analysis because the scales were dissimilar to the other measures, and because the Robinson and Rademaker [85] paper was on non-melanoma skin cancer patients, who are not a comparable population [85,91].

Twelve papers reported on the effects of the interventions on sunbed use intentions, and 10 of these used a likelihood, Likert, or intention scale [70–75,77–80]. Five of the nine papers were pooled in a meta-analysis [70,71,75,79,80]; the reasons for excluding the other five papers were that three papers had incomplete data on participants in each arm [73,74,77], one paper had incomplete outcome data [78], and the final paper was a long-term follow-up of an already included paper [72].

Two papers assessed sunbed use intentions using a dichotomous (yes or no) variable and thus could not be pooled into the meta-analysis due to differences in measures used when compared with other papers [68,83]. Moreover, the paper by Aarestrup *et al.* [68] was a cluster RCT, and it was unclear whether study design-adjusted analyses were conducted. The detailed tabular results of the feasibility assessment for education interventions are presented in Appendix F.

3.3.5.2 Meta-analysis: Frequency of sunbed use

Six papers evaluating education interventions and that reported on the frequency of sunbed use (a continuous measure) were pooled into a meta-analysis [70,75,79,87,89,90]. The data tables used for the meta-analyses of the education interventions are presented in Appendix G. Three papers that reported on the same outcome were not pooled in the analysis due to incomplete data in two [69,77], while the third was a before-and-after study that could not be pooled with the RCTs [88]. The results of the pairwise random effects meta-analysis indicated a standardised mean difference (SMD) of 0.15 (95% confidence interval (CI): −0.64 to 0.94; I^2: 91.4%; certainty of evidence: very low; 6 papers) in favour of the control, indicating a higher frequency of sunbed use in the intervention groups, but the difference was not statistically significant (p>0.05). This effect estimate is presented in Figure 11. The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) certainty of evidence ranking for this outcome was very low. The GRADE certainty of evidence rankings for all outcomes are detailed in Appendix H. There was substantial heterogeneity between the findings of the included studies, as indicated by the I^2, which measures the variability in point estimates. One of the studies by Stapleton *et al.* (2022) [90] was the highest contributor to the overall heterogeneity, as can be seen in Figure 11.

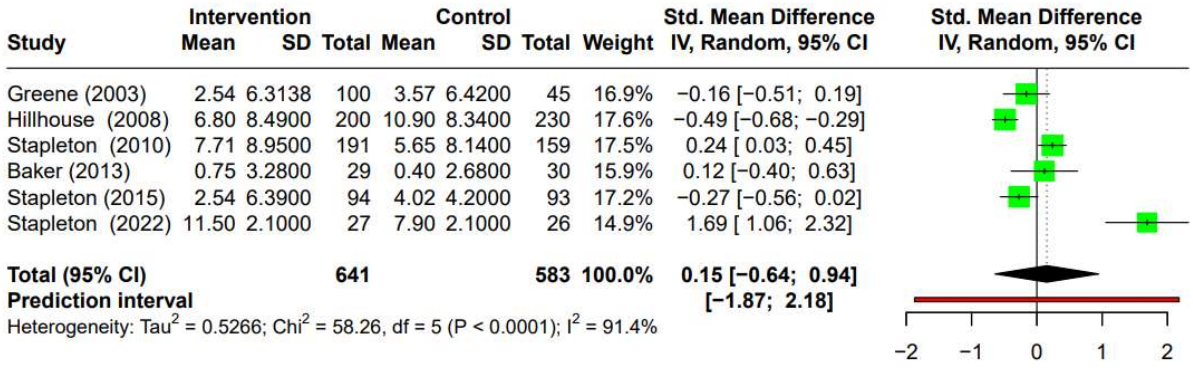

Figure 11: Forest plot of SMD (±standard deviations (SDs)) for frequency of sunbed use among those who received an education intervention compared with no intervention

A sensitivity analysis excluding the outlier study is presented in Figure 12 [90]. The sensitivity analysis included five papers but excluded Stapleton *et al.* (2022) [90], as its 95% CIs did not overlap with the 95% CIs of the pooled SMD. The results of the pairwise random effects meta-analysis indicated an SMD of

−0.13 (95% CI: −0.51 to 0.25; I^2: 84.9%; 5 papers) in favour of the intervention, but the difference was not statistically significant (p>0.05). Heterogeneity between the findings of the included studies, as indicated by the I^2 value, remained substantial.

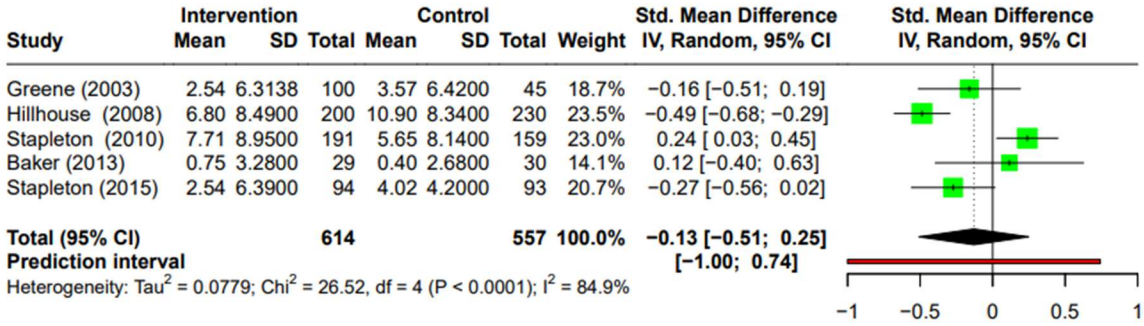

Figure 12: Sensitivity analysis forest plot (including studies with overlapping CIs) of SMD (±SDs) for frequency of sunbed use among those who received an education intervention compared with no intervention

A subgroup analysis based on the age of participants is presented in Figure 13. The subgroup analysis based on age included six papers, with Baker's [70] paper including participants who were older, with a mean age of 45 years, and the other papers including participants who were aged ≤25 years. The results of the pairwise random effects meta-analysis including participants who were aged ≤25 years indicated an SMD of 0.17 (95% CI: −0.88 to 1.22; I^2: 93%; 5 papers) weighted 84.1% in favour of the control, but the difference was not statistically significant (p>0.05) [75,79,87,89,90]. The pairwise random effects meta-analysis of the paper including participants with a mean age of 45 years indicated an SMD of 0.12 (95% CI: −0.40 to 0.63; 1 paper) weighted 15.9% in favour of the control, but the difference was not statistically significant (p>0.05). There was substantial heterogeneity between the findings of the included studies, as indicated by the I^2, which measures the variability in point estimates, and one of the papers by Stapleton *et al.* (2022) [90] was the highest contributor to the overall heterogeneity.

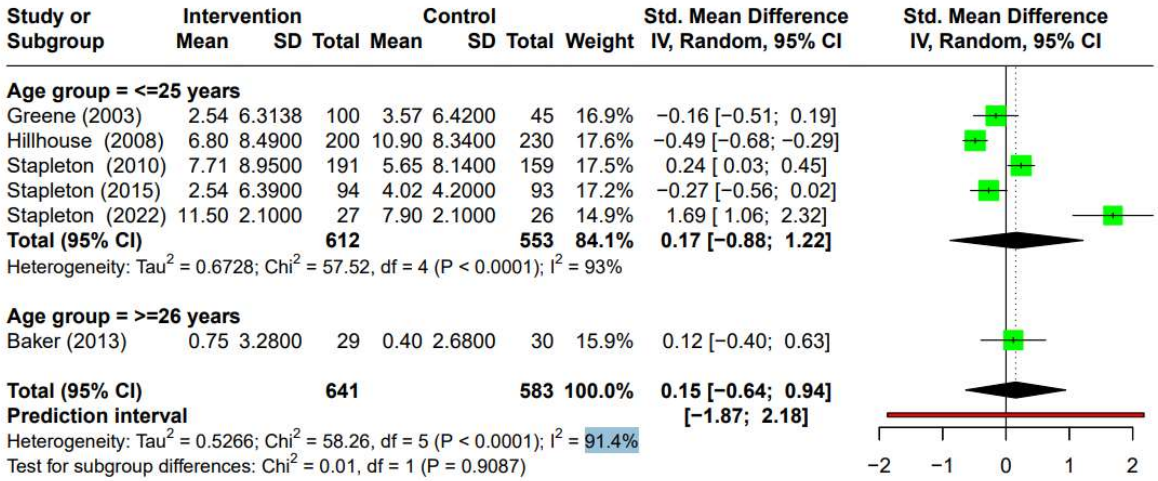

Figure 13: Subgroup analysis forest plot (including studies with participants of a similar age) of SMD (±SDs) for frequency of sunbed use among those who received an education intervention compared with no intervention

A subgroup analysis based on risk of bias is presented in Figure 14. The subgroup analysis for the six papers by risk of bias, based on pairwise random effects meta-analysis of papers with some concerns of

bias, indicated an SMD of 0.74 (95% CI: −11.00 to 12.49; I^2: 96%; 2 papers) weighted 31.8% in favour of the control, but the difference was not statistically significant (p>0.05) [75,90]; papers with a high risk of bias indicated an SMD of −0.12 (95% CI: −0.67 to 0.43; I^2: 88.7%; 4 papers) weighted 68.2% in favour of the intervention, but the difference was not statistically significant (p>0.05) [70,79,87,89].

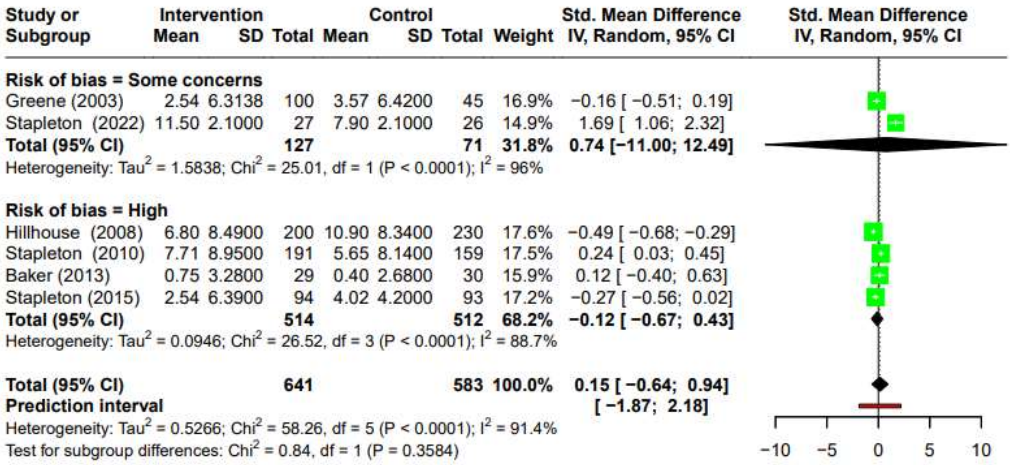

Figure 14: Subgroup analysis forest plot (by risk of bias) of SMD (±SDs) for frequency of sunbed use among those who received an education intervention compared with no intervention

A subgroup analysis based on the type of education delivered is presented in Figure 15. The subgroup analysis for the six papers by the type of education intervention showed that pairwise random effects meta-analysis of papers employing workbooks, flyers, and pamphlets for education indicated an SMD of −0.09 (95% CI: −0.63 to 0.45; I^2: 88.4%; 4 papers) weighted 67.9% in favour of the intervention, but the difference was not statistically significant (p>0.05) [70,75,79,89]. Web-based interventions indicated an SMD of 0.69 (95% CI: −11.77 to 13.14; I^2: 96.7%; 2 papers) weighted 32.1% in favour of the control, but the difference was not statistically significant (p>0.05) [87,90].

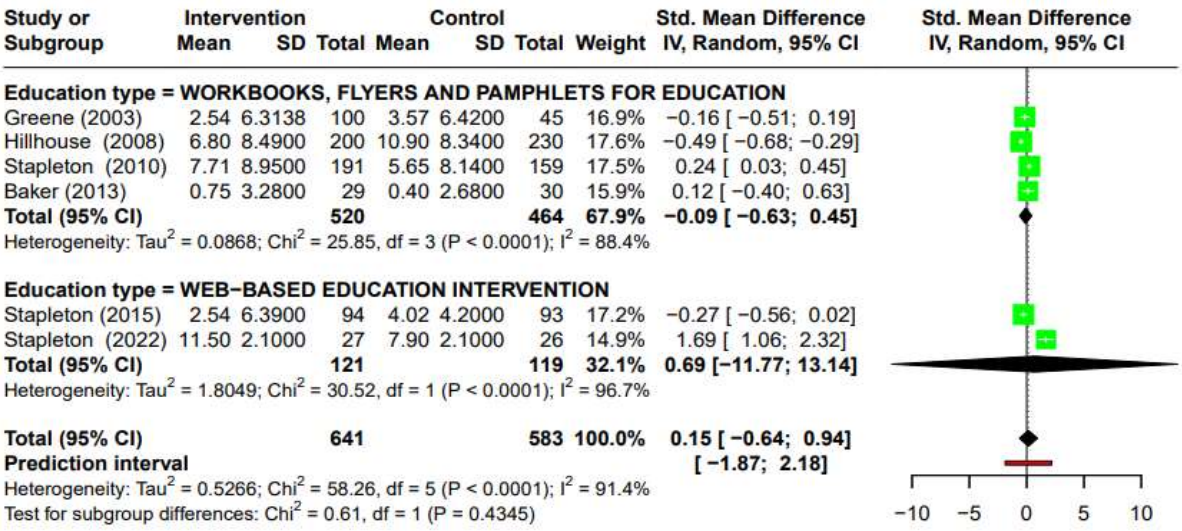

Figure 15: Subgroup analysis forest plot(by type of education intervention) of SMD (±SDs) for frequency of sunbed use among those who received an education intervention compared with no intervention

A subgroup analysis based on the duration of the follow-up period is presented in Figure 16. The subgroup analysis for the six papers by the duration of the follow-up period indicated that pairwise random effects meta-analysis of papers with a follow-up period of ≤2 months had an SMD of −0.23 (95% CI: −0.92 to 0.47; I^2: 0%; 2 papers) weighted 34.1% in favour of the intervention, but the difference was not statistically significant (p>0.05) [75,87]. Papers with a 3–4-month follow-up period had an SMD of 0.89 (95% CI: −9.10 to 10.88; I^2: 93%; 2 papers) weighted 30.8% in favour of the control, but the difference was not statistically significant (p>0.05) [70,90]. Papers with a 5–6-month follow-up period had an SMD of −0.13 (95% CI: −4.74 to 4.49; I^2: 96%; 2 papers) weighted 35.1% in favour of the intervention, but the difference was not statistically significant (p>0.05) [79,89].

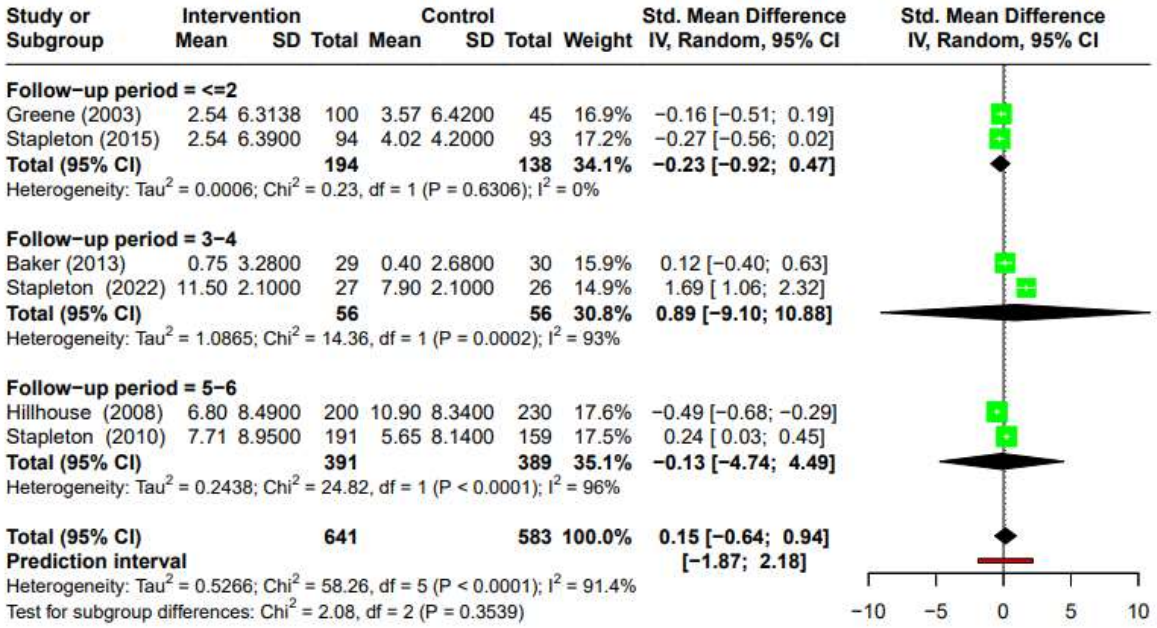

Figure 16: Subgroup analysis forest plot (by duration of follow-up) of SMD (±SDs) for frequency of sunbed use among those who received an education intervention compared with no intervention

3.3.5.3 Meta-analysis: Likelihood of sunbed use intentions

Five studies that evaluated education interventions and reported on likelihood of sunbed use intentions were pooled into a meta-analysis as presented in Figure 17 [70,71,75,79,80]. The data tables used for the meta-analyses of the education interventions are presented in Appendix G. Three papers that reported on the same outcome were not pooled in the analysis due to incomplete data [73,74,77]. The results of the pairwise random effects meta-analysis showed an SMD of −0.24 (95% CI: −0.42 to −0.05; I^2: 48.4%; certainty of evidence: very low; 5 papers) in favour of the intervention, indicating lower sunbed use intentions, and this finding was statistically significant (p<0.05). The GRADE certainty of evidence ranking for this outcome was very low (Appendix H). There was moderate heterogeneity between the findings of the included studies, as indicated by the I^2. The type of education intervention appears to contribute to the overall heterogeneity, as can be seen in Figure 19.

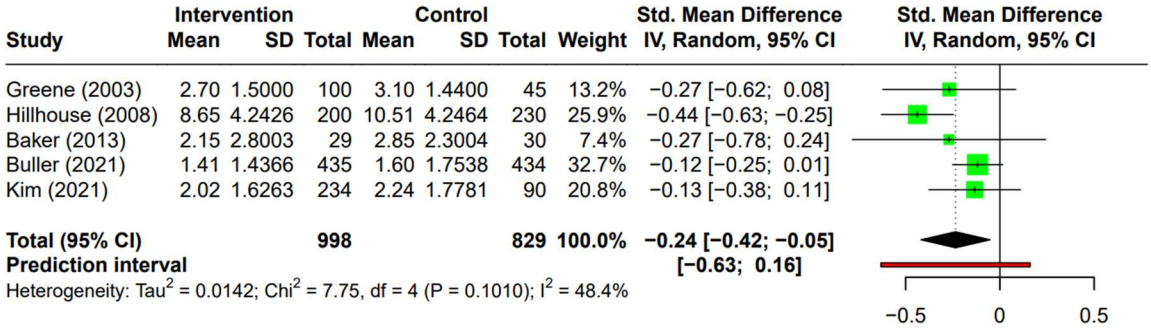

Figure 17: Forest plot of SMD (±SDs) for likelihood of sunbed use intentions among those who received an education intervention compared with no intervention

A subgroup analysis based on risk of bias is presented in Figure 18. The subgroup analysis for the five papers by risk of bias, based on pairwise random effects meta-analysis of the paper with a low risk of bias, indicated an SMD of −0.12 (95% CI: −0.25 to 0.01; 1 paper) weighted 32.7% in favour of the intervention, but the difference was not statistically significant (p>0.05) [71]. The paper with some concerns of bias indicated an SMD of −0.27 (95% CI: −0.62 to 0.08; 1 paper) weighted 13.2% in favour of the intervention, but the difference was not statistically significant [75]. The papers with a high risk of bias indicated an SMD of −0.29 (95% CI: −0.72 to 0.13; I^2: 46.5%; 3 papers) weighted 54.1% in favour of the intervention, but the difference was not statistically significant (p>0.05) [70,79,80].

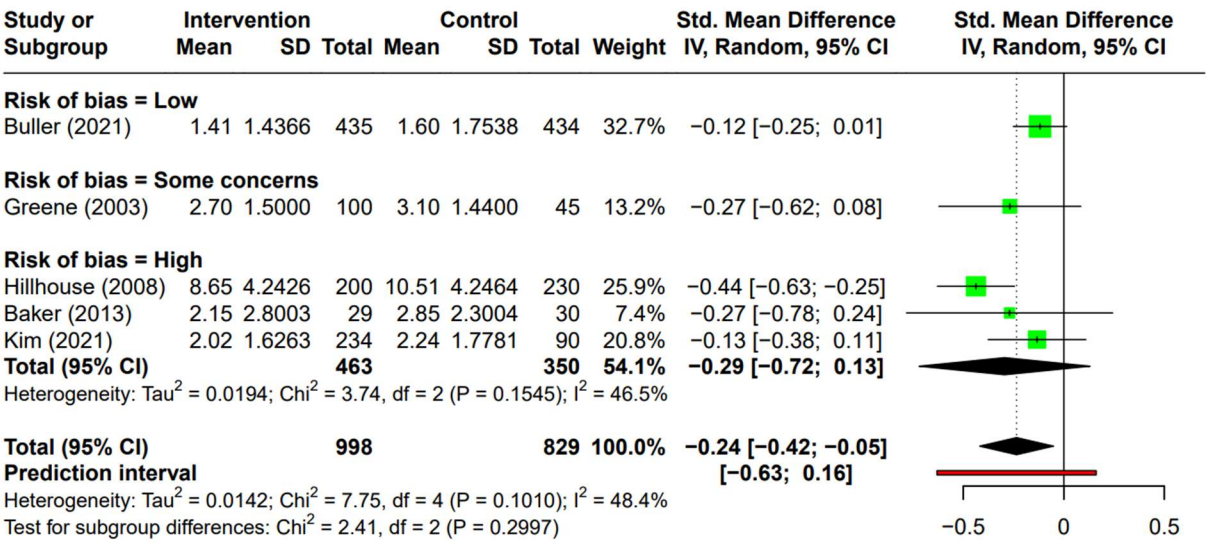

Figure 18: Subgroup analysis forest plot (by risk of bias) of SMD (±SDs) for likelihood of sunbed use intentions among those who received an education intervention compared with no intervention

A subgroup analysis based on the type of education delivered is presented in Figure 19. The subgroup analysis for the five papers by the type of education intervention indicated that a pairwise random effects meta-analysis of papers employing social media education interventions had an SMD of −0.12 (95% CI: −0.20 to −0.04; I^2: 0%; 2 papers) weighted 53.5% in favour of the intervention (p<0.05) [71,80]. Papers employing workbooks, flyers, and pamphlets for education had an SMD of −0.39 (95% CI: −0.62 to −0.15; I^2: 0%; 3 papers) weighted 46.5% in favour of the intervention, indicating higher effectiveness than social media interventions, although both groups of interventions were effective (p<0.05) [70,75,79].

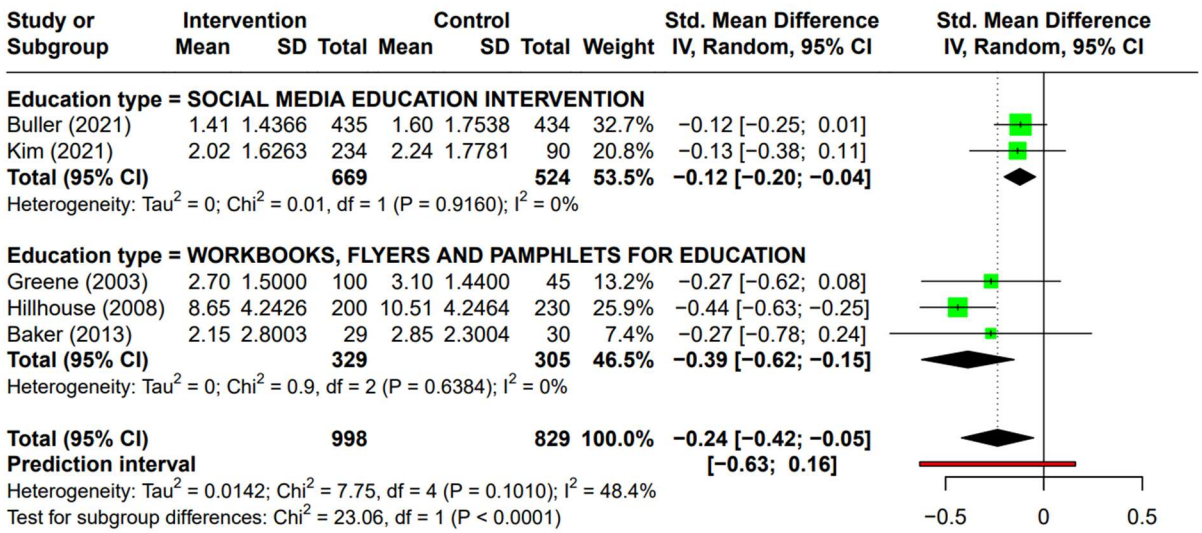

Figure 19: Subgroup analysis forest plot (by type of education intervention) of SMD (±SDs) for likelihood of sunbed use intentions among those who received an education intervention compared with no intervention

A subgroup analysis based on the duration of the follow-up period is presented in Figure 20. The subgroup analysis for the five papers by the duration of the follow-up period indicated that pairwise random effects meta-analysis of papers with a follow-up period of ≤2 months had an SMD of −0.18 (95% CI: −0.98 to 0.63; I^2: 0%; 2 papers) weighted 34.0% in favour of the intervention [75,80]. One paper had a follow-up period of 3–4 months, and had an SMD of −0.27 (95% CI: −0.78 to 0.24; 1 paper) weighted 7.4% in favour of the intervention, but the difference was not statistically significant (p>0.05) [70]. One paper had a follow-up period of 5–6 months, and had an SMD of −0.44 (95% CI: −0.63 to −0.25; 1 paper) weighted 25.9% in favour of the intervention (p<0.05) [79]. The final paper had a follow-up period of ≥12 months, and had an SMD of −0.12 (95% CI: −0.25 to 0.01; 1 paper) weighted 32.7% in favour of the intervention, but the difference was not statistically significant (p>0.05) [71].

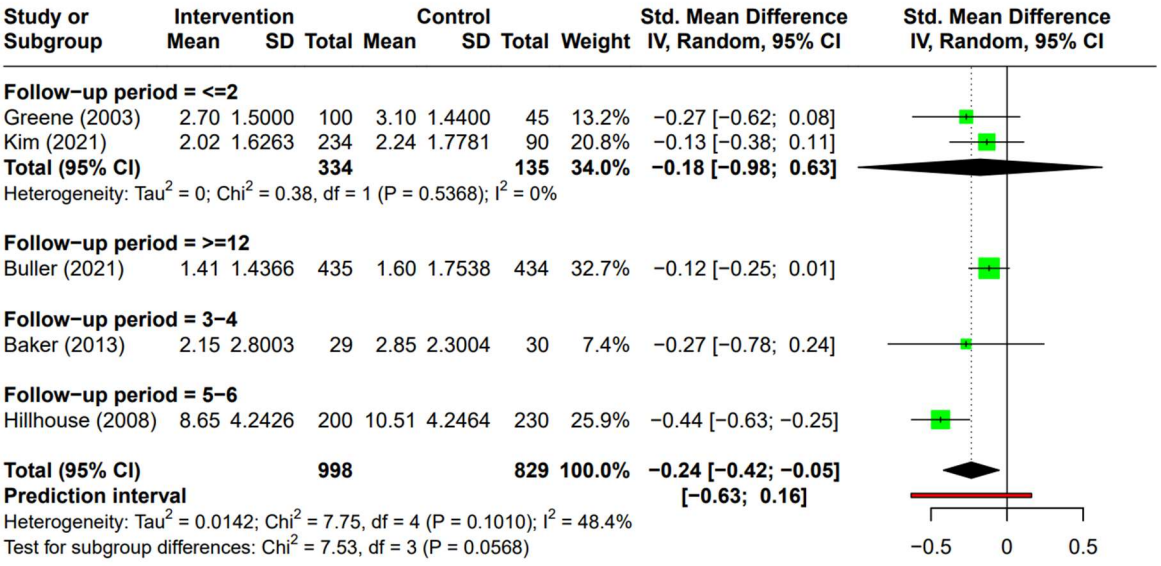

Figure 20: Subgroup analysis forest plot (by duration of follow-up) of SMD (±SDs) for likelihood of sunbed use intentions among those who received an education intervention compared with no intervention

A subgroup analysis based on the age of participants is presented in Figure *21*. The subgroup analysis for the five papers by the age of participants indicated that pairwise random effects meta-analysis of papers with participants aged ≤25 years had an SMD of −0.29 (95% CI: −0.70 to 0.11; I^2: 47%; 3 papers) weighted 59.8% in favour of the intervention, but the difference was not statistically significant (p>0.05) [75,79,80]. Papers with participants aged ≥40 years had an SMD of −0.13 (95% CI: −0.60 to 0.34; I^2: 0%; 2 papers) weighted 40.2% in favour of the intervention, but the difference was not statistically significant (p>0.05) [70,71].

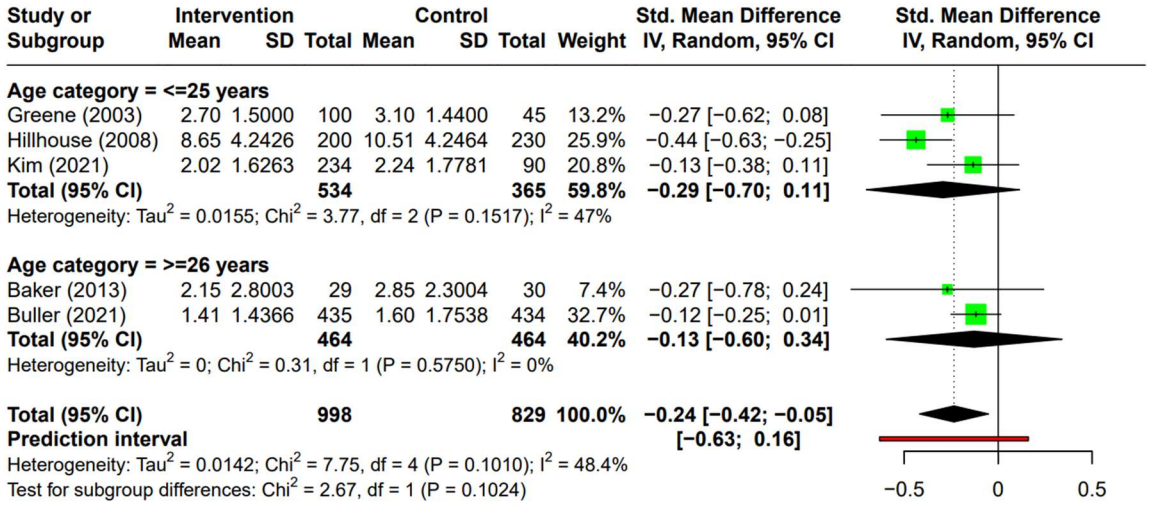

Figure 21: Subgroup analysis forest plot (by age of participants) of SMD (±SDs) for likelihood of sunbed use intentions among those who received an education intervention compared with no intervention

3.3.5.4 Narrative synthesis: Sunbed use

Sixteen papers that evaluated education interventions and reported on sunbed use were not suitable for pooling in the pairwise meta-analysis, and thus we have synthesised their findings narratively and summarised them in Table 11 [68,69,71–74,76,77,81,82,84–86,88,91,92]. Where sufficient data were available, we standardised effect estimates to odds ratios (ORs) with 95% CIs if sunbed use was reported as a dichotomous (yes or no) outcome; alternatively, we standardised effect estimates to SMDs with 95% CIs where sunbed use was reported as a continuous measure.

Seven of the 16 papers did not find statistically significant reductions in sunbed use following the interventions when compared with their respective comparators [71,72,76,86,88,91,92]. The kinds of interventions that were applied in these seven papers were social media education in three papers [71,72,88], in-person or face-to-face education in another three papers [86,91,92], and web-based education in one paper [76]. Four of the seven papers that did not attain statistically significant reductions in sunbed use covered research in adolescent or young adult populations [76,86,88,91], while the research by Buller *et al.* [71,72] targeted mothers of adolescent daughters and the research by Tari *et al.* [92] targeted kidney transplant patients.

One of the 16 papers that were not pooled indicated borderline statistical significance because the odds of using sunbeds were 39% lower following in-person education of non-medical skincare professionals, with a crude OR of 0.61 (95% CI: 0.37–1.00) compared with baseline measures, but since the CI stopped at 1, the effect was potentially neutral [84].

Research comprising national multicomponent interventions that primarily targeted young people showed that participants were 29% less likely to use sunbeds after 2 years, with a crude OR of 0.71 (95%

CI: 0.67–0.75), and 3% less likely to use sunbeds after 8 years, with an adjusted odds ratio (AOR) of 0.97 (95% CI: 0.97–0.97), when compared with the pre-campaign period [81,82].

Three of the 16 papers that were not pooled reported statistically significant findings of reduced sunbed use following in-person or face-to-face education interventions [68,74,85]. The first of these research papers focused on non-melanoma skin cancer patients and their helpers, and only explicitly indicated that the findings from helpers showed statistically significantly lower sunbed use (p=0.001) when baseline and post-intervention findings for sunbed use were compared [85]. The second paper, by Cho *et al.* (2018) [74], reported that both variations of the intervention – which was delivered as two arms in the trial – had statistically significantly lower sunbed use compared with the control arm (p<0.05). The third paper focused on adolescent pupils and found that the AOR for sunbed use among girls was 0.60, or 40% lower (95% CI: 0.42–0.86) compared with girls in the control group, and that the AOR among boys was similar, at 0.58 (95% CI: 0.35–0.96) compared with boys in the control group [68].

Two papers that utilised workbooks, flyers, and pamphlets as the education intervention were delivered among young university women, and both reported statistically significantly fewer sunbed tanning sessions in the intervention arm compared with the control arm (p<0.05) [69,77].

The final paper that was not included in the meta-analysis was a web-based education intervention by Cho *et al.* (2020) [73] that was delivered to young women, and it reported statistically significant findings for reduced sunbed use in both variations of the intervention arm compared with the control arm (p<0.05).

In summary, 16 papers reporting on sunbed use were not suitable for pooling in the pairwise meta-analysis. Seven of the 16 papers did not find statistically significant reductions in sunbed use following the interventions compared with their respective comparators. One of the 16 papers indicated borderline statistical significance in comparison with the control. The remaining eight papers reported statistically significant reductions in sunbed use following the interventions compared with their respective controls. Overall, the impact of education interventions on sunbed use is inconclusive because just over one-half (56%) of the papers reported statistically significant reductions in sunbed use. The GRADE certainty of evidence ranking for the sunbed use outcomes included in the narrative synthesis was very low (Appendix H).

Table 11: Summary of results for sunbed use in studies examining education interventions that were excluded from the meta-analysis

Study	Intervention versus comparator	Population	Reason for exclusion from meta-analysis	Analysis sample size	Effect estimates homogenised for review: OR/SMD (95% CI)	Effect estimates (author-reported)
Buller *et al.* (2021) [71]	Social media education versus active control	Mothers of adolescent daughters	Incomplete data (outcomes)	869	OR: 1.25 (0.82–1.90)	Unavailable
Buller *et al.* (2022) [72]			Incomplete data (outcomes)	869	OR: 0.94 (0.65–1.38)	Unavailable
Heckman *et al.* (2016) [76]	Web-based education versus control	Young adults at risk of skin cancer	Pooling unviable due to insufficient studies with the same outcome and design	965	OR: 0.54 (0.23–1.27)	Unavailable
Ng *et al.* (2012) [84]	In-person education versus baseline control	Non-medical skincare professionals	Pooling unviable due to insufficient studies with the same outcome and design	183	OR: 0.61 (0.37–1.00)	Unavailable
Stanganelli *et al.* (2016) [86]	In-person education versus control	Adolescent students	Pooling unviable due to insufficient studies with the same outcome and design	3,042	OR: 1.39 (0.86–2.22)	Unavailable
Stapleton *et al.* (2018) [88]	Social media education versus baseline control	Young women	Pooling unviable due to insufficient studies with the same outcome and design	16	SMD: −0.44 (−1.13 to 0.25)	Unavailable
Swindler *et al.* (2007) [91]	In-person education versus baseline control	High school pupils	Pooling unviable due to insufficient studies with the same outcome and design	517	OR: 1.19 (0.90–1.59)	Unavailable
Tari *et al.* (2024) [92]	In-person education versus baseline control	Kidney transplant patients	Pooling unsuitable because the population was in a clinical setting and not comparable	176	OR: 0.45 (0.17–1.18)	Unavailable
Køster *et al.* (2011) [81]	National multicomponent intervention versus baseline control	Adolescents and young adults	Pooling unsuitable because the intervention was not comparable with the others	13,229	OR: 0.71 (0.67–0.75)	Unavailable
Køster *et al.* (2018) [82]			Pooling unsuitable because the intervention was not comparable with the others	37,562	Unavailable	AOR* for recent sunbed use in 2015 compared with the pre-campaign level: 0.97 (95% CI: 0.97–0.97)
Robinson and	In-person education versus baseline control	Patients with non-melanoma	Pooling unsuitable because the population was in a clinical setting and not comparable	178 dyads of patients	Unavailable	The means and SDs for an ordinal scale measuring tanning device use were 1 (0.05) for patients and 1.5 (0.12) for

Study	Intervention versus comparator	Population	Reason for exclusion from meta-analysis	Analysis sample size	Effect estimates homogenised for review: OR/SMD (95% CI)	Effect estimates (author-reported)
Rademaker (1995) [85]		skin cancer and their helpers		and helpers		helpers (paired *t*-test results for helpers: *t*=6.1; df=249; *p*=0.001).
Aarestrup *et al.* (2014) [68]	In-person education versus control	Adolescent pupils	Incomplete data (outcomes)	2,351	Unavailable	Sunbed use in intervention schools versus pupils in control schools for girls: AOR:** 0.60 (95% CI: 0.42–0.86), *p*=0.005; for boys: AOR:** 0.58 (95% CI: 0.35–0.96), *p*=0.03.
Cho *et al.* (2018) [74]	In-person education versus control	Young women	Incomplete data (arm numbers)	247	Unavailable	Logistic regression analysis of the difference in the percentage of sunbed users between intervention arm 1 versus control: *t*-value: −2.57, *p*=0.0173; intervention arm 2 versus control: *t*-value: −2.09, *p*=0.0489.
Cho *et al.* (2020) [73]	Web-based education versus control	Young women	Incomplete data (arm numbers)	518	Unavailable	Mixed-effect logistic regression model of difference in the percentage of sunbed users between intervention arm 1 versus control: z-statistic: −3.60, *p*=0.0003; intervention arm 2 versus control: z-statistic: −2.09, *p*=0.0362.
Hillhouse and Turrisi (2002) [77]	Workbooks, flyers, and pamphlets versus control	Young women in university	Incomplete data (arm numbers)	106	Unavailable	Analysis of variance (ANOVA) indicated that the intervention arm (mean: 4.16; SD: 7.04) reported significantly fewer sunbed tanning sessions than the control arm (mean: 7.48; SD: 11.25); *p*<0.05.
Abar *et al.* (2010) [69]	Workbooks, flyers, and pamphlets versus control	Young women in university	Incomplete data (outcomes)	379	Unavailable	Mixed measures ANOVA indicated a significant increase over time in indoor tanning frequency (*p*<0.05). The general increase was less pronounced for the intervention arm than for the control arm.

* Adjusted for gender, age, education, skin type, and whether they had children.

** Adjusted for age, socioeconomic position, smoking, parents' attitudes towards sunbed use, and pupils' attitudes towards sunbed use at baseline.

3.3.5.5 Narrative synthesis: Sunbed use intentions

Six papers that evaluated education interventions and reported on sunbed use intentions were not suitable for pairwise meta-analysis, and therefore we have presented a narrative synthesis of their findings and summarised them in Table 12 [68,73,74,77,78,83]. If sufficient data were available, we standardised the effect estimates to crude ORs with 95% CIs where sunbed use intentions were reported as a dichotomous (yes or no) outcome.

Two of the six papers indicated that their findings were not statistically significantly different with regard to intentions to reduce sunbed use in the intervention when contrasted with comparator groups [68,83]. The intervention in Lazovich *et al*.'s paper [83] utilised written education in the form of pamphlets and was delivered to parents and their teenage children, while in-person education was provided in Aarestrup *et al*.'s research [68].

Two of the remaining four papers comprised web-based education interventions. Adolescent girls were the target population in the paper by Hillhouse *et al*. [78], and the intervention group reported statistically significantly lower sunbed tanning intentions compared with the control group ($p<0.01$). Young women were the focus of Cho *et al*.'s (2020) [73] research, and both variations of the intervention arms revealed statistically significantly lower sunbed tanning intentions compared with the control arm ($p<0.01$).

One paper delivered in-person or face-to-face education among young women and reported lower sunbed tanning intentions in both variations of the intervention arms compared with the control arm ($p<0.05$) [74]. The final paper employed educational workbooks for use by young women in university and reported that the intervention arm registered statistically significantly lower sunbed tanning intentions compared with the control arm ($p<0.001$) [77].

In summary, six papers reporting on sunbed use intentions were not suitable for pairwise meta-analysis. Two of these six papers indicated that their findings were not statistically significantly different with regard to sunbed use intentions in the intervention when contrasted with the comparator groups. The remaining four papers reported statistically significant reductions in sunbed use intentions following the interventions compared with their respective controls. Overall, the findings of these studies of education interventions on sunbed use intentions are mixed, although the majority of the papers (66%) reported statistically significant reductions in intentions to use a sunbed. The GRADE certainty of evidence ranking for the sunbed use intentions outcomes included in the narrative synthesis was very low (Appendix H).

Table 12: Summary of results for sunbed use intentions in studies examining education interventions that were excluded from the meta-analysis

Study	Intervention versus comparator	Population	Reason for exclusion from meta-analysis	Analysis sample size	Effect estimates homogenised for review: OR (95% CI)	Effect estimates (author-reported)
Lazovich *et al.* (2013) [83]	Workbooks, flyers, and pamphlets versus control	Parents and their teenage children	Pooling unviable due to insufficient studies with the same outcome and design	70 teenagers and 111 parents	0.56 (0.20–1.58)	Unavailable
Aarestrup *et al.* (2014) [68]	In-person education versus control	Adolescent pupils	Incomplete data (outcomes)	2,351	Unavailable	Sunbed tanning intentions in intervention schools versus pupils at control schools: for girls: AOR: 0.76 (95% CI: 0.43–1.37), p=0.36; for boys: unadjusted OR: 0.41 (95% CI: 0.15–1.11), p=0.08.
Hillhouse *et al.* (2017) [78]	Web-based education versus active control	Adolescent girls	Pooling unviable due to insufficient studies with the same outcome and design	443	Unavailable	Multivariate linear regression indicated that participants in the intervention group reported significantly lower sunbed tanning intentions (b = −1.54; p<0.01).
Cho *et al.* (2018) [74]	In-person education versus control	Young women	Incomplete data (arm numbers)	247	Unavailable	Covariance analysis model of differences in sunbed tanning intentions between intervention arm 1 and control: t-value: −4.02, p=0.0006; intervention arm 2 and control: t-value: 2.21, p=0.0376.
Cho *et al.* (2020) [73]	Web-based education versus control	Young women	Incomplete data (arm numbers)	518	Unavailable	Mixed-effect logistic regression model of difference in sunbed tanning intentions between intervention arm 1 versus control: z-statistic: −3.81, p=0.0002; intervention arm 2 versus control: z-statistic: −4.32, p=0.0000.
Hillhouse and Turrisi (2002) [77]	Workbooks, flyers, and pamphlets versus control	Young women in university	Incomplete data (arm numbers)	106	Unavailable	ANOVA indicated that the intervention arm reported significantly lower sunbed tanning intentions than the control arm (F statistic: 12.25; p<0.001).

3.4 Regulation interventions

3.4.1 Search and screening results for regulation interventions

The HRB identified nine papers that examined the effect of regulation interventions on sunbed users and their sunbed use [94–102].

3.4.2 Study characteristics for regulation interventions

3.4.2.1 Study designs

We identified nine studies that examined the effect of regulation interventions on sunbed users, and their characteristics are presented in Table 13. Six of the studies were conducted in the United States of America (USA) [94–96,99,101,102], one was conducted in Ireland [97], one was conducted in Canada [98], and one was conducted in Norway [100]. The studies were published in 2009 [96], 2014 [101], 2017 [94], 2018 [98,99], and 2020 [95,97,100,102].

All nine regulation intervention studies included in this systematic review employed a cross-sectional survey methodology, which provides point-in-time assessments rather than longitudinal data on intervention effectiveness. Eight of the nine studies included adolescent participants [94,96–102], with only one study including adult participants [95].

3.4.2.2 Study population

The percentage of girls in the study populations ranged from 50% to 52% in four of the nine studies [96,97,99,102]; one of the nine studies reported the percentage of girls as 59.8% prior to the ban on sunbeds and 50.3% post-ban [100]. The remaining four studies did not report the proportion of women/girls or men/boys [94,95,98,101].

3.4.2.3 Study interventions on regulation

As described in our background section (see Section 1.1), the team employed the World Health Organization's (WHO's) framework document titled *Artificial tanning devices: Public health interventions to manage sunbeds* [1]. This document organises regulatory interventions into the following categories:

1. banning sunbeds:
    a) banning all artificial tanning services
    b) banning the hire and sale of sunbeds for domestic use
2. restricting access to sunbeds:
    a) prohibiting unsupervised artificial tanning services
    b) setting an age limit on sunbed use
    c) preventing the use of sunbeds by 'high-risk' individuals
3. managing sunbed operations:
    a) conducting surveillance and licensing of tanning establishments
    b) controlling ultraviolet (UV) exposure
    c) requiring eye protection
    d) training sunbed operators
    e) taxing tanning sessions

4. prescribing risk communication:
    a) requiring the provision of information
    b) banning the marketing and promotion of sunbeds
    c) requiring the display of warning notices
5. ensuring compliance and enforcement.

All nine included studies incorporated regulation interventions that fell under category 1: restricting access to sunbeds, with two studies addressing subcategory 2a: prohibiting unsupervised artificial tanning services [99,101], and eight studies addressing subcategory 2b: setting an age limit on sunbed use [94–100,102]. No studies were identified that addressed any of the other regulatory interventions described by the WHO framework.

3.4.2.4 Study comparators

The comparator for all nine studies was no intervention, allowing for an assessment of each regulatory approach against baseline conditions [94–102]. This follow-up comparator did not take account of other temporal changes.

3.4.2.5 Study outcomes

Of the two studies addressing subcategory 2a: prohibiting unsupervised artificial tanning services [99,101], both assessed sunbed use, but neither assessed sunbed use intentions or skin cancer rates. Of the eight studies addressing subcategory 2b: setting an age limit on sunbed use [94–100,102], all assessed sunbed use, one study assessed sunbed use intentions [97], and no studies assessed skin cancer rates.

Table 13: Summary of study characteristics for studies examining regulation interventions

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
Blashill and Pagoto (2017) [94]	USA	Cross-sectional survey	In 2014, Alabama passed House Bill 254, following which minors aged under 15 years were banned from indoor tanning, 15-year-old minors were permitted to tan with in-person parental consent, and minors aged 16–17 years were required to present written parental consent. The data combine results from all interventions rather than reporting them separately. Thus, we have categorised these interventions as a single 'age restriction' intervention.	No restriction/no intervention	Adolescents	1 year	Indoor tanning within the past 12 months Dichotomised: 0 times/1 or more times	14,389 No mention of analytic sample	Age range: 14–18 years	Not reported
Bowers *et al*. (2020) [95]	USA	Cross-sectional survey	This study assessed: 1. States with an under-18 access ban	No restriction/no intervention	Adults	The duration of exposure in each state	Indoor tanning within	20,219	Adults	Not reported

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
			(16 states): Refers to the exclusion of all individuals aged under 18 years from using indoor tanning services. 2. States with other youth access restrictions (28 states): Refers to parental permission or accompaniment requirements for various ages under 18 years, or access bans for some minors aged under 17 years (commonly ages 13–16 years).			varied according to when legislation was enacted.	the past 12 months Categorical: 0 times, 1–2 times, 3–10 times, 11–24 times, and 25 or more times	No mention of analytic sample		
Cokkinides *et al.* (2009) [96]	USA	Cross-sectional survey	State legislation restricted minors' access to indoor tanning, with varying levels of restrictions across different states (not explicitly reported).	No restriction/no intervention	Adolescents	The duration of exposure in each state varied according to when legislation was enacted.	Indoor tanning within the past 12 months Prevalence – dichotomised: Yes/No Frequency: Continuous	1998: 2,392 2004: 3,226 No mention of analytic sample	Age range: 11–18 years	50%

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
			State policies were categorised into two levels: 1) states that passed legislation before 1998 and retained the policy through 2004 (8 states) 2) states that passed legislation between 1998 and 2004 (11 states).							
							Indoor tanning: 'Have you ever used a sunbed?'			
Menzies *et al.* (2020) [97]	Ireland	Cross-sectional survey	This study assessed the effect of Ireland's Public Health (Sunbed) Act 2014, which prohibits the use of sunbeds by individuals aged under 18 years.	No restriction/no intervention	Adolescents	2–3 years	Dichotomised: Yes/No Intentions to use sunbeds in the future were measured by asking students if they would consider using a sunbed in the future.	Pre-ban: 754 Post-ban: 783 No mention of analytic sample	Mean age: 15.7 years	52%

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
Nadalin *et al.* (2018) [98]	Canada	Cross-sectional survey	The Skin Cancer Prevention Act (Tanning Beds), 2013 came into effect in Ontario in May 2014. The Act prohibits the sale of tanning services to individuals aged under 18 years.	No restriction/no intervention	Adolescents	1 year	Indoor tanning within the past 12 months Dichotomised: Yes/No	2014: 1,561 2015: 2,305 No mention of analytic sample	Age range: 12–18 years	Not reported
Qin *et al.* (2018) [99]	USA	Cross-sectional survey	The study examined the impact of state indoor tanning laws on the prevalence of indoor tanning among USA high school students. The laws were categorised into two main types: 1. age restriction laws that prohibit minors younger than a certain age from using an indoor tanning device 2. parental permission laws that prohibit minors younger than a certain age from	No restriction/no intervention	Adolescents	The duration of exposure in each state varied according to when legislation was enacted.	Indoor tanning within the past 12 months Dichotomised: 0 times or 1 or more times	41,313 No mention of analytic sample	Age range: 14–18 years	51%

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
			using an indoor tanning device without parental consent or accompaniment.							
Robsahm *et al.* (2020) [100]	Norway	Cross-sectional survey	The purpose of this study was to assess the impact of the enforcement of an age ban on indoor tanning for individuals aged under 18 years, which came into effect on 1 January 2017.	No restriction/no intervention	Adolescents	1 year	Indoor tanning within the past 12 months Categorical: 0, 1–4, ≥5	Pre-ban (2016): 199 Post-ban (2017): 193 No mention of analytic sample	Age range: 15–17 years	Pre-ban (2016): 59.8% Post-ban (2017): 50.3%
Simmons *et al.* (2014) [101]	USA	Cross-sectional survey	Utah Senate Bill 41 was passed in 2012, which stipulates that individuals aged under 18 years are forbidden from using indoor tanning facilities unless: (1) they obtain a note from a physician, or (2) they are accompanied at each tanning visit by a parent or guardian	No restriction/no intervention	Adolescents	1 year	Indoor tanning within the past 12 months Categorical: 0 times, 1 or 2 times, 3–9 times, 10–19 times, 20–39 times, and 40 or more times	2011: 15,609 2013: 15,184 No mention of analytic sample	Age range: 11–18 years	Not reported

Author (year)	Country	Study design	Intervention	Comparator	Target population	Duration of intervention	Outcome	Total sample size and analytic sample size	Mean age/age range	Percentage of female participants
			who signs a waiver on their behalf.							
Stapleton *et al.* (2020) [102]	USA	Cross-sectional survey	In 2013, New Jersey legislators passed a state-wide ban on indoor tanning for youth aged under 17 years.	No restriction/no intervention	Adolescents	5 years	Indoor tanning within the past 12 months Dichotomised: 0 times or at least 1 time	12,659 No specific mention of analytic sample	Age range: 14–18 years	51%

3.4.3 Study quality for regulation interventions

The methodological quality assessment for all nine cross-sectional surveys indicated that five studies were of low quality [94,95,97,98,100] and four studies were of moderate quality [96,99,101,102]. No studies were deemed to be of high quality (Table 14).

For the moderate-quality papers, the main weaknesses in quality assessment were an inability to complete a follow-up due to study design, and the absence of sample size justification, power description, and effect estimates. The low-quality studies had significant weaknesses in most areas, including eligible population, participation rate, absence of sample size justification, power description, variance and effect estimates, and inability to complete a follow-up due to study design. Full quality assessment results are presented in Appendix E.

Table 14: Summary of methodological quality assessment ratings for cross-sectional survey studies on regulation interventions

Author	Year	Country	Study design	Q3: Eligible population and participation rate	Q4A: Similar population recruitment	Q4B: Prespecified inclusion and exclusion criteria	Q5A: Sample size justification	Q5B: Variance	Q13: Loss to follow-up	Q14: Adjusted for confounding	Total score	Rating
Blashill and Pagoto [94]	2017	USA	Cross-sectional survey	Not reported	Yes	Yes	No	Yes	Not applicable	Age, sex	2	Low
Bowers *et al.* [95]	2020	USA	Cross-sectional survey	Not reported	Yes	Yes	No	Yes	Not applicable	Age, sex, race/ethnicity	2	Low
Cokkinides *et al*. [96]	2009	USA	Cross-sectional survey	Yes	Yes	Yes	No	Yes	Not applicable	Age, sex, race/ethnicity	3	Moderate
Menzies *et al*. [97]	2020	Ireland	Cross-sectional survey	Yes	Yes	Yes	No	No	Not applicable	Age, sex	2.5	Low
Nadalin *et al*. [98]	2018	Canada	Cross-sectional survey	No	Yes	Yes	No	No	Not applicable	Age, sex	1.5	Low
Qin *et al*. [99]	2018	USA	Cross-sectional survey	Yes	Yes	Yes	No	Yes	Not applicable	Age, sex, race/ethnicity	3	Moderate
Robsahm *et al*. [100]	2020	Norway	Cross-sectional survey	Yes	Yes	Yes	No	No	Not applicable	Age, sex	2.5	Low
Simmons *et al*. [101]	2014	USA	Cross-sectional survey	Yes	Yes	Yes	No	Yes	Not applicable	Sex, race/ethnicity	3	Moderate
Stapleton *et al*. [102]	2020	USA	Cross-sectional survey	Yes	Yes	Yes	No	Yes	Not applicable	Age, sex, race/ethnicity	3	Moderate

3.4.4 Study risk of bias for regulation interventions

The risk of bias assessment used to evaluate the nine cross-sectional surveys was the Risk Of Bias In Non-randomized Studies – of Interventions (ROBINS-I) tool [93]. All nine cross-sectional surveys had a serious risk of bias (Figure 22). The main weaknesses in the risk of bias assessment were bias due to confounding, the measurement of outcomes, and the selection of the reported result.

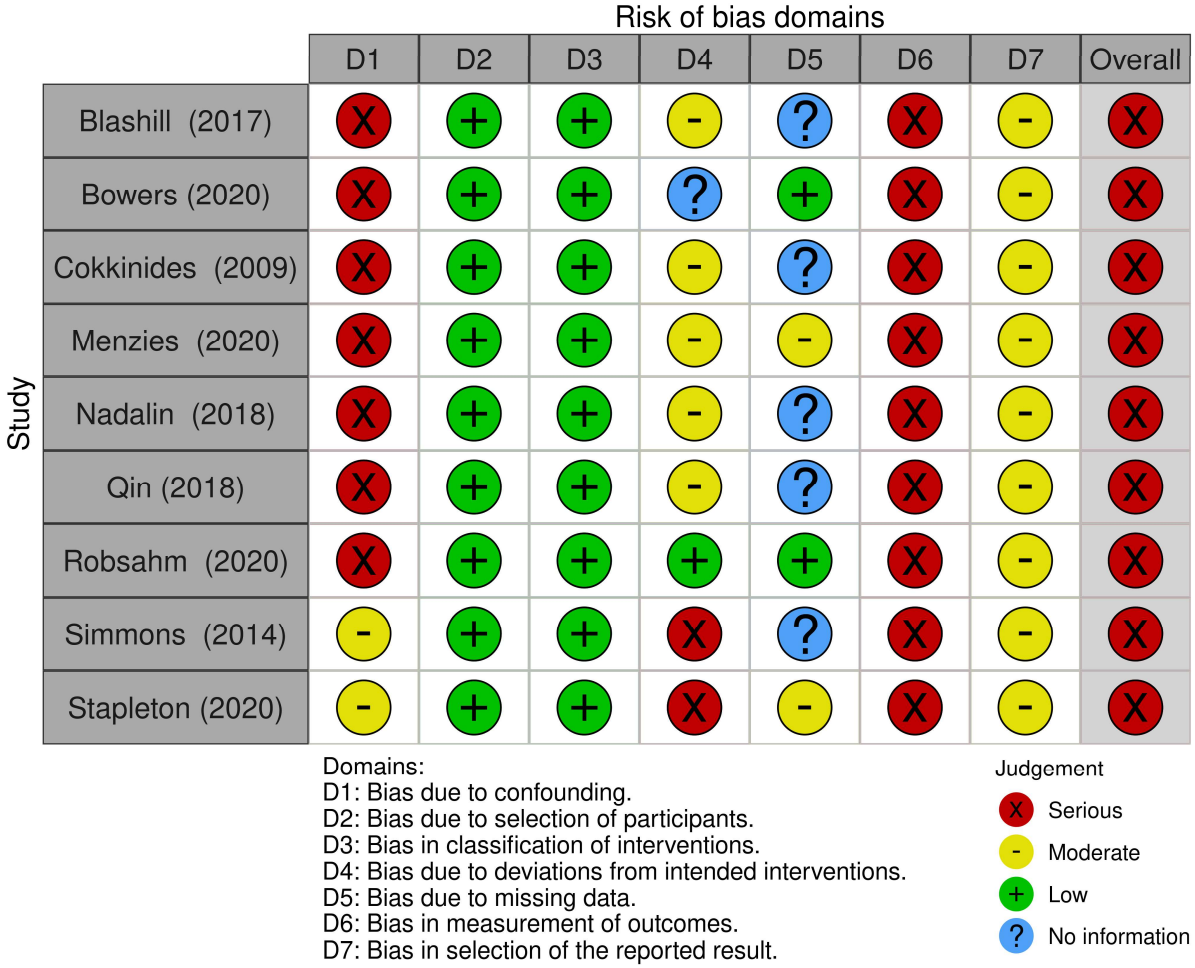

Figure 22: Risk of bias assessment using ROBINS-I for cross-sectional survey studies reporting on regulation interventions

Source: McGuinness and Higgins, 2020 [93]

3.4.5 Study findings for regulation interventions

3.4.5.1 Feasibility assessment for meta-analysis

We completed a feasibility assessment in order to determine if we should perform a meta-analysis for the effect of regulation interventions on sunbed use and sunbed use intentions. All of the nine papers that examined regulation interventions reported on the prevalence of sunbed use, which was a dichotomous (yes or no) measure [94–102]. Four of the nine papers were not pooled in the meta-analysis because of incomplete outcome data [94,95,101,102]. Furthermore, three of these excluded studies [94,95,101] did not disaggregate the effect of the regulatory intervention based on either the prohibition of unsupervised artificial tanning (the requirement for parental permission) or the setting of an age limit for sunbed use (age-specific bans). This left five of the nine papers to be pooled into a pairwise meta-analysis [96–100].

Only one paper examining a regulatory intervention reported on sunbed use intentions, and thus the pooling of studies in pairwise meta-analysis for this outcome was not feasible because the minimum number of studies required to do this is three [97]. The detailed tabular results of the meta-analysis feasibility assessment for regulation interventions are presented in Appendix F.

3.4.5.1 Meta-analysis: Prevalence of sunbed use

We pooled five papers that reported on sunbed use as a dichotomous (yes or no) measure into a pairwise random effects meta-analysis [96–100]. The data tables used for the meta-analyses of the regulation interventions are presented in Appendix G. Four papers that reported on the same outcome were not pooled in the analysis due to incomplete data [94,95,101,102]. The results of the pairwise random effects meta-analysis indicated an odds ratio (OR) of 0.74 (95% CI: 0.38–1.45; I^2: 97.0%; certainty of evidence: very low; 5 papers) in favour of the intervention, indicating 26% lower odds of sunbed use after an age ban was introduced compared with no intervention at baseline, but the effect was not statistically significant (p>0.05). This effect estimate is presented in Figure 23. The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) certainty of evidence ranking for this outcome was very low. The GRADE certainty of evidence rankings for all outcomes are detailed in Appendix H. There was substantial heterogeneity between the findings of the included studies, as indicated by the I^2, which measures the variability in point estimates. The paper by Qin *et al.* [99] was the most significant contributor to heterogeneity, as can be seen in Figure 23, Figure 24, and Figure 25.

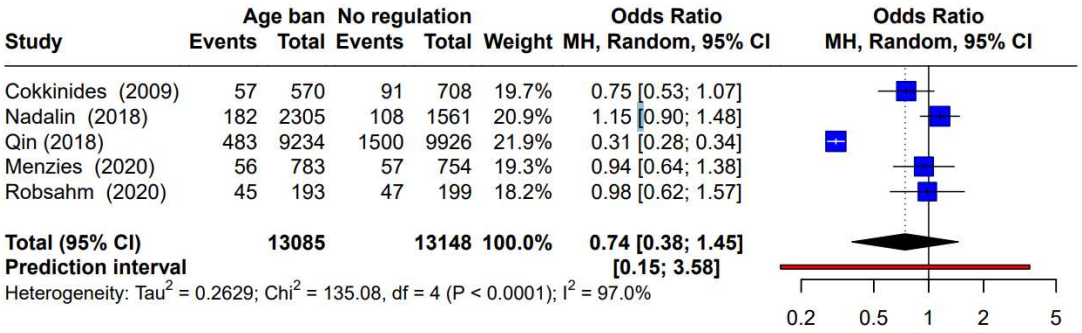

Figure 23: Forest plot of OR (95% CI) for prevalence of sunbed use following an age ban compared with no intervention

A sensitivity analysis based on participants who were adolescent girls is presented in Figure 24. The sensitivity analysis for papers with data on the intervention's effect on adolescent girls included four papers [97–100], and excluded the paper by Cokkinides *et al*. [96] because complete data were not provided. The results of the pairwise random effects meta-analysis indicated an OR of 0.74 (95% CI: 0.21–2.63; I^2: 97.6%; certainty of evidence: very low; 4 papers) in favour of the intervention, denoting 26%

lower odds of sunbed use among adolescent girls after an age ban was introduced compared with no intervention at baseline, but the effect was not statistically significant (p>0.05). The GRADE certainty of evidence ranking for this outcome was very low. The heterogeneity between the findings of the included studies, as indicated by the I^2, was considerable. The paper from Qin *et al.* [99] was the largest contributor to heterogeneity.

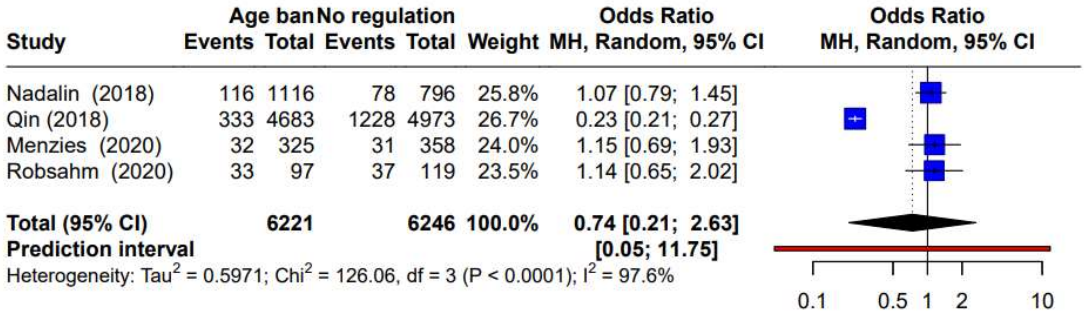

Figure 24: Sensitivity analysis forest plot of OR (95% CI) for prevalence of sunbed use among adolescent girls following an age ban compared with no intervention

A sensitivity analysis based on participants who were adolescent boys is presented in Figure 25. The sensitivity analysis for papers with data on the intervention's effect on adolescent boys included four papers [97–100], and excluded the paper by Cokkinides *et al*. [96] because complete data were not provided[97–100]. The results of the pairwise random effects meta-analysis indicated an OR of 0.85 (95% CI: 0.45–1.62; I^2: 76.8%; certainty of evidence: very low; 4 papers) in favour of the intervention, denoting 15% lower odds of sunbed use among boys after an age ban was introduced compared with no intervention at baseline, but the effect was not statistically significant (p>0.05). The GRADE certainty of evidence ranking for this outcome was very low. The heterogeneity between the findings of the included studies, as indicated by the I^2, was substantial. The paper from Qin *et al*. [99] was the most significant contributor to heterogeneity.

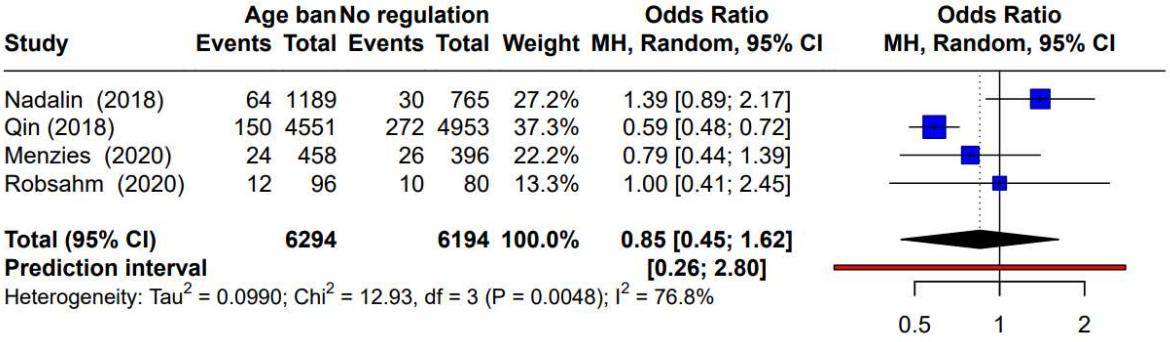

Figure 25: Sensitivity analysis forest plot of OR (95% CI) for prevalence of sunbed use among adolescent boys following an age ban compared with no intervention

3.4.5.2 Narrative synthesis: Sunbed use

Four papers that evaluated regulation interventions and reported on sunbed use were unsuitable for pooling in the pairwise meta-analysis, and thus we have synthesised their findings narratively and summarised them in Table 15 [94,95,101,102]. The data were incomplete in the four papers, thus we have not presented the effect estimates as ORs with the respective 95% CIs for sunbed use.

The paper by Blashill and Pagoto [94] was the only one to report that there was no statistically significant reduction in sunbed tanning among adolescents following the implementation of both an age ban and parental permission restrictions compared with baseline.

The other three papers indicated statistically significant reductions in sunbed use following the intervention when compared with the baseline control period [95,101,102]. The research by Bowers *et al*. (2020) [95] examined the enactment of an age ban and parental permission restrictions for sunbed use, which resulted in decreased sunbed tanning prevalence among all adults in a USA survey, from 10% in 2007 to 4% in 2018 (p<0.001). The institution of the age ban that was assessed in the paper by Stapleton *et al*. (2020) [102] found that the odds of indoor tanning decreased significantly, by 50%, in adolescents in 2018 (adjusted odds ratio (AOR): 0.50; 95% CI: 0.36–0.70) compared with the baseline period in 2012 (p<0.001). Lastly, the utilisation of both an age ban and parental permission restrictions for sunbed use that was examined in the research by Simmons *et al.* (2014) [101] indicated a statistically significant reduction in reported sunbed tanning following the introduction of the regulations, from 12.0% of adolescent students in 2011 (baseline) to 7.7% in 2013 (p<0.0001).

In summary, the findings for the regulation interventions included in the narrative synthesis are skewed towards effectiveness, with three of the four papers (75%) reporting statistically significant reductions in sunbed use. The GRADE certainty of evidence ranking for the sunbed use outcomes included in the narrative synthesis for regulation interventions was very low (Appendix H).

3.4.5.3 Narrative synthesis: Sunbed use intentions

The paper by Menzies *et al.* was the only regulation intervention paper that reported on sunbed use intentions, which meant that pooling of the results in a pairwise meta-analysis was not feasible; therefore, the results are summarised in Table 16 [97]. We standardised the effect estimates in this paper to an OR with the respective 95% CIs for sunbed use intentions [97]. The odds of sunbed use intentions among adolescents in 2017 following the introduction of an age ban compared with a baseline control in 2013 did not indicate a statistically significant change in sunbed use intentions (OR: 0.85; 95% CI: 0.64–1.13; p>0.05) [97]. The GRADE certainty of evidence ranking for the sunbed use intentions outcome included in the narrative synthesis for regulation interventions was very low (Appendix H).

Table 15: Summary of results for sunbed use in studies examining regulation interventions that were excluded from the meta-analysis

Study	Intervention versus comparator	Population	Reason for exclusion from meta-analysis	Analysis sample size	Effect estimates homogenised for review: OR (95% CI)	Effect estimates (author-reported)
Bowers *et al*. (2020) [95]	Both an age ban and parental permission restriction in 2018 versus baseline control in 2007	Adults	Incomplete data (outcome)	20,219	Insufficient data	Sunbed tanning prevalence decreased significantly over time among all USA adults, from 10% in 2007 to 4% in 2018 (p<0.001).
Stapleton *et al*. (2020) [102]	Age ban in 2018 versus baseline control in 2012	Adolescents	Incomplete data (outcome)	Pre-restriction: 12,659 Post-restriction: 12,659	Insufficient data	The weighted prevalence of sunbed tanning in the past year was 8.5% (95% CI: 5.9–11.1) in 2012 and 4.6% (95% CI: 3.7–5.5) in 2018. The AOR of indoor tanning in 2018 after the age ban was 0.50 (95% CI: 0.36–0.70; p<0.001) compared with the baseline period in 2012.
Blashill and Pagoto (2017) [94]	Both an age ban and parental permission restriction in 2015 versus baseline control in 2013	Adolescents	Incomplete data (outcome)	14,389	Insufficient data	The change in the percentage of sunbed tanners among girls (−1.8% (95% CI: −9.1 to 5.5)) and among boys (−2.7% (95% CI: −7.5 to 2.1)) was not statistically significant compared with the period before the enactment of the laws (p-values were not given).
Simmons *et al.* (2014) [101]	Both an age ban and parental permission restriction in 2013 versus baseline control in 2011	Adolescents	Incomplete data (outcome)	Pre-ban and restriction: 15,609 Post-ban and restriction: 15,184	Insufficient data	In the pre-intervention period, 12.0% of adolescent students reported sunbed tanning at least once in the past 12 months, compared with 7.7% at 2 years after the enactment of the law (p<0.0001).

Table 16: Summary of results for sunbed use intentions in the study examining regulation interventions that was excluded from meta-analysis

Study	Intervention versus comparator	Population	Reason for exclusion from meta-analysis	Analysis sample size	Effect estimate homogenised for review: OR (95% CI)	Effect estimate (author-reported)
Menzies *et al.* (2020) [97]	Age ban in 2017 versus baseline control in 2013	Adolescents	Pooling unviable due to insufficient studies with the same intervention and population	Pre-ban: 754 Post-ban: 783	0.85 (0.64–1.13)	Unavailable

4 Discussion

4.1 Key findings

4.1.1 Education interventions and sunbed use

Six of nine papers that evaluated education interventions and reported on the frequency of sunbed use were pooled into a meta-analysis. The results of the pairwise random effects meta-analysis indicated a standardised mean difference (SMD) of 0.15 (95% CI: −0.64 to 0.94; I^2: 91.4%; certainty of evidence: very low; 6 papers) in favour of the control, which had a lower mean frequency of sunbed use, but the difference was not statistically significant (p>0.05). There was considerable heterogeneity between the findings of the included studies, as indicated by the I^2, and one of the studies by Stapleton *et al*. (2022) [90] was the highest contributor to the overall heterogeneity because the study included frequent sunbed tanners. The GRADE certainty of evidence ranking for the pairwise meta-analysis results on sunbed use was very low.

Sixteen papers that evaluated education interventions and reported on sunbed use were not suitable for pooling in the pairwise meta-analysis. Seven of the 16 papers did not find statistically significant reductions in sunbed use following the interventions when compared with their respective comparators. One of the 16 papers indicated borderline statistical significance in comparison with the control, whereas the remaining 8 papers reported statistically significant reductions in sunbed use following the interventions compared with their respective controls. Overall, the impact of education interventions on sunbed use is inconclusive because just over one-half (56%) of the papers reported statistically significant reductions in sunbed use. The GRADE certainty of evidence ranking for the sunbed use outcomes included in the narrative synthesis was very low.

4.1.2 Education interventions and sunbed use intentions

Five of the 10 papers that evaluated education interventions and reported on likelihood of sunbed use intentions were pooled into a meta-analysis, and the results of the pairwise random effects meta-analysis indicated an SMD of −0.24 (95% CI: −0.42 to −0.05; I^2: 48.4%; certainty of evidence: very low; 5 papers) in favour of the intervention, indicating lower sunbed use intentions, and this finding was statistically significant (p<0.05). There was moderate heterogeneity between the findings of the included studies, as indicated by the I^2, and the type of education intervention appeared to contribute to the overall heterogeneity. The GRADE certainty of evidence ranking for the pairwise meta-analysis results on sunbed use intentions was very low.

Six papers that evaluated education interventions and reported on sunbed use intentions were not suitable for pairwise meta-analysis. Two of these six papers indicated that their findings were not statistically significantly different with regard to sunbed use intentions in the intervention groups compared with the control groups. The remaining four papers reported statistically significant reductions in sunbed use intentions following the interventions compared with their respective controls. Overall, the findings of these studies of education interventions on sunbed use intentions are mixed, although the majority of the papers (66%) reported statistically significant reductions in intentions to use a sunbed. The GRADE certainty of evidence ranking for the sunbed use intentions outcomes included in the narrative synthesis was very low.

4.1.3 Regulation interventions and sunbed use

We pooled five of the nine papers that reported on sunbed use prevalence following the implementation of regulation interventions into a meta-analysis. The results of the pairwise random effects meta-analysis

indicated an OR of 0.74 (95% CI: 0.38–1.45; I^2: 97.0%; certainty of evidence: very low; 5 papers) in favour of the intervention, indicating 26% lower odds of sunbed use after an age ban was introduced compared with no intervention at baseline, but the effect was not statistically significant (p>0.05). Heterogeneity between the findings of the included studies (as indicated by the I^2) was considerable, and the paper by Qin *et al.* [99] – also the largest study – was the most significant contributor to heterogeneity. The GRADE certainty of evidence ranking for the pairwise meta-analysis results on sunbed use was very low.

Four papers that assessed regulation interventions and reported on sunbed use were not pooled in the pairwise meta-analysis due to incomplete data. Narrative synthesis revealed that three of the four papers (75%) reported statistically significant reductions in sunbed use following the introduction of age bans and parental permission restrictions when compared with baseline. The GRADE certainty of evidence ranking for the pairwise meta-analysis results on sunbed use was very low.

4.1.4 Regulation interventions and sunbed use intentions

The only paper that reported on the effect of a regulatory intervention on sunbed use intentions found that the introduction of an age ban did not result in statistically significant changes in this outcome compared with baseline. The GRADE certainty of evidence ranking for the singular regulation intervention study reporting on sunbed use intentions was very low.

4.2 Comparison with other research

4.2.1 Education interventions

In their systematic review of the effectiveness of community-wide and mass media interventions on reducing ultraviolet (UV) radiation exposure, Sandhu *et al.* [27] acknowledged the pre-eminence of interventions that combine individually directed education strategies with mass media communication, along with environmental and policy changes, which resulted in a 4 % decrease (95% CI: 2.5–5.5%) in sunbed use. This review was, however, inconclusive on the efficacy of mass media education alone (such as print, radio, television, or Internet communication) on UV radiation exposure behaviour because effectiveness was not ubiquitously observed in the included primary studies [27]. Sandhu *et al*. and the authors of this evidence review included the 2011 research paper by Køster *et al*. [81]. We also noted the synergistic effect of combining mass media education with policy and environmental changes in the 2011 and 2018 research papers by Køster *et al*. [81,82]. We could not pool these papers (which feature a multicomponent intervention) in the pairwise meta-analysis with other education interventions because the intervention was not comparable with other interventions that solely utilised education, and thus was likely to inflate the findings of papers that relied exclusively on media education.

A 2021 systematic review of interventions aimed at changing UV-related behaviour among young adults reported that self-relevance and message framing were deterministic of intervention success [29]. Personally relevant interventions, such as those employing UV photographs in order to illustrate the photoageing or photodamaging effects of sunbed tanning, induced a negative reaction that was likely to have prompted a change in behaviour. The authors of that review also argued that targeting the main motivation behind tanning behaviour, which was the desire to achieve an attractive appearance, also contributed to the effectiveness of the intervention [29]. Our systematic review did not include papers that used UV photographs to illustrate the photoageing or photodamaging effects of sunbed tanning, but the self-relevance concept may have been a factor in the intervention demonstrating the greatest effectiveness for change in sunbed use and sunbed use intentions. The paper by Hillhouse *et al.* (2008) [79], which we included in our review, reported that the intervention was adapted based on feedback from sunbed tanners and solely focused on appearance-enhancement alternatives among young university women, which likely contributed to the enhanced intervention magnitude.

None of the existing systematic reviews paralleled our conclusion on the greater effectiveness of interventions that employ written education (workbooks, flyers, and pamphlets) compared with social media education; however, in their head-to-head randomised controlled trial comparison of the use of informational flyers versus Facebook in raising awareness of melanoma and harmful sun-related behaviour among young adults, Agha-Mir-Salim *et al*. [103] found that the former approach was more effective in enhancing a knowledge score (p<0.05) [103]. One reason that was hypothesised for this divergence was that memory retention is superior when learning from printed material rather than from electronic mediums. Social media was also criticised for its inundation of information, which reduces the visibility of health literacy intervention material and reduces the credibility of information. Furthermore, Agha-Mir-Salim *et al*. pointed out that the individually addressed and personalised delivery of flyers may have grabbed the readers' attention and thus contributed to the effectiveness of the intervention.

Existing systematic reviews also fail to delineate the differences in intervention effectiveness across the outcomes of sunbed use and sunbed use intentions. The relationship between the outcomes is such that the intention to engage in sunbed tanning is predictive of future sunbed tanning [69,104]. It is postulated that modifying attitudes towards willingness to engage in sunbed tanning through various educational efforts could affect sunbed tanning intentions among those with perceived control over the behaviour, which could have a domino effect on sunbed tanning behaviour [69,104]. The results of our systematic review suggest that multifaceted efforts will be necessary in order to achieve changes in sunbed use (which Sandhu *et al*. [27] also pointed out) because only sunbed use intentions were effectively changed through the included educational interventions in this HRB systematic review.

4.2.2 Regulation interventions

Rodriguez-Acevedo *et al*. conducted an extensive systematic review and meta-analysis that investigated the international prevalence of sunbed use after artificial tanning devices were classified as carcinogenic by the International Agency for Research on Cancer (IARC) in 2009. In total, they identified 43 papers comprising research studies, government documents, and World Health Organization (WHO) reports [30]. The findings revealed that the prevalence of sunbed use among teenagers between 2013 and 2018 was 6.5% (95% CI: 3.3–10.6), which was 70% lower than the 22.0% (95% CI: 17.2–26.8) prevalence for 2007–2012. Likewise, the prevalence of sunbed use in adults decreased by 35%, from 18.2% (95% CI: 12.2–24.1) in 2007–2012 to 10.4% (95% CI: 5.7–16.3) in 2013–2018 [30]. The regulatory interventions that were implemented following the IARC declaration – which was arguably a public education initiative – included outright bans on sunbed tanning, legislation banning minors of specified ages from sunbed tanning (the age varied by country), and the prohibition of unsupervised sunbed access for minors. Our review featured research on age bans for minors and parental permission restrictions (which are analogous to the prohibition of unsupervised sunbed access for minors), and these also constituted the bulk of the research in the review by Rodriguez-Acevedo *et al.* [30]. Despite this, statistical significance was not detected in our pairwise meta-analysis pooling all suitable regulatory interventions, potentially due to the small number of research studies we included. However, some of the included studies found statistically significant changes in sunbed use following the implementation of regulatory interventions compared with the pre-intervention period [95,99,101,102].

Rodriguez-Acevedo *et al.* identified notable differences in the efficacy of various regulatory interventions [30]. Lenient regulations – such as those requiring parental consent for engaging in sunbed tanning, or sunbed prohibition for those with Fitzpatrick skin type I (very fair skin) – resulted in low and inconsistent compliance levels. The study by Qin *et al.* [99], which was the largest individual study included in our systematic review (41,313 participants), found that age bans were associated with 47% lower sunbed tanning prevalence among adolescent girls, while parental permission restrictions did not attain

statistically significant changes in sunbed tanning behaviour in either boys or girls. Despite these findings, it is unequivocal in the literature that all partial regulatory measures, such as age bans or parental permission restrictions, are difficult to enforce effectively and require buy-in from third parties such as service providers, parents, and guardians [105]. One strategy that can improve enforcement is the enactment of mandatory age verification practices by service providers, something that has already been done for the sale of tobacco and alcohol. Moreover, the licensing and inspection of businesses that provide sunbed tanning services may also limit the unlawful sale of sunbed tanning services to minors – another enforcement strategy that was also successfully enacted with tobacco legislation [106,107].

National bans on sunbeds – such as those instituted in Brazil and Australia – are acknowledged for their supremacy in regulating sunbed tanning, with respective sunbed tanning rates of 4% and <1% in 2017; rates differ due to variable enforcement in the two countries, but these can be compared with sunbed tanning rates of about 15% in countries that do not have any regulations on sunbed tanning [30]. Our systematic review did not identify any papers that assessed comprehensive bans because only Iran, Brazil, and Australia have instituted this approach and corresponding research was unavailable [30].

The education and regulatory interventions that we synthesised in our systematic review did not examine the regulations' impact on skin cancer rates, likely due to the prolonged latency of this outcome, although the potential effect has been projected in various modelling studies. The expected health consequences of prohibiting all commercial sunbed use across North America and Europe for the generation aged between 12 and 35 years could prevent 448,000 melanomas and 9.7 million non-melanoma skin cancers, which would save the healthcare system 5.7 billion United States dollars (USD) [22]. In comparison, the institution of age bans for those aged under 18 years would yield about one-third of these gains. Gains in Australia based on the comprehensive ban on commercial sunbed tanning in 2016 encompass the prevention of 31,009 melanomas (−3.7%), 3,017 melanoma deaths (−2.3%), and 468,249 non-melanoma cancers (−3.6%). This would yield a savings of USD 46.9 million in healthcare costs and generate another USD 375.3 million in productivity costs in Australia[23]. This Australian evaluation also found that consumer interest in sunbed tanning decreased to less than one-quarter of pre-regulation peaks based on Google trends, while interest in non-UV tanning increased from 2008, which was around the time that the IARC classified artificial tanning devices as carcinogenic. The prognoses from the modelling studies illustrate some of the returns associated with the effective regulation of sunbed tanning, but the interrogation of Irish data would more accurately reflect the benefits for this context.

4.3 Strengths and limitations

As of 2025, this was the first systematic review with a meta-analysis to synthesise interventions focusing exclusively on sunbed use, and not as a component of general UV tanning, which is a much broader field encompassing varying exposure and intervention modalities and outcomes.

We carefully considered the methodology employed for the systematic review searches, with the intention of capturing all relevant studies that would best answer the review question relevant to policy-makers and public health officials in Ireland. The principal strength of the searches we conducted is that they were expert, peer-reviewed, and comprehensive; the searches were employed using best practice across a range of highly regarded databases and sources, all of which strengthens the validity of the search results. Staging the searches in order to match the process of the review – including scoping searches, main database searches, supplementary and grey literature searches, reference and citation chasing searches, and the final date-specific database searches – provided a full indication of the available evidence.

Another strength of this review was the robust process applied in the meta-analyses. We initially conducted a feasibility analysis in order to assess how plausible the synthesis was, given the variable populations, interventions, study designs, comparators, and outcome measures in the included papers. Feasibility decisions were recorded and agreed upon by at least two reviewers, which ensured that the final analyses yielded valid and reliable results. Additionally, the meta-analysis results stratified findings based on factors that were likely to confound outcomes, such as gender, age, type of education delivered, follow-up period, and risk of bias, which added to the validity of the results.

We assessed both the methodological quality and risk of bias for each study included in this systematic review. These assessments are often conflated, but the former verifies how well a study was conducted, while the latter focuses on identifying potential biases that could affect the validity of the results [48,49]. The risk of bias outcomes contributed to decisions on the GRADE certainty of evidence, which can facilitate policy-makers in their decision process for guideline or policy development.

The veracity of the systematic review process was also bolstered by our documentation of deviations from the protocol. These deviations comprised the exclusion of modelling studies that were initially included in the review in order to compensate for an expected deficit in the availability of empirical data. At the data extraction stage, however, sufficient evidence was identified from observational and experimental studies to address the research objectives, and our exclusion of modelling studies maintained methodological uniformity across the included studies. We expanded the outcomes to incorporate sunbed use intentions, as this was a consistent and valid measure frequently reported in the included studies. Moreover, we supplemented comparators to include unrelated and alternative interventions in our controls, which maximised the number of controls and, ultimately, the number of papers in the review.

Regarding the limitations of the searches, we did not perform extensive searching of non-English-language literature. This is because time and resources did not allow the recruitment of a professional translator, and the use of an automated translator (e.g. Google Translate) risked mistranslating technical phrases and details.

Our analysis was restricted to commonly reported confounders, such as age, sex and race/ethnicity. Additional factors, such as immunosuppressive conditions and personal cancer history, may influence skin cancer risk but were beyond the scope of this review due to inconsistent reporting in the primary literature.

The very low certainty of evidence identified in this review reflects several inherent challenges in evaluating sunbed use interventions that parallel those encountered in tobacco control research. Population heterogeneity emerged as a critical factor, with interventions demonstrating markedly different effects across study populations—from habitual tanners with no cessation intentions to high-risk clinical populations such as kidney transplant recipients who may be more motivated to modify behaviour. The brief follow-up periods employed in most studies (typically 1–6 months) may be insufficient to capture meaningful behavioural change, as sustained behaviour modification often requires extended timeframes. Additionally, substantial heterogeneity in intervention modalities and widespread inadequate reporting of essential methodological details, including randomisation procedures and outcome measurement, compromised evidence synthesis. As observed in tobacco control research, the lag time between intervention implementation and observable health outcomes necessitates longitudinal studies that were largely absent from the current evidence base. These methodological limitations highlight the need for standardised reporting using established guidelines, extended follow-up periods, and careful consideration of population characteristics when designing intervention studies—approaches

that have proven beneficial in other behaviour change domains where initial interventions demonstrated limited immediate effectiveness but contributed to longer-term population-level changes.

Lastly, the primary studies we included in this review reported on sunbed use and sunbed use intentions, which are both self-report outcome measures that are liable to various biases. Self-report measures are often subject to social desirability, recall inaccuracy, and respondent subjectivity [108]. Despite this, the reliability of self-reported exposure to sunbed tanning devices has been established, which may buffer some of the aforementioned biases [109].

4.4 Future research

The evidence base on sunbed use education and regulation interventions up until 2025 only includes one study conducted in Ireland. This is a major evidence gap given that skin cancer is the leading cancer in Ireland, with rising incidence rates of melanoma in women [25]. Various contextual factors need to be scrutinised before generalising the available international evidence on education and regulation interventions for sunbed use – such as the day-to-day experience of healthcare practitioners, patient or client preferences, and the Irish public health context – in order to maximise the effectiveness of these interventions [110].

The scope of evidence did not allow for inquiry into special interest groups pertinent to sunbed use, such as people with tanning addiction and sexual minority men who may have different needs in interventions aiming to limit sunbed use [30,111]. These are fields that warrant further attention, as we did not identify any existing research studies in these areas.

The methodological quality assessments and risk of bias assessments revealed that most of the included papers demonstrated issues of concern largely owing to missing information. This could be rectified in future interventions by diligently providing the necessary information outlined in various reporting checklists, which will ensure transparency, completeness in reporting, and research usability [112].

Prospective research evaluating regulatory interventions ought to consistently report data on national, state, and provincial legislation; participant age and gender; and sunbed use rates in order to better illustrate the impact of interventions on different subsets of the population. Moreover, countries seeking to enact regulatory interventions for sunbed use may benefit from collecting interrupted time series data on sunbed tanning across various populations of interest. Extant studies in countries with regulatory interventions in place chiefly conducted cross-sectional research in order to monitor outcomes. The advantages of applying interrupted time series data collection are that implicit trends in data available prior to the intervention can be controlled for more accurately at a population level, and both intended and unintended outcomes are taken into account [113].

4.5 Policy implications

We have presented our findings on education and regulatory interventions that aim to limit sunbed use separately in this review in order to ease the articulation of the findings.

More generally, education and regulation are intervention modalities that are proven to reduce the use of commodities that are harmful to the public's health (e.g. alcohol and tobacco). For instance, regulations that have been enacted in Ireland for tobacco and nicotine inhaling products include standardised warning labels and packaging, bans for individuals aged under 18 years, restrictions on advertising to minors, and the prohibition of self-service for the sale of these products [114]. Taxes on tobacco products were also introduced in order to discourage their use through inflated pricing, as well as annual mandatory licensing for retailers (costs are 800–1,000 euro (EUR)) and confining retailers to those aged 18 years or over except in extenuating situations of family businesses. Furthermore, the Health Service

Executive (HSE) is also permitted to perform undercover inspection visits in order to ensure that retailers comply with the set out regulations. The regulation strategies employed in Ireland were impelled by the WHO Framework Convention on Tobacco Control, which is an international treaty that outlines a global response to the tobacco epidemic [115,116]. This treaty has been ratified by 180 countries globally, including 50 WHO European member states.

Similar strategies have been employed for the regulation of alcohol use in Ireland, including the prohibition of the sale of alcohol to persons aged under 18 years, a ban on advertising to minors and in certain public locations or media outlets, mandatory health warnings on packaging, and the regulation of sports sponsorship by alcohol brands in order to limit exposure [117,118]. Retailers are also required to obtain a licence in order to ensure oversight of sales, while the retailing of alcohol is restricted to certain hours. Taxes on alcohol products are inflated in order to discourage excessive consumption, in conjunction with established minimum prices per unit to deter purchase. These high-impact regulatory policies are aligned with the WHO's *Global alcohol action plan 2022–2030*, which aims to decrease harmful alcohol use through effective evidence-based strategies relevant at national, regional, and global levels [119].

Education coupled with behavioural support is the complementary intervention that is leveraged in order to control tobacco and alcohol use. The Tobacco Free Ireland Programme (which is run by HSE Health and Wellbeing) incorporates public education campaigns, as well as training and support for health clinicians who can support patients; offers free treatment of tobacco dependence; provides various educational resources; and gives special attention to vulnerable groups [106]. Public awareness and education campaigns pertinent to alcohol are also available through the HSE and through several charities, including Alcohol Action Ireland, the national independent advocate for reducing alcohol harm [120,121]. Resources, personal education, behavioural support, and treatment are also provided to those seeking help for alcohol dependency through these avenues. Public education or awareness-raising, and training and support for clinicians, are education strategies that the WHO particularly endorses in order to inhibit the use of harmful commodities [119].

Education interventions operate through changing thoughts, attitudes, and beliefs, while regulatory interventions adapt the environment to facilitate the ease of enacting behaviour change [30,104]. The two approaches – education and regulation – are synergistic and function best when combined. In the case of sunbeds, education and information interventions are very useful for informing the public as to why sunbed use is deleterious to health, thus elaborating on the rationale for regulations and restrictions. Conversely, regulations minimise and inhibit the accessibility of sunbeds, which can protect the public's health and mitigate health disparities associated with sunbed tanning. Surveillance tactics highlighted in this systematic review, including licensing and inspection of businesses providing sunbed tanning services, may also enhance the effectiveness of education and regulatory actions [106,107].

4.6 Conclusion

This evidence review synthesised 34 papers on studies that aimed to reduce sunbed use and sunbed use intentions; 25 papers evaluated education interventions and 9 papers assessed regulation interventions.

There was very low-certainty evidence that education interventions did not statistically significantly decrease sunbed use in the intervention compared with the control groups in the pairwise random effects meta-analysis.

There was also very low-certainty evidence that regulation interventions did not statistically significantly decrease sunbed use in the intervention groups compared with baseline in the pairwise random effects meta-analysis.

Education interventions did statistically significantly reduce sunbed use intentions in favour of the interventions compared with the control groups in the pairwise random effects meta-analysis, but the certainty of evidence was again very low.

The only regulation intervention study reporting on sunbed use intentions found that the regulation in place did not indicate a statistically significant change compared with baseline, and the certainty of evidence was very low.

Our synthesis of the evidence on sunbed education and regulation interventions highlights the need for a combined intervention approach that leverages each of these strategies for the control of sunbed use. Both education and regulation interventions showed an inclination towards statistical significance for decreased sunbed use in many individual studies, and this decline was statistically significant for pooled education interventions assessing sunbed use intentions; thus, it appears that a combination of regulation and education interventions is necessary for a more robust outcome in favour of the intervention. Progression of Irish policy on sunbed use is justified if both education and regulatory approaches are considered and consolidated in any prospective interventions, as has been done with the control of tobacco and alcohol use.

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Appendix A PRISMA checklist

Section and topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Title page (evidence review)
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Executive summary
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Section 1.4 Purpose of the review
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Section 1.4 Purpose of the review and 1.5 Research questions
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Section 2.2 Eligibility criteria
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Section 2.3.4 Search resources and Appendix B
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Appendix B
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Section 2.3.6 Study screening
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable,	Section 2.4 Data extraction

		details of automation tools used in the process.	
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Section 2.4 Data extraction and Appendix D Extraction forms
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Section 2.4 Data extraction and Appendix D Extraction forms
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Section 2.6 Risk of bias
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Section 2.8 Data synthesis
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Section 2.8 Data synthesis
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Section 2.8 Data synthesis
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Section 2.8 Data synthesis
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of	Section 2.8 Data synthesis

		statistical heterogeneity, and software package(s) used.	
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Section 2.8 Data synthesis
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Section 2.8 Data synthesis
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Section 2.8 Data synthesis
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Section 2.9 Data synthesis
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Section 3.2 Search and screening results
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Appendix C
Study characteristics	17	Cite each included study and present its characteristics.	Table 7 and Table 13
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Section 3.3.4 and 3.3.4
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Section 3.3.5 and 3.4.5 Appendix G Table 11 and Table 12
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Sections 3.3.5.1 to 4 Sections 3.4.5.1 to 4
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical	Sections 3.3.5.1 to 3 Sections 3.4.5.1 to 2

		heterogeneity. If comparing groups, describe the direction of the effect.	
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Sections 3.3.5.1 to 4 Sections 3.4.5.1 to 4
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Sections 3.3.5.1 to 3 Sections 3.4.5.1 to 2
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Sections 3.3.5.1 to 4 Sections 3.4.5.1 to 4 Appendix H
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Section 4.1
	23b	Discuss any limitations of the evidence included in the review.	Section 4.3
	23c	Discuss any limitations of the review processes used.	Section 4.3
	23d	Discuss implications of the results for practice, policy, and future research.	Section 4.5
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Section 2.1
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Section 2.1
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Section 2.10
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Not applicable as reviews completed by public service employers

Competing interests	26	Declare any competing interests of review authors.	None
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Appendices D, E, F, G and H

Appendix B Search strategies

PRISMA-S (Preferred Reporting Items for Systematic reviews and Meta-Analyses literature search extension) checklist

Section/topic	#	Checklist item	Location(s) Reported
INFORMATION SOURCES AND METHODS			
Database name	1	Name each individual database searched, stating the platform for each.	Details in Appendix B
Multi-database searching	2	If databases were searched simultaneously on a single platform, state the name of the platform, listing all of the databases searched.	Details included in Appendix B for three shared platform searches (VHL Regional Portal databases, including Latin America and Caribbean Health Sciences Literature (LILACS), Cochrane Library and medRxiv/bioRxiv
Study registries	3	List any study registries searched.	EPPI Trials Register of Promoting Health Interventions (TRoPHI), ClinicalTrials.gov
Online resources and browsing	4	Describe any online or print source purposefully searched or browsed (e.g., tables of contents, print conference proceedings, web sites), and how this was done.	Appendix B. Supplemental Search section: Relevant Websites, and search engines were used to search for relevant topics
Citation searching	5	Indicate whether cited references or citing references were examined, and describe any methods used for locating cited/citing references (e.g., browsing reference lists, using a citation index, setting up email alerts for references citing included studies).	Appendix B and Section 2.3.5 Supplementary Search strategies

Contacts	6	Indicate whether additional studies or data were sought by contacting authors, experts, manufacturers, or others.	Section 2.3.5 Supplementary Search strategies
Other methods	7	Describe any additional information sources or search methods used.	Opengrey was searched for additional grey literature material
SEARCH STRATEGIES			
Full search strategies	8	Include the search strategies for each database and information source, copied and pasted exactly as run.	Included in Appendix B
Limits and restrictions	9	Specify that no limits were used, or describe any limits or restrictions applied to a search (e.g., date or time period, language, study design) and provide justification for their use.	No language, study design, date or geographic search limits were used.
Search filters	10	Indicate whether published search filters were used (as originally designed or modified), and if so, cite the filter(s) used.	Search filters were not required for these searches
Prior work	11	Indicate when search strategies from other literature reviews were adapted or reused for a substantive part or all of the search, citing the previous review(s).	Search strategies were not reused from other review, however, previous reviews were consulted to scope the types of terminology used in the reviews and searches.
Updates	12	Report the methods used to update the search(es) (e.g., rerunning searches, email alerts).	Updated searches were carried out as part of the Supplemental search stage (details included in Appendix B)
Dates of searches	13	For each search strategy, provide the date when the last search occurred.	Provided in the Primary and Supplemental search results tables in Appendix B
PEER REVIEW			
Peer review	14	Describe any search peer review process.	Search was peer-reviewed by an expert information specialist - Ailish Farragher of the Health Research Board Evidence Unit

Managing records			
Total Records	15	Document the total number of records identified from each database and other information sources.	Primary search results: n=10,645 Supplemental search results: n=7,310. Individual database results listed in Appendix B. Results were managed in EPPI-Reviewer after deduplication
Deduplication	16	Describe the processes and any software used to deduplicate records from multiple database searches and other information sources.	Deduplication of combined search results was carried out in Endnote X9. Additional deduplication of the references included after the title and abstract screening stage in EPPI-Reviewer

Source: Rethlefsen *et al*. (2021) [39]

Primary search results tables

Type of search platform	Name of search platform	Search date	Results
Biomedical/ clinical/ social and public health literature databases	EBSCO MEDLINE	26 Jul 2024	2,663
	EBSCO Cumulated Index to Nursing and Allied Health Literature (CINAHL)	26 Jul 2024	733
	EBSCO SocINDEX with Full Text	26 Jul 2024	83
	Embase.com	31 Jul 2024	3,121
	Epistemonikos (Primary studies limit)	1 Aug 2024	280
	EPPI Trials Register of Promoting Health Interventions (TRoPHI)	29 Jul 2024	119
	VHL Regional Portal databases (including Latin America and Caribbean Health Sciences Literature (LILACS))	2 Aug 2024	1,669
	Informit	29 Jul 2024	197
	Scientific Electronic Library Online (SciELO)	29 Jul 2024	74
	Scientific Information Database (Iran)	31 Jul 2024	1
	Wiley Cochrane Library (including Cochrane Database of Systematic Reviews (CDSR) and CENTRAL databases)	29 Jul 2024	268
Search engines	DuckDuckGo	1 Aug 2024	113
	Google.com	1 Aug 2024	305
	Google Scholar	1 Aug 2024	800
Preprint resources	Research Square	2 Aug 2024	66

	medRxiv/bioRxiv	2 Aug 2024	29
Trial resources	Clinicaltrials.gov	2 Aug 2024	124
	Total before deduplication		10,645
	Total after deduplication		4,472

Supplemental search results table

Type of search platform	Name of search platform	Search date	Results
Citation searching	Forward citation searching of research papers selected to be included from the screening process	11-15 Nov 2024	1,874
	Backward citation searching of research papers selected to be included from the screening process	11-15 Nov 2024	1,595
	Follow-up of protocols and conference abstracts identified in the screening process	14-15 Nov 2024	75
	WHO references	25 Nov 2024	104
	WHO citations (via GS)	25 Nov 2024	46
Updated searches	DuckDuckGo	21 Nov 2024	694
	Bielefeld Academic Search Engine (BASE)	18 Nov 2024	1,701
	EBSCO MEDLINE	25 Nov 2024	200
	Google Scholar	25 Nov 2024	986
	Wiley Cochrane Library (including CDSR and CENTRAL databases)	25 Nov 2024	26
Grey literature and other resources	OPENGrey via Data Archiving and Networked Services (DANS)	18 Nov 2024	9

	Searches of relevant websites	22 Nov 2024	0
	Total results before deduplication		7,310
	Total results after deduplication		3,675

I Primary searches: search strategies

Primary searches: Biomedical/ clinical/ social and public health literature databases

EBSCO MEDLINE

Database: MEDLINE

Platform: EBSCO

Search date: 26 Jul 2024

Search line	Search terms	Results
1	(MH “Sunbathing”) AND (TX (bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR cabin OR cabins OR device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))	352
2	(MH "Sunbathing") AND (TI (Indoor OR indoors OR artificial OR cosmetic OR ultraviolet OR UV OR UVA OR UVB OR "non-solar" OR nonsolar OR home))	351
3	(MH “Sunbathing”) AND (AB (indoor OR indoors OR artificial OR cosmetic OR ultraviolet OR UV OR UVA OR UVB OR "non-solar" OR nonsolar OR home))	497
4	(TX (sunbed OR sunbeds OR "sun-bed" OR "sun-beds" OR "sun bed" OR "sun beds"))	541
5	(TX (sunlamp* OR sun-lamp* OR “sun lamp” OR “sun lamps”))	378
6	(TX (Solarium* OR Solaria))	354
7	(TX (tanning OR tanned OR tanner OR tan OR tans OR suntanning OR suntanned OR suntan OR suntans OR sunburn*) N3 (bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR canopy OR canopies))	637
8	(TX (suntanning OR suntanned OR suntan OR suntans OR tanning OR tanned OR sunburn* OR sunning) N3 (device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))	291
9	(TI ("tan") N3 (device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))	4

10	(AB ("tan") N3 (device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))	20
11	(TI (tanning OR tan OR tans OR tanned OR tanner) N3 (indoor OR indoors OR home OR artificial OR cosmetic OR ultraviolet OR “ultra-violet” OR UV OR UVA OR UVB OR UVR OR "non-solar" OR nonsolar OR "high-risk" OR "stand-up" OR sunless))	531
12	(AB ((tanning OR tan OR tanned OR tanner) N3 (indoor OR indoors OR home OR artificial OR cosmetic OR ultraviolet OR “ultra-violet” OR UV OR UVA OR UVB OR UVR OR "non-solar" OR nonsolar OR "high-risk" OR "stand-up" OR sunless)))	901
13	(SU ((tanning OR tan OR tanned OR tanner) N3 (indoor OR indoors OR home OR artificial OR cosmetic OR ultraviolet OR “ultra-violet” OR UV OR UVA OR UVB OR UVR OR "non-solar" OR nonsolar OR "high-risk" OR "stand-up" OR sunless)))	130
14	(TI (Tan OR Tanning) N3 (lamp OR lamps OR tube OR tubes OR bulb OR bulbs))	15
15	(AB (Tan OR Tanning) N3 (lamp OR lamps OR tube OR tubes OR bulb OR bulbs))	53
16	(SU (Tan OR Tanning) N3 (lamp OR lamps OR tube OR tubes OR bulb OR bulbs))	1
17	(TI ("tanning unit" OR "tanning units")) OR (AB ("tanning unit" OR "tanning units")) OR (SU ("tanning unit" OR "tanning units"))	15
18	(TI (“tanning appointment” OR “tanning appointments”)) OR (AB (“tanning appointment” OR “tanning appointments”)) OR (SU (“tanning appointment” OR “tanning appointments”))	1
19	(TX (bronz*) N3 (bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR lamp OR lamps))	4
20	(TX (“lit de bronzage” OR “lits de bronzage” OR “bronzage en salle” OR Sonnenliege* OR “espreguiçadeira” OR “bronzeamento artificial” OR “salão de bronzeamento” OR “Salone d'abbronzatura” OR “Lâmpada bronzeadora“ OR “Lâmpada Solar Bronzeadora” OR “garvning inomhus” OR “innendørs soling” OR “bruinen binnenshuis” OR “sisärusketus” OR “sisällä solariumissa” OR “Parkitus sisätiloissa” OR “solariesalong” OR “Indendørs garvning” OR “abbronzatura interna” OR “solaryum” OR “solárium” OR “salon de bronzat” OR zonnebank OR “looiery salon”))	2
21	TX ("تخت آفتابی" OR "سالن برنزه" OR "لامپ برنزه کننده" OR "صالون تسمير" OR "מכון שיזוף")	0
22	TX (“曬黑沙龍” OR “日焼けサロン” OR “tiệm tắm nắng” OR “σολάριουμ”)	0
23	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22	2663

EBSCO Cumulated Index to Nursing and Allied Health Literature (CINAHL)

Database: CINAHL

Platform: EBSCO

Search date: 26 Jul 2024

Search line	Search terms	Results
1	(TX (sunbed OR sunbeds OR "sun-bed" OR "sun-beds" OR "sun bed" OR "sun beds"))	132
2	(TX (sunlamp* OR sun-lamp* OR “sun lamp” OR “sun lamps”))	30
3	(TX (Solarium* OR Solaria))	37
4	(TX (tanning OR tanned OR tanner OR tan OR tans OR suntanning OR suntanned OR suntan OR suntans OR sunburn*) N3 (bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR canopy OR canopies))	225
5	(TX (suntanning OR suntanned OR suntan OR suntans OR tanning OR tanned OR sunburn* OR sunning) N3 (device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))	99
6	(TI ("tan") N3 (device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))	0
7	(AB ("tan") N3 (device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))	3
8	(TI (tanning OR tan OR tans OR tanned OR tanner) N3 (indoor OR indoors OR home OR artificial OR cosmetic OR ultraviolet OR “ultra-violet” OR UV OR UVA OR UVB OR UVR OR "non-solar" OR nonsolar OR "high-risk" OR "stand-up" OR sunless))	277
9	(AB ((tanning OR tan OR tanned OR tanner) N3 (indoor OR indoors OR home OR artificial OR cosmetic OR ultraviolet OR “ultra-violet” OR UV OR UVA OR UVB OR UVR OR "non-solar" OR nonsolar OR "high-risk" OR "stand-up" OR sunless)))	259
10	(SU ((tanning OR tan OR tanned OR tanner) N3 (indoor OR indoors OR home OR artificial OR cosmetic OR ultraviolet OR “ultra-violet” OR UV OR UVA OR UVB OR UVR OR "non-solar" OR nonsolar OR "high-risk" OR "stand-up" OR sunless)))	0
11	(TI (Tan OR Tanning) N3 (lamp OR lamps OR tube OR tubes OR bulb OR bulbs))	1
12	(AB (Tan OR Tanning) N3 (lamp OR lamps OR tube OR tubes OR bulb OR bulbs))	10
13	(SU (Tan OR Tanning) N3 (lamp OR lamps OR tube OR tubes OR bulb OR bulbs))	0
14	(TI ("tanning unit" OR "tanning units")) OR (AB ("tanning unit" OR "tanning units")) OR (SU ("tanning unit" OR "tanning units"))	1
15	(TI (“tanning appointment” OR “tanning appointments”)) OR (AB (“tanning appointment” OR “tanning appointments”)) OR (SU (“tanning appointment” OR “tanning appointments”))	1
16	(TX (bronz*) N3 (bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR lamp OR lamps))	0

17	(TX (“lit de bronzage” OR “lits de bronzage” OR “bronzage en salle” OR Sonnenliege* OR “espreguiçadeira” OR “bronzeamento artificial” OR “salão de bronzeamento” OR “Salone d'abbronzatura” OR “Lâmpada bronzeadora“ OR “Lâmpada Solar Bronzeadora” OR “garvning inomhus” OR “innendørs soling” OR “bruinen binnenshuis” OR “sisärusketus” OR “sisällä solariumissa” OR “Parkitus sisätiloissa” OR “solariesalong” OR “Indendørs garvning” OR “abbronzatura interna” OR “solaryum” OR “solárium” OR “salon de bronzat” OR zonnebank OR “looiery salon”))	0
18	TX ("تخت آفتابی" OR "سالن برنزه" OR "لامپ برنزه کننده" OR "صالون تسمير" OR "מכון שיזוף")	0
19	TX (“曬黑沙龍” OR “日焼けサロン” OR “tiệm tắm nắng” OR “σολάριουμ”)	0
20	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19	733

EBSCO SocINDEX with Full Text

Platform: EBSCO

Database: SocINDEX

Search date: 26 Jul 2024

Search line	Search terms	Results
1	(TX (sunbed OR sunbeds OR "sun-bed" OR "sun-beds" OR "sun bed" OR "sun beds"))	12
2	(TX (sunlamp* OR sun-lamp* OR “sun lamp” OR “sun lamps”))	4
3	(TX (Solarium* OR Solaria))	4
4	(TX (tanning OR tanned OR tanner OR tan OR tans OR suntanning OR suntanned OR suntan OR suntans OR sunburn*) N3 (bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR canopy OR canopies))	35
5	(TX (suntanning OR suntanned OR suntan OR suntans OR tanning OR tanned OR sunburn* OR sunning) N3 (device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))	17
6	(TI ("tan") N3 (device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))	1
7	(AB ("tan") N3 (device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))	4
8	(TI (tanning OR tan OR tans OR tanned OR tanner) N3 (indoor OR indoors OR home OR artificial OR cosmetic OR ultraviolet OR “ultra-violet” OR UV OR UVA OR UVB OR UVR OR "non-solar" OR nonsolar OR "high-risk" OR "stand-up" OR sunless))	23
9	(AB ((tanning OR tan OR tanned OR tanner) N3 (indoor OR indoors OR home OR artificial OR cosmetic OR ultraviolet OR “ultra-violet” OR UV	43

	OR UVA OR UVB OR UVR OR "non-solar" OR nonsolar OR "high-risk" OR "stand-up" OR sunless)))	
10	(SU ((tanning OR tan OR tanned OR tanner) N3 (indoor OR indoors OR home OR artificial OR cosmetic OR ultraviolet OR “ultra-violet” OR UV OR UVA OR UVB OR UVR OR "non-solar" OR nonsolar OR "high-risk" OR "stand-up" OR sunless)))	0
11	(TI (Tan OR Tanning) N3 (lamp OR lamps OR tube OR tubes OR bulb OR bulbs))	1
12	(AB (Tan OR Tanning) N3 (lamp OR lamps OR tube OR tubes OR bulb OR bulbs))	3
13	(SU (Tan OR Tanning) N3 (lamp OR lamps OR tube OR tubes OR bulb OR bulbs))	0
14	(TI ("tanning unit" OR "tanning units")) OR (AB ("tanning unit" OR "tanning units")) OR (SU ("tanning unit" OR "tanning units"))	0
15	(TI (“tanning appointment” OR “tanning appointments”)) OR (AB (“tanning appointment” OR “tanning appointments”)) OR (SU (“tanning appointment” OR “tanning appointments”))	0
16	(TX (bronz*) N3 (bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR lamp OR lamps))	1
17	(TX (“lit de bronzage” OR “lits de bronzage” OR “bronzage en salle” OR Sonnenliege* OR “espreguiçadeira” OR “bronzeamento artificial” OR “salão de bronzeamento” OR “Salone d'abbronzatura” OR “Lâmpada bronzeadora“ OR “Lâmpada Solar Bronzeadora” OR “garvning inomhus” OR “innendørs soling” OR “bruinen binnenshuis” OR “sisärusketus” OR “sisällä solariumissa” OR “Parkitus sisätiloissa” OR “solariesalong” OR “Indendørs garvning” OR “abbronzatura interna” OR “solaryum” OR “solárium” OR “salon de bronzat” OR zonnebank OR “looiery salon”))	0
18	TX ("تخت آفتابی" OR "سالن برنزه" OR "لامپ برنزه کننده" OR "صالون تسمير" OR "מכון שיזוף")	0
19	TX (“曬黑沙龍” OR “日焼けサロン” OR “tiệm tắm nắng” OR “σολάριουμ”)	0
20	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19	83

Embase.com

Database: Embase

Platform: Ovid Embase 1974 to 2024 July 30

Search date: 31 Jul 2024

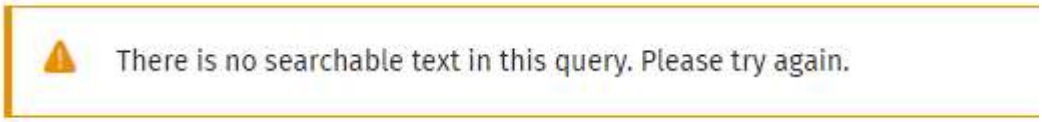
Search line	Search term	Results

1	sunbathing/ and (bed or beds or salon or salons or booth or booths or parlor or parlors or parlour or parlours or cabin or cabins or device or devices or facility or facilities or service or services).mp.	179
2	sunbathing/ and (Indoor or indoors or artificial or cosmetic or ultraviolet or UV or UVA or UVB or "non-solar" or nonsolar or home).ti,ab.	404
3	(sunbed or sunbeds or "sun-bed" or "sun-beds" or "sun bed" or "sun beds").mp.	637
4	(sunlamp* or sun-lamp* or "sun lamp" or "sun lamps").mp.	427
5	(Solarium* or Solaria).mp.	341
6	((tanning or tanned or tanner or tan or tans or suntanning or suntanned or suntan or suntans or sunburn*) adj3 (bed or beds or salon or salons or booth or booths or parlor or parlors or parlour or parlours or canopy or canopies)).mp.	781
7	((suntanning or suntanned or suntan or suntans or tanning or tanned or sunburn* or sunning) adj3 (device or devices or facility or facilities or equipment or session or sessions or service or services)).mp.	326
8	("tan" adj3 (device or devices or facility or facilities or equipment or session or sessions or service or services)).mp.	33
9	((tanning or tan or tans or tanned or tanner) adj3 (indoor or indoors or home or artificial or cosmetic or ultraviolet or "ultra-violet" or UV or UVA or UVB or UVR or "non-solar" or nonsolar or "high-risk" or "stand-up" or sunless)).mp.	1346
10	((Tan or Tanning) adj3 (lamp or lamps or tube or tubes or bulb or bulbs)).mp.	58
11	("tanning unit" or "tanning units" or "tanning appointment" or "tanning appointments").mp.	18
12	(bronz* adj3 (bed or beds or salon or salons or booth or booths or parlor or parlors or parlour or parlours or lamp or lamps)).mp.	1
13	((Bronz* adj2 (artific* or salle or casa or salon* or "salão" or lamp* or "Lâmpada" or "lámpada" or lit or lits)) or (Bronce* adj2 (artific* or salle or casa or salon* or "salão" or lamp* or "Lâmpada" or "lámpada" or lit or lits))).mp.	9
14	("espreguiçadeira" or "Salone d'abbronzatura" or "innendørs soling" or "sisärusketus" or "sisällä solariumissa" or "Parkitus sisätiloissa" or "Indendørs garvning" or "lámparas ultravioleta" or Sonnenliege* or zonnebank or "solaryum" or "solárium" or "solariesalong" or "abbronzatura interna" or "garvning inomhus" or "bruinen binnenshuis" or "looiery salon" or “tiệm tắm nắng”).mp.	4
15	or/1-15	3121

"تخت آفتابی" OR "سالن برنزه" OR "لامپ برنزه کننده" OR "صالون تسمير" OR "מכון שיזוף"

“曬黑沙龍” OR “日焼けサロン” OR “σολάριουμ”

These terms were not translated to Embase as Embase states there is no searchable text in this query



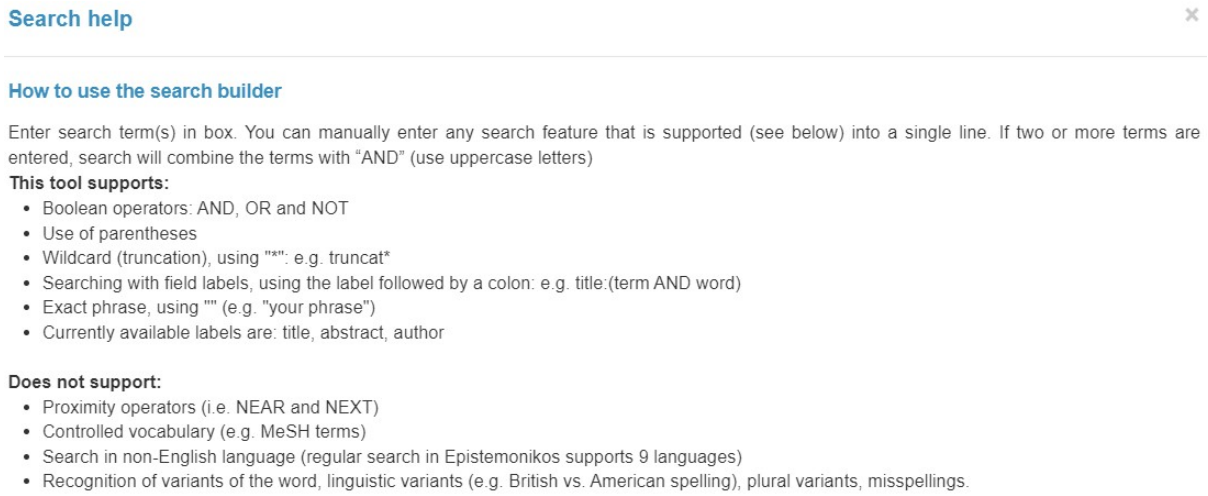
Epistemonikos

Database: Epistemonikos

Platform: https://www.epistemonikos.org/en/advanced_search

Search date 01 Aug 2024

Limit: Primary studies limit



Search line	Search terms	Results
1	(title:(Sunbed OR sunbeds OR "sun-bed" OR "sun-beds" OR "sun bed" OR "sun beds" OR "indoor tanning" OR "indoor tanners" OR "tanning indoors" OR "tanning bed" OR "tanning beds" OR "Tanning parlour" OR "Tanning parlor" OR "Tanning parlours" OR "Tanning parlors" OR "Tanning booth" OR "Tanning booths" OR "Tanning device" OR "Tanning devices" OR "Tanning session" OR "Tanning sessions" OR "tanning equipment" OR "artificial tanning" OR "cosmetic tanning" OR "non-solar tanning" OR "home tanning" OR solarium OR solaria OR "tanning canopy" OR "tanning canopies" OR "sunless tanning" OR "ultraviolet tanning" OR "UV tanning" OR "stand-up tanning" OR "tanning lamp" OR "tanning lamps" OR "suntan lamps" OR "tanning tubes" OR "tanning bulbs" OR "tanning unit" OR "tanning units" OR "tanning appointment" OR "tanning appointments" OR "bronzing beds" OR "bronzing salons") OR abstract:(Sunbed OR sunbeds OR "sun-bed" OR "sun-beds" OR "sun bed" OR "sun beds" OR "indoor tanning" OR "indoor tanners" OR "tanning indoors" OR "tanning bed" OR "tanning beds" OR "Tanning parlour" OR "Tanning parlor" OR "Tanning parlours" OR "Tanning parlors" OR "Tanning booth" OR "Tanning	Primary study filter: 280

	booths" OR "Tanning device" OR "Tanning devices" OR "Tanning session" OR "Tanning sessions" OR "tanning equipment" OR "artificial tanning" OR "cosmetic tanning" OR "non-solar tanning" OR "home tanning" OR solarium OR solaria OR "tanning canopy" OR "tanning canopies" OR "sunless tanning" OR "ultraviolet tanning" OR "UV tanning" OR "stand-up tanning" OR "tanning lamp" OR "tanning lamps" OR "suntan lamps" OR "tanning tubes" OR "tanning bulbs" OR "tanning unit" OR "tanning units" OR "tanning appointment" OR "tanning appointments" OR "bronzing beds" OR "bronzing salons"))

EPPI Trials Register of Promoting Health Interventions (TRoPHI)

Database: EPPI Trials Register of Promoting Health Interventions (TRoPHI)

Platform: https://eppi.ioe.ac.uk/webdatabases4/SearchIntro.aspx

Search date: 29 Jul 2024

Search line	Search terms	Results
1	Freetext (All but Authors): tanning	38
2	Freetext (All but Authors): ultraviolet	41
3	Freetext (All but Authors): sunbathing	14
4	Freetext (All but Authors): sunbeds	1
5	Freetext (All but Authors): "sun-bed"	3
6	Freetext (All but Authors): sunbed	1
7	Freetext (All but Authors): suntan	3
8	Freetext (All but Authors): "sun bed"	0
9	Freetext (All but Authors): sunlamp	0
10	Freetext (All but Authors): solarium	0
11	Freetext (All but Authors): sunless	3
12	Freetext (All but Authors): sunning	1
13	Freetext (All but Authors): suntan	3
14	Freetext (All but Authors): suntanning	1
15	Freetext (All but Authors): tanned	7
16	Freetext (All but Authors): "tanning device"	1
17	Freetext (All but Authors): "home tan"	0
18	Freetext (All but Authors): “tanner”	5
19	Freetext (All but Authors): "tan equipment" 0	0
20	Freetext (All but Authors): bronzing 0	0
	Total	119

Informit

Platform: Informit

Databases: https://search.informit.org/search/advanced

Informit is a search platform which Includes 8 databases

Australian Public Affairs Full Text (APAFT) Coverage: Index: 1963-onwards ; Full text: 1977-onwards
Business Collection Coverage: Index: 1963-onwards ; Full Text: 1977-onwards
Engineering Collection Coverage: Index: 1961-onwards ; Full Text: 1973-onwards
Families & Society Collection Coverage: Index & Full Text: 1961-onwards
Health Collection Coverage: Index & Full Text: 1967-onwards
Humanities & Social Sciences Collection Coverage: Index: 1901-onwards ; Full Text: 1952-onwards
Indigenous Collection Coverage: Index: 1970-onwards ; Full Text: 1973-onwards
Literature & Culture Collection Coverage: Index & Full Text: 1939-onwards

Search date: 29 Jul 2024

Search line	Search terms	Results
1	All Fields:sunbed OR All Fields:sunbeds OR All Fields:"sun-bed" OR All Fields:"sun-beds" OR All Fields:"sun bed" OR All Fields:"sun beds"	3
2	All Fields:sunlamp* OR All Fields:sun-lamp* OR All Fields:“sun lamp” OR All Fields:“sun lamps”	2
3	All Fields:Solarium* OR All Fields:Solaria	15
4	Abstract:tanning AND [Abstract:bed OR Abstract:beds OR Abstract:salon OR Abstract:salons OR Abstract:booth OR Abstract:booths OR Abstract:parlor OR Abstract:parlors OR Abstract:parlour OR Abstract:parlours OR Abstract:canopy OR Abstract:canopies]	38
5	Abstract:tanning AND [Abstract:device OR Abstract:devices OR Abstract:facility OR Abstract:facilities OR Abstract:equipment OR Abstract:session OR Abstract:sessions OR Abstract:service OR Abstract:services]	41
6	Abstract:tanning AND [Abstract:indoor OR Abstract:indoors OR Abstract:home OR Abstract:artificial OR Abstract:cosmetic OR Abstract:ultraviolet OR Abstract:“ultra-violet” OR Abstract:UV OR Abstract:UVA OR Abstract:UVB OR Abstract:UVR OR Abstract:"non-solar" OR Abstract:nonsolar OR Abstract:"high-risk" OR Abstract:"stand-up" OR Abstract:sunless]	50
7	[All: "tanning unit"] OR [All: "tanning units"] OR [All: "tanning appointment"] OR [All: "tanning appointments"]	0
8	[Abstract:tanning OR Abstract:suntan OR Abstract:sunbathing OR Abstract:suntanning OR Abstract:suntanned OR Abstract:tanned] AND [Abstract:indoor OR Abstract:indoors OR Abstract:artificial OR Abstract:cosmetic OR Abstract:ultraviolet OR Abstract:UV OR Abstract:UVA OR Abstract:UVB OR Abstract:"non-solar" OR Abstract:nonsolar OR Abstract:home]	48
	Total	197

Scientific Electronic Library Online (SciELO)

Database: Scielo Scientific Library Online

Platform: https://www.scielo.org/

Search Date 29 Jul 2024

Search line	Search terms	Results
1	(ab:(bronzeamento artificial))	2
2	(ti:(“bronzeamento artificial”))	0
3	(ti:(salão de bronzeamento))	0
4	(ab:(salão de bronzeamento))	0
5	(ab:(las lámparas ultravioleta))	7
6	(ti:(las lámparas ultravioleta))	0
7	(ti:(solarium))	3
8	(ab:(solarium))	12
9	(ti:(solaria))	1
10	(ab:(solaria))	4
11	(ab:(bronzage))	0
12	(ti:(bronzage))	0
13	(ti:(bronzeamento))	3
14	(ab:(bronzeamento))	18
15	(ab:(sunbed OR sunbeds OR "sun-bed" OR "sun-beds" OR "sun bed" OR "sun beds"))	1
16	(ti:(sunbed OR sunbeds OR "sun-bed" OR "sun-beds" OR "sun bed" OR "sun beds"))	0
17	(ti:(sunlamp* OR sun-lamp* OR “sun lamp” OR “sun lamps”))	0
18	((ab:(sunlamp* OR sun-lamp* OR “sun lamp” OR “sun lamps”))) AND ((ab:(tanning OR tanned OR tanner OR suntanning OR suntanned OR suntan OR suntans OR sunburn))	0
19	((ab:(tanning OR tanned OR tanner OR suntanning OR suntanned OR suntan OR suntans OR sunburn))) AND ((ab:(bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR canopy OR canopies)))	10
20	((ti:(tanning OR tanned OR tanner OR suntanning OR suntanned OR suntan OR suntans OR sunburn))) AND ((ti:(bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR canopy OR canopies)))	0
21	(ti:(indoor tanning)) OR (ab:(indoor tanning))	1
22	(ti:(cama de bronceado)) OR (ab:(cama de bronceado))	0
23	(ti:(artificial tanning)) OR (ab:(artificial tanning))	7
24	(ti:(lámparas uv)) OR (ab:(lámparas uv)) Selected filter: Scielo Health Sciences	3
25	(ti:(bronceado en casa)) OR (ab:(bronceado en casa))	0
26	(ab:(sunless)) AND (ab:(tanning))	0
27	(ab:(bronce*)) AND (ab:(lamp*))	2
28	(ab:(bronceado)) AND (ab:(salón))	0
29	(ab:(bronz*)) AND (ab:(caseiro))	0
30	(ab:(banhos de sol)) AND (ab:(salão))	0
	Total	74

Scientific Information Database (Iran)

Database: Scientific Information Database (Iran)

Platform: https://www.sid.ir/journal/en Academic Center for Education Culture and Research, ACECR, Tehran

Search date: 31 Jul 2024

Note: complex searching not possible, phrase searching or adjacency not possible single terms only. E.g. “sun bed” defaults or sun or bed and returned any thousands of citations only using the term ‘sun’.

No export option.

Search line	Search terms	Results
1	sunbed	o
2	sunlamp	0
3	Solarium	1
4	Suntanning	0
	سولاریوم [solarium]	1
	تخت آفتاب	2388 [unexportable and from examination mainly irrelevant – returns many terms relating to sun, bed etc]

VHL Regional Portal, including Latin America and the Caribbean Literature on Health Sciences (LILACS)

Platform: VHL Regional Portal (URL: https://pesquisa.bvsalud.org/portal/advanced/?lang=en), Biblioteca Regional de Medicina (BIREME) and the Pan-American Health Organization (PAHO)

Databases: Literatura Latino Americana e do Caribe em Ciencias da Saude: LILACS; MEDLINE; WHO IRIS; BINACIS; IBECS; LIS-Health Information Locator; WPRIM (Western Pacific); BRISA/RedTESA; LIPECS; VETINDEX.

Search date: 2 Aug 2024

1	Title/abstract/subject: Sunbed OR sunbeds OR "sun-bed" OR "sun-beds" OR "sun bed" OR "sun beds" OR "indoor tanning" OR "indoor tanners" OR "tanning indoors" OR "tanning	1,669 (of which: MEDLINE: 1683 LILACS: 15 WHO IRIS: 5 BINACIS: 4 IBECS: 3

	bed" OR "tanning beds" OR "Tanning parlour" OR "Tanning parlor" OR "Tanning parlours" OR "Tanning parlors" OR "Tanning booth" OR "Tanning booths" OR "Tanning device" OR "Tanning devices" OR "Tanning session" OR "Tanning sessions" OR "tanning equipment" OR "artificial tanning" OR "cosmetic tanning" OR "non-solar tanning" OR "home tanning" OR solarium OR solaria OR "tanning canopy" OR "tanning canopies" OR "sunless tanning" OR "ultraviolet tanning" OR "UV tanning" OR "stand-up tanning" OR "tanning lamp" OR "tanning lamps" OR "suntan lamps" OR "tanning tubes" OR "tanning bulbs" OR "tanning unit" OR "tanning units" OR "tanning appointment" OR "tanning appointments" OR "bronzing beds" OR "bronzing salons"	LIS-Health Information Locator: 2 WPRIM: (Western Pacific): 2 BRISA/RedTESA: 1 LIPECS: 1 VETINDEX: 1)

Wiley Cochrane Library (including Cochrane Database of Systematic Reviews (CDSR) and CENTRAL databases)

Databases: Cochrane Database of Systematic Reviews (CDSR) and Cochrane Central Register of Controlled Trials (CENTRAL)

Platform: John Wiley & Sons Ltd Cochrane Library https://www.cochranelibrary.com/

Search date: 29 July 2024

Search line	Search terms	Results
#1	MeSH descriptor: [Sunbathing] explode all trees	60
#2	(bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR cabin OR cabins OR device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services OR indoor OR indoors OR artificial OR cosmetic OR ultraviolet OR UV OR UVA OR UVB OR "non-solar" OR nonsolar OR home):ti,ab,kw	355,971
#3	#1 AND #2	46
#4	(sunbed OR sunbeds OR "sun-bed" OR "sun-beds" OR "sun bed" OR "sun beds")	49
#5	(sunlamp* OR sun-lamp* OR “sun lamp” OR “sun lamps”)	21
#6	(Solarium* OR Solaria)	31

#7	((suntanning OR suntanned OR suntan OR suntans OR sunburn*) NEAR (bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR canopy OR canopies))	1
#8	((tanning OR tanned OR tanner OR tan OR tans) NEAR (bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR canopy OR canopies)):ti,ab,kw	48
#9	((suntanning OR suntanned OR suntan OR suntans OR tanning OR tanned OR sunburn* OR sunning) NEAR (device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))	41
#10	(((tan) NEAR (device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))):ti,ab,kw	19
#11	((tanning OR tan OR tans OR tanned OR tanner) NEAR (sunless OR nonsolar OR "non-solar" OR artificial OR cosmetic)):ti,ab,kw	13
#12	((tanning OR tan OR tans OR tanned OR tanner) NEAR (“high-risk” OR “stand-up” OR indoor OR indoors OR home)):ti,ab,kw	57
#13	((tanning OR tan OR tans OR tanned OR tanner) NEAR (ultraviolet OR UV OR UVA OR UVB OR UVR OR "ultra-violet")):ti,ab,kw	58
#14	((Tan OR Tanning) NEAR (lamp OR lamps OR tube OR tubes OR bulb OR bulbs))	4
#15	(("tanning unit" OR "tanning units"))	2
#16	(tanning appointment OR tanning appointments)	2
#17	(((bronz*) NEAR (bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR lamp OR lamps)))	0
#18	((“lit de bronzage” OR “lits de bronzage” OR “bronzage en salle” OR Sonnenliege* OR “espreguiçadeira” OR “bronzeamento artificial” OR “salão de bronzeamento” OR “Salone d'abbronzatura” OR “Lâmpada bronzeadora“ OR “Lâmpada Solar Bronzeadora” OR “garvning inomhus” OR “innendørs soling” OR “bruinen binnenshuis” OR “sisärusketus” OR “sisällä solariumissa” OR “Parkitus sisätiloissa” OR “solariesalong” OR “Indendørs garvning” OR “abbronzatura interna” OR “solaryum” OR “solárium” OR “salon de bronzat” OR zonnebank OR “looiery salon”)):ti,ab,kw	24
#19	(("تخت آفتابی" OR "سالن برنزه" OR "لامپ برنزه کننده" OR "صالون تسمير" OR "מכון שיזוף"))	0
#20	((“曬黑沙龍” OR “日焼けサロン” OR “tiệm tắm nắng” OR “σολάριουμ”))	0
#21	#3 OR #4 OR #5 OR #6 OR #7 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20	268
	Totals Cochrane review	12
	Totals: Trials	255
	Totals: Protocols	1

Primary searches: search engines

DuckDuckGo.com

Search resource: DuckDuckGo

Platform: https://duckduckgo.com/

Search date: 01 Aug 2024

Results: filetype:pdf (to remove webpages such as news items, etc.

Search line	Search terms	examined	extracted
1	sunbed education filetype:pdf	First 100	9
2	sunbed ban filetype:pdf	First 100	13
3	sunbed restriction filetype:pdf	First 100	1
4	sunbed operators filetype:pdf	First 100	12
5	"indoor tanning" education filetype:pdf	First 100	38
6	“Indoor tanning” ban filetype:pdf	First 100	23
7	“Indoor tanning” restriction filetype:pdf	First 100	17
8	Indoor tanning operators	First 100	0

Google Scholar

Search resource: Google Scholar

Platform: Harzing’s Publish or Perish

Search date 01 Aug 2024

Search line	Search terms	Results
1	Sunbed restriction	First 100
2	indoor tanning restriction	First 100
3	indoor tanning education	First 100
4	Sunbed education	First 100
5	Sunbed ban	First 100
6	indoor tanning ban	First 100
7	sunbed operators	First 100
8	Indoor tanning operators	First 100

Google.com

Search resource: Google

Platform: www.google.com

Search date: 01 Aug 2024

The first 200 results (or total number if lower than 200) for each search set were examined by the information specialist and results relevant to the review (research relating to sunbeds) were extracted to Zotero. General webpages, commentary, FAQ, legislation without analysis etc were not extracted

		examined	extracted
1	Sunbed restriction filetype:pdf	200	81
2	Sunbed ban filetype:pdf	186	66

3	Sunbed education filetype:pdf	185	91
4	ban OR restriction OR education "indoor tanning" filetype:pdf	185	70
	Total		306

Primary searches: preprint resources

Research Square

Search resource: Research square (preprints server)

Platform: https://www.researchsquare.com/ via www.google.ie

Search date: 2 Aug 2024

Limited search interface, no phrase searching (e.g. “indoor tanning” captures all articles containing indoor and all containing tanning); no export option.

Because of this, the site was searched via Google

1	site:www.researchsquare.com "indoor tanning"	15
2	site:www.researchsquare.com "tanning salon"	2
3	site:www.researchsquare.com "tanning booth"	0
4	site:www.researchsquare.com "tanning booths"	2
5	site:www.researchsquare.com "sunbed"	7
6	site:www.researchsquare.com "sunbeds"	5
7	site:www.researchsquare.com "tanning beds"	13
8	site:www.researchsquare.com "artificial tanning"	1
9	site:www.researchsquare.com "solarium"	15
10	site:www.researchsquare.com "non-solar tanning"	0
11	site:www.researchsquare.com "nonsolar tanning"	0
12	site:www.researchsquare.com "tanning unit"	0
13	site:www.researchsquare.com "tanning device"	1
14	site:www.researchsquare.com "sun-bed"	0
15	site:www.researchsquare.com "tanning facilities"	3
	Total	66

medRxiv/bioRxiv

Search resource: medRxiv/bioRxiv

Platform: https://www.medrxiv.org/search using the combined medRxiv/bioRxiv search interface

Search date: 2 Aug 2024

Search line	Search term	Results
1	Title and abstract search: Sunbed	0

2	Title and abstract search: Sun bed (match phrase words)	0
3	Title and abstract search: tanning	25
4	Title and abstract search: Solarium	3
5	"sun-bed" (match all words)	0
6	sunlamp	0
7	tanned	1
	Total	29

Primary searches: clinical trial search resources

Clinicaltrials.gov

Database: ClinicalTrials.gov

Platform: https://clinicaltrials.gov/

Search date: 2 Aug 2024

1	Sunbed	6
2	Indoor tanning	28
3	“Sun-bed”	2
4	"Tanning salon"	0
5	"Tanning booth"	2
6	Solarium	2
7	"Artificial tanning"	1
8	“Tanning facility”	0
9	“Tanning facilities”	0
10	Tanning education	83
	Total	124

II Supplemental searches

Supplemental searches: citation searching

Resources	Results
Forward citation searching	1,874
Backward citation searching	1,595
Follow-up of protocols identified in screening of primary search results	75
WHO 2017 report: references	107
WHO 2017 report: citations (as per Google Scholar citation facility)	46

Supplemental searches: databases

Updated EBSCO MEDLINE search

Search resource: MEDLINE

Search platform: EBSCO

Search date: 25 Nov 2024

Limit: Update of original search limited to 2023-2024 only

Search line	Search terms	Results
S1	(MH “Sunbathing”) AND (TX (bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR cabin OR cabins OR device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))	351
S2	(MH "Sunbathing") AND (TI (Indoor OR indoors OR artificial OR cosmetic OR ultraviolet OR UV OR UVA OR UVB OR "non-solar" OR nonsolar OR home))	352
S3	(MH “Sunbathing”) AND (AB (indoor OR indoors OR artificial OR cosmetic OR ultraviolet OR UV OR UVA OR UVB OR "non-solar" OR nonsolar OR home))	498
S4	(TX (sunbed OR sunbeds OR "sun-bed" OR "sun-beds" OR "sun bed" OR "sun beds"))	549
S5	(TX (sunlamp* OR sun-lamp* OR “sun lamp” OR “sun lamps”))	380
S6	(TX (Solarium* OR Solaria))	358
S7	(TX (tanning OR tanned OR tanner OR tan OR tans OR suntanning OR suntanned OR suntan OR suntans OR sunburn*) N3 (bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR canopy OR canopies))	641
S8	(TX (suntanning OR suntanned OR suntan OR suntans OR tanning OR tanned OR sunburn* OR sunning) N3 (device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))	298
S9	(TI ("tan") N3 (device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))	4
S10	(AB ("tan") N3 (device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))	20
S11	(TI (tanning OR tan OR tans OR tanned OR tanner) N3 (indoor OR indoors OR home OR artificial OR cosmetic OR ultraviolet OR “ultra-violet” OR UV OR UVA OR UVB OR UVR OR "non-solar" OR nonsolar OR "high-risk" OR "stand-up" OR sunless))	533
S12	(AB ((tanning OR tan OR tanned OR tanner) N3 (indoor OR indoors OR home OR artificial OR cosmetic OR ultraviolet OR “ultra-violet” OR UV OR UVA OR UVB OR UVR OR "non-solar" OR nonsolar OR "high-risk" OR "stand-up" OR sunless)))	911
S13	(SU ((tanning OR tan OR tanned OR tanner) N3 (indoor OR indoors OR home OR artificial OR cosmetic OR ultraviolet OR “ultra-violet” OR UV OR UVA OR UVB OR UVR OR "non-solar" OR nonsolar OR "high-risk" OR "stand-up" OR sunless)))	131
S14	(TI (Tan OR Tanning) N3 (lamp OR lamps OR tube OR tubes OR bulb OR bulbs))	15

S15	(AB (Tan OR Tanning) N3 (lamp OR lamps OR tube OR tubes OR bulb OR bulbs))	53
S16	(SU (Tan OR Tanning) N3 (lamp OR lamps OR tube OR tubes OR bulb OR bulbs))	1
S17	(TI ("tanning unit" OR "tanning units")) OR (AB ("tanning unit" OR "tanning units")) OR (SU ("tanning unit" OR "tanning units"))	15
S18	(TI (“tanning appointment” OR “tanning appointments”)) OR (AB (“tanning appointment” OR “tanning appointments”)) OR (SU (“tanning appointment” OR “tanning appointments”))	1
S19	(TX (bronz*) N3 (bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR lamp OR lamps))	5
S20	(TX ("lit de bronzage" OR "lits de bronzage" OR "bronzage en salle" OR Sonnenliege* OR "espreguiçadeira" OR "bronzeamento artificial" OR "salão de bronzeamento" OR "Salone d'abbronzatura" OR "Lâmpada bronzeadora" OR "Lâmpada Solar Bronzeadora" OR "garvning inomhus" OR "innendørs soling" OR "bruinen binnenshuis" OR "sisärusketus" OR "sisällä solariumissa" OR “Parkitus sisätiloissa" OR "solariesalong" OR "Indendørs garvning" OR "abbronzatura interna" OR "solaryum" OR "solárium" OR "salon de bronzat" OR zonnebank OR "looiery salon"))	2
S21	TX (“曬黑沙龍” OR “日焼けサロン” OR “tiệm tắm nắng” OR “σολάριουμ”)	0
S22	TX ("تخت آفتابی" OR "سالن برنزه" OR "لامپ برنزه کننده" OR "صالون تسمير" OR "מכון שיזוף")	0
S23	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22	2,688
S24	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 Limiters - Publication Date: 20230101-20241231	200

Updated Cochrane CDSR/CENTRAL search

Database: Cochrane Database of Systematic Reviews and Cochrane Central Register of Controlled Trials (CENTRAL)

Platform: John Wiley & Sons Ltd Cochrane Library https://www.cochranelibrary.com/

Search date: 25 Nov 2024

Limit: Search limited to items with Cochrane publication date “In the last 2 years” using on the final line of the search.

Search line	Search terms	Results
#1	MeSH descriptor: [Sunbathing] explode all trees	60
#2	(bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR cabin OR cabins OR device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service	366238

	OR services OR indoor OR indoors OR artificial OR cosmetic OR ultraviolet OR UV OR UVA OR UVB OR "non-solar" OR nonsolar OR home):ti,ab,kw	
#3	#1 AND #2	46
#4	(sunbed OR sunbeds OR "sun-bed" OR "sun-beds" OR "sun bed" OR "sun beds")	49
#5	(sunlamp* OR sun-lamp* OR “sun lamp” OR “sun lamps”)	21
#6	(Solarium* OR Solaria)	31
#7	((suntanning OR suntanned OR suntan OR suntans OR sunburn*) NEAR (bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR canopy OR canopies))	1
#8	((tanning OR tanned OR tanner OR tan OR tans) NEAR (bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR canopy OR canopies)):ti,ab,kw	51
#9	((suntanning OR suntanned OR suntan OR suntans OR tanning OR tanned OR sunburn* OR sunning) NEAR (device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))	41
#10	(((tan) NEAR (device OR devices OR facility OR facilities OR equipment OR session OR sessions OR service OR services))):ti,ab,kw	20
#11	((tanning OR tan OR tans OR tanned OR tanner) NEAR (sunless OR nonsolar OR "non-solar" OR artificial OR cosmetic)):ti,ab,kw	13
#12	((tanning OR tan OR tans OR tanned OR tanner) NEAR (“high-risk” OR “stand-up” OR indoor OR indoors OR home)):ti,ab,kw	59
#13	((tanning OR tan OR tans OR tanned OR tanner) NEAR (ultraviolet OR UV OR UVA OR UVB OR UVR OR "ultra-violet")):ti,ab,kw	58
#14	((Tan OR Tanning) NEAR (lamp OR lamps OR tube OR tubes OR bulb OR bulbs))	4
#15	(("tanning unit" OR "tanning units"))	2
#16	(tanning appointment OR tanning appointments)	2
#17	(((bronz*) NEAR (bed OR beds OR salon OR salons OR booth OR booths OR parlor OR parlors OR parlour OR parlours OR lamp OR lamps))) 0	0
#18	((“lit de bronzage” OR “lits de bronzage” OR “bronzage en salle” OR Sonnenliege* OR “espreguiçadeira” OR “bronzeamento artificial” OR “salão de bronzeamento” OR “Salone d'abbronzatura” OR “Lâmpada bronzeadora“ OR “Lâmpada Solar Bronzeadora” OR “garvning inomhus” OR “innendørs soling” OR “bruinen binnenshuis” OR “sisärusketus” OR “sisällä solariumissa” OR “Parkitus sisätiloissa” OR “solariesalong” OR “Indendørs garvning” OR “abbronzatura interna” OR “solaryum” OR “solárium” OR “salon de bronzat” OR zonnebank OR “looiery salon”)):ti,ab,kw	24
#19	(("تخت آفتابی" OR "سالن برنزه" OR "لامپ برنزه کننده" OR "صالون تسمير" OR "מכון שיזוף")) 0	0
#20	(“曬黑沙龍” OR “日焼けサロン” OR “tiệm tắm nắng” OR “σολάριουμ”)) 0	0
#21	#3 OR #4 OR #5 OR #6 OR #7 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20	272
#22	#21 with Cochrane Library publication date: In the last 2 years	26 trials

Supplemental searches: search engines and grey literature

BASE (Bielefeld Academic Search Engine)

Search resource: BASE (Bielefeld Academic Search Engine)

Provider: Bielefeld University Library, Germany

Search platform: https://www.base-search.net/Search/Advanced

Search date: 18 Nov 2024

Search number	Search terms	Results
1	All fields: Sunbed ban (including additional word forms)	66
2	All fields: sunbed education (including additional word forms)	130
3	All fields: sunbed legislation (including additional word forms)	69
4	All fields: sunbed intervention (including additional word forms)	79
5	All fields: indoor tanning intervention (including additional word forms)	301
6	All fields: indoor tanning ban (including additional word forms)	121
7	All fields: indoor tanning education (including additional word forms)	276
8	All fields: indoor tanning legislation (including additional word forms)	160
9	All fields: tanning booth legislation (including additional word forms)	12
10	All fields: tanning booth intervention (including additional word forms)	113
11	All fields: tanning booth ban (including additional word forms)	253
12	All fields: tanning booth education (including additional word forms)	121
	Total	1701

DuckDuckGo

Search resource:

Search platform: https://duckduckgo.com/

Search date: 21 Nov 2024

Search limits: All regions; Safe search: moderate; Date: any time

The first 200 results (or total number if lower than 200) for each search set were examined by IS and results relevant to the review (research relating to sunbeds) were extracted to Zotero. General webpages, commentary, FAQ, legislation without analysis etc were not extracted

Search number	Search terms	Results
1	Sunbed ban	29
2	Sunbed education	69
3	Sunbed restriction	56
4	Sunbed legislation	92

5	Sunbed intervention	48
6	“indoor tanning” ban	134
7	“indoor tanning” education	95
8	“indoor tanning” restriction	32
9	“indoor tanning” legislation	42
10	"indoor tanning" intervention	97
	Total	694

Google Scholar

Search resource: Google Scholar

Search platform: Harzing’s Publish or Perish software

Search date: 25 Nov 2024

Search limit: 2023-2024

Search number	Search terms	Results
1	Sunbed restriction	100
2	Sunbed education	100
3	Sunbed ban	88
4	Sunbed legislation	98
5	Sunbed intervention	100
6	Indoor tanning restriction	100
7	indoor tanning education	100
8	indoor tanning ban	100
9	Indoor tanning legislation	100
10	Indoor tanning intervention	100
	Total	986

OpenGrey

Note: OpenGrey ceased collection in 2020 but the archive up to 2020 is available to search via the Data Archiving and Networked Services (DANS) EASY archive. The EASY Archive will be unavailable from 2 Dec 2024. https://easy.dans.knaw.nl/easy-static/index.html

Search resource: OpenGrey

Search platform: DANS Easy Archive https://easy.dans.knaw.nl/

Search date: 18 Nov 2024

1	Sunbed	0
2	“Indoor tanning”	7
3	“tanning booth”	0
4	“tanning salon”	1
5	Solarium	0

6	"tanning facility"	0
7	"tanning facilities"	0
8	Tanning education	1
9	"sun-bed"	0
10	"artificial tanning"	0
11	Solaria	0
12	tanning bed	0
	total	9

Relevant websites: non-exhaustive search

Terminology: indoor tanning, sunbeds, tanning bed plus broad non-English language equivalent terms where relevant

Websites searched and results assessed by information specialist, potential results matching the review PICO and relating to interventions to reduce sunbed use noted below. Any research previously identified was not added in again here.

Countries fully banning sunbeds: Australia, Brazil, Iran

Organisation	URL	Search terms	Potentially relevant results
World Health Organization	https://www.who.int/	Sunbed; indoor tanning; tanning bed	0
International Agency for Research on Cancer (IARC)	https://www.iarc.who.int/	Sunbed; indoor tanning; tanning bed	0
United Nations	https://www.un.org/	Sunbed; indoor tanning; tanning bed	0
Centers for Disease Control and Prevention (CDC)	https://www.cdc.gov/	Sunbed; indoor tanning; tanning bed	0
Agency for Healthcare Research and Quality (AHRQ)	https://www.ahrq.gov/	Sunbed; indoor tanning; tanning bed	0
International Cancer Foundation	https://internationalcancerfoundation.org/	Sunbed; indoor tanning; tanning bed	0
European Cancer Organisation	https://www.europeancancer.org/	Sunbed; indoor tanning; tanning bed	0

European Commission. Public Health	https://health.ec.europa.eu/index_en	Sunbed; indoor tanning; tanning bed	0
World Cancer Research Fund	https://www.wcrf.org/	Sunbed; indoor tanning; tanning bed	0
Skin Cancer Foundation	https://www.skincancer.org/	Sunbed; indoor tanning; tanning bed	0
AIM at Melanoma	https://www.aimatmelanoma.org/	Sunbed; indoor tanning; tanning bed	0
Iran Ministry of Health and Medical Education	https://irangov.ir/ministry-of-health-and-medical-education	Sunbed; indoor tanning; tanning bed برنزه کردن داخل ساختمان تخت آفتاب تخت برنزه کننده	0
Iran National Institute of Health Research	https://nihr.tums.ac.ir/	Sunbed; indoor tanning; tanning bed برنزه کردن داخل ساختمان تخت آفتاب تخت برنزه کننده	0
Iranian Journal of Public Health	https://ijph.tums.ac.ir/index.php/ijph	Sunbed Indoor tanning Tanning bed برنزه کردن داخل ساختمان تخت آفتاب تخت برنزه کننده	0
Australian Institute of Health and Welfare, Australian Government	https://www.aihw.gov.au	Sunbed Indoor tanning Tanning bed	0
Commonwealth Scientific and	https://www.csiro.au/	Sunbed Indoor tanning	0

Industrial Research Organisation (CSIRO)		Tanning bed	
Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)	https://www.arpansa.gov.au/	Sunbed Indoor tanning Tanning bed	0
Cancer Council	https://www.cancer.org.au/	Sunbed Indoor tanning Tanning bed	0
Ministério da Saúde Brazil	https://www.gov.br/saude/en	Sunbed Indoor tanning Tanning bed Espreguiçadeira Bronzeamento artificial cama de bronzeamento	0
Agência Nacional de Vigilância Sanitária (ANVISA)	https://antigo.anvisa.gov.br/en/english	Sunbed Indoor tanning Tanning bed Espreguiçadeira Bronzeamento artificial cama de bronzeamento	0
Sociedade Brasileira de Clínica Médica (SBCM)	https://www.sbcm.org.br/v2/	Sunbed Indoor tanning Tanning bed Espreguiçadeira Bronzeamento artificial cama de bronzeamento	0

Appendix C Studies excluded at full text

I Papers excluded at the full-text screening stage from the primary search results

- Papers excluded on population screening code (n=16)
- Papers excluded on intervention (n=24)
- Papers excluded on comparator (n=25)
- Papers excluded on outcomes (n=23)
- Papers excluded on study design (n=27)
- Papers excluded as modelling studies (n=5)
- Papers excluded on relevant conference abstract (n=19)
- Papers excluded on potentially relevant systematic review (n=2)

	Papers excluded on population screening code (n=16)
1	Böttcher S, Buck C, Zeeb H, et al. Randomised controlled trial to evaluate the influence of mHealth and eHealth skin cancer prevention education among young organ transplant recipients: the HIPPOlino intervention study. BMJ Open 2019;9:e028842. https://doi.org/10.1136/bmjopen-2018-028842
2	Brinker TJ, Faria BL, de Faria OM, et al. Effect of a face-aging mobile app-based intervention on skin cancer protection behavior in secondary schools in Brazil: a cluster-randomized clinical trial. JAMA Dermatol 2020;156:737–45. https://doi.org/10.1001/jamadermatol.2020.0511
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3.	Blashill A. Strategies to promote skin health. San Diego: San Diego State University 2017. https://clinicaltrials.gov/study/NCT03237013 (accessed 13 Dec 2024).
4.	Brinker TJ. Facial-aging apps in waiting rooms: A new opportunity for melanoma prevention? Pigment Cell Melanoma Res 2019;32:103. https://doi.org10.1111/pcmr.12738
5.	Brinker TJ. Photoaging mobile apps in school-based melanoma prevention: Preliminary results from Germany and Brazil and perspectives for large scale implementation. Pigment Cell Melanoma Res 2019;32:103. https://doi.org/10.1111/pcmr.12738
6.	Chen A, Morrison L, Torres JS, et al. Social media advertising as a potential tool for melanoma prevention. J Am Acad Dermatol 2019;81:AB125. https://doi.org/10.1016/j.jaad.2019.06.472
7.	Coups EJ, Stapleton JL, Delnevo CD. Indoor tanning among New Jersey high school students before and after the enactment of youth access restrictions. J Am Acad Dermatol 2016;75:440–2. https://doi.org/10.1016/j.jaad.2016.03.040
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10.	Greene A, Ho A, Zhang N, et al. Whiteboard-based video education for melanoma within the Hispanic population. J Invest Dermatol 2024;144:S87. https://doi.org/10.1016/j.jid.2024.06.516
11.	Haiducu ML, McLean D. SkinSafe: An evaluation of the long-term impact of a province-wide sun safety and skin cancer high school education campaign. J Am Acad Dermatol 2013;68:AB92. https://doi.org/10.1016/j.jaad.2012.12.384
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14.	Lee SI, Macherianakis A, Roberts Lauren. Are children younger than 18 years still using sunbeds after the ban? A survey of school children aged 15–17 years in Sandwell, UK. Lancet (London, England) 2012;380:S57. https://doi.org/10.1016/S0140-6736(13)60413-4
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	Kingdom. J Prim Care Community Health 2013;4:265–74. https://doi.org/10.1177/2150131913482142
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17.	Murphrey M, Connolly S. Indoor tanning in sorority members: Attitudes and interventions. J Am Acad Dermatol 2018;79:AB167. https://doi.org/10.1016/j.jaad.2010.09.347
18.	Ng A, Chang AL, Peng D. Getting the word out: A fast intervention to educate nonmedical skin care professionals at salons and spas in southern California about tanning bed usage and skin cancer. J Am Acad Dermatol 2011;64:AB78. https://doi.org/10.1016/j.jaad.2010.09.347
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1.	Reimann J. Indoor tanning and youth - compliance, inspection, and enforcement of legislation. Dissertation. Guelph, Ontario: University of Guelph 2019. https://atrium.lib.uoguelph.ca/items/2bfd267e-6a42-4cd4-b697-31b6df4b8e35 (accessed 13 Dec 2024).
2.	Heckman CJ, Manne SL, editors. Shedding light on indoor tanning. Springer Dordrecht 2011. https://doi.org/10.1007/978-94-007-2048-0

II Papers excluded at the full-text screening stage from the supplemental search results

- Papers excluded on population (n=2)
- Papers excluded on intervention (n=1)
- Papers excluded on comparator (n=7)
- Papers excluded on outcomes (n=4)
- Papers excluded on study design (n=7)
- Papers excluded as modelling study (n=1)

	Papers excluded on population (n=2)
1	Asdigian NL, Whitesell NR, Bull S, et al. Design and effectiveness of the youth engaged strategies for changing adolescent norms! (YES-CAN!) program for reducing skin cancer risk. J Cancer Educ 2023;38:333–43. https://doi.org/10.1007/s13187-021-02121-z
2	Hubbard G, Cherrie J, Gray J, et al. Sun protection education for adolescents: a feasibility study of a wait-list controlled trial of an intervention involving a presentation, action planning, and SMS messages and using objective measurement of sun exposure. BMC Public Health 2020;20:131. https://doi.org/10.1186/s12889-020-8265-0

	Papers excluded on intervention (n=1)

1	Collins LG, Minto C, Ledger M, et al. Cost-effectiveness analysis and return on investment of SunSmart Western Australia to prevent skin cancer. Health Promot Int 2024;39:daae091. https://doi.org10.1093/heapro/daae091

	Papers excluded on comparator (n=7)
1.	Dykstra J. Avoiding reactance: The utility of ultraviolet photography, persuasion, and parental protectiveness in improving the effectiveness of a UV exposure intervention. Dissertation. Ames, Iowa: Iowa State University 2007. https://www.proquest.com/openview/f8ceb5fd8d6dc1924f10abb00b849426/1
2.	Lee SI, Macherianakis A, Roberts LM. Sunbed use, attitudes, and knowledge after the under-18s ban: a school-based survey of adolescents aged 15 to 17 years in Sandwell, United Kingdom. J Prim Care Community Health 2013;4:265–74. https://doi.org/10.1177/2150131913482142
3.	Mays D, Alalwan MA, Long L, et al. Effects of a tailored mobile messaging intervention for indoor tanning cessation in young females: a randomized clinical trial. Cancer Epidemiol Biomarkers Prev Published Online First: November 2024. https://doi.org/10.1158/1055-9965.EPI-24-0964
4.	Nittas V, Mütsch M, Frey T, et al. Effectiveness of a tailored web app on sun protection intentions and its implications for skin cancer prevention: A randomized controlled trial. PLOS Digit Health 2022;1:e0000032. https://doi.org/10.1371/journal.pdig.0000032
5.	Owen AL, Grogan S, Clark-carter D. Effects of an appearance-focussed versus a health-focussed intervention on men's attitudes towards UV exposure. International Journal of Men's Health 2016;15:34–51.
6.	Porter E, Rafferty S, Dolan M, et al. The impact of a novel digital sun protection campaign on sun-related attitudes and behaviours of healthcare workers: A prospective observational study. Skin Health Dis 2024;4:e256. https://doi.org/10.1002/ski2.256
7.	Wu YP, Hamilton JG, Kaphingst KA, et al. Increasing skin cancer prevention in young adults: the cumulative impact of personalized UV photography and MC1R genetic testing. J Cancer Educ 2023;38:1059–65. https://doi.org/10.1007/s13187-022-02232-1

	Papers excluded on outcomes (n=4)
1.	Mahler HIM, Beckerley SE, Vogel MT. Effects of media images on attitudes toward tanning. Basic Appl Soc Psych 2010;32:118–27. https://doi.org/10.1080/01973531003738296
2.	Mahler H I, Kulik J A; Gerrard M and Gibbons FX. Effects of photoaging information and UV photo on sun protection intentions and behaviours: a cross-regional comparison. Psychol Health 2013;28:1009-31.https://doi.org/10.1080/08870446.2013.777966
3.	Pope K. Making an impact on skin cancer prevention and strategies for sun safety. Dissertation. Arizona State University 2021. https://keep.lib.asu.edu/items/162173
4.	Wu YP, Nagelhout E, Aspinwall LG, et al. A novel educational intervention targeting melanoma risk and prevention knowledge among children with a familial risk for melanoma. Patient Educ Couns 2018;101:452–9. https://doi.org/10.1016/j.pec.2017.10.008

	Papers excluded on study design (n=7)
1.	Brinker TJ, Klode J, Esser S, et al. Facial-aging app availability in waiting rooms as a potential opportunity for skin cancer prevention. JAMA Dermatol 2018;154:1085–6. https://doi.org/10.1001/jamadermatol.2018.1907

2. Crowley T. Skin cancer - education and prevention: the role of social marketing. Cork, Ireland: Munster Technological University 2013. https://sword.cit.ie/allthe/78 (accessed 17 Dec 2024).
3. Head K. Tanning bed use, deviance regulation theory, and source factors. Texas A&M University 2010. https://oaktrust.library.tamu.edu/bitstream/handle/1969.1/ETD-TAMU-2368/HEAD-THESIS.pdf (accessed 17 Dec 2024).
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7. Vogel M. Turning fad into fiction: the influence of two appearance-based interventions on tanning attitudes and behaviors. Dissertation. California State University San Marcos 2011. https://scholarworks.calstate.edu/downloads/3t945r35r

	Papers excluded as modelling study (n=1)
1	De Vries, E, M Arnold, E Altsitsiadis, M Trakatelli, B Hinrichs, E Stockfleth, J Coebergh, and Group on behalf of the Epiderm. 2012. 'Potential Impact of Interventions Resulting in Reduced Exposure to Ultraviolet (UV) Radiation (UVA and UVB) on Skin Cancer Incidence in Four European Countries, 2010–2050'. British Journal of Dermatology 167 (s2): 53–62. https://doi.org/10.1111/j.1365-2133.2012.11087.x.

Appendix D Extraction forms

1. General info and eligibility

Study ID *From Epi*	Author (Year) *First author (Year)*	Year of publication	Review grouping *Insert review specific prompt*	Study location *Country of study*	Study aims and/or objectives	Linked publication *First author, Year, Link*	Intended use of linked publication *e.g. additional methodological information, additional outcome data, double counting risk for analysis*	Study funding source *Including role of funders*	Conflicts of interest *Declared by authors (recommend extracting exact wording)*	Ethical approval obtained for study *Yes/No/Unclear/Not required*	Study design eligible (HRB assigned) *yes/no*	Participants eligible *yes/no*	Intervention/exposure eligible *Yes/no*	Comparator/non-exposed eligible *Yes/no*	Outcome type eligible *e.g., safety, effectiveness, cost etc. yes/no*	Comment on eligibility *Reasons for 'no' on any PICO/PEO element*	Extracted *Reviewer's initials*	Date extraction completed *Day/Month/Year*	Validated *Reviewer's initials*	Date validation completed *Day/Month/Year*	Include/ Exclude	Queries for follow up with author *yes/no*

2. Study characteristics

Study name *If applicable, e.g. of trial, surveillance system*	Study design *HRB assigned*	Study setting *Review specific setting*	Participant eligibility criteria *Reported by study authors*	Sample size *Add review specific prompt*	Sampling frame *If applicable, source(s) used to draw/recruit participants*	Random assignment to study group *(yes/no/not reported/not applicable)*	Level of blinding *(Single, double, triple, not reported, not applicable)*	Intervention/exposure name *Brief name/phrase to describe the exposure/intervention*	Duration of exposure/intervention *Total time period over which contact occurs e.g. 12 weeks*	Comparator type(s) *Placebo, no intervention/exposure, active, external/historical*	Outcome types captured *e.g. pain, QoL, cost-effectiveness*	Notes

3. Study design and methods

Sample size *Starting sample*	Sample size *Analytic sample*	Response rate *The difference between the number of respondents versus the number of approached participants.*	Recruitment method *e.g., hospital records, consecutive patients*	Unit of allocation *e.g. individual patients, individual body parts, cluster (describe)*	Random assignment to study group *Yes/no/not reported/ not applicable*	Duration of exposure/intervention *e.g. 12 weeks*	Duration of follow-up *Last follow-up*	% lost to follow-up	Frequency of follow-up	Level of blinding *Single, double, triple, not reported, not applicable*	Outcome type(s) captured *(e.g. pain, QoL, cost-effectiveness)*	Planned primary analysis *Main statistical assumptions on which conclusions are based*	Planned subgroup analyses *List subgroups examined e.g. gender, age*	Planned sensitivity analyses *List assumptions tested ee.g alternative analytic approach, exclusion of data*	Method for handling missing data	Confounders *Accounted for in study*	Method to control for confounding	Effect modifiers *List variables being tested*

4. Intervention/experiment vs. comparator(s)

Intervention/exposure description *Detail to the level appropriate for the review*	Intervention/exposure category	Intervention composition (materials and procedures) *Physical materials for training/delivery and procedures/activities followed*	Intervention provider *Job/role of person delivering intervention*	Mode of intervention delivery/exposure *Face-to-face, telephone, app, community, group, individual*	Intervention/exposure location *where delivered*	Intervention/exposure dose *Number of times intervention delivered and/or number of sessions/frequency or volume of exposure*	Description of tailoring/adaptation of the intervention *Planned adaptations e.g., per population subgroup*	Modifications *Unplanned modifications over the course of the study*	Intervention fidelity *How and extent delivered as planned*	Comparator 1 type *Placebo, no intervention/exposure, active, external/historical*	Comparator 1 name *Brief name/phrase to describe the comparison*	Comparator 1 composition (materials and procedures) *Physical materials for training/delivery and procedures/activities followed*	Comparator 1 provider *Job and experience of person delivering comparison*	Mode of comparator 1 delivery/exposure *Face-to-face, telephone, app, community, group, individual*	Comparator 1 location *Where delivered*	Comparator 1 dose *Number of times comparator delivered and/or number of sessions/frequency or volume of comparator*	Comparator 1 modifications *Unplanned modifications over the course of the study*	Comparator 1 fidelity *If assessed, how and extent delivered as planned*
										0								

5. Participant characteristics

N included in final analysis	Mean age / Age range	% Female	Mean other key demographic 1 (e.g., BMI, health status) *Add review specific name and prompt*	Mean other key demographic 2 (e.g., BMI, health status) *Add review specific name and prompt*

6. Outcome 1 results

Outcome collection method e.g. *self-reported validated tool, objective clinical parameter*	Outcome measurement tool *i.e. name of tool, scale*	Sample size for analysis	Study arm *intervention/exposure and comparator e.g. medication A vs medication B*	Number of participants	Outcome prevalence/rate *e.g. mean/% intervention/exposure vs comparison*	Outcome range *e.g. SD or range*	Unadjusted outcome effect measurement e.g. OR, RR, MD, SMD	Unadjusted effect	95% lower confidence interval	95% upper confidence interval	Significance of change *i.e. p-value*	List of adjusted variables	Adjusted outcome effect measurement *e.g. OR, RR, MD, SMD*	Adjusted effect	Unadjusted effect	95% lower confidence interval	95% upper confidence interval	Significance of change *i.e. p-value*	Subgroup name *e.g. participant gender, age, health status*	Subgroup outcome effect measurement *e.g. OR, RR, MD, SMD*	Subgroup outcome effect	95% lower confidence interval	95% upper confidence interval	Significance of change *i.e. p-value*	Sensitivity analysis name	Sensitivity analysis effect measurement *e.g. OR, RR, MD, SMD*	Sensitivity analysis effect	95% lower confidence interval	95% upper confidence interval	Significance of change *i.e. p-value*	Effect modifier name	Effect modifier measurement *e.g. OR, RR MD/SMD*	Effect modifier effect	95% lower confidence interval	95% upper confidence interval	Significance of change *i.e. p-value*

Appendix E Complete quality assessment scores

Education interventions

Table 17: National Heart, Lung, and Blood Institute's (NHLBI's) quality assessment tool for observational cohort and cross-sectional studies: Education interventions

Author (year)	Study design	Q1	Q2	Q3	Q4A	Q4B	Q5A	Q5B	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Quality rating
Køster (2011)	Cross-sectional survey	Yes	Yes	No	Yes	Yes	No	Yes	NA	Yes	NA	NR	Yes	Yes	NA	NA	Yes	Low
Koster (2018)	Cross-sectional survey	Yes	Yes	CD	Yes	Yes	No	Yes	NA	Yes	No	NR	Yes	Yes	NA	NA	Yes	Low

Source: Tool and guidance can be found here: https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools

Table 18: NHLBI's quality assessment tool for controlled intervention studies: Education interventions

Author (year)	Study design	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Quality rating
Aarestrup (2014)	Cluster RCT	Yes	NR	NR	NR	No	Yes	No	Yes	NR	Yes	Yes	NR	Yes	Yes	Low
Abar (2010)	Simple RCT	Yes	NR	NR	NR	No	Yes	NR	NR	CD	NR	Yes	NR	Yes	NR	Low
Buller (2021)	Simple RCT	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	NR	Yes	Yes	Yes	Yes	Yes	High
Buller (2022)	Simple RCT	Yes	NR	Yes	Yes	Yes	Yes	No	Yes	NR	Yes	Yes	Yes	Yes	Yes	Moderate
Cho (2018)	Cluster RCT	Yes	NR	NR	No	No	Yes	CD	CD	NR	NR	Yes	No	No	NR	Low
Cho (2020)	Simple RCT	Yes	NR	NR	NR	No	Yes	No	CD	No	NR	Yes	NR	Yes	NR	Low
Greene (2003)	Simple RCT	Yes	CD	CD	CD	Yes	NR	Yes	Yes	CD	Yes	Yes	NR	Yes	NR	Low
Heckman (2016)	Simple RCT	Yes	Yes	CD	CD	No	Yes	No	Yes	CD	NR	Yes	No	Yes	NR	Low
Hillhouse (2002)	Simple RCT	Yes	NR	NR	CD	No	Yes	No	CD	NR	NR	Yes	NR	Yes	NR	Low
Hillhouse (2008)	Simple RCT	Yes	NR	NR	CD	No	Yes	Yes	Yes	CD	NR	Yes	NR	Yes	Yes	Low
Hillhouse (2017)	Simple RCT	Yes	NR	NR	CD	No	Yes	Yes	Yes	Yes	NR	Yes	NR	Yes	Yes	Low
Lazovich (2013)	Simple RCT	Yes	NR	NR	CD	No	CD	CD	CD	No	NR	Yes	No	Yes	Yes	Low
Stanganelli (2016)	Cluster RCT	Yes	NR	NR	NR	No	NR	Yes	Yes	NR	NR	Yes	NR	Yes	NR	Low

Author (year)	Study design	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Quality rating
Stapleton (2010)	Simple RCT	Yes	NR	NR	NR	No	Yes	Yes	Yes	CD	NR	Yes	No	Yes	NR	Low
Stapleton (2022)	Simple RCT	Yes	Yes	Yes	NR	No	No	Yes	Yes	NR	NR	Yes	Yes	Yes	NR	High
Stapleton (2015)	Simple RCT	Yes	NR	NR	NR	No	Yes	Yes	Yes	NR	NR	Yes	NR	Yes	No	Low
Baker (2013)	Simple RCT	Yes	NR	NR	NR	No	Yes	No	No	CD	Yes	Yes	No	Yes	NR	Low
Kim (2021)	Simple RCT	Yes	NR	NR	NR	No	NR	Yes	Yes	NR	NR	Yes	NR	Yes	NR	Low

Source: Tool and guidance can be found here: https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools

Table 19: NHLBI's quality assessment tool for before and after studies: Education interventions

Author (year)	Study design	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9a	Q9b	10a	10b	11	12	Quality rating
Ng (2012)	Before and after study	Yes	No	No	Yes	NR	Yes	CD	No	No	No	Yes	No	No	NA	Low
Robinson (1995)	Before and after study	Yes	No	No	No	NR	No	Yes	No	Yes	No	Yes	Yes	No	NA	Low
Stapleton (2018)	Before and after study	Yes	No	Yes	CD	No	Yes	Yes	No	Yes	No	Yes	Yes	No	NA	Low
Tari (2024)	Before and after study	Yes	Yes	No	CD	NR	CD	CD	No	No	No	Yes	Yes	No	NA	Low
Swindler (2007)	Before and after study	Yes	Yes	Yes	NR	NR	Yes	CD	No	Yes	No	Yes	Yes	No	NA	Low

Source: Tool and guidance can be found here: https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools

Regulation interventions

Table 20: NHLBI's quality assessment tool for observational cohort and cross-sectional studies: Regulation interventions

Author (Year)	Study design	Q1	Q2	Q3	Q4A	Q4B	Q5A	Q5B	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Quality rating
Blashill (2017)	Cross-sectional survey	Yes	Yes	NR	Yes	Yes	No	Yes	NA	Yes	Yes	Yes	Yes	Yes	NA	NA	Yes	Low
Bowers (2020)	Cross-sectional survey	Yes	Yes	NR	Yes	Yes	No	Yes	NA	Yes	Yes	Yes	Yes	Yes	NA	NA	Yes	Low
Cokkinides (2009)	Cross-sectional survey	Yes	Yes	Yes	Yes	Yes	No	Yes	NA	Yes	Yes	Yes	Yes	Yes	NA	NA	Yes	Moderate
Menzies (2020)	Cross-sectional survey	Yes	Yes	Yes	Yes	Yes	No	No	NA	Yes	NA	Yes	Yes	Yes	NA	NA	Yes	Low
Nadalin (2018)	Cross-sectional survey	Yes	Yes	No	Yes	Yes	No	No	NA	Yes	NA	Yes	Yes	Yes	NA	NA	Yes	Low
Qin (2018)	Cross-sectional survey	Yes	Yes	Yes	Yes	Yes	No	Yes	NA	Yes	Yes	Yes	Yes	Yes	NA	NA	Yes	Moderate
Robsahm (2020)	Cross-sectional survey	Yes	Yes	Yes	Yes	Yes	No	No	NA	Yes	NA	Yes	Yes	Yes	NA	NA	Yes	Low
Simmons (2014)	Cross-sectional survey	Yes	Yes	Yes	Yes	Yes	No	Yes	NA	Yes	NA	Yes	Yes	Yes	NA	NA	Yes	Moderate
Stapleton (2020)	Cross-sectional survey	Yes	Yes	Yes	Yes	Yes	No	Yes	NA	Yes	NA	Yes	Yes	Yes	NA	NA	Yes	Moderate

Source: Tool and guidance can be found here: https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools

Appendix F Feasibility assessment results

Education interventions

Number of studies *(Less than 3)*	Outcome Measure	Population	Intervention	Comparison	Outcome Data	Study design	Timeframe	Effect measures	Quality assessment or risk of bias	MA feasibility decision
	Sunbed use									-
	IN-PERSON OR FACE TO FACE EDUCATION					**CLUSTER RCTS**				
Aarestrup (2014)	Sunbed use (yes/no) in 6 months	Pupils aged 14-18 years from continuation schools (where pupils reside) in Denmark, about 50% female. Schools where with extremely strong or weak smoking policies were excluded.	Face to face teacher and classroom delivered education intervention to encourage nonuse of sunbeds through risk awareness among pupils in intervention schools.	Control group schools with no intervention	Percentage sunbed users (yes/no) by gender (Intervention girls vs control girls; Intervention boys vs control boys)	CLUSTER RCT	Exposure is 3 to 9 lessons, depending on the teacher's timeframe (Mean 5.6 lessons per class) Follow up at about 6 months	Odds Ratio from logistic regression	High	Combine 2 arm and 3 arm as the populations and settings are similar enough; INSUFFICIENT NO OF STUDIES FOR OUTCOME
Stanganelli (2016)	Sun lamp use (yes/no)	Teenage students (13-20 yrs) from Italy from a subsample of schools, 54.6 % female.	Face to face education for students and teachers in school by health personnel on skin cancer prevention with take home resources	No intervention control schools	Percentage of sunbed users in the intervention and control	CLUSTER RCT	Exposure is 3 months and follow up 6 months	NOT GIVEN	High	
						3 ARM CLUSTER RCTS				

Number of studies *(Less than 3)*	Outcome Measure	Population	Intervention	Comparison	Outcome Data	Study design	Timeframe	Effect measures	Quality assessment or risk of bias	MA feasibility decision
Cho (2018)	Indoor tanning (yes/no) in past month	Young women from sororities in the US who tanned or had intentions to	Face to face educational media literacy intervention delivered by interventionists to deter unhealthy effects of the media on indoor tanning with sorority cluster arms developing i) counter-argument or ii) counter-story production (based on past experience) cluster arms	No intervention control sororities	Differences between indoor tanners in the 3 arms	(Three-arm) Cluster RCT	Exposure is 1 session 60 to 75 minutes follow up is 6 months	T value from logistic regressions	High	Combine 2 arm and 3 arm as the populations and settings are similar enough; INSUFFICIENT NO OF STUDIES FOR OUTCOME
Ng (2012)	Tanning bed usage (yes/ no)	Non-medical skin care professionals from US	PowerPoint on tanning bed use and cancer with accompanying flyers	No intervention at baseline	Percentage tanning bed users before and after	**BEFORE AND AFTER** Before and after	Exposure is 10 minutes (presentation) and 1 month (flyer) and follow up is 1 month	Odds Ration but test unclear	Critical	POPULATION HETEROGENEOUS
Tari (2024)	Tanning bed use (yes/no)	Kidney transplant recipients (mean age 55.1) from Hungary and 38% female	Face to face education about the increased risk of skin cancer and sun protection (clinical setting)	No intervention baseline	Percentage using indoor tanning before and after	Before and after	Exposure is 1 hour (single session) and follow up 4 years	P value from Chi-square test or the Fisher exact test	Critical	Clinical POPULATIONS MIGHT NOT BE REPRESENTATIVE
Swindler (2007)	Tanning bed use (Never, Just for special occasions, >15x/year)	High school students (15 -16 yrs) from a US institution, females 52.8%	Educational lecture on proper skin protection and UV radiation delivered by a medical student	No intervention baseline	Percentages tanning bed use by gender before and after	Before and after	Exposure is 45 minutes (1 lecture) and follow up 4 months	Z score from Mann-Whitney test	Critical	INSUFFICIENT NO OF STUDIES FOR OUTCOME

Number of studies *(Less than 3)*	Outcome Measure	Population	Intervention	Comparison	Outcome Data	Study design	Timeframe	Effect measures	Quality assessment or risk of bias	MA feasibility decision
Robinson (1995)	Scale on frequency of tanning device use in past year (scale 1-5)	Patients and helpers (30 to 60 yrs) of those who'd experienced skin cancer from US, females 53% among patients and 68% for helpers	Face to face education for patients from Drs and nurses with written material for helper on skin cancer protection/prevention	No intervention at baseline	Mean tanning device us using scale for patients and helpers, both before and after	Before and after	Exposure is 6 months and follow up is 1 year	T statistic from paired t test for helpers only	Critical	INSUFFICIENT NO OF STUDIES FOR OUTCOME
Number of studies *(Less than 3)*	Outcome Measure	**Population** *(Eligibility, key demographics)*	Intervention	**Comparison**	**Outcome** Data	**Study design**	**Timeframe**	**Effect measures**	**Quality assessment or risk of bias**	**MA feasibility decision**
	WORKBOOKS, FLYERS AND PAMPHLETS FOR EDUCATION					**RCTS**				
Abar (2010)	Indoor tanning frequency per month (continuous)	Female university students from the US (mean age of 19.23 years) who had indoor tanned in the past year and/or having above average (5 or higher out of 7) intentions to indoor tan in the next year	Educational workbook on health information regarding indoor tanning dangers and strategies to decrease this where participants were self taught	No intervention control	NO OVERALL OUTCOMES; GIVEN Probability of indoor tanning over time for 8 subgroups of tanning behaviour (Heavy tanners categories (never, no more than once a week, no more than twice a week, more than twice a week); Moderate tanners (never, no more than once a week,	Simple RCT	1 month exposure and 6 month follow up	Probability from ANOVA	High	HILLHOUSE (2002), HILLHOUSE (2008) , BAKER (2013)and GREENE 2003 MAY BE POOLED BUT SOME DIFFERENCES PRESENT WITH TIMEFRAME OF INTERVENTION AND DURATION OF OUTCOME MEASURE

Number of studies *(Less than 3)*	Outcome Measure	Population	Intervention	Comparison	Outcome Data	Study design	Timeframe	Effect measures	Quality assessment or risk of bias	MA feasibility decision
					no more than twice a week, more than twice a week) (					
Hillhouse (2002)	Indoor tanning frequency in last 2 months (continuous)	Female university (1 institution) students (mean age 20.8) from the USA who tanned monthly	Educational workbook on indoor tanning and health that is self-taught	No intervention control	Mean tanning sessions for the intervention and control	Simple RCT	Exposure is 2 weeks and followed up for 2 months	NOT GIVEN	High	
Hillhouse (2008)	Indoor tanning frequency in last 3 months (continuous)	Female university (2 institutions) students (mean age 18.6) from the USA who tanned	Educational workbook on indoor tanning and health that is self-taught	No intervention control	Mean past 3-month indoor tanning sessions for intervention and control	Simple RCT	Exposure is 1 month and follow up is 6 months	F statistic (authors do not specify the type of test)	High	
Stapleton (2010)	Indoor tanning sessions in past 3 months (continuous)	Female undergraduates (mean age 18.2 years) from 2 US universities who tanned or had the intention	Educational booklet on indoor tanning, risks and recommendations that was self-taught	No intervention controls	NO OVERRAL OUTCOMES; GIVE Mean indoor tanning sessions based on 4 subgroups based on knowledge for intervention and control	Simple RCT	Exposure is 6 months later ? and follow up 6 months	T statistic from independent t test	High	

Number of studies *(Less than 3)*	Outcome Measure	Population	Intervention	Comparison	Outcome Data	Study design	Timeframe	Effect measures	Quality assessment or risk of bias	MA feasibility decision
Baker (2013)	Tanning bed/device use in past 3 months (continuous)	Mother (mean age intervention = 43.6yrs & control + 47.1yrs) and daughter (13-18 yrs) pairs from US	Educational handbook for mothers on relationship with daughters and how to navigate skin cancer and exposure to ultraviolet radiation (e.g. indoor tanning).	No intervention waitlist control group	Mean of past 3 month tanning sessions for mothers in intervention and control	Simple RCT **3 ARM RCTS**	Exposure is 1 month and follow up 4 months	F value from 2 (condition) X 2 (time) repeat measures analysis of variance	High	
Greene (2003)	Indoor tanning frequency in last month (continuous)	Caucasian female (mean age 21.4 years) college students from US	Educational flyers with messages on tanning risk 2 formats for the separate arms 1) statistical information provision 2) narrative/story messages	No intervention control	Mean indoor tanning frequency for each intervention vs control	(Three arm) Simple RCT	Exposure is 1 session approximately twenty minutes follow up 3-4 weeks later	F statistic from ANOVA (Only provided for statistical message vs control because significant)	Some concerns	INSUFFICIENT NO OF STUDIES

Number of studies *(Less than 3)*	Outcome Measure	**Population** *(Eligibility, key demographics)*	Intervention	**Comparison**	**Outcome** data	**Study design**	**Timeframe**	**Effect measures**	**Quality assessment or risk of bias**	**MA feasibility decision**
	SOCIAL MEDIA EDUCATION INTERVENTIONS					**RCTS**				
Buller (2021)	Indoor tanning (yes/no)	US Mothers (mean age 43.13) of daughters aged 14–17 in 34 states without complete bans on IT by minors	Social media educational intervention on indoor tanning dangers, indoor tanning permissiveness towards daughters and state policy on indoor tanning delivered by an interventionist	Social media educational intervention on prescription drug misuse delivered by an interventionist	Percentage of mother indoor tanners (yes/no) in intervention compared to control	Simple RCT	Exposure 12 months and follow up 12 months	Regression coefficient from linear regressions	Low	INSUFFICIENT NO OF STUDIES FOR OUTCOME
Buller (2022)	Indoor tanning (yes/no)	US Mothers (mean age 43.13) of daughters aged 14–17 in 34 states without complete bans on IT by minors	Social media educational intervention on indoor tanning dangers, indoor tanning permissiveness towards daughters and state policy on indoor tanning delivered by an interventionist	Social media educational intervention on prescription drug misuse delivered by an interventionist	Difference in indoor tanners (yes/no) between intervention vs control among mothers	Simple RCT	Exposure 12 months and follow up at 18 months	Regression coefficient from structural equation model regressions	Some concerns	
						BEFORE AND AFTER				
Stapleton (2018)	Indoor tanning sessions in past 1 month(continuous)	Women (mean age 20.8 years) from US who used Facebook from a campus and online	Educational Facebook intervention to create dissonance with indoor tanning by changing beliefs	No intervention baseline	Mean past 1-month tanning sessions before and after intervention	Before and after	Exposure is about 4 weeks and follow up 5 weeks	T statistic from paired-sample 2-tailed t-test	Critical	INSUFFICIENT NO OF STUDIES FOR OUTCOME

Number of studies *(Less than 3)*	Outcome Measure	**Population** *(Eligibility, key demographics)*	Intervention	**Comparison**	**Outcome** data	**Study design**	**Timeframe**	**Effect measures**	**Quality assessment or risk of bias**	**MA feasibility decision**
	WEB-BASED EDUCATION INTERVENTIONS					**RCTS**				
Stapleton (2022)	Indoor tanning sessions in past 2 months (continuous)	Women (average age 22.6yrs) from US who used sunbeds regularly some from a campus others recruited online	Web-based education that assessed tanning behavior coupled with personalized feedback	No intervention waitlist control group	Mean past 2-month indoor tanning sessions for intervention and control	Simple RCT	Exposure is about 4 weeks and follow up 12 weeks	F value from mixed ANOVA models	Some concerns	
Stapleton (2015)	Tanning bed or booth use in past 6 weeks (continuous)	Women (mean age 19.8) from a US university who indoor tanned	Web-based education that engaged women to reflect on and restructure their indoor tanning beliefs, counter-perspectives were given and a plan to change behaviour developed	No intervention waitlist control group	Mean indoor tanning sessions in past 6 weeks for intervention and control	Simple RCT	Exposure is about 6 weeks and follow up 6 weeks	Z value from zero-inflated negative binomial (ZINB) regression models	High	INSUFFICIENT NO OF STUDIES FOR OUTCOME
						3 ARM RCTS				
Cho (2020)	Indoor tanning (yes/no) in past month	College women(mean age 20.13 years) from a US university who tanned or had intentions to	Web-based educational media literacy intervention to deter unhealthy effects of the media on indoor tanning with the arms developing i) counter-argument or ii) counter-story production (based on past experience)	No intervention control	Difference in indoor tanning for each intervention vs control	(Three arm) Simple RCT	Exposure is 1 session about 38.02 min long and follow up is 6 months	Z effect from mixed-effect logistic regression model	High	
Heckman (2016)	Indoor tanning (yes/no) in past month	Young adults (mean age 21.8) from the US at moderate to high risk of skin cancer, 66.1% female	Web-based tailored and interactive education on indoor tanning (self taught) is arm 1 and the generalised website from Skin Cancer Foundation (SCF) website on prevention	No intervention control	Percentage indoor tanning for the 3 arms	(Three arm) Simple RCT	Exposure is 12 modules each 10 min each (for arm 1) and 12 weeks follow up	NOT GIVEN	High	INSUFFICIENT NO OF STUDIES FOR OUTCOME

Number of studies *(Less than 3)*	Outcome Measure	**Population** *(Eligibility, key demographics)*	Intervention	**Comparison**	**Outcome** data	**Study design**	**Timeframe**	**Effect measures**	**Quality assessment or risk of bias**	**MA feasibility decision**
			and detection is arm 2 (self taught)							

Number of studies *(Less than 3)*	Outcome Measure	**Population** *(Eligibility, key demographics)*	Intervention	**Comparison**	**Outcome** data	**Study design**	**Timeframe**	**Effect measures**	**Quality assessment or risk of bias**	**MA feasibility decision**
	NATIONAL MULTICOMPONENT INTERVENTIONS					**CROSS-SECTIONAL**				
Køster (2011)	Sunbed use within the past 12 months (recent use and non-recent use [within the past 12 months])	Danish population aged 15-59yrs with 54.3% females	National antisunbed campaign on social media, traditional media and on the internet mainly targeting those aged 15–25 years	No intervention at baseline	Percentage sunbed users in August 2008 and March 2007	Cross-sectional survey	Exposure is about 1.5 years and follow up 1.5 years	Odds Ratio from logistic regression	Serious	INSUFFICIENT NO OF STUDIES FOR OUTCOME
Koster (2018)	Sunbed within the past 12 months (yes/no)	Danish people (15-64 years) representative of population and 51.2% female	National antisunbed campaign on social media, traditional media and on the internet mainly targeting those aged 15–25 years	No intervention baseline	Percentage decrease in sunbed use overall and also by gender before and after the intervention	Cross-sectional survey	Exposure is 10 years (but ongoing) and follow up 9 years (but ongoing)	OR from logistic regression	Serious	INSUFFICIENT NO OF STUDIES FOR OUTCOME

TANNING INTENTIONS

Number of studies *(Less than 3)*	Outcome Measure	Population *(Eligibility, key demographics)*	Intervention	Comparison	Outcome Data	Study design	Timeframe	Effect measures	Quality assessment or risk of bias	MA feasibility decision
	IN-PERSON OR FACE TO FACE EDUCATION					**CLUSTER RCTS**				
Aarestrup (2014)	Intentions for sunbed use (yes/no)	Pupils aged 14-18 years from continuation schools (where pupils reside) in Denmark about 50% female. Schools where with extremely strong or weak smoking policies were excluded.	A face to face teacher and classroom delivered education intervention to encourage nonuse of sunbeds among pupils in intervention schools.	Control group schools with no intervention	Percentage with intentions for sunbed use (yes/no) by gender (Intervention girls vs control girls; Intervention boys vs control boys)	Cluster-RCT	3 to 9 lessons, depending on the teacher's timeframe (Mean 5.6 lessons per class, about 6 months) Follow up at about 6 months	Odds Ratio from logistic regressions	High	INSUFFICIENT NO OF STUDIES FOR OUTCOME
Cho (2018)	Indoor tanning intention in next 2 months(continuous 7-point likelihood scale 1 "very unlikely" to 7 "very likely)	Young women from sororities in the US who tanned or had intentions to	Face to face educational media literacy intervention delivered by interventionists to deter unhealthy effects of the media on indoor tanning with sorority cluster arms developing i) counter-argument or ii) counter-story production (based on past experience) cluster arms	No intervention control sororities	Indoor tanning intentions for each intervention vs control	**3 ARM CLUSTER RCTS** (Three-arm) Cluster randomized controlled study	Exposure is 1 session 60 to 75 minutes follow up is 6 months	T value from covariance models	High	INSUFFICIENT NO OF STUDIES FOR OUTCOME

Number of studies *(Less than 3)*	Outcome Measure	Population	Intervention	Comparison	Outcome Data	Study design	Timeframe	Effect measures	Quality assessment or risk of bias	MA feasibility decision
	WORKBOOKS, FLYERS AND PAMPHLETS FOR EDUCATION					**RCTS**				
Hillhouse (2002)	Indoor tanning intention (continuous 7-point Likert scale)	Female university students (mean age 20.8) from the USA who tanned monthly	Educational workbook on indoor tanning	No intervention control	Mean indoor tanning intentions for the intervention and control	Simple RCT	Exposure is 2 weeks and followed up for 2 months	F statistic from ANOVA	High	HILLHOUSE (2002) & HILLHOUSE (2008) ARE COMPRABLE BUT BAKER (2013) HAS A SLIGHTLY DIFFERENT POPULATION
Hillhouse (2008)	Indoor tanning intention (continuous 7-point Likert scale)	Female university (2 institutions) students (mean age 18.6) from the USA who tanned	Educational workbook on indoor tanning and health that is self-taught	No intervention control	Mean intention to use indoor tanning for intervention and control	Simple RCT	Exposure is 1 month and follow up is 6 months	F statistic (authors do not specify the type of test)	High	
Baker (2013)	Intentions to indoor tan in the future (7-point Likert scale)	Mother (mean age intervention = 43.6yrs & control + 47.1yrs) and daughter (13-18 yrs) pairs from US	Educational handbook for mothers on relationship with daughters and how to navigate skin cancer and exposure to ultraviolet radiation (e.g. indoor tanning).	No intervention waitlist control group	Mean for Intentions to use indoor tanning in intervention and control mothers	Simple RCT	Exposure is 1 month and follow up 4 months	F value from 2 (condition) X 2 (time) repeat measures analysis of variance	High	
Lazovich (2013)	Intention to tan indoors soon (yes/no)	Parent and teenagers (15 or 16 years), females about 70% from a US state	Mailed educational pamphlets on indoor tanning risks	No intervention control	Percentage intend to tan indoors soon in intervention and control among daughters	Simple RCT	Exposure is about 6 weeks and follow up 6 weeks	NONE	High	INSUFFICIENT NO OF STUDIES FOR OUTCOME
Lazovich (2013)	Intention to tan indoors in next 12 months (yes/no)	Parent and teenagers (15 or 16 years), females about 70% from a US state	Mailed educational pamphlets on indoor tanning risks	No intervention control	Percentage intend to tan indoors in next 12 months in intervention and control among daughters	Simple RCT	Exposure is about 6 weeks and follow up 6 weeks	NONE	High	INSUFFICIENT NO OF STUDIES FOR OUTCOME

Number of studies *(Less than 3)*	Outcome Measure	Population	Intervention	Comparison	Outcome Data	Study design	Timeframe	Effect measures	Quality assessment or risk of bias	MA feasibility decision
						3 ARM RCTS				
Greene (2003)	Indoor tanning intention (continuous 5-point responses ranging from ‘‘Strongly Agree’’ to ‘‘Strongly Disagree)	Caucasian female (mean age 21.4 years) college students from US	Educational flyers with educational messages on tanning risk in 2 formats for the separate arms 1) statistical information provision 2) narrative/story messages	No intervention control	Mean indoor tanning intentions for each intervention vs control	(Three arm) Simple RCT	Exposure is 1 session approximately twenty minutes follow up 3-4 weeks later	F statistic from mixed ANOVAs	Some concerns	MAY BE POOLED WITH 2 ARM RCTS WITH THE SAME CONTINUOUS OUTCOME

Number of studies *(Less than 3)*	Outcome Measure	**Population**	Intervention	**Comparison**	**Outcome** Data	**Study design**	**Timeframe**	**Effect measures**	**Quality assessment or risk of bias**	**MA feasibility decision**
	SOCIAL MEDIA EDUCATION INTERVENTIONS					**RCTS**				
Buller (2021)	Indoor tanning intention (continuous 7-point likelihood scale)	US Mothers (mean age 43.13) of daughters aged 14–17 in 34 states without complete bans on IT by minors	Social media educational intervention on indoor tanning dangers, indoor tanning permissiveness towards daughters and state policy on indoor tanning delivered by an interventionist	Social media educational intervention on prescription drug misuse delivered by an interventionist	Indoor tanning intentions difference btw intervention and control mothers	Simple RCT	Exposure 12 months and follow up 12 months	Regression coefficient from linear regressions	Low	INSUFFICIENT NO OF STUDIES FOR OUTCOME BECAUSE BULLER 2021 AND 2022 ARE FROM THE SAME STUDY
Buller (2022)	Indoor tanning intention (continuous 7-point likelihood scale)	US Mothers (mean age 43.13) of daughters aged 14–17 in 34 states without complete bans on IT by minors	Social media educational intervention on indoor tanning dangers, indoor tanning permissiveness towards daughters and state policy on indoor tanning delivered by an interventionist	Social media educational intervention on prescription drug misuse delivered by an interventionist	Difference in indoor tanning intentions between intervention vs control mothers	Simple RCT	Exposure 12 months and follow up at 18 months	Regression coefficient from structural equation model regressions	Some concerns	
						4 ARM RCTS				
Kim (2021)	Intentions to tan indoors (7-point scale - 1 (strongly disagree) to 7 (strongly agree)	US youth residents mean age 21.02 and 79% females in intervention & 74% in control.	Digital game targeting indoor tanning beliefs where participants engage and message other players	No intervention controls	Mean intention to indoor tan by gender for intervention and control	Simple RCT	Exposure is 30 days and follow up 30 days	F value from Two-way ANOVA	High	

Number of studies *(Less than 3)*	Outcome Measure	**Population** *(Eligibility, key demographics)*	Intervention	**Comparison**	**Outcome**	**Study design**	**Timeframe**	**Effect measures**	**Quality assessment or risk of bias**	**MA feasibility decision**
	WEB-BASED EDUCATION INTERVENTIONS					**RCTS**				
Hillhouse (2017)	Index of intention to indoor tan (Definitely do not intend (1) to definitely do intend (7)	Adolescent females (mean age15.2) from the US who tan or intend to	Website education designed to reduce indoor tanning motivations which was self-taught	Website on alcohol prevention	NOT GIVEN BUT CALCULATED EFFECT FROM difference in indoor tanning intentions	Simple RCT **3 ARM RCTS**	Exposure 6 months? follow up 6 months	T statistic from multivariate linear regression	High	INSUFFICIENT NO OF STUDIES FOR OUTCOME
Cho (2020)	Indoor tanning intention in next month(continuous 5-point likelihood scale from “very unlikely” to “very likely.”)	College women(mean age 20.13 years) from a US university who tanned or had intentions to	Web-based educational media literacy intervention to deter unhealthy effects of the media on indoor tanning with the arms developing i) counter-argument or ii) counter-story production (based on past experience)	No intervention control	Difference in indoor tanning for each intervention vs control	(Three arm) Simple RCT	Exposure is 1 session about 38.02 min long and follow up is 6 months	Z effect from mixed-effect linear regression model	High	INSUFFICIENT NO OF STUDIES FOR OUTCOME

Regulation interventions

Outcome	Number of studies *(Less than 3)*	Quality assessment or risk of bias	Population	Intervention	Comparison	Outcome	Study design	Timeframe	MA feasibility decision
2 b) i. Prohibiting unsupervised artificial tanning services									
Sunbed use	2 studies: Qin (2018) and Simmons (2014)	**Same risk of bias judgement** Both Qin (2018) and Simmons (2014) have a SERIOUS risk of bias according to ROBINS-I	**Same eligibility** Participants of Qin (2018) and Simmons (2014) were users of artificial tanning devices for cosmetic purposes **Similar demographics** Country: Qin (2018) - United States Simmons (2014) - United States Age: Qin (2018) - Adolescents in grades 9 through 12 attending public and private schools Simmons (2014) - Adolescents in grades 6, 8, 10,	**Similar interventions** Qin (2018) - Parental permission laws that prohibit minors younger than a certain age from using an indoor tanning device without parental consent or accompaniment. Simmons (2014) - Utah Senate Bill 41 in 2012, which stipulates that individuals under the age of 18 are forbidden from using indoor tanning facilities unless (1) they obtain a note from a physician or (2) they are accompanied at each tanning visit by a parent or guardian who signs a waiver on their behalf	**Same comparator** Qin (2018) - No intervention Simmons (2014) - No intervention	**Similar outcomes** Qin (2018) - Prevalence of Indoor Tanning (%) and Association between State Indoor Tanning Laws and Indoor Tanning (Adjusted Prevalence Ratio (APR)) Simmons (2014) - Prevalence of indoor tanning (%)	**Same study design** Qin (2018) and Simmons (2014) both have a cross-sectional study design	**Unclear timeframe** Qin (2018) - Restrictions in each state were enacted at different times Simmons (2014) - 1 year	Does not meet criteria – too few studies

Outcome	Number of studies *(Less than 3)*	Quality assessment or risk of bias	Population	Intervention	Comparison	Outcome	Study design	Timeframe	MA feasibility decision
			and 12 in participating school districts and charter schools % female: Qin (2018) - 0.508 Simmons (2014) - Not reported						
Intentions to use sunbeds	No studies	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Does not meet criteria – too few studies

ii. Setting an age limit on sunbed use Sunbed use	8 studies: Blashill (2017), Bowers (2020), Cokkinides (2009), Menzies (2020), Nadalin (2018), Qin (2018), Robsahm (2020), Stapleton (2020)	**Same risk of bias judgement** Blashill (2017), Bowers (2020), Cokkinides (2009), Menzies (2020), Nadalin (2018), Qin (2018), Robsahm (2020), Stapleton (2020) all have a SERIOUS risk of bias according to ROBINS-I	**Same eligibility** Participants of Blashill (2017), Bowers (2020), Cokkinides (2009), Menzies (2020), Nadalin (2018), Qin (2018), Robsahm (2020), Stapleton (2020) were users of artificial tanning devices for cosmetic purposes **Broadly similar demographics** Similar locations, all OECD countries Country: United States: Blashill (2017), Bowers (2020), Cokkinides (2009), Qin (2018), Stapleton (2020) Canada: Nadalin (2018) Ireland: Menzies (2020) Norway: Robsahm (2020) Similar ages, 7/8 studies have adolescent participants. Age: Blashill (2017) - Mean age of participants = 16.10 years Bowers (2020) -	**Broadly similar interventions** All studies restrict the use of indoor tanning amongst adolescents < 18 years old. Blashill (2017) - In 2014, Alabama passed House Bill 254, where minors younger than 15 years are banned from indoor tanning, 15-year-old minors are permitted to tan with in-person parent consent and minors aged between 16 and 17 years are required to present written parental consent. Bowers (2020) - Indoor tanning youth access legislation across the US. 43 states and Washington, DC, have passed legislation to regulate and restrict indoor tanning for older adolescents; this legislation included prohibition of indoor tanning for all minors younger than 18 years (15 states and the District of Columbia), prohibition of tanning for minors younger than 14 through 16 years (12 states), and requirement of parental permission or accompaniment to tanning for those aged younger than 14 through 17 years (16 states). Cokkinides (2009) - State legislation restricting minors' access to indoor tanning, with varying levels of restrictions across different states (not explicitly reported). Menzies (2020) - The Irish Public Health (Sunbed) Act of 2014 which prohibits the use of sunbeds by individuals under 18 years old. Nadalin (2018) - The Skin Cancer Prevention Act (Tanning Beds) came into effect in Ontario, in May 2014. The Act prohibits the sale and advertising of tanning services to individuals under 18	**Similar comparators** All 8 studies reported no intervention as comparator. Blashill (2017) - 2013 - Prior to legislation Bowers (2020) - States with no restrictive legislation Cokkinides (2009) - States with no restrictive legislation Menzies (2020) - Pre-ban <18 years Nadalin (2018) - 2014 survey Qin (2018) -The group of students who were not affected by any state indoor tanning laws Robsahm (2020) - Prior to the enforcement of the age ban Stapleton (2020) - Prior to the implementation of the 2013 statewide ban on indoor tanning for minors under 17 years in New Jersey.	**Different definitions** How many are similar? Blashill (2017) - Change in prevalence of indoor tanning pre-legislation (2013) vs post-legislation (2015) Bowers (2020) - 1) Indoor tanning prevalence over time (2007-2018) by Type of Youth Access Legislation, and 2) Differences in Prevalence of Indoor Tanning (IT) Over Time by Type of Youth Access Legislation Cokkinides (2009) - 1) Change in prevalence of indoor tanning between 1998 and 2004 by Type of Youth Access Legislation, and 2) Change in Frequency of Use Among Users by Type of Youth Access Legislation, and 3) Prevalence odds ratio (predictors of	**Same study design** All 8 studies have a cross-sectional study design.	**Uncertain timeframe** 1 year - Blashill (2017), Nadalin (2018), Robsahm (2020) 2-3 years - Menzies (2020) 5 years - Stapleton (2020) The duration of exposure in each state varied with the enactment of legislation - Bowers (2020), Cokkinides (2009), Qin (2018)	??

US adults
Cokkinides (2009) - Age range 11-18 years
Menzies (2020) - Mean age 15.7 years
Nadalin (2018) - Age range 12-18 years
Qin (2018) - Students in grades 9 through 12
Robsahm (2020) - Age range 15–17 years
Stapleton (2020) - Mean age 15.8 years

% female is similar in 5/8 studies. 3 studies did not report.
% female:
Blashill (2017) - Not reported
Bowers (2020) - Not reported
Cokkinides (2009) - 0.5%
Menzies (2020) - 0.52%
Nadalin (2018) - Not reported
Qin (2018) - 0.508%
Robsahm (2020) - Pre-ban (2016) - 59.8% Post-ban (2017) - 50.3%
Stapleton (2020) - 0.51%

years of age.
Qin (2018) - The impact of state indoor tanning laws on the prevalence of indoor tanning among US high school students. The laws were categorized into two main types:
1. Age Restriction Laws
2. Parental Permission Laws
Robsahm (2020) - The enforcement of an age ban on indoor tanning for individuals under 18 years, which came into effect on January 1, 2017.
Stapleton (2020) - New Jersey legislators passed a statewide ban on indoor tanning for youths younger than 17 years in 2013.

indoor tanning use) by Type of Youth Access Legislation
Menzies (2020) - Rate of sunbed use pre- and post-ban
Nadalin (2018) - Percentage of adolescents who used UV tanning device in the previous 12 months pre-ban and post-ban
Qin (2018) - 1) Prevalence (Weighted) of Indoor Tanning for males and females by Type of Youth Access Legislation
2) Association Between State Indoor Tanning Laws and Indoor Tanning - Male and female
Robsahm (2020) - Prevalence of solarium use in the last year pre-ban and post-ban
Stapleton (2020) - 1) Weighted Prevalence of Indoor Tanning in Past Year Among New Jersey High School Students - Pre-legislation

(2012), Post-legislation (2014), Post-legislation (2016), and Post-legislation (2018)
2) Association between the prevalence of indoor tanning in 2012 (the year prior to the tanning ban) 2018 (the final follow-up)

Broadly similar measurements
Blashill (2017) - Percentage (%)
Bowers (2020) - Percentage (%) and Weighted Estimate
Cokkinides (2009) - Percentage (%) and Prevalence odds ratio (POR)
Menzies (2020) - Percentage (%)
Nadalin (2018) - Percentage (%)
Qin (2018) - Percentage (%) and Adjusted prevalence ratio (APR)
Robsahm (2020) - Percentage (%)
Stapleton (2020) - Percentage (%) and AOR

Outcome			Number of studies *(Less than 3)*	Quality assessment or risk of bias	Population	Intervention	Comparison	Outcome	Study design	Timeframe	MA feasibility decision
Intentions to use sunbeds	1 study: Menzies (2020)	N/A	N/A	N/A		N/A	N/A	N/A	N/A		Does not meet criteria – too few studies

Appendix G Tables used for the meta-analyses presented in the main report

Education interventions and sunbed use outcome

Author	Year	Country	Risk of bias	Design	Intervention	Follow_up	fu_cat	age_cat	% Female	Intervention arm 1	a1_n_users	Arm 1 mean	Arm1 sd	effect 1	se_e1	Intervention arm 2	a2_n_users	Arm 2 mean	Arm2 sd	effect 2	se_e2	Control	control_n_users	Control mean	Control sd
Greene	2003	USA	Some concerns	3-arm rct	Workbooks, flyers and pamphlets for education	1	<=2	<25	100	50		1.31	5.03	2.87		50		3.78	7.22			45		3.57	6.42
Hillhouse	2008	USA	High	Rct	Workbooks, flyers and pamphlets for education	6	5-6	<25	100	200		6.8	8.49	12.42	0.93							230		10.9	8.34
Stapleton	2010	USA	High	Rct	Workbooks, flyers and pamphlets for education	6	5-6	<25	100	191		7.71	8.95	1.31								159		5.65	8.14
Stapleton	2022	USA	Some concerns	Rct	Web-based education intervention	3	3-4	<25	100	27	21	11.5	2.1	0.6								26		7.9	2.1
Stapleton	2015	USA	High	Rct	Web-based education intervention	1.5	<=2	<25	100	94		2.54	6.39	2.03	0.41							93		4.02	4.2
Baker	2013	USA	High	Rct	Workbooks, flyers and pamphlets for education	4	3-4	>25	100	29		0.75	3.28	3.58								30		0.4	2.68

Education interventions and sunbed use intention outcome

Author	Year	Country	Risk of bias	Design	Intervention	Follow_up	fu_cat	Mean age	age_cat	% Female	Intervention arm 1	Arm1 mean	Arm 1 sd	effect 1	se_e1	Intervention arm 2	Arm2 mean	Arm2 sd	effect 2	se_e2	Control	Control mean	Control sd
Buller	2021	USA	Low	Rct	Social media education intervention	12	>=12	43.13	>25	100	435	1.41	1.43655	-0.2021	0.08885						434	1.6	1.75377
Greene	2003	USA	Some concerns	3-arm rct	Workbooks, flyers and pamphlets for education	1	<=2	21.4	<25	100	50	2.67	1.42	3.93		50	2.73	1.59			45	3.1	1.44
Hillhouse	2008	USA	High	Rct	Workbooks, flyers and pamphlets for education	6	5-6	18.6	<25	100	200	8.65	4.2426	15.64							230	10.51	4.2464
Baker	2013	USA	High	Rct	Workbooks, flyers and pamphlets for education	4	3-4	45.41	>25	100	29	2.15	2.80 03	4.09							30	2.85	2.30 04
Kim	2021	USA	High	4-arm rct	Social media education intervention	1	<=2	21.02	<25	52.00	234	2.0152	1.6263	3.1							90	2.2384	1.7781

Regulation interventions and sunbed use outcome

Author	Year published	Country	Region	Risk of bias	Design	Survey title	Year(s)_data_collection	Survey_weighted	Representative_sample	Age_cat	% Female	sunbed use_timeframe_m	Adjusted_analysis	N_no intervention	n_no intervention but sunbed use	prop_none but sunbed use	N_ban	n_ban and sunbed use	prop_ban and sunbed use	N_partial ban	n_partial ban and sunbed use	prop_partial ban and sunbed use
Cokkinides	2009	USA	USA	Serious	Cross-sectional survey	American Cancer Society	2004	Yes	Yes	14-18	50	12	Yes	708	91	12.9	570	57	10	nr	nr	nr
Menzies	2020	Ireland	Ireland	Serious	Survey	Pre-post	2013, 2017	No	No	14-18	52	12	No	754	57	7.5	783	56	7.2	nr	nr	nr
Nadalin	2018	Canada	Ontario	Serious	Survey	Canadian Cancer Society	2014, 2015	Yes	Yes	12-18	nr	12	No	1561	108	6.9	2305	182	7.9	nr	nr	nr
Robsahm	2020	Norway	Oslo	Serious	Survey	Pre-post	2016, 2017	No	No	15-17	59.8 - 50.3	12	Unknown	199	47	23.6	193	45	23.3	nr	nr	nr
Qin	2018	USA	37 States	Serious	Survey	YRBS	2009-2015	Yes	Yes	14-18	50.51	12	No	9926	1500	15.1	2334	483	5.2	2211 53	2776	12.4

Appendix H GRADE scores and justifications

Education intervention outcomes

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	public health education interventions	comparator	Relative (95% CI)	Absolute (95% CI)		
Frequency of sunbed use (in meta-analysis) (follow-up: range 1 months to 6 months)												
6[a]	randomised trials	serious[b]	serious[c]	not serious	serious[d]	none	641	583	-	SMD **0.14 SD more** (0.66 fewer to 0.93 more)	⨁◯◯◯ Very low[b,c,d]	CRITICAL
Frequency of sunbed use (in narrative synthesis) (follow-up: range 1.25 months to 6 months)												
3[e]	randomised trials	very serious[f]	serious[g]	not serious	serious[h,i]	none[i]			-	see comment	⨁◯◯◯ Very low[f,g,h,i,j]	CRITICAL
Sunbed use (yes/no) or other categories (in narrative synthesis) (follow-up: range 1 months to 9 years)												
13[k]	randomised trials	very serious[l]	serious[m]	not serious	serious[l]	none[n]			not pooled	see comment	⨁◯◯◯ Very low[l,l,m,n]	CRITICAL
Sunbed use intentions scale (in meta-analysis) (follow-up: range 1 months to 12 months)												
6[o]	randomised trials	very serious[p]	not serious	serious[q]	not serious	none	998	829	-	SMD **0.24 SD lower** (0.42 lower to 0.05 lower)	⨁◯◯◯ Very low[p,q]	IMPORTANT
Sunbed use intentions scale (in narrative synthesis) (follow-up: range 2 weeks to 6 months)												
4[r]	randomised trials	very serious[s]	serious[t]	serious[q]	serious[u]	none			not estimable		⨁◯◯◯ Very low[q,s,t,u]	IMPORTANT

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	public health education interventions	comparator	Relative (95% CI)	Absolute (95% CI)		
Sunbed use intentions (yes/no) in narrative synthesis (follow-up: range 6 weeks to 6 months)												
2[v]	randomised trials	very serious[w]	serious[x]	serious[q]	serious[y]	none			not estimable		⨁◯◯◯ Very low[q,w,x,y]	IMPORTANT

Explanations

a. Greene (2003), Hillhouse (2008), Stapleton (2010), Baker (2013), Stapleton (2015) & Stapleton (2022)

b. Four of the six studies were at high risk of bias and two had some concerns domains; the high overall risk of bias was due to insufficient information on the randomisation process, deviations from intended intervention and measurement of the outcomes

c. Considerable heterogeneity >75% was present even after sensitivity analysis which may contribute to inconsistency

d. The lower versus the upper boundary of the CI differ in relation to the decision for effectiveness

e. Abar (2010), Hillhouse (2002) & Stapleton (2018) = 922 participants

f. Two studies were at high risk of bias (RCTs) and the last at critical risk (before and after design) due to potential issues with randomisation, confounding, outcome measurement and reporting due to insufficient inclusion of requisite information

g. Evidence of variation in point estimates across studies; confidence intervals not available for 2 studies

h. Lower versus the upper boundary of the CI for the one study with this information indicates that these differ as it pertains to decision for effectiveness.

i. Lower versus the upper boundary of the CIs for some studies indicate that these differ as it pertains to decision for effectiveness.

j. Stapleton (2018) was a before and after study which demonstrated risk of confounding

k. Aarestrup (2014), Stanganelli (2016), Cho (2018), Ng (2012), Tari (2024), Swindler (2007), Robinson (1995), Buller (2021), Buller (2022), Cho (2020), Heckman (2016), Køster (2011), Koster (2018) = 60,161 participants

l. Six studies were at high risk of bias (4 RCTs, 2 cross sectional), another four at critical risk of bias (before and after), two studies presented some concerns (RCTs), and one had a low risk of bias (RCT); high overall risk in bias was due to insufficient information on randomisation, deviations from intervention, measurement of outcomes, potential confounding, and selection of reported result.

m. Some variation in point estimates but CI overlap in some studies

n. The before and after studies demonstrate risk of confounding

o. Greene (2003), Hillhouse (2008) Baker (2013), Buller (2021), Buller (2022) and Kim (2021)

p. Three studies had a high risk of bias (RCTs), one displayed some concerns (RCTs) and one was at low risk due to insufficient information on randomisation, intervention deviations, missing outcomes and outcome measurement

q. Outcome is of secondary importance to actual sunbed use

r. Cho (2018), Cho (2020), Hillhouse (2002) and Hillhouse (2017) = 1358 participants

s. Four studies were at high risk of bias (RCTs) due to potential issues with randomisation, deviations from intended intervention, missing outcome data and outcome measurement

t. Some variation in point estimates but CI only available in one study

u. CI not provided but the sample size of studies totals to over >1000

v. Aarestrup (2014), Lazovich (2013) = 3816 participants

w. Both studies were at high risk of bias; primary issues were insufficient information on randomisation, deviations from intervention, and outcome measurement

x. Some variation in point estimates but CI overlap

y. Lower versus the upper boundary of the CIs for some studies indicate that these differ as it pertains to decision for effectiveness.

Regulation interventions outcomes

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	public health regulatory intervention	comparator	Relative (95% CI)	Absolute (95% CI)		
Prevalence of sunbed use (in meta-analysis) (follow-up: range 1 years to 3 years)												
5[a]	non-randomised studies	extremely serious[b]	serious[c]	not serious	serious[d]	none	823/13085 (6.3%)	1803/13148 (13.7%)	**OR 0.74** (0.38 to 1.45)	**32 fewer per 1,000** (from 80 fewer to 50 more)[e]	⨁◯◯◯ Very low[b,c,d]	CRITICAL
Prevalence of sunbed use (in narrative synthesis) (follow-up: range 1 years to 5 years)												
4[f]	non-randomised studies	extremely serious[g]	serious[h]	not serious	serious[i]	none			not pooled	see comment	⨁◯◯◯ Very low[g,h,i]	CRITICAL
Sunbed use intentions (yes/no) in narrative synthesis (follow-up: range 2 years to 3 years)												
1[j]	non-randomised studies	extremely serious[k]	not serious	serious[l]	serious[d]	none			not estimable		⨁◯◯◯ Very low[d,k,l]	IMPORTANT

CI: confidence interval; **OR:** odds ratio

Explanations

a. Cokkinides et al. (2009), Menzies et al. (2020), Nadalin et al. (2018), Qin et al.(2018) and Robsahm et al.(2020)

b. All 5 papers had a serious risk of bias due to potential for confounding, outcome measurement and selection of reported results (missing outcomes).

c. There was substantial heterogeneity between the findings of the included studies as indicated by the I2 (97.0%) which measures the variability in point estimates

d. The lower versus the upper boundary of the CI differ in relation to the decision for effectiveness

e. Results are inputted directly from meta-analysis

f. Bowers et al. 2020; Stapleton et al. 2020; Blashill et al. 2017; Simmons et al. 2014

g. All 4 papers had a serious risk of bias due to potential for confounding, outcome measurement and selection of reported results (missing outcomes).

h. CI not available for all studies but some variability in point estimates of prevalence of sunbed use as one study (Simmons et al. 2014) has almost double the prevalence of the two others (Stapleton et al. 2020 and Bowers et al. 2020) .

i. Not all CI were available but 3 studies report statistically significant changes and 1 does not thus it is likely this study's CI does not overlap the with the others.

j. Menzies et al. (2020)

k. The study had a serious risk of bias due to potential for confounding, outcome measurement and selection of reported results (missing outcomes).

l. Sunbed use intentions is a proxy for sunbed use in prospective situations