

BMJ Open The extent of public awareness, understanding and use of the Global Solar UV index as a worldwide health promotion instrument to improve sun protection: protocol for a systematic review

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ABSTRACT

Introduction (Over)exposure to ultraviolet radiation is a major risk factor for skin cancer. The Global Solar Ultraviolet Index (UVI) was introduced by the WHO and partner organisations in 1995 as a simple measure of the intensity of solar UV radiation, providing guidance for the population to use appropriate sun protective measures. Little is known about the impact of the UVI on actual sun protection behaviour. Our systematic review aims to assess global levels of awareness, understanding and use of the UVI as prerequisites for the preventive effectiveness of this public health tool.

Methods and analysis Systematic searches will be performed in 10 electronic literature databases including Medline, Scopus and Web of Science–Core Collection, two clinical trials registries and at least two grey literature databases (OpenGrey, Bielefeld Academic Search Engine). Additional literature sources will be retrieved using hand search of reference lists of included studies and snowballing methods. We will include studies with all types of quantitative study designs and participants reporting on at least one outcome in the three main categories (i) awareness, (ii) understanding and (iii) use of the UVI. We will assess the risk of bias within studies with an abbreviated version of the AXIS tool, designed specifically for cross-sectional studies. As we expect large heterogeneity in outcomes, we will conduct a narrative synthesis of results instead of a meta-analysis.

Ethics and dissemination Ethical approval and patient consent are not required as this is a systematic review based on published studies. The results of this study will be published in an international peer-reviewed journal.

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INTRODUCTION

Ultraviolet (UV) radiation is electromagnetic radiation in the wavelength ranges 315–400 nm (UVA), 280–315 nm (UVB) and 100–280 nm (UVC).¹ About 9% of solar radiation is UV radiation,² but only UVA

Strengths and limitations of this study

- Exhaustive search for relevant studies in all relevant databases and through additional literature sources.
- This review is not limited to specific study designs or participant groups.
- Due to expectedly very heterogeneous outcomes, we will have to undertake narrative synthesis instead of meta-analysis.

and roughly 10% of UVB pass Earth's atmosphere³ and can, therefore, exhibit biological effects on humans living on Earth's surface.

Although UV radiation initiates positive effects like vitamin D production in the human body,⁴ overexposure can lead to serious adverse health effects, with cataract and skin cancer having a great public health impact.⁵

The global incidence of all types of skin cancer (melanoma and non-melanoma skin cancers) has been rising for decades.^{6 7} This development largely originates from an increase in intentional sun exposure motivated by a change in attitude towards tanned skin which has become a symbol of attractiveness, health and fashion⁸ during recent decades. Studies have shown that a substantial proportion of skin cancer cases can be attributed to UV (over)exposure.⁵ This implies that skin cancer is largely preventable using appropriate sun protection.

As humans lack a sensory organ for UV radiation, finding the appropriate level of sun protection intuitively is challenging for the population. This entails the need for a tool to visualise the intensity of terrestrial UV radiation. Initially, scientists at Environment

Canada, the Canadian federal Department of the Environment nowadays termed Environment and Climate Change Canada, created the concept of the UV index in 1992.^{9,10} In 1995, the World Health Organization (WHO), together with the World Meteorological Organization (WMO), the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the United Nations Environment Programme (UNEP), adopted a slightly modified version of the Canadian UV index as the Global Solar UV Index (UVI) to provide uniform information to the public worldwide.¹¹ The UVI constitutes a measure of the daily maximum intensity of erythemally weighted^{12,13} solar UV irradiance or, in other words, the potential of the prevailing UV radiation to induce sunburn. Surveys in the early years following the introduction of the UVI suggested that many people were aware of the UVI, but did not understand it and failed to translate recommendations into practice.¹⁴ Subsequently, the WHO and partner organisations published a practical guide in 2002 to improve the use of the UVI as an educational tool, wherein they proposed a harmonised UVI reporting scheme.¹⁵ The categories of the UVI and their corresponding sun protection messages are: at 'low' UVI levels (1–2), no protection is required. For 'moderate' (3–5) and 'high' (6–7) UVI values, application of all sun protection measures including shade (during midday hours), clothing, sunscreen, sunglasses and a hat is recommended. At 'very high' (8–10) or 'extreme' (11+) UVI levels people should use all of the aforementioned sun protection measures, seek shade all day and, in addition, avoid being outdoors during midday hours.

As with every public health tool, it should be evaluated whether the UVI is indeed effective concerning the role it was intended for. Due to the latency between UV exposure and the development of skin cancer, it is neither sensible nor feasible to evaluate a possible reduction of skin cancer incidence since the UVI has been introduced. Similarly, it is not feasible to examine on a population level whether the introduction of the UVI has led to reduced sun exposure. Nevertheless, it seems meaningful to investigate whether the UVI is a broadly accepted tool for improving sun protection and whether studies with an intervention incorporating the UVI could show an influence on sun protection behaviour. Both these questions have previously been evaluated in a systematic review closely related to ours, published in 2012 by Italia and Rehfuess¹⁶: aspects relating to UVI dissemination like awareness and understanding, as well as the effects of interventions including the UVI on knowledge, attitude and behaviour concerning sun protection, were investigated. Based on the data available at that time, the authors concluded that the number and quality of eligible studies were insufficient to fully answer the review questions and further studies were strongly recommended. Since then, 7 years have elapsed which motivates us to perform a new systematic review. Due to the extent and complexity of both fundamentally different aspects assessed in the former review, we decided to narrow the topic down.

The objective of the systematic review described in this protocol is to focus solely on reporting the worldwide 'status quo' regarding awareness, understanding and self-reported use of the UVI as these aspects are necessary conditions for the UVI being able to contribute to an improvement of sun protection and a subsequent reduction of skin cancer rates in the future. No restrictions concerning study participants will be applied. In our analysis, we will particularly delineate geographic differences and temporal trends. Analysing disparities between geographic regions is considered meaningful due to environmental (level of exposure to solar UV radiation) and policy-related (presence of education and sun protection/skin cancer prevention campaigns) factors.

METHODS AND ANALYSIS

Patient and public involvement

Patients and/or the public were not involved in the development of this research project.

Design

This study will be a systematic review with narrative data synthesis and will be based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) checklist.¹⁷ In the event of protocol amendments, the date of each amendment will be accompanied by a description of the change and the rationale.

Eligibility criteria

Eligibility criteria for studies to be included in the systematic review are reported following the PICOS scheme¹⁸ in table 1.

The UV index as a health promotion instrument can be used to target any population group of interest and is often directed at the general population. The scope of the systematic review is not limited to a particular subgroup of the population. All studies irrespective of the type of study participants will be included. If the study is confined to a specific subgroup of the population (outdoor workers in specific occupations, children, parents or child care workers/teachers responsible for sun protection of children, or health professionals), this information will be extracted and used to perform subgroup-specific analyses.

The focus of this systematic review is on a quantitative assessment of the extent of public awareness, understanding and use of the Global Solar UV index in different regions in the world over time. Frequency measures (mostly percentages) describing the degree of awareness, understanding and use of the UVI will be extracted and summarised. We will apply further subcategorisation of these outcomes for data extraction, but will not exclude any studies due to their specific subtype of the outcome.

We will include all types of studies with quantitative empirical data. As very few randomised controlled trials have been conducted, observational studies are likely to be the most important source of information for this

Table 1 Eligibility criteria following the PICOS scheme¹⁸

Criteria	Inclusion	Exclusion
Participants	All types of participants	None
Intervention	The Global Solar UV Index (introduced in 1995 by the WHO and partner organisations)	Other versions of UV indices
Comparator	N/A	N/A
Outcome	<ul style="list-style-type: none"> ▶ Quantitative ‘status quo’ estimates (including baseline data of intervention studies) of <ul style="list-style-type: none"> – Awareness of the UV index – Understanding of the UV index – Use of the UV index 	Other outcomes
Study design	<ul style="list-style-type: none"> ▶ Experimental studies <ul style="list-style-type: none"> – Randomised controlled trials – Others ▶ Observational studies <ul style="list-style-type: none"> – Before-and-after studies with and without controls – Case-control studies – Prospective and retrospective cohort studies – (Repeated) cross-sectional studies 	Qualitative studies

N/A, not applicable; UV, ultraviolet.

review. If data from (randomised or non-randomised) intervention studies eligible for the systematic review are used, only data about awareness, understanding and use of the UVI at baseline (prior to the intervention) will be included as only these reflect the ‘status quo’ in the population, which we intend to depict in this systematic review.

Searches

We will conduct systematic searches using the following electronic databases: Pubmed/Medline, Scopus, Web of Science–Core Collection, ScienceDirect, The Cochrane library (CDSR, CENTRAL, CMR, DARE, HTA, EED), Applied Sociological Sciences Index and Abstracts (ASSIA), EPPI-Centre database of health promotion research (DoPHER, Bibliomap, TRoPHI), Educational Resource Information Centre database (ERIC), Sociological Abstracts and PsycINFO. Additionally, two clinical trials registries will be searched: ClinicalTrials.gov and the International Clinical Trials Registry Platform (ICTRP). In order to include relevant studies not published in the peer-reviewed literature, we will search the grey literature databases OpenGrey and Bielefeld Academic Search Engine (BASE). Time permitting, we will also perform searches in the Federated Search for relevant policy documents and the GreyNet Source Index. Furthermore, we will hand search the bibliographies of all studies identified through the electronic database search and meeting the inclusion criteria. We will also perform forward-snowballing by using six important references (five older epidemiological studies on aspects of the UV index published between 1997 and 2004^{14 19–22} and the systematic review by Italia and Rehfuss published in 2012)¹⁶ and check all references citing any of these publications. This citation analysis will be performed based on the Scopus database. Additively, we will assess the eligibility of studies included

in the 2012 systematic review¹⁶ and consult experts in the field.

As the UVI was introduced in 1995, only literature published in the year 1995 or thereafter will be searched for relevant information. We will use English search terms only, but we will not exclude documents on the basis of language or country if only the title/abstract, but not the full text is available in English. Potentially important studies in German and French can be included directly; for potentially important studies in other languages, we will seek assistance with their translation.

Search terms consist of variations of the term UV index and a wide range of terms related to the outcomes awareness, knowledge and use of the UVI for sun protection. In addition to general terms, we also incorporated specific terms used in the psychological literature on modelling of health behaviour. An internet synonym database (<http://www.synonyms.com/>) was employed to systematically identify all relevant synonyms. The search terms related to the UVI will be combined with other search terms using the Boolean operator ‘AND’. These general search terms will be adapted to the needs of specific electronic and grey literature databases.

The explicit search string (in the notation used for searching the Scopus database) will be as follows:

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TITLE-ABS-KEY({UV Index} OR {UVI} OR {Solar Index} OR {Ultraviolet Radiation Index} OR {UVR Index} OR (“UV forecast*”) OR (“UV Radiation forecast*”) OR {Ultraviolet Index})
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AND

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TITLE-ABS-KEY(“familiar*” OR “understand*” OR {comprehension} OR {comprehend} OR “know*” OR “aware*” OR {perception} OR {perceive} OR {attitude} OR “behav*” OR {sun tan} OR {suntan} OR {tanning})
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OR “sunbath*” OR {sunburn} OR “sunscreen*” OR {sunblock} OR {sun protection} OR {midday} OR {noon} OR {dangerous hours} OR {peak hours} OR {sun avoidance} OR {shade} OR “tree*” OR {indoors} OR “cloth*” OR {shirt} OR {sunglasses} OR {shades} OR {hat} OR {sun exposure} OR {time in the sun} OR {sun seeking} OR {use} OR “consider*” OR {Health Belief Model} OR {Protection Motivation Theory} OR {Theory of Reasoned Action} OR {Theory of Planned Behaviour} OR {Theory of Planned Behavior} OR {Transtheoretical Model} OR {Precaution Adoption Process Model} OR {Health Action Process Approach} OR {self-efficacy} OR {belief in efficacy of coping response} OR {perceived behavioural control} OR {perceived behavioral control} OR {plan} OR {planning} OR “intent*” OR {protection motivation} OR {risk perception} OR “perceived threat*” OR {perceived susceptibility} OR {perceived seriousness} OR {appraised severity} OR “fear appeal*”)

AND

PUBYEAR >1994

Study selection

A two-phase screening and selection process to include all eligible studies will be implemented. All records identified by the searches will be collected in an EndNote X8 library and given unique publication IDs. These IDs will be used in the further selection process to document all decisions in Microsoft EXCEL tables. Nonetheless, neither of the review authors will be blind to the journal titles or to the study authors or institutions. In the first screening phase, after removal of duplicates, titles and abstracts will be checked regarding eligibility independently by two authors (ML and MH). A third author (OG) will

decide in the case of contradictory assessments of the first two authors. This first phase will be implemented using maximum sensitivity of the screening, that is, only publications clearly showing in the abstract that they are not eligible will be excluded. All full texts of the remaining publications will be checked in the second phase by two authors (ML and MH) independently. A third author (OG) will make final decisions in contradictory cases. All decisions and reasons leading to the exclusion of studies will be documented using separate tables for the two phases of the selection process providing information on the individual assessments by both authors (ML and MH) and the final decision (OG).

Data extraction and management

Two authors (ML and MH) will independently extract the data from studies meeting the inclusion criteria using a standardised, pre-piloted form. A third author (OG) will review the extracted data and make final decisions in contradictory cases. We will extract the following data: Publication ID, verification that UV index in the WHO version is used, year of study execution, country of origin, study design, method of selecting participants, data collection instruments, study setting and population involved, information on basic characteristics of participants (eg, age, gender, ethnicity, educational level and health literacy), number of participants and response rate. Outcomes will be extracted in subcategories as defined in [table 2](#) to enable meaningful data synthesis and analysis.

If necessary, outcome information will be approximated from figures in the reports. If more than one publication reports on the same study we will combine information from the publications if they report on different

Table 2 Subcategories of outcomes

Main outcome category	Subcategories
Awareness	<ul style="list-style-type: none"> ▶ General awareness of UV index or UV index forecasts/reports ▶ Perceiving the value of the UV index on a specific day ▶ Knowledge of the (correct) value of the UV index on a specific day ▶ Other
Understanding	<ul style="list-style-type: none"> ▶ Knowledge of the general definition of the UV index (definition used by study authors explicitly given in the publication) ▶ Knowledge of the general definition of the UV index (definition used by study authors not given in the publication) ▶ Understanding the factors influencing the UV index ▶ Specific knowledge about the scale of the UV index <ul style="list-style-type: none"> – Meaning of a general change of UV index values – Value range and labelling of the risk categories – Risk category and/or recommended protective measures for specific UV index values – UV index threshold values for recommending sun protection ▶ Perceived complexity of information provided by the UV index ▶ Other
Use	<ul style="list-style-type: none"> ▶ General active use of the UV index ▶ Active use of the UV index for decision making concerning sun protection ▶ Information procurement activities ▶ Other

UV, ultraviolet.

outcomes and use the more comprehensive one(s) if the shorter one(s) do(es) not add any additional information. If any contradictions with regards to content appear between such multiple publications, we will extract the information given in the more recent publication. We will contact study authors by email if important methodological details or statistical data are missing.

Risk of bias within included studies, meta-biases and quality of evidence assessment

Two authors (ML and MH) will independently appraise studies meeting the inclusion criteria without being blinded to the studies. The published AXIS tool²³ developed in a consensus approach will be used. This quality assessment tool has been specifically designed for evaluating cross-sectional studies which we expect to be dominating among the studies included in the systematic review. Some of the components of the AXIS tool relate to aspects of comparing intervention groups in a cross-sectional study and thus are not applicable to our purpose. Therefore, we will use an abbreviated version of the AXIS tool (online supplement 1) consisting of 13 items (2 items have 2 subitems, 1 item has 4 subitems). Disagreements will be resolved first by a discussion between ML and MH and then by consulting a third author (OG) for arbitration. Finally, a global rating as 'strong' or 'weak' study quality will be assigned to all studies.

Exploration of possible meta-biases is not deemed meaningful for our systematic review as our outcomes are 'status quo' estimates not related to specific interventions. This makes selective reporting due to stakeholder influences largely unlikely and also leads to temporal and geographic differences between estimates being expected a priori. As a further consequence, analysis of publication bias becomes inapplicable and an analysis of the strength of the body of evidence becomes unsuitable.

Data synthesis and analysis

It is very likely that there will be substantial heterogeneity in outcomes. Instead of a meta-analysis, we will conduct a narrative synthesis following guidance from the Centre for Reviews and Dissemination.¹⁸ Summary tables will present the main characteristics of the included studies, their finding as well as their quality rating.

Depending on the number of studies found for different regions, points in time and potential restrictions of the study population, we intend to present summaries of outcome information on the extent of public awareness, understanding and use of the UVI in subgroups defined by the study region (Australia/New Zealand, Europe, North America, South America, Africa and Asia), the time of the study (≤ 2002 , 2003–2010 and > 2010), the type of the study population (general population, outdoor workers, children, parents, child care workers/teachers and health professionals), and study quality (strong and weak). If

information on educational level and health literacy of participants is given in a sufficiently large number of studies, we will also conduct subgroup analyses regarding these individual aspects which might have an impact on the outcomes. If the number of studies is sufficiently large, we will additionally present summaries of outcome information for crossed subgroups.

Ethics and dissemination

Ethical approval and patient consent are not required as this is a systematic review based on published studies. This systematic review has been registered in PROSPERO (CRD42018093693). The results of this review will be published in an international peer-reviewed journal.

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