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# A systematic review on the impact of preventative education programmes upon the moderation of high-risk ultraviolet exposure behaviours among those under 18 years of age and their caregivers

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# Declaration

I hereby declare that this thesis is my own work and effort and that it is has not been submitted elsewhere for any award. Where other sources of information have been used, they have been acknowledged.

## Contents

# Acknowledgements

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## Abstract

**Background** Ultraviolet exposure is the primary preventable risk factor in the development of both non-melanoma and melanoma skin cancers (Narayanan, Saladi & Fox, 2010). UV exposure accumulated during childhood and adolescence have a significant impact in increasing risk of skin cancer development in adulthood (Suman & Suman, 2019). Under 18-year-olds represent a key target population for education, as behaviour change at a younger age could result in long term reduction of high-risk UV exposure behaviours throughout the lifespan, consequently reducing skin cancer incidence (Williams, Olsen, Hayward & Whiteman, 2011). This systematic review focuses on the role of behaviour modification strategies as well as social and environmental factors in promoting sustained sun-safe behaviours.

**Research Design** A narrative synthesis approach has been utilised to systematically review and analyse studies of preventative UV education programmes targeted at under 18-year-olds and their care givers. 9 studies have been included and were selected based on pre-determined inclusion and exclusion criteria. Included studies are randomised controlled trials and quasi-experimental studies, allowing comprehensive examination of programme efficacy across diverse settings and age groups.

**Findings** This systematic review highlights consistent improvement in knowledge of UV risk and sun protection behaviours following educational interventions. Hanna et al (2022) and Norman et al (2007) demonstrated that interactive, peer-led and family inclusive approaches improved engagement and adherence to high-risk behaviour modification. Evidence for long term behaviour change was limited to three studies (Crane et al, 1999; Aulbert et al, 2009; Wu et al, 2019). These studies demonstrated evidence for improved longevity of positive intervention outcomes when reinforcement and ongoing support are maintained following intervention. Additionally, structural modifications such as sunscreen access and shaded areas in conjunction with education were effective in promoting consistent sun safe practices (Crane et al, 1999; Aulbert et al 2009).

**Conclusion** Preventative education programs are effective in improving knowledge and awareness of UV exposure risks among young people and their care givers. Education programmes including peer-led and family-based approaches show promise in modifying high-risk UV exposure behaviours. Evidence for long term behaviour change following sun safety education is limited, and further research is required in this area to demonstrate longevity in behaviour moderation. Future education models should include personalised messaging and mixed modality of education materials to maximise impact of this education. This systematic review contributes to understanding key elements of sun safety education and provides recommendations for future education programme development to enhance impact and prevent UV related skin damage in young populations.

# Chapter 1: Introduction & Background

## 1.1 Introduction

This research dissertation comprises a systematic review on the impact of preventative education programmes upon the moderation of high-risk ultraviolet (UV) exposure behaviours among those under 18 years of age and their caregivers.

In this chapter, the background context underpinning the review will be explored in detail, including summary of relevant preventative education reviews to date. The rationale for targeting children within this review will be explored, along with a critical discussion of what constitutes high-risk UV exposure behaviours. The research question will be defined using the PICO framework, along with summary of the development of the research question.

## 1.2 Background

In the 2022 national institute for health and care excellence (NICE) guideline for assessment and management of melanoma, skin cancer is recognised as the fifth most common cancer in the United Kingdom. Since the early 1990s, melanoma skin cancer rates in the United Kingdom have doubled in Females (106% increase) and almost tripled in males (186% increase) (Cancer Research UK, 2022). This upward trajectory has continued over the last decade, with melanoma skin cancer rates increasing by 27% in females, and 38% in males since 2016 (Cancer Research UK, 2022). On average, 16,744 new cases of Melanoma were diagnosed each year in the United Kingdom between 2016-2018 (Cancer Research UK, 2022). This increase in melanoma skin cancer incidence in the United Kingdom equates to a projected rise from 20,800 cases in 2023-2025, to 26,500 cases in 2038-2040 (Cancer Research UK, 2022). Whilst melanoma only accounts for only about 4% of new skin cancer diagnoses in the United Kingdom, Melanoma is the cause of 74% of skin cancer attributable deaths (Smith, Mettlin & Eyre, 2003).

Non-Melanoma skin cancer rates are also projected to rise by 14% in the United Kingdom by 2040 (Marsden, Newton-Bishop, Burrows et al, 2010). There are currently 156,000 new cases of non-melanoma skin cancer diagnosed in the United Kingdom each year (Lomas, Leonardi-Bee & Bath-Hextall, 2012). Non-Melanoma skin cancer incidence in the United Kingdom has increased more rapidly than melanoma skin cancer since the early 1990s, with an increase of 169% in both males and females (Cancer Research UK, 2023). Non-Melanoma skin cancer incidence has also had a

steeper increase than melanoma skin cancer over the last decade, with an increase of 42% in females, and 40% in males (Melanoma UK, 2020).

Locally, the States of Jersey released a skin cancer prevention strategy in 2014. This strategy showed an elevated rate of skin cancer in Jersey, with Jersey having an age standardised skin cancer rate of 48 per 100,000 (States of Jersey, 2014). Comparatively, the age standardised rate of skin cancer in southwest England was 30 per 100,000 persons, whilst the entirety of the United Kingdom had an average skin cancer rate of 22 per 100,000 (States of Jersey, 2014). Within the States of Jersey Skin cancer prevention strategy (2014), and annual cost per year of Melanoma is identified at £400,000. Locally, the increased skin cancer incidence is attributable to a higher number of sunshine hours, meaning an elevated amount of UV exposure in comparison to the rest of the United Kingdom (Jersey Public Health Department, 2013). Locally, the annual average sunshine hours have been reported at 1915 hours, compared to the highest average in the United Kingdom being the Isle of Wight with a total of 1752 hours annually (Jersey Public Health Department, 2013). Additionally, the skin cancer prevention strategy highlighted a number of methods for managing and reducing skin cancer rates locally, including school workshops on sun safety, media campaigns and ultraviolet forecasting (States of Jersey, 2014).

Exposure to Ultraviolet radiation is the most significant modifiable risk factor in the development of skin cancer (Narayanan, Saladi & Fox, 2010). Ultraviolet radiation is released naturally by the sun, and artificially from tanning beds (Watson, Holman & Maguire-Eisen, 2016). There are three types of ultraviolet radiation: ultraviolet A (UVA), ultraviolet B (UVB) and ultraviolet C (UVC) (Diffey, 2002). UVC is completely blocked out by the ozone layer, and does not reach the earth's surface (Ysasi, 2019). UVB is primarily responsible for sunburn, and directly damages the DNA in skin cells, leading to mutations within the skin that can result in skin cancer (Suman & Suman, 2019). UVA penetrates deeper into the skin, contributing to skin aging and indirect damage to DNA through oxidative stress (Agar & Young, 2005). The effect of ultraviolet radiation exposure is cumulative, as DNA damage builds up over time, cumulatively increasing likelihood of cancerous mutation occurring within the skin (Williams, Olsen, Hayward & Whiteman, 2011). Other risk factors in the development of skin cancer include genetic factors, occupational exposure to some chemicals, phenotypic characteristics, behavioural and lifestyle factors including smoking and alcohol use, and immunosuppression (Gordon, 2013). Of these risk factors, the single most modifiable risk factor is that of ultraviolet exposure management (Narayanan, Saladi & Fox, 2010; D'Orazio, Jarrett, Amaro-Ortiz & Scott, 2013; Reichrath, 2020; Merin, Campbell & Kameswaran, 2022). The influence that ultraviolet radiation can have on skin cancer risk makes ultraviolet exposure behaviours, makes the moderation of these behaviours a priority in skin cancer management strategies (Mancebo & Wang, 2014).

When considering the impact of ultraviolet exposure behaviour on skin cancer risk, the type and pattern of ultraviolet exposure must be considered (Mancebo & Wang, 2014). Epistemological studies have established clear dose-response relationship between UV exposure and skin cancer risk (Baron & Suggs, 2014). A meta-analysis by Wu et al (2016) showed that individuals with a history of sunburn /have significantly higher risk of melanoma. This underpins the knowledge that intermittent, intense ultraviolet exposure, often associated with sunburn, is particularly associated with melanoma (El Ghissassi, Baan, Straif et al, 2009). Chronic ultraviolet exposure, common among outdoor workers, is more strongly linked to non-melanoma skin cancers such as squamous cell carcinoma (Que, Zwald & Schmults, 2018).

With the underpinning knowledge regarding types of ultraviolet radiation, and the impacts that these can have upon the lifetime skin cancer risk, the level of risk associated with specific ultraviolet exposure practices can be analysed based on potential for these to increase skin cancer likelihood (Hasan, Nadaf, Imran et al, 2023).

Sunbathing is a prevalent high-risk ultraviolet exposure behaviour whereby skin is deliberately exposed to the sun for tanning (Linares, Zakaria & Nizran, 2015). Sunbathers often spend extended periods of time outdoors, with minimal clothing and inadequate sun protection (Supapannachart, Chen, Wang & Yeung, 2022) This is a particularly high-risk behaviour as it can lead to intense, intermittent ultraviolet exposure which is strongly associated with melanoma development (Marks, Arron & Mansh, 2020). Wehner et al (2014) found that individuals reporting frequent sunbathing in adolescence and young adulthood had significantly increased risk of both melanoma and non-melanoma skin cancers.

Tanning bed use is a very significant high-risk ultraviolet exposure behaviour, with tanning beds capable of emitting radiation at levels up to fifteen times stronger than midday sun (Levine, Sorace, Spencer & Siegel, 2005). A meta-analysis by Boniol, Autier, Boyle and Gandini (2012), found the use of tanning beds before the age of 35 to increase the risk of melanoma skin cancer by 75%. The world health organisation (WHO) classifies tanning devices as group 1 carcinogens for their role in contributing to skin cancer development (Linares, Zakaria & Nizran, 2015). Despite knowledge on the impact of tanning beds upon skin cancer risk, tanning beds continue to be widely used, with 37.5% of adults reported to have used tanning beds during their lifetime, and 55% of university students reporting tanning bed use (Wehner, Chren, Nameth et al, 2014). Tanning bed usage is most prevalent among adolescents and young adults aged 16 to 25 years old, with teenage girls and young women having the highest rates of tanning bed use (Miyamoto, Berkowitz & Saraiya, 2012). This prevalence among young people makes children and adolescents a key target audience for sun safety education, as education in reducing high risk UV behaviours, including

tanning bed use is paramount in reducing UV induced skin damage and skin cancers (Russo, Van Acker, Vander Wal & Sinha, 2012).

Inadequate use of sunscreen can constitute a high-risk ultraviolet exposure behaviour (Guan, Lim & Mohammad, 2021). This can be in the form of insufficient application, Low sun protection factor (SPF) and failure to reapply sunscreen (Bennett & Khachemoune, 2020). Autier, Boniol and Dore (2007), found that many people apply less than half the recommended amount of sunscreen, significantly decreasing its effectiveness. Furthermore, failure to reapply sunscreen after swimming, sweating or following the recommended two-hour interval, poses higher risk of sunburn (Petersen & Wulf, 2014). The causality of inappropriate sunscreen use becoming a high-risk ultraviolet exposure behaviour is of particular interest within this systematic review, as effective use of sunscreen can be taught within a school setting and has historically been the target of public education campaigns (Guan, Lim & Mohammad, 2021).

Outdoor occupations requiring employees to spend prolonged periods in the sun, particularly where there is inadequate utilisation of ultraviolet protection measures poses a significant increase in risk of developing non-melanoma skin cancers (Schmitt, Seidler, Diepgen & Bauer, 2011). This is due to the cumulative effect of chronic ultraviolet exposure over the course of the persons career (Williams, Olsen, Hayward & Whiteman, 2011).

The skin cancer risk elevation for persons engaging in outdoor activities is comparable to that of outdoor occupations (Bennett, Dahl, Furness, Kemp-Smith & Climstein, 2021). Outdoor activities such as hiking, cycling and water sports can form high-risk ultraviolet exposure behaviours when ultraviolet protective measures are not observed (Wu, Parsons, Chipman et al, 2022). This is particularly the case with outdoor sports, where regular participation is associated with an increased risk of melanoma (Armstrong & Kricker, 2001).

Sun-seeking travel, intentional travel to locations with high ultraviolet indexes forms a high-risk ultraviolet behaviour (Wiken, Andersson & Radkiewicz, 2023). Often, sun-seeking travel is often coupled with tan-seeking behaviours, resulting in neglect of sun protection measures and participation in intense sun exposure behaviours (Reinau, Achermann, Arnet, Meier, Hatz & Surber, 2014). This results in intense, intermittent ultraviolet exposure which is strongly associated with melanoma development (Marks, Arron & Mansh, 2020).

The association between high-risk ultraviolet exposure behaviours, skin cancer development and skin photoaging is well documented (Campbell & Kameswaran, 2022; Neale, Lucas, Byrne et al, 2023; Chen, Yang & Jiang, 2021). Basal cell carcinoma (BCC) is linked with intermittent, intense ultraviolet exposure and sunburn (Green & Olsen, 2017). The risk of developing basal cell

carcinoma is influenced by the cumulative effect of overexposure to ultraviolet radiation, and as such is common in older age (Armstrong & Kricker, 2001). Ultraviolet radiation has been linked as the primary causative factor in up to 90% of BCC cases (Teng, Huang, Xu, Tao & Fan, 2021). There is a particularly strong link between sunburn during childhood and adolescence, and BCC incidence, demonstrating the impact of childhood ultraviolet radiation exposure (Green & Olsen, 2017).

This association is echoed in the development of Squamous cell carcinoma (SCC), with ultraviolet exposure being the primary risk factor in the development of SCC (Leiter & Garbe, 2008). In contrast to melanoma and BCC, the primary driver for SCC development is chronic, long-term ultraviolet exposure (Madan, Lear & Szeimies, 2010). Whilst sunburn contributes to the risk of development of all skin cancers, the role of sunburn in SCC development is secondary to that of chronic ultraviolet exposure (Leiter & Garbe, 2008). This puts outdoor workers at particularly increased risk of developing SCC, as the chronic, long-term ultraviolet exposure accumulates throughout their working life (Madan, Lear & Szeimies, 2010).

Research has shown that both intermittent intense UV exposure, and chronic UV exposure significantly increases melanoma risk (Lazovich, Vogel, Berwick, Weinstock, Anderson & Warshaw, 2010). Episodes of intense sun exposure, particularly during childhood and adolescence are strongly linked to melanoma (Suppa & Gandini, 2019), with 86-90% of melanoma cases being attributable to UV exposure (Shreberk-Hassidim, Ostrowski & Fisher, 2023). Use of tanning beds is strongly linked with elevated melanoma risk, as tanning beds emit high levels of UV radiation over short durations (Boniol, Autier, Boyle & Gandini, 2012). This risk is further elevated in young people, with those who have used tanning beds before the age of 35 increasing their melanoma risk by 59% (Wehner, Chren, Nameth, Choudhry, Gaskins, Nead, Boscardin & Linos, 2014). Additionally, young tanning bed users are more likely to are more likely to experience severe sunburns from tanning beds, further elevating melanoma risk (Boniol, Autier, Boyle & Gandini, 2012).

Sun safety education forms a crucial public health strategy aimed at decreasing skin cancer incidence through increasing knowledge of sun safety and reducing high-risk ultraviolet exposure behaviours (Raymond-Lezman & Riskin, 2023). Children represent a vital target audience for sun safety education initiatives, as a significant proportion of lifetime UV exposure occurs during childhood and adolescence (Lucas, Armstrong, Smith & McMichael, 2006), with early life UV exposure playing a crucial role in the development of skin cancer later in life (Woo & Eide, 2010). Consequently, reducing UV exposure in childhood is essential in lowering skin cancer risk within the population (Whiteman, Whiteman, & Green, 2001; Saggese, Verucci, Boot et al, 2015).

Additionally, children's skin is thinner and contains less melanin which in adults provides some protection against UV damage (Woo & Eide, 2010). Thus, children's skin is more sensitive to UV radiation, with increased risk of sunburn and UV induced DNA damage (Lucas, Armstrong, Smith & McMichael, 2006). Strategically targeting children with public health education provides an opportunity for early habit formation (Rizvi, 2022). Sun safety behaviours established during childhood give an increased likelihood for this to be maintained in adulthood (Hahn, et al., 2016). Additionally, educational programmes delivered to children can further influence the wider community as children influence the behaviours of their families and peers (Rueter, et al., 2021). Educating children on the dangers of UV exposure empowers them to take responsibility for their own health, which in turn can encourage other proactive health protection behaviours (Rizvi, 2022).

Public health education on sun safety and skin cancer prevention has evolved significantly since the link between UV radiation and skin cancer was determined (Drissi, Carr & Housewright, 2021). In the 1960's and 1970's, scientific research began to establish the link between UV radiation and skin cancer (Marks, 1999). Early public health messaging at this point focused on preventing sunburn through wearing hats and staying in the shade (Mahon, 2003). In the 1980's, recognition of skin cancer within the medical community began to improve, leading to increased melanoma diagnoses (Wright, du Preez, Millar & Norval, 2020). This increase in skin cancer diagnoses drove the development of the first targeted sun safety campaigns within localised government jurisdictions (Marks, 1999). The 1990's saw the launch of major sun safety education campaigns, with particular emphasis in countries with higher skin cancer rates (Mahon, 2003). In 1991, the cancer council Victoria; Australia, launched the *'Slip! Slap! Slop!'* campaign (Drissi, Carr & Housewright, 2021). This campaign encouraged people to *'Slip on a shirt, Slop on sunscreen and Slap on a hat'* and has become recognisable worldwide (Buller, 1998). The United States followed suit, releasing the '*Sun Wise'* programme in 1998, which aimed to educate children and their caregivers on sun protection (Emmons, Geller, Viswanath, Rutsch, Zwirn, Gorham & Puleo, 2008). The 2000's saw the integration of sun safety education into school curricula globally (Trakatelli, Ulrich, del Marmol, Euvrard, Stockfleth & Abeni, 2007). Simultaneously, the development of the internet and digital media allowed for the dissemination of sun safety messaging through new digital platforms, including websites and social media (Gillen, Forman, Nunley, Bhole, Eliason, Fox & McCall, 2011). In the 2010's, sun safety campaigns began using multifaceted approaches, combining policy initiatives with community programmes and media campaigns to reinforce sun safety messaging, in addition to the implementation of sun safety policies in workplaces and schools (Odone, Buttigieg, Ricciardi, Azzopardi-Muscat & Staines, 2019). Currently evolving technologies are now making sun safety education more accessible and engaging through the use of apps, virtual reality and personalised sun safety advise based on UV exposure levels and skin type (Trakatelli, Ulrich, del Marmol, Euvrard, Stockfleth & Abeni, 2007).

As detailed above, skin cancer has a significant impact within the United Kingdom, and worldwide, with skin cancer rates in the UK continuing to rise (Cancer Research UK, 2022). This therefore makes skin cancer prevention and detection a priority within governmental public health programmes, both in the UK (NICE, 2016) and locally (Health and Social Services, 2014). With ultraviolet exposure being the primary modifiable cause of skin cancer, public health education to reduce high-risk ultraviolet behaviour is a key focus point worldwide (Narayanan, Saladi & Fox, 2010). To date, reviews of the impact of education interventions have focused primarily upon adult participants, and the reduction in skin cancer rates associated with the education (Raymond-Lezman & Riskin, 2023; Eshtiaghi, Khosravi-Hafshejani, Sara, Lui & Kalia, 2022). Additionally, current research within this topic fails to draw comparison between different education models, leaving a gap in current research (Bellamy, 2005). Conversely, this systematic review seeks to understand the impact of different education models in the modification high-risk ultraviolet exposure behaviours as a key skin cancer preventative measure. Understanding the impact that current education has had upon behaviour modification will provide insight into the effectiveness of current education practices, providing knowledge to enhance future education programmes.

## 1.3 Defining the Research Question

The review question was developed and modified during the literature scoping stage of this systematic review. Initially, the target population was exclusively children under the age of 18 years, with studies including adult participants being excluded. This was adjusted during the scoping phase of the review, as many of the relevant research studies included parent and caregiver participants. The inclusion of parents and caregivers in educating under 18-year-olds formulates a multi-faceted approach to education which enhances the effectiveness of education programmes (Johnson, Davy, Boyett, Weathers & Roetzheim, 2001). The impact of parental role modelling and consistent education messages between the school and home environments improves the likelihood of these behaviours being adopted long-term (Dadlani & Orlow, 2008). Additionally, educating caregivers empowers them to make informed decisions about the child's health, including selecting appropriate sun protection measures and creating sun-safe activities for children (Johnson, Davy, Boyett, Weathers & Roetzheim, 2001). It was therefore determined that the inclusion of studies educating caregivers of under 18-year-olds were pertinent in ascertaining the impact of the education interventions upon the behaviour moderation of the children in their care.

The literature scoping exercise revealed only four studies based within the United Kingdom. It was therefore determined that the inclusion criteria should not be limited based on geography, and instead with limited to include only studies written in English. Additionally, limiting the included studies based on geography prevents the inclusion of public health promotion initiatives released worldwide. This is particularly pertinent when considering the impact that Australian sun safety education initiatives upon global education initiatives. Australia, with the highest global rate of annual new melanoma diagnosis, takes a proactive, preventative approach to skin cancer prevention (Gamage, Nguyen, Clare, Lucas, Strickland, Granich & Gorman, 2021). Australia was first to develop and implement a government initiated public health campaign on sun safety in 1991 (Drissi, Carr & Housewright, 2021), and has since been considered a world leader in sun safety and skin cancer prevention initiatives, with other governmental bodies modelling local policy upon that of Australian models (Leske, Young, White & Hawkes, 2014). Consequently, it was deemed appropriate to include analysis of global research on the impact of education interventions on the modification of high-risk ultraviolet exposure behaviours. Additionally, this allows for comparison of the education methods utilised across different countries, which will be explored in the discussion section of this review.

Studies were included only where these included a control group within the study design. These study designs were specifically selected to provide increased rigour to this systematic review. The use of a control group in research design is key in enabling the review to account for confounding variables that may influence outcomes, allowing for increased accuracy and robustness in conclusions about the intervention delivered (Sedgwick, 2013). Additionally, Higgins and Deeks (2019) highlight the impact of control group studies in increasing the internal and external validity of a systematic review, as this allows the reviewer to assess the reliability of intervention across different settings and studies. For these reasons, this systematic review exclusively includes studies that utilise control groups.

The research question for this systematic review was formulated using the PICO framework (Hayward, Nishikawa, Wilson & Richardson, 1995). This requires the research question to be broken down into four key components comprising Population, Intervention, Comparison and Outcome (Scells, Zuccon, Koopman, Deacon, Azzopardi & Geva, 2017). Utilisation of the PICO framework provides structure and clarity for the development of the review question (Eriksen & Frandsen, 2018). The PICO framework format was further utilised to determine the inclusion and exclusion criteria, allowing effective literature search through identification of key themes, ease of exclusion of irrelevant studies, and assurance mitigating risk of missing relevant studies (Methley, Campbell, Chew-Graham, McNally & Cheraghi-Sohi, 2014). The PICO framework is also a useful tool in enhancing the critical appraisal of research studies, as it supports the assessment of

applicability and validity of evidence within the specific context of the systematic review through providing a basis for critical appraisal of study design, methodology and results (Scells, Zuccon, Koopman, Deacon, Azzopardi & Geva, 2017).

PICO was selected as the most appropriate framework for structuring this systematic review, as it provides structure to the systematic assessment of the impact of preventative education programmes targeting the defined population.

**Population:** Children under 18 years of age, and their caregivers.

**Intervention:** Preventative education programmes aimed at reducing high-risk ultraviolet exposure behaviours.

**Comparison:** Research studies including a control group or pre-intervention assessment to accurately determine changes borne of the delivered education programme.

**Outcome:** Measurable changes in behaviour through moderation of high-risk ultraviolet exposure behaviours.

The review question is therefore: *"What is the impact of preventative education programmes upon the moderation of high-risk ultraviolet exposure behaviours among those under 18 years of age and their caregivers?"*

## 1.4 Conclusion

The purpose of this research dissertation is to critically appraise the impact of preventative education programmes on the moderation of high-risk ultraviolet exposure behaviours of those under 18 years of age and their caregivers. This will be achieved through a systematic review of the current evidence base assessing the impact of sun safety education initiatives. This will include analysis of research studies providing a relevant intervention to the target population, to determine the impact of these interventions, as well as opportunities for expansion of education delivery and development of future education models. The research design used for this review will be critically discussed in the next chapter, where the theoretical basis, search strategy and data analysis will be explored.

# Chapter 2: Research Design

This chapter will explore the philosophical and theoretical underpinnings of the systematic review. The search strategy, data synthesis and analysis methods will be critically discussed, including inclusion and exclusion criteria. The database search strategy will be explained, including the PRISMA framework utilised for this. A summary of the included studies will be given along with rationale for their inclusion within this review. Finally, data synthesis and analysis methods will be critically discussed, including rationale for selection of the methods which will be utilised within this review.

## 2.1 Theoretical Basis

This systematic review is grounded epistemologically in the post-positivist research paradigm. The post-positivist perspective recognises the value of systematic inquiry, whilst acknowledging the limitations of objective observation and measurement (Resnik, 2022). Post-positivism maintains the belief that an external reality exists independently of human observation, whilst recognising that interpretation of this is interposed by human perception (London, 2022). This paradigm assumes that whilst knowledge is imperfect, approximate objective reality can be obtained through systematic enquiry and theoretical interpretation (Carpiano, 2006).

Conversely, the positivist paradigm assumes that scientific knowledge is objective and can be directly observed and measured (Fischer, 1998). Therefore, reality can be studied in an objective manner, using standardised measures (Kaplan, 2004). Whilst a positivist stance offers clarity and objectivity, it may overlook the influence of contextual factors in shaping scientific understanding (Bowling, 2023).

As this systematic review seeks to understand the impact of education upon human behaviours, a post-positivist stance is well suited to allow consideration of both empirical evidence and theoretical explanations (Jackson & Dolan, 2021). Post-positivism allows for the recognition that scientific phenomena are embedded in broader social, cultural and historical contexts, providing scope for the understanding of how these contexts influence interpretation of reality (Polgar & Thomas, 2011). This paradigm is therefore most appropriate for this systematic review, where personal social and cultural constructs may influence behaviour moderation (McMurtry, 2020).

This review will include quantitative research studies in the forms of randomised controlled trials and quasi-experimental trials. Quantitative research focuses upon quantifying and generalising study results from a sample population (Bradley, 2013). This includes the collection and analysis of numerical data to test hypothesis, make predictions and discover patterns within the population (Bell, Bryman & Harley, 2022). Quantitative research utilises pre-designed structured instruments such as surveys, questionnaires and experiments (Carr & Chadwick, 2011). Data is collected in numerical format using lager sample sizes than that of qualitative research (Bradley, 2013). Statistical analysis is used to test hypotheses and establish causal relationships (Martin & Bridgmon, 2012). The larger sample sizes and standardised data collection methods used in quantitative research studies allow for enhanced generalisability in comparison to qualitative research (Zyphur & Pierides, 2019). Additionally, the use of structured instruments enhances objectivity and reduces researcher bias (Bell, Bryman & Harley, 2022). When compared with qualitative research, quantitative research can more precisely measure variables and control for extraneous factors, resulting in more accurate results (Carr & Chadwick, 2011).

As this systematic review seeks to assess the impact of preventative education upon a large population, under 18-year-olds, the enhanced replicability and generalisability provided with quantitative studies makes quantitative the most appropriate type of research to be included in this systematic review (Edwards & Atenstaedt, 2019). Additionally, the statistical analysis made possible through quantitative research, provides greater scope for understanding the direct impact of the study intervention upon the moderation of high-risk UV exposure behaviours. This is particularly pertinent in the high-risk UV exposure behaviours among those under 18 years of age, as these behaviours are influenced by a range of individual, social and environmental factors, as explored in chapter one (Watson, Holman & Maguire-Eisen, 2016). The use of quantitative research in analysing these factors enhances the validity and reliability of the review findings through comprehensive analysis of the impact of preventative education (Cypress, 2017).

## 2.2 Search Strategy

This systematic review was performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines (Moher, 2009). Bibliographic databases CINAHL Ultimate, MEDLINE, PsychINFO were searched from inception to 24 June 2024. These searches included primary research into the impact of preventative education

programmes upon the moderation of high-risk ultraviolet exposure behaviours.

### 2.2.1 Search Terms

The search terms were categorised based on the aspect of the review question that was being searched for. Comparable and alternative search terms were linked with the Boolean operator 'OR', and the groups of search terms were each linked with the Boolean operator 'AND' to ensure that any results covered all aspects of the review question (Table 2.1).

Expanders were applied to include equivalent subjects. Limiters were applied based on publication language being English. This systematic review included studies based on the eligibility criteria (Table 2.2).

**Table 2.1 Search terms and Boolean Operators**

| | | | | |
|---|---|---|---|---|
| Sun exposure<br>'OR'<br>Sunlight<br>'OR'<br>Tanning<br>'OR'<br>Ultraviolet Radiation<br>'OR'<br>Ultraviolet<br>'OR'<br>Daylight<br>'OR'<br>Sunshine<br>'OR'<br>UV exposure | 'AND' | Education<br>'OR'<br>Public health interventions<br>'OR'<br>Public health education<br>'OR'<br>Health prevention<br>'OR'<br>Health promotion<br>'OR'<br>Health education<br>'OR'<br>Student education<br>'OR'<br>Preventative education<br>'OR'<br>Intervention programme | 'AND' | Behaviour change<br>'OR'<br>Lifestyle change<br>'OR'<br>Behaviour modification<br>'OR'<br>Lifestyle modification<br>'OR'<br>Behaviour moderation<br>'OR'<br>Lifestyle moderation<br>'OR'<br>Risk moderation<br>'OR'<br>Risk reduction<br>'OR'<br>Risk aversion |

**Table 2.2 Eligibility Criteria**

| Criteria | Inclusion | Exclusion |
|---|---|---|
| **Population** | Studies involving participants under 18 years of age or direct care providers of under 18-year-olds (Parents, Guardians and teachers). | Studies involving participants over 18 years of age, or non-direct care providers. |
| **Intervention** | Studies evaluating preventative education programmes aimed at reducing high-risk ultraviolet exposure behaviours | Studies examining interventions unrelated to behaviour moderation, or evaluating causal factors for high-risk UV exposure behaviours |
| **Comparator** | Studies including a control group or pre-intervention assessment of prior knowledge or behaviours | Studies lacking a control group or pre-intervention assessment of prior knowledge or behaviours |
| **Outcome** | Studies assessing the impact of preventative education programmes on the moderation of high-risk ultraviolet exposure behaviours as defined in chapter 1 | Studies focusing on types of high-risk behaviours observed by the participants.<br>Studies focusing solely on knowledge or attitudes without assessing behaviour change outcomes |
| **Study Design** | Randomised controlled trials (RCTs), quantitative studies. | Studies lacking primary data or relevant outcome measures |
| **Publication status** | Published studies<br>Studies with accessible full-text versions | Unpublished studies<br>Studies without accessible full-text versions |
| **Language** | Studies published in English | Studies published in languages other than English |

## 2.3 Data Synthesis and Analysis Methods

The research studies included within this systematic review have had their quality assessed using the Critical Appraisal Skills Programme (CASP) randomised controlled trials standard checklist and CASP cohort study standard checklist (CASP, 2023). These tools were chosen as they enable comparative level of analysis for both types of research design included in this review (Long, French & Brooks, 2020). The CASP checklists include questions covering study validity, results and relevance, supporting a comprehensive critical analysis of each study (Quigley, Thompson, Halfpenny & Scott, 2018).

In determining the methods for assessing quality of the included research, a number of quality assessment tools were considered to determine the most appropriate method. The Cochrane risk of bias tool was considered for assessing the included randomised controlled trials (Higgins, Savovic, Page, Elbers & Sterne, 2019). This tool is a widely used standard for randomised controlled trials, providing clear criteria for assessment and covering key aspects of study design and execution (Altman, 2001). However, this tool is exclusively applicable to randomised controlled trials, so could not be applied to the quasi-experimental studies included in this review, and therefore its' use within this review would be inappropriate (Minozzi, Cinquini, Gianola, Gonzalez-Lorenzo & Banzi, 2020). The Newcastle-Ottowa scale tool (NOS) was considered for the analysis of non-randomised studies. The NOS tool evaluates the selection of study groups, comparability of study groups and the outcome of interest (Luchini, Stubbs & Veronese, 2017). A study comparing NOS with other methodological quality assessment tools found that NOS demonstrated moderate reliability and weak validity (Moskalewicz & Oremus, 2020). Of particular importance, NOS does not have a comparable assessment tool for the analysis of randomised controlled trials (Stang, 2010). Consequently, the NOS tool was deemed not appropriate for use in this review. The Jadad scale for assessing the methodological quality of clinical trials was also considered for application within this review (Jadad, Moore, Carroll, Jenkinson, Reynolds, Gavaghan & McQuay, 1996). This scale provides a 0 to 5 scoring system primarily focusing upon randomisation, blinding and participant withdrawal (Moshina, Gurushankari, Niranjan, Sureshkumar, Sreenath & Kate, 2022). Whilst this scale focuses on critical aspects of trial quality, it does not cover potential sources of bias, and the binary judgement made in assessing with a yes or no response does not allow for nuanced, in-depth analysis (Lunny, Thirugnanasampanthar, Kanji et al, 2021). Consequently, the Jadad scale was not applied to this review.

Conversely, the CASP tool provides checklists for critical appraisal of various types of research, including randomised-controlled trials, case-control studies and cohort studies (CASP, 2023). The CASP tool provides tailored checklists based on study type, with each checklist including questions covering study results, validity and relevance (Zeng, Zhang, Kwong, Zhang, Li, Sun, Niu & Du, 2015). The comprehensive approach provided through the questions included within this tool ensures that all areas of each study are critically appraised (Buccheri & Sharifi, 2017). CASP allows for a more nuanced appraisal of studies through the use of qualitative questions (Quigley, Thompson, Halfpenny & Scott, 2018). When compared with score-based tools such as Jadad which give only binary responses, CASP is superior in assessing the more nuanced differences in studies, thus making it superior when used in a systematic review (Tran, Tam, Elshafay, Dang, Hirayama & Huy, 2021).

The synthesis of data is an essential aspect of a systematic review as it converts individual study findings into a cohesive narrative summary to provide comprehensive understanding of the review topic and allowing for application to practice and recommendations for policy and education development (Lockwood, Munn & Porritt, 2015). The data synthesis will highlight overarching patterns and themes as well as discrepancies and areas requiring further exploration (Maeda, Kenney & Lolkus, 2023). Synthesising data from multiple studies can enhance the overall reliability and quality of evidence, leading to more robust and generalisable conclusions (Munn, Porritt, Lockwood, Aromataris & Pearson, 2014). The data synthesis of multiple studies provides accurate, actionable insights and recommendations which supports informed decision-making in healthcare and education based on the best available evidence (Jonnalagadda, Goyal & Huffman, 2015). Additionally, this synthesis enables the identification of research gaps including understudied populations, outcomes or intervention strategies (van den Berg, Heymans, Leone et al, 2013). The identification of research gaps is crucial in guiding future research priorities, enabling targeted research addressing the most pressing needs within the field (Soilemezi & Linceviciute, 2018). Additionally, data synthesis can mitigate the impact of individual study biases through the use of methodological rigor (Verbeek, Ruotsalainen & Hoving, 2011).

There are numerous methods for data synthesis that must be considered when determining the most appropriate synthesis method for the review topic. Meta-analysis is a process of statistically combining the results of multiple studies to produce a combined estimate of the effect size (Harrer, 2022). Meta-analysis increases the statistical power and precision of effect estimates through combining data sets from multiple studies (Siddaway, Wood & Hedges, 2019). This provides a clear, quantitative summary of the evidence base which can demonstrate patterns and relationships which otherwise may not be apparent in individual studies (Arte & Filenko, 2023). Meta-analysis is particularly suited to systematic reviews of randomised-controlled trials and quasi-experimental studies with comparable methodologies addressing similar research questions (Schmid, White & Stijnen, 2020). However, meta-analysis is subject to publication bias, whereby studies with positive results are more likely to be published, and thus included within the systematic review (Riley, Higgins & Deeks, 2011). The impact of publication bias can be amplified through meta-analysis as the outcomes of multiple studies are combined, thus increasing the weight of the positive study outcomes (Cooper, Robinson & Dorr, 2006). Additionally, variation in study quality can influence results, with high-quality study outcomes being combined with those of their lower quality counterparts (Cheung, 2019). Finally, and as the primary factor in a decision not to utilise meta-analysis within this systematic review, meta-analysis lends itself primary to homogenous study design, population, intervention and outcomes (Cheung & Vijayakumar, 2016). This means that meta-analysis is best applied to studies including very similar study interventions and outcome measures (Ioannidis, Patsopoulos & Rothstein, 2008). Owing that this systematic review seeks to

explore the impact of different education models upon the moderation of high-risk UV exposure behaviours, the study interventions and outcome measures being reviewed vary between studies. Using meta-analysis to understand the impact of the interventions would not be appropriate to fully interpret the variation in impact based on the individual interventions (Glasziou & Sanders, 2002). Consequently, meta-analysis was removed from consideration.

Other forms of data analysis were excluded as their focus point was primarily targeted to qualitative studies, making them inappropriate for use in this systematic review which exclusively utilises quantitative research. Examples of these tools for qualitative data synthesis include meta-ethnography, thematic synthesis, grounded theory synthesis and critical interpretative synthesis (Richards & Hemphill, 2018). All of these data analysis methods were removed from consideration.

Meta-regression was considered for application to this systematic review. Meta-regression is a statistical analysis technique that builds upon meta-analysis through exploration of the impact of study-level characteristics on effect sizes (Higgins & Thompson, 2004). In contrast to meta-analysis, which combines study effects to provide a pooled estimation, meta-regression explores how factors such as sample size, study design and participant demographics can explain heterogenicity among individual study outcomes (Tipton, Pustejovsky & Ahmadi, 2019). The ability for meta-regression to explain heterogenicity among studies through the identification of moderator variables is one of the primary strengths in this model of data analysis (Schmidt, 2017). Additionally, meta-regression can adjust for confounding variables that may influence study biases, enabling researchers to isolate the effect of specific variables and improve the validity of the synthesis (Stanley & Doucouliagos, 2013). Comparably to meta-analysis, meta-regression is susceptible to publication bias, which can distort the overall findings and accuracy of the synthesis in favour of published data with positive outcomes (Willis & Riley, 2017). Meta-regression is suitable for systematic reviews where heterogeneity is present and is suitable for exploratory analysis aimed at uncovering relationships between variables, both factors making meta-regression a suitable option for this review (Bom & Rachinger, 2019). However, meta-regression is a complex statistical technique, requiring expertise and time investment that go beyond the scope of this review (Tipton, 2015). Additionally, meta-regression analysis usually requires multiple researchers working on the synthesis simultaneously to reduce researcher bias and burden of workload, which again falls outside of the scope of this review (Tipton, Pustejovsky & Ahmadi, 2019). Consequently, meta-regression was removed from consideration in this systematic review.

Narrative synthesis was selected as the most applicable model for data synthesis for the purposes of this review. Narrative synthesis is a qualitative process used to integrate diverse study findings through a descriptive and interpretative approach (Cruzes, Dyba, Runeson & Host, 2014). This is

particularly applicable to reviews comprising heterogeneous studies that are too diverse in design and method for meta-analysis to be applied (Whittlemore, Chao, Jang, Minges & Park, 2014). This is the case with the included research studies, as heterogenicity in study interventions is necessary to comprehensively review the impact of education models on behaviour moderation (Von Hippel, 2015). Additionally, narrative synthesis preserves the richness and context of the original studies, providing a deeper, more nuanced understanding of the research topic compared to that provided through meta-analysis and meta-regression data synthesis methods (Cumpston, Brennan, Ryan & McKenzie, 2023). Comparing and contrasting the findings of multiple studies through narrative synthesis also supports the identification of overarching themes and patterns, offering a comprehensive view of the evidence (Haddaway, Woodcock, Macura & Collins, 2015). The primary limitation of narrative synthesis is the inherent subjectivity of this compared to meta-analysis (Lisy & Porritt, 2016). Subjectivity within narrative synthesis can produce bias within the review and must be managed through rigorous and transparent analysis process (Aromataris & Pearson, 2014). Publication bias can also impact narrative synthesis in a comparable manner to that of meta-analysis and meta-regression (Rahi, 2017). The risk of publication bias impacting on this review has been mitigated through rigorous search strategy applied across multiple databases, using standardised search terms and inclusion and exclusion criteria (Lin & Chu, 2017).

In order to reduce risk of bias in the narrative synthesis, a clear protocol must be developed before the synthesis is commenced (Cumpston, Brennan, Ryan & McKenzie, 2023). This includes detailed planning of the research question using the PICO framework and clear, unambiguous inclusion and exclusion criteria, as detailed above (Haddaway, Woodcock, Macura & Collins, 2015). Additionally, a systematic approach to data extraction will be undertaken using a standardised table developed using PRISMA and Cochrane collaboration data collection template (Gough, Thomas & Oliver, 2012). Another method commonly used to reduce risk of individual bias in narrative synthesis is the use of multiple researchers working concurrently together (Abrami, Borokhovski, Bernard, Wade et al, 2010). The use of additional researchers is not within the scope of this review (Evans, 2022). This will be alternately managed through reflective practice, with the researcher applying reflexivity throughout the synthesis process (Pollock & Berge, 2017). Simultaneously, the researcher will engage in regular academic supervision to review the synthesis process and outcomes, with the aim to improve rigour and further reduce risk of bias (Heale & Forbes, 2013). The use of the established CASP tools to systematically assess quality of the studies will also support in reducing the risk of bias within the narrative synthesis, as this tool provides a structured approach for research appraisal (Pati & Lorusso, 2017). Triangulation will be conducted through the comparison of included studies to validate interpretations and further reduce risk of bias (Rahi, 2017). The studies will be analysed in two groups; RCT's and quasi-experimental research, and the narrative synthesis will follow the stages set out in centre for reviews and disseminations' guidance for

systematic reviews (McKenney & Reeves, 2013). There are four key elements to this framework: developing a theory of how, when, why and for whom the intervention works, developing a preliminary synthesis of findings of included studies, exploring relationships within and between the studies, and assessing the robustness of the synthesis (Pollock & Berge, 2017). Additionally, narrative synthesis allows for exploration of qualitative aspects of the review question to provide rich, contextualised insights into UV exposure behaviours (Noble & Heale, 2019). The additional information through the review of qualitative aspects influencing UV exposure behaviours will provide useful insight for future application to practice (Kim, Sefcik &Bradway, 2016).

## 2.4 Conclusion

This chapter has critically discussed the underpinning theoretical basis of this systematic review, including rationale for the types of data included within the review. The formulation of the research question has been explored using the underpinning PICO framework (Methley, Campbell, Chew-Graham, McNally & Cheraghi-Sohi, 2014). The search terms, Boolean operators and inclusion and exclusion criteria have been critically discussed, providing rationale for these. The database search process has been detailed using the PRISMA framework (Moher, 2009), and rationale for studies excluded has been provided. The characteristics of the included studies has been provided. Data synthesis and analysis methods have been critically discussed in depth, providing rationale for the exclusion of a range of methods, as well as rationale and method of the chosen synthesis and analysis methods, including tools utilised to reduce risk of bias within the analysis.

The next chapter will present the findings of the systematic review as a narrative synthesis.

# Chapter 3: Findings

This chapter will systematically present the findings of the included studies, detailing the results of each study individually, before these are combined and compared within the discussion section of this review.

## 3.1 Application of Search Strategy

A systematic literature search was conducted using the defined search terms, Boolean Operators. Each database was searched individually. The following process was then followed to apply the inclusion and exclusion criteria:

1. **Screening of titles** – Titles of retrieved studies were screened, applying the inclusion/exclusion criteria. This allowed for the immediate exclusion of studies pertaining to irrelevant topics.

2. **Screening of Abstracts** – The abstracts of studies not already excluded were then reviewed, applying the inclusion/exclusion criteria. At this stage, it became apparent that some of the studies included participants over 18 years of age, who did not provide direct care to those under 18 years of age, leading to their exclusion.

3. **Review of Full Texts** – Full texts of the remaining studies were obtained and reviewed. The eligibility criteria were again applied, ensuring that the selected studies were appropriate for inclusion in the systematic review. One text was excluded at this point, as this was a narrative on sun safety education programmes as opposed to research.

## 3.2 Database Search Results

Search of the database CINAHL Ultimate yielded 11 results. Two duplicate studies were removed. One study was removed as it did not meet the inclusion criteria of including participants under 18 years of age or their direct care providers (Andersen, Buller, Walkosz et al, 2017). Two studies were excluded as they did not provide a behaviour change intervention or control group (Carter, Mills,

Mazzucchelli & Carolan, 2015; Baker, Finch, Soyer, Marshall Baade, Youl & Janda, 2015). One further study was excluded as this was a feasibility study, with the full research project not yet completed (Hubbard, Cherrie, Gray et al, 2020). Five studies met the eligibility criteria and were included in this systematic review:

i. Hubbard, G., Kyle, R. G., Neal, R. D., Marmara, V., Wang, Z., & Dombrowski, S. U. (2018). Promoting sunscreen use and skin self-examination to improve early detection and prevent skin cancer: Quasi-experimental trial of an adolescent psycho-educational intervention. *BMC Public Health*, *18*(1). https://doi.org/10.1186/s12889-018-5570-y.

ii. Hewitt, M. (2001). Evaluation of `sun-safe': A Health Education Resource for Primary Schools. *Health Education Research*, *16*(5), 623–633. https://doi.org/10.1093/her/16.5.623.

iii. Reynolds, K. D., Buller, D. B., Yaroch, A. L., Maloy, J., Geno, C. R., & Cutter, G. R. (2008). Effects of program exposure and engagement with tailored prevention communication on Sun Protection by young adolescents. *Journal of Health Communication*, *13*(7), 619–636. https://doi.org/10.1080/10810730802412149.

iv. Norman, G. J., Adams, M. A., Calfas, K. J., Covin, J., Sallis, J. F., Rossi, J. S., Redding, C. A., Cella, J., & Patrick, K. (2007). A randomized trial of a multicomponent intervention for adolescent Sun Protection Behaviours. *Archives of Paediatrics & Adolescent Medicine*, *161*(2), 146. https://doi.org/10.1001/archpedi.161.2.146.

v. Crane, L., Morelli, J., Yohn, J., & Schneider, L. (1999). Block the sun, not the fun: Evaluation of a skin cancer prevention program for Child Care Centres. *American Journal of Preventive Medicine*, *17*(1), 31–37. https://doi.org/10.1016/s0749-3797(99)00031-8.

Search of the database PsychINFO yielded 16 results. 3 duplicates were removed. This database did not have facility to limit the search results based on age of participants, therefore, 12 of these were excluded due to study participants being exclusively adults (Heckman, Handorf, Darlow, Ritterband & Manne, 2017; Spring, King, Pagoto, Van Horn & Fisher, 2015; Abar, Turrisi, Hillhouse, Loken, Stapleton, & Gunn, 2010; Mahler, Kulik, Gerrard, & Gibbons, 2007; Prochaska, Velicer, Rossi et al, 2004.) One cluster randomised controlled trial was included in this systematic review:

i. Wu, Y. P., Parsons, B. G., Nagelhout, E., Haaland, B., Jensen, J., Zaugg, K., Caputo, H., Lensink, R., Harding, G., Yancey, J., Klein, S. Z., Leachman, S. A., & Tercyak, K. P. (2019). A four-group experiment to improve Western High School Students' Sun Protection Behaviours. *Translational Behavioural Medicine*, *9*(3), 468–479. https://doi.org/10.1093/tbm/ibz021.

Search of the Medline database yielded 8 results. Of these, 3 were excluded as they included participants over 18 years of age who were not direct care givers of under 18-year-olds. One study was excluded as the intervention provided was in reducing other high-risk behaviours such as smoking and alcohol consumption. 1 duplicate study was removed. Three studies met the inclusion criteria and were included within this literature review:

i. Hanna, S., Marinos, E., Bryan, D., Ahmed, T., Lo, S. N., Carlino, M. S., Smith, A., Cairns, G., Shannon, K., Long, G. V., Scolyer, R. A., & Saw, R. P. (2022). Effect of the sun safe student ambassador program on the attitudes, knowledge and behaviour of Australian high-school students towards Sun Safety: A Prospective Study. *Clinical and Experimental Dermatology*, *47*(11), 1956–1967. https://doi.org/10.1111/ced.15220.

ii. Aulbert, W., Parpart, C., Schulz-Hornbostel, R., Hinrichs, B., Krüger-Corcoran, D., & Stockfleth, E. (2009). Certification of sun protection practices in a German child day-care centre improves children's Sun Protection - the 'sun pass' pilot study. *British Journal of Dermatology*, *161*, 5–12. https://doi.org/10.1111/j.1365-2133.2009.09443.x.

iii. Hughes, B. R., Altman, D. G., & Newton, J. A. (1993). Melanoma and skin cancer: Evaluation of a Health Education Programme for secondary schools. *British Journal of Dermatology*, *128*(4), 412–417. https://doi.org/10.1111/j.1365-2133.1993.tb00201.x.

Database searches were systematically organised and tracked utilising personal saved search options within the databases, as well as externally using Zotero to organise and track searches. The final selection is demonstrated in the PRISMA flowchart (Figure 1). The characteristics of the studies are presented in Table 3.1 and the study findings are summarised in Table 3.2.

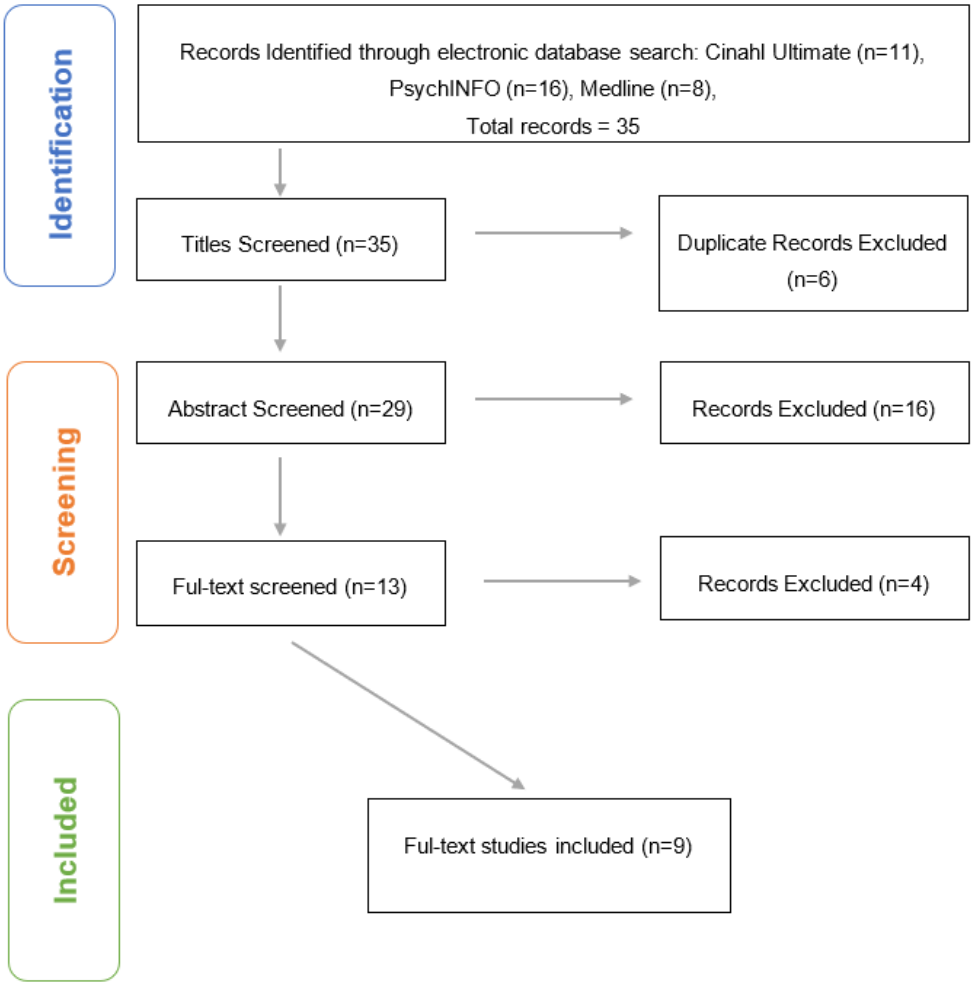


**Figure 1 PRISMA Flow Diagram**

**Table 3.1 Characteristics of Included Studies**

| Study ID | Authors | Country | Target Group | Recruitment | Sample size & setting | Design (Intervention groups, duration, randomisation) | Intervention | Outcomes | Outcome measures |
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| **1-HDHPW-RCT** | Hewitt, Denman, Hayes, Pearson & Wallbank, 2001. | United Kingdom | Primary school children aged 10-11 | Headteachers approached for participation. | Local state maintained primary school classes<br><br>A priori sample size calculation conducted to determine number of schools to include.<br><br>12 intervention, 4 control school classes. | Design: three-armed randomised controlled trial. Intervention groups:<br><br>1) Control group (no intervention; 104 children).<br>2) Workbook intervention (142 children).<br>3) Computer intervention (128 children).<br><br>Duration: 6 weeks<br><br>- Baseline, pre-intervention<br>- 6 weeks post-intervention<br><br>Randomisation: 179 schools approached for participation in randomised order until 12 confirmed then further schools approached for control group participation. | 1) Control group received no intervention<br>2) Workbook intervention group received a workbook version of the computer program, containing the same text and still images as the computerised programme, designed to meet the same objectives as the computer intervention.<br>3) Computer intervention group received a commercially developed, medically approved computer based teaching resource, taking approx. 20 minutes for children to work through. | Sun safety knowledge, attitudes and behavioural intentions | Children's sun safety knowledge, attitudes and behavioural intentions were measured using written test papers administered to the children under normal classroom conditions pre-intervention and 6 weeks post-intervention. |

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| **2-HMBALCSCSLSS-QI** | Hanna, Marinos, Bryan, Ahmed, Lo, Calino, Smith, Cairns, Shannon, Long, Scolyer & Saw, 2022 | Australia | High school children aged 11-16 years. | Headteachers of schools that had participated in the sun safe student ambassador programme (SSSAP) approached for participation.<br><br>Opt-out form provided to parents. | Five schools approached, two confirmed to participate. | Design: Quasi-experimental<br><br>Intervention groups: Assessment of the efficacy of the sun safe ambassador programme, no control group.<br><br>Duration: 3 months<br><br>- Baseline, pre-presentation<br>- Immediately post-presentation<br>- 3 months post-presentation<br><br>Randomisation: Schools were non-randomly selected based on prior programme delivery | The SSSAP as delivered by the melanoma institute Australia, a comprehensive day long training session for student ambassadors who then deliver their own sun safe presentation to peers. | Effect of SSSAP on knowledge, attitudes and behaviours students regarding melanoma and sun safety.<br><br>Secondary objective to assess correlation of students' school, gender and family history with sun safety. | Student self-conducted survey delivered using locally licensed health district computer software. Data extraction and scoring of free text performed by independent reviewers. |
| **3-WPNHJZCLHYKLT-QI** | Wu, Parsons, Nagelhout, Haaland, Jensen, Zaugg, Caputo, Lensink, Harding, Yancey, Klein, Leachman & Tercyak, 2019 | Utah, United States | High school children aged 14-17 years. | Headteachers approached for participation.<br><br>Opt-out form provided to parents. | 13 schools approached for inclusion, 11 confirmed. | Design: Quasi-experimental<br><br>Intervention groups:<br><br>1) Control; education only (565 children).<br>2) Education plus Sunscreen experiment (354 children)<br>3) Education plus UV photography (197 children).<br>4) Education plus Behaviour change intention setting | 1) Control group: received a skin cancer education PowerPoint presentation delivered in the classroom by a team of research assistants.<br><br>2) Sunscreen experiment group: received the same PowerPoint presentation in addition to a sunscreen experiment activity comprising the students working in small groups to test the level of UV detected when a UV generating light was blocked using different SPF sunscreens, followed by | Sun protection and tanning behaviours, sunburn occurrence, demographic characteristics. | Student self-conducted survey comprising demographic questionnaire, sunburn occurrence and sun protection and tanning behaviour assessment using Likert-type scale. |

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| | | | | | | worksheet (457 children).<br><br>Duration: 3 months<br><br>- Baseline, pre-presentation<br>- Immediately post-presentation<br>- 3 months post-presentation<br><br>Randomisation: Schools were non-randomly selected. | researcher led discussion of results.<br><br>3) photography group: received the same PowerPoint presentation in addition to a personalised photograph of their current facial UV skin damage, followed by researcher led discussion of the photographs.<br><br>4) Intention setting group: received the same PowerPoint presentation in addition to a behaviour change intention setting worksheet. | | |
| **4- APSHK CS-QI** | Aulbert, Parpart, Schulz-Hornbostel, Hinrichs, Kruger-Corcoran & Stockfleth, 2009 | Germany | Parents & daycare staff members | Daycare centre associated with the researching hospital enrolled for participation. | Only one day care centre included | Design: Quasi-experimental<br><br>Intervention groups:<br><br>1) Parents of daycare children<br>2) Daycare staff members<br><br>Duration: 13 months<br><br>- Baseline, pre-education<br>- Post-education questionnaire<br><br>Randomisation: No randomisation, study conducted with only one daycare centre. | 1) Written sun protection policy developed with day care staff.<br>2) 90-minute training sessions delivered to both staff and parents.<br>3) Parents received an information leaflet.<br>4) Sunscreen samples distributed.<br>5) A sun-safety mascot delivered to children.<br><br>6) UV index was announced by the centre director each day. | Sun safety knowledge, attitudes and behaviours. | Daycare centre unexpectedly visited by researchers on 5 sunny days where sunscreen application, hat use and shaded area availability were observed.<br><br>Pre and post education questionnaires given to both staff and parents. |

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| **5-RBYMGC-RCT** | Reynolds, Buller, Yaroch, Maloy, Geno & Cutter, 2008 | Colorado New Mexico & Arizona | Middle school student 11-13 years old, and their parents. | Parents and students approached for participation.<br><br>Written parental consent and student assent recorded. | Stratified, pair-matched, group-randomized, pretest-post-test, controlled design enrolling schools in Colorado, New Mexico, and Arizona.<br><br>Schools stratified by state and paired on size, grade levels, proportion of minority students & proportion of students on free meals.<br><br>599 students and 494 parents included | Design: Randomised controlled trial.<br><br>Intervention groups:<br>1) Receiving no sunny day's healthy ways (SDHW) middle school curriculum but receiving the summer intervention (115 students).<br>2) Receiving no SDHW middle school curriculum and no summer intervention (128 students).<br>3) Receiving the SDHW middle school curriculum and the summer intervention (173 students).<br>4) Receiving the SDHW middle school curriculum but no summer intervention (183 students).<br><br>Duration: 4 months<br><br>- Baseline assessment, pre-intervention<br>- 4 months post-intervention<br><br>Randomisation: Within each stratum, students were randomly assigned to either receive or not receive the | The summer intervention provided four individual parent and student newsletters mailed to participant homes. | Sun safety knowledge, sun protection and tanning behaviours | Student and parent self-conducted surveys comprising self-report measures on sun protection. Sunburn occurrence and sun protection and tanning behaviour assessment using Likert-type scale. |

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| | | | | | | summer intervention programme. | | | |
| **6- NACCS RRCP-RCT** | Norman, Adams, Calfas, Covin, Sallis, Rossi, Redding, Cella & Patrick, 2007. | California, United States. | Children aged 11-15. | 45 Primary care providers sent participation letters to parents with children in the eligible age range, including opt-out slips. | Participants were randomised to intervention or control group once inclusion was confirmed.<br><br>Total of 819 participants enrolled. | Design: Randomised controlled trial.<br><br>Intervention groups:<br><br>1) Control group; physical activity and diet intervention (424 children).<br>2) Sun Smart intervention (395 children).<br><br>Duration: 2 years<br><br>- Baseline assessment, pre intervention<br>- 6 months post intervention assessment.<br>- 12 months post intervention assessment.<br>- 24 months post intervention assessment.<br><br>Randomisation: Children were randomly assigned to intervention or control group. | Control group; physical activity and diet intervention:<br><br>Computerised expert kiosk in the physician's office, monthly telephone calls, a printed manual and mail contact for 24 months. Control condition designed to target physical activity, sedentary behaviour, fat intake and daily servings of fruits and vegetables.<br><br>Sun smart intervention: Brief counselling on sun protection from primary care provider, interactive computer sessions, telephone assessments, printed tailored feedback, a printed manual, mailed tip sheets and sunscreen samples. | Sun protection behaviour scale,<br><br>Stage of change for using sun protection | Child self-reported sun protection behaviours using 7-item scale questionnaire.<br><br>Self-reported intention to consistently protect from sun exposure. Score used to classify children into 1 of 5 stages of change. |

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| **7-HKNMWD-QI** | Hubbard, Kyle, Neal, Marmara, Wang & Dubrowski, 2018 | Scotland, United Kingdom | 15–16-year-old school students | Headteachers of 37 secondary schools approached for participation.<br><br>Opt-out forms sent to parents.<br><br>5 schools participated; 4 intervention and 1 control group. | Schools assigned randomly to the intervention or control group. | Design: quasi-experimental<br><br>Intervention groups:<br><br>3) Control group; no intervention (79 children).<br>4) Sun Smart intervention (627 children).<br><br>Duration: 6 weeks<br><br>- Baseline assessment, 2 weeks before intervention.<br>- 4 weeks after intervention<br><br>Randomisation: No randomisation, no aim to recruit a representative sample. | Control group: No intervention<br><br>Intervention group: A skin cancer nurse specialist delivered a 50-minute presentation to students in school and gave a home-based assignment comprising an exercise for self-skin examination and action plan. | Sunscreen use, intention and planning<br><br>Skin self-examination behaviour, intention and planning.<br><br>Rates of discussion about skin cancer.<br><br>Understanding of skin cancer risk. | Student self-reported survey using continuous rating scales and free text. |
| **8-HAN-QI** | Hughes, Altman & Newton, 1993 | England, United Kingdom. | 12–16-year-old school students | 7 schools in different areas of England participated.<br><br>No comment made to how they were selected, enrolled or randomised. | Within each school, five classes within the same year group were assigned to one of the 5 intervention groups. (543 students total). | Design: quasi-experimental<br><br>Intervention groups, 1 of each group at each of the 7 participating schools:<br><br>1) Control group, no education.<br>2) 'Sun Cool' workbook intervention only.<br>3) 'Sun Cool' workbook and video intervention.<br>4) 'Sun Cool' workbook and poster design homework. | Control group, no education.<br><br>'Sun Cool' workbook intervention only designed to make covering-up look desirable, and giving information about UV radiation and skin cancer, and tips for avoiding sun exposure.<br><br>'Sun Cool' workbook and video intervention – Known actress discussing sun and skin cancer<br><br>'Sun Cool' workbook and poster design homework – Students given homework | Sun safety knowledge, attitudes and behaviours. | Student self-reported surveys. |

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| | | | | | | 5) 'Sun Cool' workbook and follow up classroom discussion.<br><br>Duration: 4 months:<br>- 2 months post intervention.<br>- 4 months post intervention<br><br>Randomisation: No randomisation, schools across England included to target a wider range of social and regional factors. | project to design sun safety public education posters.<br><br>'Sun Cool' workbook and follow up classroom discussion later the same week about the issues raised by the information package. | | |
| **9-CSYMP-RCT** | Crane, Schneider, Yohm, Morelli & Plomer, 1999 | Colorado, United States | Local state-licensed preschool and daycare centres | Schools and daycare centres recruited by mail and phone.<br><br>27 centres recruited and stratified | 159 centres responded, of which 44% did not provide adequate sun protection and were targeted for recruitment.<br><br>Only centres with 20+ children considered. | Design: Randomised controlled trial<br><br>Intervention groups: Control group: no intervention (14 centres). Intervention group: (13 centres)<br><br>Duration: 1 year<br><br>- Pre-intervention<br>- 1-year post-intervention.<br><br>Randomisation: centres were stratified by number of students, paired within the group based on estimated proportion of minority students, and randomly assigned to intervention or control groups. | Control group: no intervention.<br><br>Intervention group: 3-hour educational workshop for centre staff and parent packs including information leaflet, sunscreen samples, learning activities to complete with children and a fridge magnet. | Sun safety knowledge, attitudes and behaviours. | Interview and self-survey of centre directors.<br><br>Observations of exposure behaviours during outdoor free play.<br><br>Review of written centre policies prior to intervention. |

## 3.3 Narrative Synthesis

### 3.3.1 Study ID: 1-HDHPW-RCT

The first study included within this literature review is that of Hewitt, Denman, Hayes, Pearson and Wallbanks (2001), titled *'Evaluation of 'Sun-Safe': a health education resource for primary schools.* This study is a randomised controlled trial designed to compare the impact of an intervention delivered in paper format versus digital format. This is the only included study that aims to directly assess the impact of digital education tools in the moderation of ultraviolet exposure behaviours.

**Population**

The study population is comprised of primary school children aged 10-11 years. Headteachers of 179 state-maintained schools within the Nottingham health district were approached for participation. Schools confirmed for inclusion were allocated to one of the intervention groups, until the a priori sample size had been achieved with a total of 12 schools. Once the intervention groups had been set, further schools were approached for inclusion as control groups. Throughout the participant enrolment process, the allocation sequence was not concealed from either participants or investigators.

**Interventions**

Three distinct participant groups were established: workbook intervention group, computer intervention group and control group. The computer intervention group were delivered a commercially developed, medically approved computer-based teaching resource. The computer intervention was delivered to 128 students within a classroom setting and took the students approximately 20 minutes to work through. The workbook intervention was designed using text and still images from the computer intervention, in order to match the education materials across both interventions. The workbook intervention was delivered to 142 students within the classroom setting and took the students approximately 20 minutes to work through.

**Comparison**

The comparison group within this study is the control group, comprising 104 students who received no intervention.

**Outcomes**

Sun safety knowledge, attitudes and behavioural intentions were measured using written test papers administered under normal classroom conditions. The study showed improvement in knowledge, attitudes and behavioural intentions scoring across both intervention groups. Whilst there was no statistically significant difference in improvements between the two intervention modalities, the workbook group scored marginally higher on some areas than the computer group, suggesting that there was no benefit to the computer model over the workbook model, although further research would be required to confirm this. The control group showed no significant increase in scores across all outcome measures.

**Strengths and Limitations**

This study used a well-designed education resource which was carefully planned to ensure the computer and workbook styles provided comparable education resources. The pre and post-test questionnaires delivered to students allowed for the collection of detailed insights into student perception and knowledge, using a qualitative approach to capture the richness of participant experiences. This study was primarily limited by the small sample size totalling 374 students across all groups. Additionally, the participant sample was selected from within one district of the United Kingdom. Consequently, the generalizability of findings within this study are limited to similar education settings and cannot be assumed as a representative sample of the United Kingdom.

### 3.3.2 Study ID: 2-HMBALCSCSLSS-QI

The second study included within this literature review is that of Hanna, Marinos, Bryan, Ahmed, Lo, Calino, Smith, Cairns, Shannon, Long, Scolyer and Saw (2022) titled *'Effect of the Sun Safe Student Ambassador Programme on the attitudes, knowledge and behaviour of Australian high-school students towards sun safety: a prospective study'.* This is a quasi-experimental prospective study design to assess the impact of an education programme delivered in Australia.

**Population**

Headteachers of high schools that had participated in the sun safe student ambassador programme (SSSAP) approached for participation. Five schools enrolled comprising 503 participants aged 11-16 enrolled in the study.

**Interventions**

The SSSAP delivered by the melanoma institute Australia comprises a comprehensive day long training session for student ambassadors who then deliver their own sun safety presentation to their peers. The impact of the student delivered peer presentations is assessed in this study.

**Comparison**

Comparison drawn from pre-presentation questionnaire data of the same study cohort.

**Outcomes**

Knowledge, attitudes and behaviours regarding melanoma and sun safety measured using student self-conducted surveys using computer software. Immediately post-presentation questionnaires revealed increase in scores across all knowledge outcome measures, as well as improvement in some of the attitude and behaviour measures. At 3 months post-presentation, these improvements were sustained. The researchers note that further research is required to determine if this improvement is sustained longer term, ultimately decreasing skin cancer incidence within this cohort.

**Strengths and Limitations**

The prospective design and larger sample size included within this study enhances the credibility and generalisability of the findings. Additionally, the outcome measures focus on self-efficacy provides valuable insight into behaviour change mechanisms which can be further utilised to enhance current understanding of education models for ultraviolet exposure behaviour moderation targeted to under 18-year-olds.

### 3.3.3 Study ID: 3-WPNHJZCLHYKLT-QI

The third study included within this review is that of Wu, Parsons, Nagelhout, Haaland, Jensen, Zaugg, Caputo, Lensink, Harding, Yancey, Klein, Leachman and Tercyak (2019) titled *'A four-group experiment to improve western high school students' sun protection behaviours.* This study is quasi-experimental in design, comparing the impacts of classroom delivered PowerPoint presentation alone with the impact of concurrent interventions including sunscreen experiments, UV photography and behavioural intention setting.

**Population**

This study included high-school students aged 11-16 from 11 schools, for a total of 1,573 students.

**Interventions**

Three separate interventions were delivered in addition to the PowerPoint presentation as provided to the control group. A cohort of 354 students was given a sunscreen experiment comprising students working in small groups to test the level of UV detected when a UV light was blocked using different sunscreens, followed by researcher led discussion of results. One cohort of 197 students received a personalised UV photograph of their current facial UV skin damage followed by researcher led discussion of results. A cohort of 457 students received a behaviour intention setting worksheet which they completed in class, followed by a researcher led discussion of the results.

**Comparison**

A cohort of 565 students was used as the control group. This cohort was delivered a PowerPoint presentation within the classroom setting provided by a team of research assistants. The results from this group were used as a comparator to demonstrate changes directly resulting from the additional concurrent interventions.

**Outcomes**

Sun protection, tanning behaviours, sunburn occurrence and demographic characteristics were measured pre-intervention, immediately post-intervention and 3 months post-intervention. Contrary to the hypothesis, the control group showed overall improvement over time, demonstrating that the PowerPoint alone had a greater impact upon outcomes than was anticipated. Demographic characteristics showed greater increase in sun protection, but simultaneous increase in intentional tanning and sunburn occurrence among non-white students. Overall, across all groups, sunburn occurrence increased. Use of wide brim hats and long trousers/skirts did not improve across any of the intervention or control groups. All other outcomes measured showed positive intervention impacts.

**Strengths and Limitations**

This study design is robust through randomisation and four-group comparison design. Randomised controlled trials are considered the gold standard in hierarchy of evidence (Djulbegovic & Guyatt, 2017). The participants were randomised, reducing selection bias and increasing the internal validity of the study findings (Haneuse, 2016). In addition, the inclusion of four different intervention

groups alongside the control group allows for comprehensive comparison of different education strategies (Amir-Behghadami & Janati, 2020). The sample size was large, with a total of 1573 participants. This large sample size increases the generalisability of the results as well as increasing the statistical power to detect significant differences between groups. Conversely, the participant selection is limited to one geographic location, which could reduce the generalisability of the findings to the specific demographic and cultural context of western high schools. Additionally, the studies reliance upon follow-up assessments may have introduced attrition bias, although percentage of participants lost to follow up is not commented upon.

### 3.3.4 Study ID: 4-APSHKCS-QI

The fourth study included in this review is that of Aulbert, Parpart, Schulz-Hornbostel, Hinrichs, Kruger-Corcoran and Stockfleth (2009) titled *'Certification of sun protection practices in a German child day-care centre improves children's sun protection – the 'Sun Pass' pilot study'*. This study is a quasi-experimental designed pilot study assessing the impact of introducing a sun safety certification programme into daycare centres.

**Population**

A daycare centre associated with the researching hospital was enrolled in the study

**Interventions**

A written sun protection policy developed with the daycare staff, in addition to a 90-minute education session for both staff and parents. Parents received an information leaflet, and sunscreen samples. A sun-safety mascot was delivered to the children along with daily announcements of the UV index within the centre.

**Comparison**

Pre-intervention baseline outcome measure scores used as comparator to demonstrate effect of the certification programme.

**Outcomes**

Sun safety knowledge, attitudes and behaviours were assessed using pre and post intervention questionnaires. Additionally, the daycare was unexpectedly visited by researchers on 5 separate occasions to observe sunscreen application, hat use and shaded area availability. The intervention

was successful in increasing children's hat and sunscreen use as well as both staff and parent knowledge. However, the intervention failed in reducing the time spent outdoors during the highest daylight UV hours and did not improve staff role modelling behaviours.

**Strengths and Limitations**

This study provided valuable insights into the feasibility and effectiveness of day care centre sun safety certification programmes. The use of mixed methods in the delivery of the education intervention enriched the understanding of the programme, and sun safety education models as a whole. In addition, this study was able to highlight the impact and importance of including children's primary carers within the education models. The small sample size utilised in this pilot study reduces the reliability and generalisability of this study. Although the study does not aim to provide exhaustive evidence of the impact of the certification model, further research would be required to confirm the results of this study prior to the wider implementation of a certification model to improve high risk UV exposure behaviours.

### 3.3.5 Study ID: 5-RBYMGC-RCT

The fifth study included within this review is that of Reynolds, Buller, Yaroch, Maloy, Geno and Cutter (2008) titled *'Effects of Program exposure and engagement with tailored prevention communication on Sun protection by young adolescents.* This is a randomised controlled trial designed to compare the impacts of school curriculum-based interventions with a summer holiday newsletter-based intervention.

**Population**

Students aged 11-13 years and their parents in Colorado, New Mexico and Arizona recruited from middle schools. Schools were stratified by state and pair matched based on size, grade levels, proportion of minority students and proportion of students receiving free school meals.

**Interventions**

Participants and their parents were assigned to one of the three intervention groups, or control groups. The first intervention group of 173 participants received both the Sunny Days Healthy Ways (SDHW) school-based curriculum and the summer newsletter intervention. The second intervention group of 183 participants received the SDHW curriculum but no summer newsletter intervention.

The third intervention group of 115 participants received no SDHW intervention but did receive the summer newsletter intervention.

**Comparison**

The control group of 128 participants received neither the SDHW curriculum nor the summer newsletter intervention.

**Outcomes**

Sun safety knowledge, sun protection and tanning behaviours were measured for both student and parent using self-conducted surveys comprising self-reported measures using a Likert-type scale. Whilst the intervention showed positive impact upon parent knowledge and behaviours, no significant improvement was demonstrated among the students on any of the outcome measures.

**Strengths and Limitations**

The newsletter design was tailored to the students based on their personal information as well as the results of their pre-intervention questionnaires. This meant that the newsletters focused on specific areas where the individual scores showed areas for development. This tailored prevention communication was innovative, with no other comparable education models included within this review or located during the systematic database search process. Additionally, this study utilised a large sample size and rigorous statistical analysis to determine the efficacy of the delivered education models.

Over half of the participants were lost to follow up across all interventions (56%) and control groups (58%). This was attributed to the students transitioning from middle to high school during the time between intervention and post-intervention testing. This large proportion of participants lost to follow up reduces the validity of the results, as the research data is incomplete. Additionally, the researchers identify significant differences between the intervention and control groups in ages, parental marital and education statuses and ethnicity. However, the researchers fail to explore the potential impact that these demographic differences may have had upon the results. This constitutes a significant variable within this study, with no attempt made to control for this, bringing into question the reliability and validity of the study results. Consequently, the results from this study are not generalisable to a wider population, with the reliability and validity being uncertain.

### 3.3.6 Study ID: 6-NACCSRRCP-RCT

The sixth study included within this review is that of Norman, Adams, Calfas, Covin, Sallis, Rossi, Redding, Cella and Patrick (2007) titled *'A Randomized trial of a multicomponent intervention for adolescent sun protection behaviours.* This is a randomised controlled trial designed to assess the impact of an intensive sun smart intervention in improving sun protection behaviours and intentions.

**Population**

The intervention group was comprised of 395 participants aged 11-15, recruited from 45 primary care providers regular patient lists.

**Interventions**

The sun smart intervention delivered to the intervention group used a multifaceted approach to education and included a brief counselling on sun protection from primary care provider, interactive computer sessions, telephone assessments, printed tailored feedback, a printed manual, mailed tip sheets and sunscreen samples.

**Comparison**

The control group was delivered a physical activity and diet intervention comprising of a computerised expert kiosk for participants in the physician's office, monthly telephone calls, a printed manual and mail contact for 24 months. The control condition was designed to target physical activity, sedentary behaviour, fat intake and daily servings of fruits and vegetables.

**Outcomes**

Outcomes were measured using a self-reported questionnaire comprising a 7-item scale of sun protection behaviours. Change stage was identified using a self-reported intention to consistently protect oneself from sun exposure. This showed a statistically significant improvement in sun protection behaviours across all outcome measures. It also demonstrated a positive association with number of intervention sessions attended directly correlating to increased improvement of sun protection behaviours.

**Strengths and Limitations**

This randomised controlled trial had robust methodological rigor, including randomisation and blinding, enhancing the reliability of the study findings. The multicomponent nature of the intervention enabled this to target multiple behaviours, increasing the ecological validity of this

study. The generalizability of the findings is limited owing to the specific geographical location in which this study was conducted. This could be improved through repeating the study across multiple additional geographic locations. Additionally, long-term follow up was not conducted, thus the sustainability of the behaviour changes achieved through this intervention cannot be confirmed.

### 3.3.7 Study ID: 7-HKNMWD-QI

The seventh study included in this review is that of Hubbard, Kyle, Neal, Marmara, Wang and Dubrowski (2018) titled *'Promoting sunscreen use and skin self-examination to improve early detection and prevent skin cancer: quasi-experimental trial of an adolescent psycho-educational intervention'.* This study is quasi-experimental in design assessing the impact of an education intervention in moderating high risk UV exposure behaviours and improving self-skin examination.

**Population**

The intervention group contained 627 participants aged 15-16 years, recruited from Scottish primary schools randomly assigned to the intervention or control groups.

**Interventions**

The intervention group received a 50-minute presentation delivered in school by a skin cancer specialist nurse, followed by a home-based assignment comprising a self-skin examination and action planning exercise.

**Comparison**

Control group comprising 79 participants received no intervention. Additionally, baseline scores were assessed pre-intervention delivery to provide comparison.

**Outcomes**

Sunscreen use, intentions and planning were assessed using self- reported surveys using continuous rating scales and free text. Self-skin examination and skin cancer understanding and discussion rates were also assessed through questionnaires.

**Strengths and Limitations**

This study utilised a quasi-experimental design with a large sample size, ensuring good external validity. The intervention was well structured, using varied educational techniques focusing on self-efficacy in behavioural change. The schools were assigned to study or intervention group without randomisation or blinding, and researchers make no comment on the demographic statistics of the groups, with no aim to recruit a representative sample. This lack of randomisation and blinding could introduce selection bias and may ultimately impact upon the internal validity of the results.

### 3.3.8 Study ID: 8-HAN-QI

The eighth study included in this review is that of Hughes, Altman and Newton (1993) titled *'Melanoma and skin cancer: evaluation of a health education programme for secondary schools.* This study is quasi-experimental in design, comparing the impacts of different education delivery methods to assess their individual impact on moderating high-risk UV exposure behaviours.

**Population**

The intervention groups contained a combined total of 543 participants, although no individual participant numbers by intervention were given. The participants were 12–16-year-olds recruited from schools from one region of England. No comment is made to how these schools were selected, enrolled or randomised within the study.

**Interventions**

Four intervention groups were set up, and received sun cool workbook only, sun cool workbook plus video intervention, sun cool workbook plus poster design homework, or sun cool workbook plus classroom discussion. The sun cool workbook was designed to make covering up in the sun appear desirable whilst providing information about UV radiation, skin cancer and tips for avoiding sun exposure.

**Comparison**

The control group containing an undisclosed number of participants received no interventions.

**Outcomes**

The outcomes were assessed using self-reported surveys measuring sun safety knowledge, attitudes and behaviours. The study demonstrated statistically significant improvements in knowledge and reported attitudes among the intervention groups. No significant differences in behaviours were observed when compared with the control group.

**Strengths and Limitations**

This study delivered an intervention comprising a variety of educational tools, including presentations, interactive sessions, visual aids and homework task. This comprehensive approach likely encouraged student engagement and improved the conveyance of information to students through the facilitation of active learning (Chi & Wylie, 2014). However, the study contains major weaknesses, primarily concerning participant numbers and recruitment. Throughout the study, participant numbers are not explicitly given, bringing the reliability and validity of the study into question. Additionally, the demographic characteristics of the participant groups was not discussed, meaning potential for selection bias is not managed and the internal validity of the study is reduced. Additionally, the participants were recruited from only one district in England, limiting the generalisability of the study. Further to this, the study demonstrated successful increases in knowledge scores, but not in sun protection behaviours. This outcome suggests that increasing knowledge alone is not sufficient to drive significant behavioural changes.

### 3.3.9 Study ID: 9-CSYMP-RCT

The Final study included in this review is that of Crane, Schneider, Yohn and Plomer (1999) titled *“Block the sun, not the fun”: Evaluation of a skin cancer prevention Program for childcare centres.* This study is a randomised controlled trial assessing the impact of a preventative skin cancer education programme upon children, day care centres and parents.

**Population**

Specific participant numbers not given, instead displayed as number of day care centres enrolled with an average of 75 children per day care centre. 13 centres enrolled into intervention group.

**Interventions**

The intervention groups received a 3-hour educational workshop for day care centre staff, parent information leaflets, sunscreen samples, fridge magnets and a learning activity to complete with children.

**Comparison**

No intervention initially, although the education package was delivered to the control group at a later time on completion of study data collection.

**Outcomes**

Outcomes were measured using self-reported pre and post intervention questionnaires. Results showed a significant increase in sun protection knowledge and sunscreen use at childcare centres. There was no significant increase demonstrated in sun protection attitudes or practices of parents. Additionally, no change in use of shade or clothing was observed in childcare centres.

**Strengths and Limitations**

The participant sample was selected from a diverse range of childcare centres, which were stratified based on number of children and paired according to estimated proportion of minority children. Additionally, the centres were randomly assigned to the intervention or control groups. The consideration given to these aspects of the study increases the reliability and generalisability of the study, as the participant groups can be considered representative of the study population.

Table 3.2 Summary of Study Results

| Study ID | Intervention group size | Control group size | Intervention | Control | Outcome Measures | Effect Size | Confidence Interval | p-Value |
|---|---|---|---|---|---|---|---|---|
| **1-HDHPW-RCT** | Workbook intervention = 142<br><br>Computer intervention = 128 | 104 | Workbook intervention: workbook version of computer programme containing same text and still images, designed to meet the same objectives. Computer intervention: commercially developed, medically approved computer based teaching resource, taking approx. 20 minutes for children to work through. | No intervention | Sun safety knowledge, attitudes and behavioural intentions | Workbook: 2.36 increase<br><br>Computer: 1.73 increase<br><br>Control: 0.93 increase Mean difference between interventions: 0.45 | 95% | Differences between groups (P=0.014)<br><br>Increases in knowledge compared to pre-intervention (P=0.0001) Increase in knowledge variation between interventions (P=0.0005). |
| **2-HMBALCSCSLSS-QI** | Immediately post-presentation assessment = 274<br><br>3 months post-presentation assessment = 337 | Pre-presentation assessment = 503 | The SSSAP as delivered by the melanoma institute Australia, a comprehensive day long training session for student ambassadors who then deliver their own sun safe presentation to peers. | Pre-presentation scores used as control | Effect of SSSAP on knowledge, attitudes and behaviours students regarding melanoma and sun safety. Secondary objective to assess correlation of students' school, gender and family history with sun safety. | Statistically significant improvement at all points, across knowledge, attitudes and behaviour scores across cohorts.<br><br>Increase in sunscreen use noted initially but not sustained at 3 month follow up. | Not Given | Knowledge increased from mean 11.8 to 13.8 (P<0.001)<br><br>Improvement in attitude to tanning (P<0.01) Daily sunscreen uses improvement (P=0.03) Reduction in time spent outdoors (P=0.04) |
| **3-WPNHJZCLHYKLT-QI** | Education plus Sunscreen | Control; education only = 565 | Sunscreen experiment group: received the same PowerPoint | skin cancer education PowerPoint | Student self-conducted survey comprising | All interventions showed | 95% | P values across all outcome |

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| | experiment = 354<br><br>Education plus UV photography = 197<br><br>Education plus Behaviour change intention setting worksheet =457 | | presentation in addition to a sunscreen experiment activity comprising the students working in small groups to test the level of UV detected when a UV generating light was blocked using different SPF sunscreens, followed by researcher led discussion of results.<br>UV photography group: received the same PowerPoint presentation in addition to a personalised photograph of their current facial UV skin damage, followed by researcher led discussion of the photographs.<br>Intention setting group: received the same PowerPoint presentation in addition to a behaviour change intention setting worksheet. | presentation delivered in the classroom by a team of research assistants. | demographic questionnaire, sunburn occurrence and sun protection and tanning behaviour assessment using Likert-type scale. | statistically significant increases in sun protection use, tanning behaviours. Sunburn incidence increased across all groups, with the UV photograph group showing the lowest increase. | | measures P<0.01 |
| **4-APSHKCS-QI** | 12 Staff members and 46 parents | Pre-intervention assessment to determine baseline | 1) Written sun protection policy developed with day care staff.<br>2) 90-minute training sessions delivered to both staff and parents.<br>3) Parents received an information leaflet.<br>4) Sunscreen samples distributed.<br>5) A sun-safety mascot delivered to children.<br>6) UV index was announced by the | Pre-intervention baseline assessment | Daycare centre unexpectedly visited by researchers on 5 sunny days where sunscreen application, hat use and shaded area availability were observed. Pre and post education questionnaires given to both staff and parents. | 20% increase in shaded playground area.<br><br>Statistically significant increases in sunscreen application, sun safety knowledge, and hat use. | Not Given | P=0.001 |

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| | | | centre director each day. | | | Intervention failed to improve staff role modelling behaviours. | | |
| **5-RBYMGC-RCT** | Summer intervention only = 115<br><br>Curriculum and summer intervention = 173<br><br>Curriculum only = 183 | No intervention = 128 | Receiving no sunny day's healthy ways (SDHW) middle school curriculum but receiving the summer intervention<br><br>Receiving the SDHW middle school curriculum and the summer intervention<br><br>Receiving the SDHW middle school curriculum but no summer intervention | Receiving no SDHW middle school curriculum and no summer intervention | Student and parent self-conducted surveys comprising self-report measures on sun protection. Sunburn occurrence and sun protection and tanning behaviour assessment using Likert-type scale. | Summer intervention did not improve outcomes for students but did improve parent knowledge. | Not Given | P<0.05 for all outcome measures |
| **6-NACCSRRCP-RCT** | Sun smart intervention = 395 | 424 | Computerised expert kiosk in the physician's office, monthly telephone calls, a printed manual and mail contact for 24 months. Control condition designed to target physical activity, sedentary behaviour, fat intake and daily servings of fruits and vegetables.<br>Sun smart intervention: Brief counselling on sun protection from primary care provider, interactive computer sessions, telephone assessments, printed tailored feedback, a printed manual, mailed tip sheets and sunscreen samples. | Physical activity and diet intervention | Child self- reported sun protection behaviours using 7-item scale questionnaire. Self-reported intention to consistently protect from sun exposure. Score used to classify children into 1 of 5 stages of change. | Statistically significant improvement in sun protection behaviours, positively associated with increased numbers of intervention sessions. | 95% | P=0.002 |

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| **7-HKNMWD-QI** | Intervention group = 627 | 79 | A skin cancer nurse specialist delivered a 50-minute presentation to students in school and gave a home-based assignment comprising an exercise for self-skin examination and action plan. | No intervention | A skin cancer nurse specialist delivered a 50-minute presentation to students in school and gave a home-based assignment comprising an exercise for self-skin examination and action plan. | Statistically significant changes observed in sunscreen use, Self-skin examination, sun safety planning, and illness perception | Not given | P<0.05 |
| **8-HAN-QI** | Intervention groups combined total = 543<br><br>No breakdown given of participant numbers in each intervention group. | Not specified | 1) 'Sun Cool' workbook intervention only.<br>2) 'Sun Cool' workbook and video intervention.<br>3) 'Sun Cool' workbook and poster design homework.<br>4) 'Sun Cool' workbook and follow up classroom discussion. | No intervention | 'Sun Cool' workbook intervention only designed to make covering-up look desirable, and giving information about UV radiation and skin cancer, and tips for avoiding sun exposure.<br>'Sun Cool' workbook and video intervention – Known actress discussing sun and skin cancer<br>'Sun Cool' workbook and poster design homework – Students given homework project to design sun safety public education posters.<br>'Sun Cool' workbook and follow up classroom discussion later | Statistically significant difference in knowledge and reported attitudes amongst intervention group.<br><br>No significant difference in behaviour compared to control group. | Not given | P < 0.005 |

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| | | | | | the same week about the issues raised by the information package. | | | |
| **9-CSYMP-RCT** | Specific participant numbers not given – explained as number of daycare centres enrolled containing an average of 75 children Intervention = 13 centres | 14 centres with an average of 75 children. | Intervention group: 3-hour educational workshop for centre staff and parent packs including information leaflet, sunscreen samples, learning activities to complete with children and a fridge magnet. | No intervention | Sun safety knowledge, attitudes and behaviours assessed using self-reported questionnaires. | Significant positive change in sun protection knowledge and sunscreen use at childcare centres.<br><br>No change in sun protection attitudes or practices of parents. No change in use or clothing or shade at childcare centres. | Not Given | P Value variable dependent on assessed value, ranging from 0.002 to 1 |

## 3.4 Conclusion

Having presented and summarised the findings, in the next chapter these will be discussed in relation to the key themes.

# Chapter 4: Discussion

This chapter will draw together the findings from the included studies into a critical discussion, to enable the identification of conclusions and recommendations for practice and future education model development.

## 4.1 Mechanisms of high-risk UV exposure behaviour change

In order to deliver effective behaviour modification education, it is vitally important to understand the mechanisms involved in behaviour change (Jones, Smith & Llewellyn, 2013). The health belief model provides a useful understanding of health behaviours (Rosenstock, 1974). The health belief model is a psychological model for explaining and predicting health behaviours through focusing on individuals' beliefs about perceived health conditions (Green, Murphy & Gryboski, 2020). The model suggests that behaviour change is influenced by perceived susceptibility, severity, benefits, barriers and cues to action (Jones, Jensen, Scherr, Brown, Christy & Weaver). Educational models that highlight the risks of UV exposure can increase perceived susceptibility and severity, motivating the adoption of protective behaviours (Glanz, Rimer & Viswanath, 2011). Additionally, education programmes emphasising the benefits of sun protection, while addressing benefits such as inconvenience and discomfort can increase perceived benefits while simultaneously reducing perceived barriers (Ahadzadeh, Pahlevan Sharif, Ong & Khong, 2015).

The health belief model was applied in the design of five of the included studies (Hubbard et al, 2018; Hewitt, Denman, Hayes, Pearson & Wallbanks, 2001; Reynolds et al, 2008; Norman et al, 2007; Crane, Schneider, Yohm, Morelli & Plomer, 1999). The education interventions all aimed to improve perceived susceptibility and severity through education about dangers of UV exposure, and skin cancer risk. Hubbard et al (2018) targeted this messaging specifically to students through emphasizing the increasing incidence of skin cancer among young people to increase perception of the personal and immediate susceptibility. Reynolds et al (2008) enhanced this messaging through tailoring the information to individual participant skin type and UV exposure habits, enhancing the relevance of the perceived threat.

However, despite tailoring this messaging, Reynolds et al (2008) summer intervention did not improve sun protection outcomes overall. This study was the first to trial personalised messaging within a sun safety education initiative, and the only included study to have utilised written messaging as the sole method of education. This study emphasized the importance of child

engagement with the education materials, with the mean average number of newsletters read by the children being 1.9 of 6 delivered. Of the households which did read the educational newsletters, a positive change in sun protection outcomes was evident for both parents and children. Consequently, the education materials could be considered effective when participant engagement is obtained, meaning the personalisation of materials is an effective method of delivering education messages. This hypothesis is supported by the later study conducted by Wu et al (2019), which used personalised education materials in the form of a UV photograph of each child's current facial UV damage. Wu et al (2019) showed the personalisation from the UV photographs to be superior in reducing sunburn occurrence and outdoor tanning when compared with non-personalised education materials. Comparatively, the method of delivery for the UV photography being delivered in the classroom setting meant that the intervention obtained 100% engagement from the students. This demonstrates that the personalisation of education materials can have strong impact when delivered in a manner that ensures student uptake (Illeris, 2018).

## 4.2 Educational strategies and engagement

All of the five studies utilising the health belief model employed comparable methods to improve perceived benefits and barriers to the moderation of high-risk UV exposure (Jones, Smith & Llewellyn, 2013). Another aspect of the health belief model applied to these studies was in improving self-efficacy to empower children and their caregivers to confidently perform UV protective behaviours (Babazadeh, Nadrian, Banayejeddi & Rezapour, 2016). There were two main methods utilised within these studies to support improved self-efficacy: interactive education tools encouraging engagement of the children, and the inclusion of caregivers in the education (Boyer, 2014). Hubbard et al (2018), Hewitt et al (2001) and Crane et al (1999) all utilised interactive education materials in the form of hands-on demonstrations and role-playing exercises to enhance child engagement and improve self-efficacy. This proved an effective method across all studies, with positive improvements in children's sun protection knowledge, attitudes and behaviours demonstrated throughout. Reynolds et al (2008) used personalised advice and feedback to enhance self-efficacy, although as this did not improve child engagement, outcomes were not improved overall.

## 4.3 Role of social and environmental influences

The studies by Norman et al (2007), Hanna et al (2022) and Wu et al (2019) all utilised peer and parental involvement to enhance the impact of the education and further improve UV-protective behaviours within the study cohorts. Norman et al (2007) included parental care givers by informing them of the study and providing copies of the education materials to parents. This study directly demonstrated positive correlation between parental and peer support with an increased improvement in sun protection behaviours compared to interventions lacking family support (Norman et al, 2007). Hanna et al (2022) informed parents of the study but did not directly engage parents within the study. Hanna et al (2022) highlight the potential for parental involvement to further improve education uptake and further reinforce sun safe practices. Wu et al (2019) included parents through providing education materials in paper format to parents by post. Although none of these studies directly assessed for the impact that parental involvement had upon behaviour modification, all of these studies showed overall positive impacts of the intervention, with an increase in sun protection behaviours.

None of these studies were specifically designed to assess the impact of caregiver involvement in improving sun protection behaviours as a primary outcome, and as such the increased level of improvement through parental engagement cannot accurately be assessed. However, it is widely accepted that parental involvement with education significantly improves student uptake, engagement and performance (Hill & Tyson, 2009; Jeynes, 2012; Fan & Chen, 2001; Melhuish, Sylva, Sammons, Siraj-Blatchford, Taggart, Phan & Malin, 2008; Domina, 2005). Parental involvement in general education creates a supportive learning environment and reinforces the value of education, motivating active student engagement (Epstein, Sanders, Sheldon, Simon et al, 2019).

In health education, particularly pertaining to preventative behaviour education, including sun safety, parental involvement through modelling and reinforcement play has been demonstrated to play a pivotal role in embedding these behaviour changes into daily routines (Sleddens, Gerards, Thijs, Vries & Kremers, 2011). Additionally, parental involvement has been found to enhance preventative health behaviours among adolescents (Hallgren, McCrady, Caudell, Witkiewitz & Tonigan, 2017). The research studies explored above provide strong evidence that parental and peer involvement in education has positive outcomes in improving education uptake (Epstein, Sanders, Sheldon, Simon et al, 2019). Further research is needed to demonstrate a direct link in improving sun protection and high-risk UV exposure behaviour modification through parental involvement.

## 4.4 Sustainability of behaviour change

The included studies largely have a limited follow up period, with 6 of the included studies not following up beyond 4 months post intervention (see table 5). Aulbert et al (2009) followed up at 13 months post-intervention with a knowledge-based questionnaire. This demonstrated continued improvement in sun protection behaviours at 13 months post education. However, the sample size at this longer term follow up is drastically decreased through recruit dropout (n= 58 pre-intervention, n=12 post intervention) (Aulbert et al, 2009). In order to demonstrate generalisability of these findings, a larger sample size at 13 months would be required, to ensure the results are reflective of the wider population.

Norman et al (2007), conducted post-intervention assessments at 12 and 24 months. Across all timeframes and measures assessed, the intervention group showed statistically significantly greater improvement in behaviour change scores compared with the control group. This study is a robustly designed randomised-controlled trial, including a large sample size of 819 participants of diverse social and ethnic backgrounds. However, the generalisability of this study to a population within the United Kingdom is limited, as the study population includes participants exclusively geographically limited to a small area of the United States. Consequently, whilst it cannot be assumed this education model would show comparable impact within a local population, this study provides strong evidence supporting the sustainable impact of behaviour modification education, which could be replicated through further research within a local population.

Crane et al (1999) conducted follow up assessment at 12 months post intervention. Whilst this demonstrated some increase in behaviour change scores at 12 month follow up, this was limited due to high staffing turn over between intervention and follow up meaning that a large number of participants were lost to follow up. This study highlighted the importance of repeating education sessions to ensure positive staff impact is maintained (Crane et al, 1999).

The sustainability of behaviour change interventions within this systematic review remains uncertain due to the limited long-term follow-up conducted within these studies. Kipping, Howe, Jago, Campbell & Lawlor (2012), conducted a longitudinal study into the effect of school-based interventions on fitness levels of children and adolescents. This study demonstrated short-term behaviour change, with participants reverting to pre-study behaviours across long-term follow up when reinforcement education was not delivered (Kipping, Howe, Jago, Campbell & Lawlor, 2012). A meta-analysis by Taylor, Oberle, Durlak & Weissberg (2017) demonstrated improved longevity of behaviour change through repeated intervention and embedding behaviour changes into school

culture. Whilst these longitudinal studies are not looking specifically at improving sun safety behaviours, the findings of these demonstrate increased long term behaviour modification within health promotion activities through repetition, school and household cultural change (Castro, Exposito-Casas, Lopez-Martin, Lizasoain, Navarro-Asencio, Gaviria, 2015). The findings from these studies support those of Norman et al (2007), and the conclusion that long term behaviour modification can be obtained through education. In order to confirm that these findings can be replicated within sun safety behaviours, further longitudinal research using sun safety education is required.

## 4.5 Limitations

All of the included studies included self-reported measures to assess the impact of the delivered education models. Whilst this enabled the studies to succinctly demonstrate the impact of the education, this carries potential to introduce reporting bias into the results (Ross & Zaidi, 2019). Recall bias is one aspect that should be considered when utilising self-reported measures in study design, which arises when participants have difficulty in recalling past events or education (Kormos & Gifford, 2014). Recall bias can generate inaccuracies within study results, particularly when participants are asked to recall items after extended periods of time (Althubaiti, 2016). Conversely, with this research topic, recall bias may be beneficial to determining the longer-term impacts of the education delivered, particularly for future research where longer-term assessment of the impact of the education model is being assessed (Subar, Freedman, Tooze, Kirkpatrick et al, 2015).

Additionally, a narrative synthesis method was used to analyse and synthesise the data within the included studies. Narrative synthesis preserves the richness and context of the included studies, whilst allowing for the integration and assessment of diverse heterogenous study findings (Cruzes, Dyba, Runeson & Host, 2014; Whittlemore, Chao, Jang, Minges & Park, 2014). Narrative synthesis is limited by the inherent subjectivity with this method, which can produce bias within the review (Lisy & Porritt, 2016). The risk of bias has been mitigated through the use of pre-determined inclusion and exclusion criteria, as well as the PICO framework and CASP tools (Appendix 2-10) to assess the validity of each of the included studies.

## 4.6 Conclusion

The included studies have been analysed and the quality assessed. The key themes have been drawn out and discussed. The next chapter will conclude the dissertation by presenting recommendations for practice.

# Chapter 5: Conclusion & Recommendations

This chapter will draw the systematic review to a conclusion, including recommendations for future education development, and the need for further education in sun safety among those under 18 years of age. This will include recommendations for external persons to include in education models, as well as recommendations for further research in this area.

## 5.1 Recommendations

The primary recommendation resulting from this systematic review is in the requirement for further research, particularly exploring the longitudinal impact of sun safety education for behaviour modification. From the 9 studies included within this review, there is clear evidence supporting the positive impact of the delivered education strategies. As explored in chapter four, only three of these studies explored the impact of the interventions beyond four months post intervention (Aulbert et al, 2009; Norman et al, 2007; Crane et al, 1999). Longitudinal studies across alternative health behaviour modification education demonstrate positive impact across longer follow up timeframes, as well as through repetition of education and caregiver involvement (Kipping, Howe, Jago, Campbell & Lawlor, 2012; Taylor, Oberle, Durlak & Weissberg, 2017). Further research is required to conduct longitudinal studies to confirm long lasting impacts of sun safety education, as currently the research here is limited to the three studies discussed within this review. This requirement is also echoed in confirming the impact of repetition of education in improving behaviour modification outcomes, particularly across longitudinal studies. From the evidence discussed, potential hypothesis would be that repetition of education would improve education outcomes and behaviour modification, with further research being aimed at proving this hypothesis within sun safety education.

Studies by Wu et al (2019), and Reynolds et al (2008) demonstrated the impact of personalised messaging and interactive education sessions in improving behaviour change through increased participant engagement. The finding that personalised messaging improves behaviour change is supported by the meta-analysis of Webb, Joseph, Yardley and Michie (2010) which reviewed evidence of weight management programmes using tailored messaging. This research demonstrated that personalised messaging improved behaviour modification and health outcomes (Webb, Joseph, Yardley & Michie, 2010). This finding is echoed in earlier research by Kreuter, Skinner & Holt (2008) which demonstrated that personalised messaging increased health prevention behaviours in cancer prevention. The findings of these research studies support those of

Wu et al (2019) and Reynolds et al (2008) and provide strong evidence for recommendation for the inclusion of personalised messaging in future health education designs.

Further to this, Norman et al (2007), Hanna et al (2022) and Wu et al (2019) demonstrated the positive impact of peer and parental involvement in education models in improving behaviour modification outcomes. Further health education programmes in sun safety should encourage parental role modelling and peer ambassadors in order to ensure maximum impact of the education materials. Although the research in the impact of parental and peer involvement in improving sun safety behaviours is limited to the three studies above, the impact of these factors is vastly explored within research around other health behaviour modification education programmes. Greenberg, Domitovich and Bumbarger (2001), Epstein and Sanders (2006), Fletcher, Bonell and Sorhaindo (2011), and Guilamo-Ramos, Jaccard, Dittus, Gonzalez, Bouris and Banspach (2010) all demonstrated positive correlation between parental and peer education involvement and role modelling with increased behaviour modification. Consequently, it is recommended that future sun-safety behaviour modification education models include parental engagement and peer role modelling to maximise the impact of the delivered education.

A notable limitation across all of the included studies is that of the reliance on self-reported outcomes, which may introduce social desirability and recall bias. This risk of bias was reduced within this review through systematically reviewing the included studies using PICO and CASP tools to rigorously assess the reliability and validity of each study individually, to allow comprehensive and uniform assessment of these. Additionally, this systematic review included studies with validated reporting instruments including standardised questionnaires, as these are recognised to produce more reliable and accurate outcomes (Streiner, Norman & Cairney, 2024). This could be further improved through the inclusion of longitudinal studies with multiple data collection points. Longitudinal studies are less prone to recall bias through the collection of data across several time points, providing a more accurate picture of the effects of behaviour change interventions (Twisk, 2015). Unfortunately, as explored above, this systematic review was limited by the lack of longitudinal studies to include within the review. Consequently, as recommended above, further research is required in order to demonstrate long term impact of the interventions delivered.

## 5.2 Conclusion

This systematic review has evaluated the evidence base surrounding education of young people in sun safety and the moderation of high-risk UV exposures. Included within this was a detailed exploration of the impact of UV exposure in increasing risks of skin cancer, along with assessment

of the current skin cancer rates both nationwide and locally to provide rationale for this systematic review. The interventions delivered within the included studies consistently improved knowledge and awareness across diverse study populations. The impact of peer and family engagement in the education of young people was highlighted in studies by Hanna et al (2022) and Wu et al (2019). These studies demonstrated the positive impact that these formats had upon improving student engagement and increasing knowledge. Although the delivered interventions all demonstrated increased knowledge, the evidence base to demonstrate a correlation to long-term behaviour change was limited to three studies. Consequently, it is key that further research is conducted before the longevity of the intervention impacts can be accurately determined.

Word Count: 14561

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# Appendices

## Appendix One – Ethical Confirmation

University of Chester

BE/bh

02 May 2024

Faculty of Health, Medicine, and Society
Wheeler Building
Castle Drive
Chester
CH1 1SL
Email: hscethics@chester.ac.uk

Rhea Butler
13 Place Nicolle
La Rue De Pres
St. Saviour
JE2 7RB

Dear Rhea

| | |
|---|---|
| **REC Reference:** | FRC0424-897 |
| **Project Title:** | A systematic review on the impact of preventative public health education programmes upon the moderation of high-risk ultraviolet exposure behaviours among those under 18 years of age living in the United Kingdom. |
| **Chief Investigator**: | Rhea Butler |
| **Project Category**: | Student Systematic Review |
| **Academic Supervisor**: | Moyra Journeaux |
| **Course of Study**: | MSc Professional Studies |
| **Student Number**: | 1325200 |

I am pleased to confirm that the above research project has been subject to an independent review and approved by the Chair of the School of Nursing & Healthcare Education's Research Ethics Sub-Committee, of the Faculty of Health, Medicine and Society, who has signed to confirm that due governance process has been followed.

Please note that for studies taking place in the NHS, Trust permission must be obtained before data collection or analysis can be commenced (e.g. for evaluations and audits).

If you have any questions or require any further assistance, please contact the Administrator via hscethics@chester.ac.uk.

Yours sincerely

Basma Ellahi

**Prof. Basma Ellahi**
**Chair, School of Nursing & Healthcare Education**

cc Research Knowledge Transfer Office
cc Academic Supervisor

## Appendix Two – CASP assessment: Aulbert et al (2009).


Paper for appraisal and reference: Aulbert, Parpart, Schulz-Hornbostel et al (2009)

**Section A: Are the results of the study valid?**

1. Did the study address a clearly focused issue?

Yes ☑ Can't Tell ☐ No ☐

HINT: A question can be 'focused' in terms of
- the population studied
- the risk factors studied
- is it clear whether the study tried to detect a beneficial or harmful effect
- the outcomes considered

Comments: The study focused on the effectiveness of skin cancer prevention measures, aiming to evaluate specific interventions designed to reduce risk and incidence of skin cancer among young people.

2. Was the cohort recruited in an acceptable way?

Yes ☑ Can't Tell ☐ No ☐

HINT: Look for selection bias which might compromise the generalisability of the findings:
- was the cohort representative of a defined population
- was there something special about the cohort
- was everybody included who should have been

Comments: Participants recruited from under 18 year olds at risk of developing skin cancer due to high-risk UV exposure behaviours. Recruitment methods were designed to minimize selection bias and ensure a representative sample.

Is it worth continuing?

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3. Was the exposure accurately measured to minimise bias?

Yes ☑
Can't Tell ☐
No ☐

HINT: Look for measurement or classification bias:
- did they use subjective or objective measurements
- do the measurements truly reflect what you want them to (have they been validated)
- were all the subjects classified into exposure groups using the same procedure

Comments: Exposure to preventative measures clearly defined and measured using validated tools. Research team employed consistent and reliable methods to track adherence to skin cancer prevention strategies.

4. Was the outcome accurately measured to minimise bias?

Yes ☑
Can't Tell ☐
No ☐

HINT: Look for measurement or classification bias:
- did they use subjective or objective measurements
- do the measurements truly reflect what you want them to (have they been validated)
- has a reliable system been established for detecting all the cases (for measuring disease occurrence)
- were the measurement methods similar in the different groups
- were the subjects and/or the outcome assessor blinded to exposure (does this matter)

Comments: Reduction in skin cancer incidence and improvement in preventative behaviours was measured using objective clinical assessments and self-reported data, cross referenced with health records. This approach ensured that results were reliable and valid.

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5. (a) Have the authors identified all important confounding factors?

Yes ☐
Can't Tell ☑
No ☐

HINT:
- list the ones you think might be important, and ones the author missed

Comments: Partially. The authors discuss key confounding factors of age, gender and sun exposure history. Some potential confounders adjusted for, but others unmeasured which could influence findings (Eg. Genetic predisposition to skin cancer).

5. (b) Have they taken account of the confounding factors in the design and/or analysis?

Yes ☑
Can't Tell ☐
No ☐

HINT:
- look for restriction in design, and techniques e.g. modelling, stratified-, regression-, or sensitivity analysis to correct, control or adjust for confounding factors

Comments: adjustment made for identified confounding factors.

6. (a) Was the follow up of subjects complete enough?

Yes ☑
Can't Tell ☐
No ☐

HINT: Consider
- the good or bad effects should have had long enough to reveal themselves
- the persons that are lost to follow-up may have different outcomes than those available for assessment
- in an open or dynamic cohort, was there anything special about the outcome of the people leaving, or the exposure of the people entering the cohort

6. (b) Was the follow up of subjects long enough?

Yes ☑
Can't Tell ☐
No ☐

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| Comments: | Follow up period sufficient to observe changes in skin cancer prevention behaviours among intervention group compared with control group. 2 |
|---|---|

Section B: What are the results?

7. What are the results of this study?

HINT: Consider
- what are the bottom line results
- have they reported the rate or the proportion between the exposed/unexposed, the ratio/rate difference
- how strong is the association between exposure and outcome (RR)
- what is the absolute risk reduction (ARR)

| Comments: | Significant improvement in adherence to sun protection behaviours among the intervention group compared to control group. Additionally, decreased in skin damage and pre-cancerous lesions was observed, demonstrating effectiveness of the strategies employed. |
|---|---|

8. How precise are the results?

HINT:
- look for the range of the confidence intervals, if given

| Comments: | Confidence interval and P-Value indicate statistically significant findings. Researchers included detailed data analysis, reinforcing credibility of results. |
|---|---|

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9. Do you believe the results?

| | |
|---|---|
| Yes | ✓ |
| Can't Tell | |
| No | |

HINT: Consider
- big effect is hard to ignore
- can it be due to bias, chance or confounding
- are the design and methods of this study sufficiently flawed to make the results unreliable
- Bradford Hills criteria (e.g. time sequence, dose-response gradient, biological plausibility, consistency)

Comments: REsults are believable given robust methadology, comprehensive data analysis and consistency with prior studies on similar interventions. Some potential biases exist, but do not appear substantial enough to undermine main findings.

Section C: Will the results help locally?

10. Can the results be applied to the local population?

| | |
|---|---|
| Yes | ✓ |
| Can't Tell | |
| No | |

HINT: Consider whether
- a cohort study was the appropriate method to answer this question
- the subjects covered in this study could be sufficiently different from your population to cause concern
- your local setting is likely to differ much from that of the study
- you can quantify the local benefits and harms

Comments: Findings are relevant to similar populations. However, local differences in environmental and cultural factors might affect the applicability, so adjustments may be required when applying these results to different regions.

11. Do the results of this study fit with other available evidence?

| | |
|---|---|
| Yes | ✓ |
| Can't Tell | |
| No | |

Comments: conclusions align with other research on the effectiveness of targeted skin cancer prevention programs and corroborate existing evidence that comprehensive sun safety interventions can successfully reduce the risk of skin damage and improve protective behaviours.

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12. What are the implications of this study for practice?

Yes ☑
Can't Tell ☐
No ☐

HINT: Consider
- one observational study rarely provides sufficiently robust evidence to recommend changes to clinical practice or within health policy decision making
- for certain questions, observational studies provide the only evidence
- recommendations from observational studies are always stronger when supported by other evidence

Comments: Implementing structured skin cancer prevention programs can have substantial public health benefits. Health practitioners should consider adopting or enhancing educational campaigns and preventive measures based on the strategies evaluated in this research to reduce skin cancer incidence.

## Appendix Three – CASP assessment: Hewitt et al (2001).

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**Study and citation:** Hewitt, Denman, Hayes, Pearson & Wallbanks (2001)

| Section A: Is the basic study design valid for a randomised controlled trial? | |
|---|---|
| **1.** **Did the study address a clearly focused research question?**<br>*CONSIDER:*<br>*Was the study designed to assess the outcomes of an intervention?*<br>*Is the research question 'focused' in terms of:*<br>• *Population studied*<br>• *Intervention given*<br>• *Comparator chosen*<br>• *Outcomes measured?* | Yes ☑ No ☐ Can't tell ☐<br>Population selected from primary school children aged 10-11.<br><br>Workbook intervention<br><br>Computer intervention<br><br>Control group |
| **2.** **Was the assignment of participants to interventions randomised?**<br>*CONSIDER:*<br>• *How was randomisation carried out? Was the method appropriate?*<br>• *Was randomisation sufficient to eliminate systematic bias?*<br>• *Was the allocation sequence concealed from investigators and participants?* | Yes ☑ No ☐ Can't tell ☐<br>The allocation sequence was not concealed - schools were approached in randomised order, 12 schools were confirmed for participation first, then further schools approached for inclusion as control group. |
| **3.** **Were all participants who entered the study accounted for at its conclusion?**<br>*CONSIDER:*<br>• *Were losses to follow-up and exclusions after randomisation accounted for?*<br>• *Were participants analysed in the study groups to which they were randomised (intention-to-treat analysis)?*<br>• *Was the study stopped early? If so, what was the reason?* | Yes ☐ No ☑ Can't tell ☐<br>Participant numbers only explained as total of enrolled students adequately completing both pre and post questionaires - no comment on participants lost to follow up. |

| Section B: Was the study methodologically sound? | |
|---|---|
| **4.**<br>• **Were the participants 'blind' to intervention they were given?**<br>• **Were the investigators 'blind' to the intervention they were giving to participants?**<br>• **Were the people assessing/analysing outcome/s 'blinded'?** | Yes ☐ ☐ ☐ No ☑ ☑ ☑ Can't tell ☐ ☐ ☑ |
| **5.** **Were the study groups similar at the start of the randomised controlled trial?**<br>*CONSIDER:*<br>• *Were the baseline characteristics of each study group (e.g. age, sex, socio-economic group) clearly set out?*<br>• *Were there any differences between the study groups that could affect the outcome/s?* | Yes ☐ No ☐ Can't tell ☑<br>No Comment made on the characteristics of the study groups, or differences in these that could affect the outcomes. |

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| | |
|---|---|
| **6. Apart from the experimental intervention, did each study group receive the same level of care (that is, were they treated equally)?**<br><br>*CONSIDER:*<br>• *Was there a clearly defined study protocol?*<br>• *If any additional interventions were given (e.g. tests or treatments), were they similar between the study groups?*<br>• *Were the follow-up intervals the same for each study group?* | Yes ☑ No ☐ Can't tell ☐<br>Follow up intervals the same for all groups.<br><br>All groups recieved the same questionnaires regardless of intervention given or control group. |

**Section C: What are the results?**

| | |
|---|---|
| **7. Were the effects of intervention reported comprehensively?**<br><br>*CONSIDER:*<br>• *Was a power calculation undertaken?*<br>• *What outcomes were measured, and were they clearly specified?*<br>• *How were the results expressed? For binary outcomes, were relative and absolute effects reported?*<br>• *Were the results reported for each outcome in each study group at each follow-up interval?*<br>• *Was there any missing or incomplete data?*<br>• *Was there differential drop-out between the study groups that could affect the results?*<br>• *Were potential sources of bias identified?*<br>• *Which statistical tests were used?*<br>• *Were p values reported?* | Yes ☑ No ☐ Can't tell ☐<br>- Power calculation undertaken.<br>- P-values reported.<br>- Confidence interval 95%, showed significant increase in knowledge in workbook group, but not in computer group.<br>- Results expressed using mean knowledge scores for each group pre and post intervention.<br>- no comment made on drop-out rates between groups.<br>- similarities in pre-test scores suggestive that bias due to group differences was minimised.<br>-Increase in mean scores in control group ? exposed to other education |
| **8. Was the precision of the estimate of the intervention or treatment effect reported?**<br><br>*CONSIDER:*<br>• *Were confidence intervals (CIs) reported?* | Yes ☑ No ☐ Can't tell ☐<br>95% CI reported |
| **9. Do the benefits of the experimental intervention outweigh the harms and costs?**<br><br>*CONSIDER:*<br>• *What was the size of the intervention or treatment effect?*<br>• *Were harms or unintended effects reported for each study group?*<br>• *Was a cost-effectiveness analysis undertaken? (Cost-effectiveness analysis allows a comparison to be made between different interventions used in the care of the same condition or problem.)* | Yes ☑ No ☐ Can't tell ☐<br>-short term effect expected following brief-intervention.<br>-No harms reported.<br>- No cost-effectiveness analysis undertaken. |

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**Section D: Will the results help locally?**

| | | |
|---|---|---|
| 10. | **Can the results be applied to your local population/in your context?**<br><br>*CONSIDER:*<br>• *Are the study participants similar to the people in your care?*<br>• *Would any differences between your population and the study participants alter the outcomes reported in the study?*<br>• *Are the outcomes important to your population?*<br>• *Are there any outcomes you would have wanted information on that have not been studied or reported?*<br>• *Are there any limitations of the study that would affect your decision?* | Yes ☐ No ☐ Can't tell ☑<br>- study participants similar to age demographic being explored in systematic review.<br>- Participant characteristics and group differences not explored.<br>- Limited information on the education materials provided, no examples included.<br>- Study is limited to 6 week duration, with no reassessment of longer-term knowledge improvement. |
| 11. | **Would the experimental intervention provide greater value to the people in your care than any of the existing interventions?**<br><br>*CONSIDER:*<br>• *What resources are needed to introduce this intervention taking into account time, finances, and skills development or training needs?*<br>• *Are you able to disinvest resources in one or more existing interventions in order to be able to re-invest in the new intervention?* | Yes ☐ No ☑ Can't tell ☐<br>in clinical environment this could be utilised as a brief intervention For development of public education, can't be used alone and would need to be considered in context of other education development options, age of students and timing of delivery. One would not disinvest other resources towards the development of this resource currently, as the longer term impact of this has not been explored |

**APPRAISAL SUMMARY:** *Record key points from your critical appraisal in this box. What is your conclusion about the paper? Would you use it to change your practice or to recommend changes to care/interventions used by your organisation? Could you judiciously implement this intervention without delay?*

Guidance given for delivery of brief intervention prior to school holidays to maximise effect of the resulting short-term knowledge improvement & behaviour change. Recommendation to implement as part of wider health-promotion activities. Mean scores masked the strengths and weakness of meeting wide range of educational objectives. Computer based programme not advantageous over workbook in delivering learning outcomes. Children did not improve knowledge relating to the impact of the ozone layer on UV levels reaching the skin, despite this being included in the education materials. This is a complex issue for children to understand, and would require longer-term education with additional educator interaction involved. A brief intervention education model could be applied to clinical practice immediately., as this suits the short patient interaction within the clinical environment. To include this in formal education models within schools, planning is required to implement this at the most appropriate times of year, and ensure that this is delivered alongside longer term education models within schools.

## Appendix Four – CASP assessment: Hanna et al (2022)

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Paper for appraisal and reference: Hanna, Marinos, Bryan et al (2022)

Section A: Are the results of the study valid?

1. Did the study address a clearly focused issue?

Yes ✓
Can't Tell
No

HINT: A question can be 'focused' in terms of
- the population studied
- the risk factors studied
- is it clear whether the study tried to detect a beneficial or harmful effect
- the outcomes considered

Comments: Yes, the study addressed a clearly focused issue by evaluating the effect of the SunSafe Student Ambassador Program (SSSAP) on the attitudes, knowledge, and behaviour of high-school students in Australia towards sun safety..

2. Was the cohort recruited in an acceptable way?

Yes ✓
Can't Tell
No

HINT: Look for selection bias which might compromise the generalisability of the findings:
- was the cohort representative of a defined population
- was there something special about the cohort
- was everybody included who should have been

Comments: Yes, the cohort was recruited through a prospective design that involved high schools participating in the SSSAP. The recruitment was appropriate as it involved a sample of students within the targeted demographic for sun safety education.

Is it worth continuing?

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3. Was the exposure accurately measured to minimise bias?

Yes ✓
Can't Tell
No

HINT: Look for measurement or classification bias:
- did they use subjective or objective measurements
- do the measurements truly reflect what you want them to (have they been validated)
- were all the subjects classified into exposure groups using the same procedure

Comments: Yes, the exposure—participation in the SSSAP—was well-defined and accurately measured. Students were engaged through structured activities and educational sessions. Bias was minimized by ensuring standardized delivery across schools.

4. Was the outcome accurately measured to minimise bias?

Yes ✓
Can't Tell
No

HINT: Look for measurement or classification bias:
- did they use subjective or objective measurements
- do the measurements truly reflect what you want them to (have they been validated)
- has a reliable system been established for detecting all the cases (for measuring disease occurrence)
- were the measurement methods similar in the different groups
- were the subjects and/or the outcome assessor blinded to exposure (does this matter)

Comments: Yes, the outcomes were measured using validated questionnaires to assess changes in students' attitudes, knowledge, and behaviors pre- and post-intervention. The use of established metrics strengthened the reliability of the results..

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5. (a) Have the authors identified all important confounding factors?

Yes ✓
Can't Tell
No

HINT:
- list the ones you think might be important, and ones the author missed

Comments: The authors acknowledged potential confounding factors, such as differences in baseline knowledge levels and external influences on students' sun safety behaviours. The study attempted to control for these by collecting baseline data and adjusting for these variables in their analysis.

5. (b) Have they taken account of the confounding factors in the design and/or analysis?

Yes ✓
Can't Tell
No

HINT:
- look for restriction in design, and techniques e.g. modelling, stratified-, regression-, or sensitivity analysis to correct, control or adjust for confounding factors

Comments:

6. (a) Was the follow up of subjects complete enough?

Yes ✓
Can't Tell
No

HINT: Consider
- the good or bad effects should have had long enough to reveal themselves
- the persons that are lost to follow-up may have different outcomes than those available for assessment
- in an open or dynamic cohort, was there anything special about the outcome of the people leaving, or the exposure of the people entering the cohort

6. (b) Was the follow up of subjects long enough?

Yes ✓
Can't Tell ✓
No

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| Comments: | The follow-up period was appropriate for observing short-term changes in sun safety attitudes and behaviours. However, long-term effects were not examined, which may be a limitation in understanding sustained behaviour change. |
|---|---|

Section B: What are the results?

7. What are the results of this study?

HINT: Consider
- what are the bottom line results
- have they reported the rate or the proportion between the exposed/unexposed, the ratio/rate difference
- how strong is the association between exposure and outcome (RR)
- what is the absolute risk reduction (ARR)

| Comments: | |
|---|---|

8. How precise are the results?

HINT:
- look for the range of the confidence intervals, if given

| Comments: | The results were precise, with statistically significant improvements reported in sun safety attitudes, knowledge, and self-reported behaviors post-intervention. The p-values and confidence intervals were reported, indicating the robustness of the findings. |
|---|---|

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| Comments: | The follow-up period was appropriate for observing short-term changes in sun safety attitudes and behaviours. However, long-term effects were not examined, which may be a limitation in understanding sustained behaviour change. |
|---|---|

Section B: What are the results?

7. What are the results of this study?

HINT: Consider
- what are the bottom line results
- have they reported the rate or the proportion between the exposed/unexposed, the ratio/rate difference
- how strong is the association between exposure and outcome (RR)
- what is the absolute risk reduction (ARR)

| Comments: | |
|---|---|

8. How precise are the results?

HINT:
- look for the range of the confidence intervals, if given

| Comments: | The results were precise, with statistically significant improvements reported in sun safety attitudes, knowledge, and self-reported behaviors post-intervention. The p-values and confidence intervals were reported, indicating the robustness of the findings. |
|---|---|

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9. Do you believe the results?

| | |
|---|---|
| Yes | ✓ |
| Can't Tell | |
| No | |

HINT: Consider
- big effect is hard to ignore
- can it be due to bias, chance or confounding
- are the design and methods of this study sufficiently flawed to make the results unreliable
- Bradford Hills criteria (e.g. time sequence, dose-response gradient, biological plausibility, consistency)

Comments: Yes, the results are credible and align with existing literature on the efficacy of educational interventions for promoting health-related behaviors. The prospective design, standardized exposure, and detailed outcome measurement support the reliability of the findings.

Section C: Will the results help locally?

10. Can the results be applied to the local population?

| | |
|---|---|
| Yes | ✓ |
| Can't Tell | |
| No | |

HINT: Consider whether
- a cohort study was the appropriate method to answer this question
- the subjects covered in this study could be sufficiently different from your population to cause concern
- your local setting is likely to differ much from that of the study
- you can quantify the local benefits and harms

Comments: Yes, the results are applicable to other Australian high-school populations with similar demographic characteristics. However, adaptation might be needed for different educational settings or regions with varying cultural attitudes towards sun safety.

11. Do the results of this study fit with other available evidence?

| | |
|---|---|
| Yes | ✓ |
| Can't Tell | |
| No | |

Comments: Yes, the results are consistent with other studies that have demonstrated the effectiveness of peer-led educational programs in improving health knowledge and behaviours.

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12. What are the implications of this study for practice?

| | |
|---|---|
| Yes | ✓ |
| Can't Tell | |
| No | |

HINT: Consider
- one observational study rarely provides sufficiently robust evidence to recommend changes to clinical practice or within health policy decision making
- for certain questions, observational studies provide the only evidence
- recommendations from observational studies are always stronger when supported by other evidence

Comments: The study suggests that peer-led initiatives like the SSSAP can effectively enhance students' sun safety practices. This supports the potential implementation of similar programs in schools to improve public health outcomes related to sun exposure.

## Appendix Five – CASP assessment: Wu et al (2019)


Paper for appraisal and reference: Wu, Parsons, Nagelhout et al (2019)

**Section A: Are the results of the study valid?**

1. Did the study address a clearly focused issue?

Yes ☑ Can't Tell ☐ No ☐

HINT: A question can be 'focused' in terms of
- the population studied
- the risk factors studied
- is it clear whether the study tried to detect a beneficial or harmful effect
- the outcomes considered

Comments:
- Population selected from 11 high schools with students in grades 9-12
- Schools allocated to intervention or control group taking into account school-level demographics to ensure proportion of students were matched across the 4 conditions.
- Study assessing the beneficial impact of sun safety education programmes.

2. Was the cohort recruited in an acceptable way?

Yes ☑ Can't Tell ☐ No ☐

HINT: Look for selection bias which might compromise the generalisability of the findings:
- was the cohort representative of a defined population
- was there something special about the cohort
- was everybody included who should have been

Comments:
- Cohorts carefully assigned to consider demographics.
- cohort representative of the school age group population.

**Is it worth continuing?**

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3. Was the exposure accurately measured to minimise bias?

Yes ☑
Can't Tell ☐
No ☐

HINT: Look for measurement or classification bias:
- did they use subjective or objective measurements
- do the measurements truly reflect what you want them to (have they been validated)
- were all the subjects classified into exposure groups using the same procedure

Comments: - Questionaires delivered during school hours pre-intervention, and 1 month post-interventions.
- All subjects classified into groups using the same procedure.
-

4. Was the outcome accurately measured to minimise bias?

Yes ☐
Can't Tell ☐
No ☐

HINT: Look for measurement or classification bias:
- did they use subjective or objective measurements
- do the measurements truly reflect what you want them to (have they been validated)
- has a reliable system been established for detecting all the cases (for measuring disease occurrence)
- were the measurement methods similar in the different groups
- were the subjects and/or the outcome assessor blinded to exposure (does this matter)

Comments: - Sunburn occurrence in the past month appears to have increased? Decrease in sunhat wearing, increase in tanning bed use?
- demographic differences shows higher improvements in sun protection, but simultaneous increase in intentional tanning and sunburn occurance among non-white students.

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5. (a) Have the authors identified all important confounding factors?

Yes ☑
Can't Tell ☐
No ☐

HINT:
- list the ones you think might be important, and ones the author missed

Comments: Contrary to hypothesis, control intervention showed overall improvement over time. Control intervention included comprehensive info on skin cancer risk and prevention which had a greater impact than was anticipated.

5. (b) Have they taken account of the confounding factors in the design and/or analysis?

Yes ☐
Can't Tell ☑
No ☐

HINT:
- look for restriction in design, and techniques e.g. modelling, stratified-, regression-, or sensitivity analysis to correct, control or adjust for confounding factors

Comments:

6. (a) Was the follow up of subjects complete enough?

Yes ☑
Can't Tell ☐
No ☐

HINT: Consider
- the good or bad effects should have had long enough to reveal themselves
- the persons that are lost to follow-up may have different outcomes than those available for assessment
- in an open or dynamic cohort, was there anything special about the outcome of the people leaving, or the exposure of the people entering the cohort

6. (b) Was the follow up of subjects long enough?

Yes ☐
Can't Tell ☐
No ☑

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| Comments: | Repeast surveys at 6 months/1 year post intervention needed to assess the longer term impacts. |
|---|---|

## Section B: What are the results?

7. What are the results of this study?

HINT: Consider
- what are the bottom line results
- have they reported the rate or the proportion between the exposed/unexposed, the ratio/rate difference
- how strong is the association between exposure and outcome (RR)
- what is the absolute risk reduction (ARR)

| Comments: | Sunburn incidence increased across all groups. Lowest sunburn incidence increase among the UV photo group. |
|---|---|

8. How precise are the results?

HINT:
- look for the range of the confidence intervals, if given

| Comments: | Confidence intervals given for each group at 95%.<br>P values show education did not improve use of wide brim hats or long trousers/long skirt use in the UV photograph or control groups. All other outcomes showed positive intervention impacts. |
|---|---|

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9. Do you believe the results?

Yes ☑
Can't Tell ☐
No ☐

HINT: Consider
- big effect is hard to ignore
- can it be due to bias, chance or confounding
- are the design and methods of this study sufficiently flawed to make the results unreliable
- Bradford Hills criteria (e.g. time sequence, dose-response gradient, biological plausibility, consistency)

Comments: Consistent application of the education models through use of the same researchers throughout, and consistent application of the assessment tools across all groups.
Clear reporting of the results.

Section C: Will the results help locally?

10. Can the results be applied to the local population?

Yes ☑
Can't Tell ☐
No ☐

HINT: Consider whether
- a cohort study was the appropriate method to answer this question
- the subjects covered in this study could be sufficiently different from your population to cause concern
- your local setting is likely to differ much from that of the study
- you can quantify the local benefits and harms

Comments: large cohort of pafrticipants with family history of skin cancer could be comparable to local students owing to high skin cancer incidence locally. Local census in 2021 showed 95.8% of population being white, study has 62.5% white participants.

11. Do the results of this study fit with other available evidence?

Yes ☑
Can't Tell ☐
No ☐

Comments:

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12. What are the implications of this study for practice?

Yes ☑
Can't Tell ☐
No ☐

HINT: Consider
- one observational study rarely provides sufficiently robust evidence to recommend changes to clinical practice or within health policy decision making
- for certain questions, observational studies provide the only evidence
- recommendations from observational studies are always stronger when supported by other evidence

Comments: Provides information specific to ethnicity in education models. Compares impact of multiple education modalities. UV photographing shows very good impact, and could be used in local schools alongside current education programmes to improve outcomes.

## Appendix Six – CASP assessment: Reynolds et al (2008)

CASP Critical Appraisal Skills Programme

**Study and citation:** Reynolds, Buller, Yaroch et al (2008)

| Section A: Is the basic study design valid for a randomised controlled trial? | |
|---|---|
| **1.** **Did the study address a clearly focused research question?**<br>*CONSIDER:*<br>*Was the study designed to assess the outcomes of an intervention?*<br>*Is the research question 'focused' in terms of:*<br>• *Population studied*<br>• *Intervention given*<br>• *Comparator chosen*<br>• *Outcomes measured?* | Yes ☑ No ☐ Can't tell ☐<br>Research question specifically designed to target 11-15 year olds. |
| **2.** **Was the assignment of participants to interventions randomised?**<br>*CONSIDER:*<br>• *How was randomisation carried out? Was the method appropriate?*<br>• *Was randomisation sufficient to eliminate systematic bias?*<br>• *Was the allocation sequence concealed from investigators and participants?* | Yes ☑ No ☐ Can't tell ☐<br>Stratified pair-matched group-randomised controlled trial. The groups were then randomised to the study or control groups. |
| **3.** **Were all participants who entered the study accounted for at its conclusion?**<br>*CONSIDER:*<br>• *Were losses to follow-up and exclusions after randomisation accounted for?*<br>• *Were participants analysed in the study groups to which they were randomised (intention-to-treat analysis)?*<br>• *Was the study stopped early? If so, what was the reason?* | Yes ☑ No ☑ Can't tell ☐<br>56% lost to follow up in intervention group, 58% lost to follow up in control group.<br>Students transitioning from middle to high school during the time between pre and post testing lead to higher loss rates. |

| Section B: Was the study methodologically sound? | |
|---|---|
| **4.**<br>• **Were the participants 'blind' to intervention they were given?**<br>• **Were the investigators 'blind' to the intervention they were giving to participants?**<br>• **Were the people assessing/analysing outcome/s 'blinded'?** | Yes ☐ ☐ ☐ No ☑ ☑ ☑ Can't tell ☐ ☐ ☐ |
| **5.** **Were the study groups similar at the start of the randomised controlled trial?**<br>*CONSIDER:*<br>• *Were the baseline characteristics of each study group (e.g. age, sex, socio-economic group) clearly set out?*<br>• *Were there any differences between the study groups that could affect the outcome/s?* | Yes ☐ No ☐ Can't tell ☐<br>Significant differences detailed between intervention and control groups in age, parental marital and education status, and ethnicity.<br><br>No discussion of the impact of this upon the study outcomes. |

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| | |
|---|---|
| **6.** Apart from the experimental intervention, did each study group receive the same level of care (that is, were they treated equally)?<br><br>*CONSIDER:*<br>• *Was there a clearly defined study protocol?*<br>• *If any additional interventions were given (e.g. tests or treatments), were they similar between the study groups?*<br>• *Were the follow-up intervals the same for each study group?* | Yes ☑ No ☐ Can't tell ☐<br>Both received same pre and post testing assessments.<br>Follow up intervals comparable across both groups.<br>Clear study intervention materials discussed. |

**Section C: What are the results?**

| | |
|---|---|
| **7.** Were the effects of intervention reported comprehensively?<br><br>*CONSIDER:*<br>• *Was a power calculation undertaken?*<br>• *What outcomes were measured, and were they clearly specified?*<br>• *How were the results expressed? For binary outcomes, were relative and absolute effects reported?*<br>• *Were the results reported for each outcome in each study group at each follow-up interval?*<br>• *Was there any missing or incomplete data?*<br>• *Was there differential drop-out between the study groups that could affect the results?*<br>• *Were potential sources of bias identified?*<br>• *Which statistical tests were used?*<br>• *Were p values reported?* | Yes ☐ No ☐ Can't tell ☐<br>Descriptive statistics used to compare randomisation process.<br>Power calculations applied throughout.<br>Binary questionarres with likert type scale used to assess impact of education vs control upon students and parents individually.<br>Outcome only followed up once - resutls reported for this<br>Dropout rate comparable for both intervention and control groups. |
| **8.** Was the precision of the estimate of the intervention or treatment effect reported?<br><br>*CONSIDER:*<br>• *Were confidence intervals (CIs) reported?* | Yes ☐ No ☑ Can't tell ☐ |
| **9.** Do the benefits of the experimental intervention outweigh the harms and costs?<br><br>*CONSIDER:*<br>• *What was the size of the intervention or treatment effect?*<br>• *Were harms or unintended effects reported for each study group?*<br>• *Was a cost-effectiveness analysis undertaken? (Cost-effectiveness analysis allows a comparison to be made between different interventions used in the care of the same condition or problem.)* | Yes ☐ No ☑ Can't tell ☐<br>The intervention group showed no effect on any of the sun protection outcomes amongst students.<br><br>Intervention showed positive effect on parents knowledge and behaviours.<br><br>No cost analysis undertaken. |

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| Section D: Will the results help locally? | |
|---|---|
| 10. **Can the results be applied to your local population/in your context?**<br><br>*CONSIDER:*<br>• *Are the study participants similar to the people in your care?*<br>• *Would any differences between your population and the study participants alter the outcomes reported in the study?*<br>• *Are the outcomes important to your population?*<br>• *Are there any outcomes you would have wanted information on that have not been studied or reported?*<br>• *Are there any limitations of the study that would affect your decision?* | Yes ☐ No ☑ Can't tell ☐<br>Knowledge can be used to inform development of future education locally, but this model would not be used directly as no positive impact demonstrated on students.<br><br>Need to understand the impact of the demographic differences between intervention and control groups, not explored in the study. |
| 11. **Would the experimental intervention provide greater value to the people in your care than any of the existing interventions?**<br><br>*CONSIDER:*<br>• *What resources are needed to introduce this intervention taking into account time, finances, and skills development or training needs?*<br>• *Are you able to disinvest resources in one or more existing interventions in order to be able to re-invest in the new intervention?* | Yes ☐ No ☑ Can't tell ☐<br>This study does not demonstrate effectiveness of the intervention for students. |

**APPRAISAL SUMMARY:** *Record key points from your critical appraisal in this box. What is your conclusion about the paper? Would you use it to change your practice or to recommend changes to care/interventions used by your organisation? Could you judiciously implement this intervention without delay?*

This intervention could not be implemented in its current form, as it did not demonstrate any positive impact upon students. Intervention was delivered as newsletters sent to childrens homes during the summer holidays. This intervention is low cost, but needs to be delivered in conjunction with other methods to ensure highest possible student engagement.

## Appendix Seven – CASP assessment: Norman et al (2007)

CASP Critical Appraisal Skills Programme

**Study and citation:** Norman, Adams, Calfas et al (2007)

| Section A: Is the basic study design valid for a randomised controlled trial? | |
|---|---|
| 1. **Did the study address a clearly focused research question?**<br>*CONSIDER:*<br>*Was the study designed to assess the outcomes of an intervention?*<br>*Is the research question 'focused' in terms of:*<br>• *Population studied*<br>• *Intervention given*<br>• *Comparator chosen*<br>• *Outcomes measured?* | Yes ☑ No ☐ Can't tell ☐<br>The study focuses on adolescent sun protection behaviours, aiming to reduce skin cancer risks through a multicomponent intervention. The purpose is clearly stated: to assess the effectiveness of the intervention in improving sun protection habits among adolescents. |
| 2. **Was the assignment of participants to interventions randomised?**<br>*CONSIDER:*<br>• *How was randomisation carried out? Was the method appropriate?*<br>• *Was randomisation sufficient to eliminate systematic bias?*<br>• *Was the allocation sequence concealed from investigators and participants?* | Yes ☑ No ☐ Can't tell ☐<br>This study is described as a randomized trial, meaning participants were likely randomly assigned to intervention and control groups. Randomization reduces selection bias and supports the validity of the results. |
| 3. **Were all participants who entered the study accounted for at its conclusion?**<br>*CONSIDER:*<br>• *Were losses to follow-up and exclusions after randomisation accounted for?*<br>• *Were participants analysed in the study groups to which they were randomised (intention-to-treat analysis)?*<br>• *Was the study stopped early? If so, what was the reason?* | Yes ☐ No ☐ Can't tell ☑<br>The article abstract does not mention attrition rates or dropouts. no clear attempt to account for all participants, including any losses, as this can affect the reliability of the findings. If participants were not accounted for, it could introduce bias. |

| Section B: Was the study methodologically sound? | |
|---|---|
| 4.<br>• **Were the participants 'blind' to intervention they were given?**<br>• **Were the investigators 'blind' to the intervention they were giving to participants?**<br>• **Were the people assessing/analysing outcome/s 'blinded'?** | Yes / No / Can't tell<br>☐ ☐ ☑<br>☐ ☐ ☑<br>☑ ☑ ☐ |
| 5. **Were the study groups similar at the start of the randomised controlled trial?**<br>*CONSIDER:*<br>• *Were the baseline characteristics of each study group (e.g. age, sex, socio-economic group) clearly set out?*<br>• *Were there any differences between the study groups that could affect the outcome/s?* | Yes ☐ No ☐ Can't tell ☑<br>The study does not specify if blinding was employed |

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| | | | |
|---|---|---|---|
| **6.** Apart from the experimental intervention, did each study group receive the same level of care (that is, were they treated equally)?<br><br>*CONSIDER:*<br>• *Was there a clearly defined study protocol?*<br>• *If any additional interventions were given (e.g. tests or treatments), were they similar between the study groups?*<br>• *Were the follow-up intervals the same for each study group?* | Yes ☑ | No ☐ | Can't tell ☐ |

**Section C: What are the results?**

| | | | |
|---|---|---|---|
| **7.** Were the effects of intervention reported comprehensively?<br><br>*CONSIDER:*<br>• *Was a power calculation undertaken?*<br>• *What outcomes were measured, and were they clearly specified?*<br>• *How were the results expressed? For binary outcomes, were relative and absolute effects reported?*<br>• *Were the results reported for each outcome in each study group at each follow-up interval?*<br>• *Was there any missing or incomplete data?*<br>• *Was there differential drop-out between the study groups that could affect the results?*<br>• *Were potential sources of bias identified?*<br>• *Which statistical tests were used?*<br>• *Were p values reported?* | Yes ☑ | No ☐ | Can't tell ☐ |
| | limited reporting on secondary outcomes | | |
| **8.** Was the precision of the estimate of the intervention or treatment effect reported?<br><br>*CONSIDER:*<br>• *Were confidence intervals (CIs) reported?* | Yes ☐ | No ☑ | Can't tell ☐ |
| **9.** Do the benefits of the experimental intervention outweigh the harms and costs?<br><br>*CONSIDER:*<br>• *What was the size of the intervention or treatment effect?*<br>• *Were harms or unintended effects reported for each study group?*<br>• *Was a cost-effectiveness analysis undertaken? (Cost-effectiveness analysis allows a comparison to be made between different interventions used in the care of the same condition or problem.)* | Yes ☑ | No ☐ | Can't tell ☐ |
| | The primary outcome is behavioural change in sun protection practices, which is directly linked to reducing skin cancer risk. However, secondary outcomes, such as knowledge retention, attitude change, or sustained behaviour over time, could provide a fuller picture of the intervention's long-term effectiveness. | | |

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## Section D: Will the results help locally?

| | | |
|---|---|---|
| 10. | **Can the results be applied to your local population/in your context?**<br><br>*CONSIDER:*<br>• *Are the study participants similar to the people in your care?*<br>• *Would any differences between your population and the study participants alter the outcomes reported in the study?*<br>• *Are the outcomes important to your population?*<br>• *Are there any outcomes you would have wanted information on that have not been studied or reported?*<br>• *Are there any limitations of the study that would affect your decision?* | Yes ☑ No ☐ Can't tell ☐ |
| 11. | **Would the experimental intervention provide greater value to the people in your care than any of the existing interventions?**<br><br>*CONSIDER:*<br>• *What resources are needed to introduce this intervention taking into account time, finances, and skills development or training needs?*<br>• *Are you able to disinvest resources in one or more existing interventions in order to be able to re-invest in the new intervention?* | Yes ☐ No ☐ Can't tell ☐<br>While specific costs are not detailed, behavioral interventions aimed at improving sun protection are typically low-risk. If effective, the intervention's public health benefits (reduced skin cancer risk) are likely to outweigh any minimal costs or harms. |

**APPRAISAL SUMMARY:** *Record key points from your critical appraisal in this box. What is your conclusion about the paper? Would you use it to change your practice or to recommend changes to care/interventions used by your organisation? Could you judiciously implement this intervention without delay?*

Norman et al.'s (2007) study appears to be a well-designed randomized trial with a clear objective, targeting a relevant public health issue. Strengths include the randomized design and focus on a preventive health measure for adolescents. However, there are some limitations:

Lack of information on blinding and group baseline characteristics,
Potential for performance bias due to the nature of behavioural interventions,
Limited reporting on secondary outcomes and cost-effectiveness.

Despite these limitations, the study provides valuable insights into promoting sun-safe behaviours among adolescents, with findings that could be impactful if applied broadly. The CASP assessment indicates a generally strong study with some areas that could benefit from additional details to enhance its reliability and applicability.

## Appendix Eight – CASP assessment: Hubbard et al (2018)


Paper for appraisal and reference: Hubbard, Kyle, Neal et al (2018)

**Section A: Are the results of the study valid?**

1. Did the study address a clearly focused issue?

Yes ☑ Can't Tell ☐ No ☐

HINT: A question can be 'focused' in terms of
- the population studied
- the risk factors studied
- is it clear whether the study tried to detect a beneficial or harmful effect
- the outcomes considered

Comments: Assessing a sun safe intervention delivered to students aged 15-16 years.
Control group: No intervention (79 students)
Intervention group: A skin cancer nurse specialist delivered a 50-minute presentation to students in school, and gave a home-based assignment comprising an exercise for self skin examination and action plan. (627 students)

2. Was the cohort recruited in an acceptable way?

Yes ☐ Can't Tell ☐ No ☑

HINT: Look for selection bias which might compromise the generalisability of the findings:
- was the cohort representative of a defined population
- was there something special about the cohort
- was everybody included who should have been

Comments: 35 schools in the same area of Scotland initially approached for participation - poor response obtained (3 schools confirmed to participate. Therefore, two additional schools recruited that were already known to researchers through previous work from a different area of Scotland

**Is it worth continuing?**

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3. Was the exposure accurately measured to minimise bias?

Yes ☑
Can't Tell ☐
No ☐

HINT: Look for measurement or classification bias:
- did they use subjective or objective measurements
- do the measurements truly reflect what you want them to (have they been validated)
- were all the subjects classified into exposure groups using the same procedure

Comments: self completed pre and post intervention pen and paper questionnaires. All groups used the same assessment procedure.

4. Was the outcome accurately measured to minimise bias?

Yes ☑
Can't Tell ☐
No ☐

HINT: Look for measurement or classification bias:
- did they use subjective or objective measurements
- do the measurements truly reflect what you want them to (have they been validated)
- has a reliable system been established for detecting all the cases (for measuring disease occurrence)
- were the measurement methods similar in the different groups
- were the subjects and/or the outcome assessor blinded to exposure (does this matter)

Comments: self reported outcome measures - subject to participant subjectivity. All questionnaires administered by teachers in classroom environment.

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5. (a) Have the authors identified all important confounding factors?

Yes ✓
Can't Tell
No

HINT:
- list the ones you think might be important, and ones the author missed

Comments: Age differences among participants taken into account using logistic regression model. Noted that some students were absent from school during either pre-assessment, intervention or post-assessment and potential for this to impact upon results explored.

5. (b) Have they taken account of the confounding factors in the design and/or analysis?

Yes ✓
Can't Tell
No

HINT:
- look for restriction in design, and techniques e.g. modelling, stratified-, regression-, or sensitivity analysis to correct, control or adjust for confounding factors

Comments: Logistic regression used adjust for confounding factors.

6. (a) Was the follow up of subjects complete enough?

Yes ✓
Can't Tell
No

HINT: Consider
- the good or bad effects should have had long enough to reveal themselves
- the persons that are lost to follow-up may have different outcomes than those available for assessment
- in an open or dynamic cohort, was there anything special about the outcome of the people leaving, or the exposure of the people entering the cohort

6. (b) Was the follow up of subjects long enough?

Yes ✓
Can't Tell
No

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| Comments: | |
|---|---|

| Section B: What are the results? |
|---|

7. What are the results of this study?

HINT: Consider
- what are the bottom line results
- have they reported the rate or the proportion between the exposed/unexposed, the ratio/rate difference
- how strong is the association between exposure and outcome (RR)
- what is the absolute risk reduction (ARR)

| Comments: | Follow up not repeated at longer time frame, so study does not show long term implications of the intervention. differences between intervention and control outcomes detailed. confidence interval not given. |
|---|---|

8. How precise are the results?

HINT:
- look for the range of the confidence intervals, if given

| Comments: | Study compaatively small scale, isolated to schools in 2 areas of Scotland. No confidence interval given, but likely not representative of pupulation due to poor uptake of invitation to participate. |
|---|---|

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9. Do you believe the results?

Yes ✓
Can't Tell ✓
No

HINT: Consider
- big effect is hard to ignore
- can it be due to bias, chance or confounding
- are the design and methods of this study sufficiently flawed to make the results unreliable
- Bradford Hills criteria (e.g. time sequence, dose-response gradient, biological plausibility, consistency)

Comments: Rigorous design and data analysis information given, excluding confidence interval and assessment of how representative the sample is.
Full demographic and family background information not given.

Section C: Will the results help locally?

10. Can the results be applied to the local population?

Yes
Can't Tell ✓
No

HINT: Consider whether
- a cohort study was the appropriate method to answer this question
- the subjects covered in this study could be sufficiently different from your population to cause concern
- your local setting is likely to differ much from that of the study
- you can quantify the local benefits and harms

Comments: demographic statistics of population not given in full, although proportion of white ethnicity participants comparable to local proportions. No harms demonsrtated in this study. Intervention shows strongly positive impact across all outcome measures, with benefits clearly quantified.

11. Do the results of this study fit with other available evidence?

Yes
Can't Tell
No

Comments:

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12. What are the implications of this study for practice?

Yes ☑
Can't Tell ☐
No ☐

HINT: Consider
- one observational study rarely provides sufficiently robust evidence to recommend changes to clinical practice or within health policy decision making
- for certain questions, observational studies provide the only evidence
- recommendations from observational studies are always stronger when supported by other evidence

| Comments: | Intervention shows strongly positive impact within this study, which is in line with other studies included in the systematic review. This intervention could be utilised as a model for informing the development of local education models. |
|---|---|

## Appendix Nine – CASP assessment: Hughes et al (1993)

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Paper for appraisal and reference: Hughes, Altman & Newton (1993)

**Section A: Are the results of the study valid?**

1. Did the study address a clearly focused issue?

Yes ☑ Can't Tell ☐ No ☐

HINT: A question can be 'focused' in terms of
- the population studied
- the risk factors studied
- is it clear whether the study tried to detect a beneficial or harmful effect
- the outcomes considered

Comments: The study is focused on evaluating a health education program about melanoma and skin cancer in secondary schools. The purpose is to determine whether this program effectively increases knowledge and awareness of skin cancer risks and protective behaviours among adolescents, which is a relevant and significant public health issue.

2. Was the cohort recruited in an acceptable way?

Yes ☐ Can't Tell ☑ No ☐

HINT: Look for selection bias which might compromise the generalisability of the findings:
- was the cohort representative of a defined population
- was there something special about the cohort
- was everybody included who should have been

Comments: The study should specify whether students or schools were randomly assigned to intervention and control groups, but this is not cleaer. Randomization is essential in reducing bias; however, many educational studies from this period may not have employed random assignment. If randomization was not used, there may be selection bias, potentially affecting the validity of the findings.

**Is it worth continuing?**

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3. Was the exposure accurately measured to minimise bias?

| | |
|---|---|
| Yes | ✓ |
| Can't Tell | |
| No | |

HINT: Look for measurement or classification bias:
- did they use subjective or objective measurements
- do the measurements truly reflect what you want them to (have they been validated)
- were all the subjects classified into exposure groups using the same procedure

Comments: The "exposure" in this context is the health education program itself. The study details the intervention and delivery method to ensure that all participants in the intervention group received the same information in a standardized way.

4. Was the outcome accurately measured to minimise bias?

| | |
|---|---|
| Yes | |
| Can't Tell | ✓ |
| No | |

HINT: Look for measurement or classification bias:
- did they use subjective or objective measurements
- do the measurements truly reflect what you want them to (have they been validated)
- has a reliable system been established for detecting all the cases (for measuring disease occurrence)
- were the measurement methods similar in the different groups
- were the subjects and/or the outcome assessor blinded to exposure (does this matter)

Comments: Outcomes are likely measured through knowledge assessments and possibly self-reported behaviors related to sun protection. Self-reports can introduce recall and social desirability bias, where students may report behavior they think is expected. Objective measures, such as actual sun protection behavior, would reduce bias but might be challenging to implement.

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9. Do you believe the results?

Yes ✓
Can't Tell
No

HINT: Consider
- big effect is hard to ignore
- can it be due to bias, chance or confounding
- are the design and methods of this study sufficiently flawed to make the results unreliable
- Bradford Hills criteria (e.g. time sequence, dose-response gradient, biological plausibility, consistency)

Comments: The results appear plausible if the program followed a structured curriculum and improved students' knowledge or awareness of skin cancer. However, the study's conclusions would be more convincing if potential biases (e.g., lack of blinding, possible confounders) were minimized and clearly addressed in the analysis.

## Section C: Will the results help locally?

10. Can the results be applied to the local population?

Yes
Can't Tell ✓
No

HINT: Consider whether
- a cohort study was the appropriate method to answer this question
- the subjects covered in this study could be sufficiently different from your population to cause concern
- your local setting is likely to differ much from that of the study
- you can quantify the local benefits and harms

Comments: The findings may be relevant to similar school settings and student demographics but could have limited generalizability if the cohort is not representative of the broader adolescent population. Applicability would be higher if the study sample reflects diverse backgrounds and regions

11. Do the results of this study fit with other available evidence?

Yes ✓
Can't Tell
No

Comments: Key outcomes include knowledge about melanoma and self-reported sun protection behaviours. Long-term effects, actual observed behaviour change, or potential unintended consequences (e.g., heightened anxiety about sun exposure) would also be relevant for a comprehensive assessment.

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9. Do you believe the results?

| | |
|---|---|
| Yes | ✓ |
| Can't Tell | |
| No | |

HINT: Consider
- big effect is hard to ignore
- can it be due to bias, chance or confounding
- are the design and methods of this study sufficiently flawed to make the results unreliable
- Bradford Hills criteria (e.g. time sequence, dose-response gradient, biological plausibility, consistency)

Comments: The results appear plausible if the program followed a structured curriculum and improved students' knowledge or awareness of skin cancer. However, the study's conclusions would be more convincing if potential biases (e.g., lack of blinding, possible confounders) were minimized and clearly addressed in the analysis.

Section C: Will the results help locally?

10. Can the results be applied to the local population?

| | |
|---|---|
| Yes | |
| Can't Tell | ✓ |
| No | |

HINT: Consider whether
- a cohort study was the appropriate method to answer this question
- the subjects covered in this study could be sufficiently different from your population to cause concern
- your local setting is likely to differ much from that of the study
- you can quantify the local benefits and harms

Comments: The findings may be relevant to similar school settings and student demographics but could have limited generalizability if the cohort is not representative of the broader adolescent population. Applicability would be higher if the study sample reflects diverse backgrounds and regions

11. Do the results of this study fit with other available evidence?

| | |
|---|---|
| Yes | ✓ |
| Can't Tell | |
| No | |

Comments: Key outcomes include knowledge about melanoma and self-reported sun protection behaviours. Long-term effects, actual observed behaviour change, or potential unintended consequences (e.g., heightened anxiety about sun exposure) would also be relevant for a comprehensive assessment.

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12. What are the implications of this study for practice?

| | |
|---|---|
| Yes | ✓ |
| Can't Tell | |
| No | |

HINT: Consider
- one observational study rarely provides sufficiently robust evidence to recommend changes to clinical practice or within health policy decision making
- for certain questions, observational studies provide the only evidence
- recommendations from observational studies are always stronger when supported by other evidence

| Comments: | School-based health education is generally low-cost and low-risk. If the intervention effectively raises awareness and promotes protective behaviour, the benefits, such as reduced skin cancer risk, would outweigh the costs associated with implementing such programs in schools. |
|---|---|

## Appendix Ten – CASP assessment: Crane et al (1999)

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**Study and citation:** Crane, Schneider, Yohm et al (1999)

**Section A: Is the basic study design valid for a randomised controlled trial?**

| | | Yes | No | Can't tell |
|---|---|---|---|---|
| 1. | **Did the study address a clearly focused research question?**<br>*CONSIDER:*<br>*Was the study designed to assess the outcomes of an intervention?*<br>*Is the research question 'focused' in terms of:*<br>• *Population studied*<br>• *Intervention given*<br>• *Comparator chosen*<br>• *Outcomes measured?* | ☑ | ☐ | ☐ |
| | | The study aims to evaluate the effectiveness of the "Block the Sun, Not the Fun" skin cancer prevention program in child care centres. To determine if the program improves sun protection practices among children and staff. | | |
| 2. | **Was the assignment of participants to interventions randomised?**<br>*CONSIDER:*<br>• *How was randomisation carried out? Was the method appropriate?*<br>• *Was randomisation sufficient to eliminate systematic bias?*<br>• *Was the allocation sequence concealed from investigators and participants?* | ☐ | ☐ | ☑ |
| | | It is not specified if the assignment to intervention or control groups was randomized, which is crucial for reducing selection bias. | | |
| 3. | **Were all participants who entered the study accounted for at its conclusion?**<br>*CONSIDER:*<br>• *Were losses to follow-up and exclusions after randomisation accounted for?*<br>• *Were participants analysed in the study groups to which they were randomised (intention-to-treat analysis)?*<br>• *Was the study stopped early? If so, what was the reason?* | ☐ | ☐ | ☑ |

**Section B: Was the study methodologically sound?**

| | | Yes | No | Can't tell |
|---|---|---|---|---|
| 4. | • **Were the participants 'blind' to intervention they were given?**<br>• **Were the investigators 'blind' to the intervention they were giving to participants?**<br>• **Were the people assessing/analysing outcome/s 'blinded'?** | ☐<br>☐<br>☐ | ☑<br>☑<br>☑ | ☐<br>☐<br>☐ |
| 5. | **Were the study groups similar at the start of the randomised controlled trial?**<br>*CONSIDER:*<br>• *Were the baseline characteristics of each study group (e.g. age, sex, socio-economic group) clearly set out?*<br>• *Were there any differences between the study groups that could affect the outcome/s?* | ☐ | ☐ | ☑ |

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| | |
|---|---|
| **6. Apart from the experimental intervention, did each study group receive the same level of care (that is, were they treated equally)?**<br><br>*CONSIDER:*<br>• *Was there a clearly defined study protocol?*<br>• *If any additional interventions were given (e.g. tests or treatments), were they similar between the study groups?*<br>• *Were the follow-up intervals the same for each study group?* | Yes ☑ No ☐ Can't tell ☐<br>For a fair comparison, both groups should have been treated similarly outside of the program activities. The study should confirm that no additional support or training was provided that might influence sun protection behaviours in one group but not the other. |

**Section C: What are the results?**

| | |
|---|---|
| **7. Were the effects of intervention reported comprehensively?**<br><br>*CONSIDER:*<br>• *Was a power calculation undertaken?*<br>• *What outcomes were measured, and were they clearly specified?*<br>• *How were the results expressed? For binary outcomes, were relative and absolute effects reported?*<br>• *Were the results reported for each outcome in each study group at each follow-up interval?*<br>• *Was there any missing or incomplete data?*<br>• *Was there differential drop-out between the study groups that could affect the results?*<br>• *Were potential sources of bias identified?*<br>• *Which statistical tests were used?*<br>• *Were p values reported?* | Yes ☐ No ☑ Can't tell ☐ |
| **8. Was the precision of the estimate of the intervention or treatment effect reported?**<br><br>*CONSIDER:*<br>• *Were confidence intervals (CIs) reported?* | Yes ☐ No ☑ Can't tell ☐ |
| **9. Do the benefits of the experimental intervention outweigh the harms and costs?**<br><br>*CONSIDER:*<br>• *What was the size of the intervention or treatment effect?*<br>• *Were harms or unintended effects reported for each study group?*<br>• *Was a cost-effectiveness analysis undertaken? (Cost-effectiveness analysis allows a comparison to be made between different interventions used in the care of the same condition or problem.)* | Yes ☑ No ☐ Can't tell ☐<br>School-based and child care educational programs are generally low-risk and low-cost interventions. If the program significantly improves sun protection behaviors, the long-term benefits of potentially reducing skin cancer risk in children would likely outweigh any minimal costs associated with implementing and maintaining the program in child care centers. |

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**Section D: Will the results help locally?**

| | | |
|---|---|---|
| 10. | **Can the results be applied to your local population/in your context?**<br><br>*CONSIDER:*<br>• *Are the study participants similar to the people in your care?*<br>• *Would any differences between your population and the study participants alter the outcomes reported in the study?*<br>• *Are the outcomes important to your population?*<br>• *Are there any outcomes you would have wanted information on that have not been studied or reported?*<br>• *Are there any limitations of the study that would affect your decision?* | Yes ☑ No ☐ Can't tell ☐<br><br>If the child care centres in the study are representative of other centres, then the results may be generalizable to similar populations. However, variations in demographics, regional sun exposure, or cultural attitudes toward sun protection could affect the program's applicability in other settings. |
| 11. | **Would the experimental intervention provide greater value to the people in your care than any of the existing interventions?**<br><br>*CONSIDER:*<br>• *What resources are needed to introduce this intervention taking into account time, finances, and skills development or training needs?*<br>• *Are you able to disinvest resources in one or more existing interventions in order to be able to re-invest in the new intervention?* | Yes ☑ No ☐ Can't tell ☐ |

**APPRAISAL SUMMARY:** *Record key points from your critical appraisal in this box. What is your conclusion about the paper? Would you use it to change your practice or to recommend changes to care/interventions used by your organisation? Could you judiciously implement this intervention without delay?*

Strengths include the study's clear focus on sun protection education and its application in a population where early sun protection can have lasting benefits. However, there are limitations:

Potential lack of randomization, which could introduce selection bias,
The difficulty of blinding participants and staff, which could lead to performance bias,
Limited information on follow-up or sustained behavioural impact beyond the intervention period.

while the study provides promising insights into sun protection behaviour change, additional details on long-term impact, randomization, and cost-effectiveness would strengthen its findings and support broader applicability. Overall, the study presents valuable evidence that early interventions in child care centres could play an essential role in skin cancer prevention by instilling protective habits in young children.