UV Radiation Protection: More than just sunscreen.

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Background - Issues/Current Context

What is UV radiation and how is UV exposure changing?

UV radiation is an invisible form of energy divided into subcategories based on wavelength. Most relevant to human health is UVA radiation which penetrates deep into the skin causing tanning and premature skin ageing, and UVB radiation which penetrates the skin's outermost layer causing tanning, sunburns, and the majority of skin cancers.[1] Ozone, a highly reactive gas compound found in Earth's atmosphere is primarily responsible for blocking UV radiation before it reaches the Earth's surface absorbing 5% of UVB and 95% of UVA radiation from the sun.[2] Ozone depletion is an ongoing global issue, which results in increasing UVR exposure.[1]

Why UV radiation is a pressing public health concern

Increased exposure to ultraviolet (UV) radiation is a growing public health concern. In 2004, UV radiation (UVR) was found to contribute to 0.2 % of the global disease burden and is estimated to cause a loss of 2.5 million disability-adjusted life years and 60,000 deaths. Disability-adjusted life years (DALYs) are defined as the loss of the equivalent of one year of full health. Increased morbidity and mortality are associated with a greater risk for health conditions such as skin cancers, immune suppression, and ocular impairment with UVR exposure. While exposure to exceedingly high levels of UVR can be detrimental to one's health, a certain level of UVR is needed to provide health benefits, such as vitamin D production and immune system modulation.[2]

Risk factors and high-risk populations

There are many risk factors for diseases caused by UVR exposure. For example, human behaviour is a strong modulator of UVR exposure and can be considered a risk factor. Recently, it was found that roughly 168,000 new cases of cutaneous malignant melanoma developed in 2012 due to excess UVR caused by increasing sun-seeking behaviour.[3] There is a range of one-tenth to ten times the mean of UVR exposure which can lead to both health risks and benefits. Additionally, according to Lucas et al. having lighter skin pigmentation combined with higher exposure to UVR increases the risk of developing skin cancer.[2] The incidence of UVR-related diseases is higher in females than males as well.[2,3] Children are at an increased risk of damage due to UV as they are developing skin and eye structure which can result in a greater risk of cancer in later life.[3] Statistics Canada (2017) discovered that the association between increased UVR exposure and increased melanoma risk is stronger for those who are low-income and have low educational attainment.[3]

In addition to sun-seeking behaviour, occupational exposure to UVR can increase the risk of UVR-related illnesses. Peters et al. (2012) found that over 1.5 million Canadian workers are exposed to solar UVR at work, with over half deemed as "high exposed" by spending over 75% of their workday outdoors.[4] The workers that made up most of the proportion exposed to UVR included: farmers, construction labourers, and landscapers. While this study details the level of UVR exposure, it does not discuss the implications on health

which limits the understanding of the full impact of such exposure.[4] Additionally, other populations that spend increased time outdoors for work or leisure are also at an increased risk due to UV rays. These occupations include individuals working in defence, land transport, and the military.[1]

There are also genetic risk factors for UVR-related illnesses including skin pigmentation, tumour suppressor pathways, immune suppression, and telomere maintenance.[4] Those who are immunosuppressed following solid organ or stem cell transplants are at higher risks of skin cancer which is modulated by levels of UVR exposure.[1]

Health outcomes of UVR exposure

In skin cancer, UV radiation is the most important modifiable risk factor as both a tumour initiator and promoter.[5] It is suggested that 90% of non-melanoma cases are directly due to damage by UVR. Further, with a10% decrease in ozone, it is estimated an additional 4,500 melanoma and 300,000 non-melanoma cases will arise globally in a year. In Canada, it has been found that increased exposure to UVR is estimated to be responsible for approximately 62.3% of new melanoma cases. Furthermore, a combination of sunburn, intentional sunbathing, and indoor tanning accounted for 29.7% of melanomas.[6] The study estimates that 10,349 melanoma cases will occur in 2042 and of these, 3032 will be due to modifiable behaviours that increase UVR exposure. However, if 50% of sun-seeking behaviours were avoided, an estimated cumulative number of 11,980 melanoma cases could be prevented by 2042.[5]

Damage to the skin via UV radiation can also lead to the suppression of the immune system and the skin's natural defences increasing vulnerability to infections.[3] An additional emerging issue is that by increasing exposure of the eye to UVR, several ocular issues can arise including photokeratitis, photo conjunctivitis, pterygium, ocular surface neoplasia, melanoma, cataract formation, and macular degeneration.[1]

In addition to UV radiation's direct impact on the skin and eyes, UV radiation has many important indirect impacts on health including mortality, respiratory disease and communicable disease spread. Through a process called photodegradation, UV radiation reacts with plant matter to increase the release of CO2 into the atmosphere. The increased CO2 contributes to the accumulation of greenhouse gases in the atmosphere which leads to global warming and climate change. Climate change has been associated with rising temperatures which in turn have increased heat-related illness/deaths and temperature-related mortality.[7] Rising temperatures also increase the rate of wildfires. The smoke from these fires increases the risk of respiratory illnesses.[8] In addition, reduced water quality due to runoff from extreme precipitation and warming water temperatures has increased the incidence of cholera and harmful algal blooms in rivers and lakes.[6]

Current Initiatives

The first step in solving a problem is determining the burden of the issue. Too little UVR can lead to vitamin D deficiency and too much has led to a measurable chronic disease burden.

Initiatives regarding UVR exposure and research have occurred on an international, national, and local level. With each jurisdiction, there are evident differences in the focus of the initiative and the authority held by that organization. WHO works to "champion health and a better future for all".[7] WHO oversees the Global Health Observatory which tracks and reports on deaths and DALY's lost due to UVR exposure. In 2006, the WHO published a paper titled, "Solar Ultraviolet Radiation - Global burden of disease from solar ultraviolet radiation".[8] This paper is part of a series on the global impact of UV radiation. It includes research on quantifying the UV global health burden and the importance of that statistical data when supporting and implementing public health policy.

The INTERSUN Programme is an interdisciplinary initiative that highlights research, policy changes, and the dissemination of information regarding UVR.[9] The programme is a collaboration among several organizations, including WHO, the United Nations, and the International Agency on Cancer Research. According to the WHO website, the INTERSUN Programme, "collaborates with experts and specialist agencies to implement key research activities, identifies and quantifies health risks from UVR, develops reliable predictions of health and environmental consequences of changes in UV exposure".[5]

In addition, WHO has published several fact sheets surrounding the global effects of UVR. These include fact sheets on "Ultraviolet radiation", "Cancer", and "Protecting workers' health". Between 2005 and 2020, WHO supported several resolutions to address the health burden of UVR. At the 58th World Health Assembly in 2005, member states were encouraged to investigate the relationship between radiation exposure and cancer. At the 70th World Health Assembly in 2017, member nations were encouraged to review their process for the diagnosis and treatment of cancer.[11] At the 72nd World Health Assembly in 2019, the WHO presented a list of goals to address radiation safety. These goals included spreading awareness of UVR risk, avoiding medical imaging when possible, and ensuring that nuclear incidents are managed appropriately.[12]

In Canada, the federal government supports a UV index forecast which provides the UV index for 47 Canadian communities. This allows Canadians to decide for themselves what protection measures should be taken based on the expected UV index for that day.[13,] These efforts have contributed to definitive observations of ozone recovery, with a 20 percent decrease in ozone depletion from 2005 to 2016. The Antarctic ozone layer is predicted to mostly recover by 2040.[22]

Local initiatives for UV radiation safety vary across Canada. In Edmonton, Alberta, the O-day'min Primary Care Network created a Green Healthcare Toolkit that focuses on the environmental impact of healthcare. The 'Inhaler Toolkit' discusses the carbon footprint of

metered-dose inhalers and offers alternatives.[14,15] The O-day'min Primary Care Network maintains an active social media presence through its Instagram account 'greenforhealth_eopcn'.

Global Context

Many countries around the world have acknowledged the importance of controlling UV radiation levels that reach the Earth and have taken collaborative steps toward protecting the ozone layer. Chemicals used in air-conditioning and refrigeration are known to damage the ozone layer[23]; controlling the release of such chemicals is a crucial part of this global effort.

The Montreal Protocol

To address the emerging threat, in 1987, 24 nations - including Canada - signed onto an unprecedented international agreement named the Montreal Protocol on Substances that Deplete the Ozone Layer. Over 70 additional countries have signed since the first edition of this agreement. Under the Montreal Protocol, all participating nations have specific responsibilities related to controlling the use of ozone-depleting substances (ODS), the phase-out of different groups of ODS, annual data and progress reports, and ODS import and export control, among many others. Responsibilities and target timelines assigned to each nation differ based on developmental status. The Multilateral Fund, established in 1991 for the implementation of the Montreal Protocol, provides financial and technical support to eligible developing countries in assistance to meet their respective targets promptly. All countries are subject to measurable goals and binding commitments.[16,17]

The Protocol is amended regularly and has been instrumental in reducing ozone-depleting chemicals and greenhouse gases. In the report that provides updates on the progress of the Montreal Protocol every 4 years, it was confirmed that 99% of banned ozone-depleting substances had been successfully phased out.[18,19]

Epidemiology

UV rays are strongest in areas close to the equator. Higher altitudes have greater UV exposure because there is less atmosphere to absorb UV rays.[20] These geographical factors interact with skin colour and behaviours related to sun exposure and contribute to differing rates of skin cancer by country. In 2020, melanoma and non-melanoma types of skin cancer rates are both highest in Australia followed by New Zealand, with many Northern European countries in the top ten. Canada ranked number four in its non-melanoma skin cancer rates.[21]

Gaps in Current Initiatives

While the current initiatives introduced by various organizations have been promising, certain gaps should be addressed to improve their implementation and uptake by the public and governmental organizations. Canada should consider becoming a part of the INTERSUN programme.[9] This program has made significant contributions to raising

awareness and promoting sun safety, however, it has a few potential gaps. First off, the program may face challenges in translating guidelines into actionable policies at the federal, provincial, and municipal levels, especially in areas with limited resources or competing priorities. Secondly, adequate funding and resources are crucial for the implementation of this program.

Limitations in terms of financial resources, staffing, and infrastructure could create barriers to success. Expenses include educational public health materials, the availability of sun protection products, and establishing of UV radiation monitoring systems, which will be discussed shortly in a Canadian context. It could be advisable to explore funding options through WHO and other governmental entities before committing to the program's objectives. Thirdly, the field of UV radiation research is constantly evolving, and new technologies may allow for better sun protection. However, it can be challenging to keep up with these advancements and there may be limited access to these possibly newer and more expensive technologies. Lastly, sun protection practices and attitudes towards UV radiation may vary across different regions. The INTERSUN programme may need to consider these variations, such as with Indigenous populations, and adapt strategies accordingly to ensure cultural sensitivity and relevance.

In terms of the strategies outlined by the World Health Assembly reports regarding awareness and education on cancer prevention strategies, there are a few areas that may warrant further attention.[10,11,12] Firstly, individuals may lack awareness of detection/screening methods, and available treatment options. Resources and funding must be directed towards improving public knowledge. Secondly, inadequate access to healthcare services, especially in lower-income or rural regions, can hinder the early detection and treatment of cancer. Disparities in access to cancer care based on social determinants of health (e.g., socioeconomic, race/ethnicity, geographical location, etc.) can affect vulnerable populations. Thirdly, if there is limited collaboration and differing viewpoints among stakeholders, such as governments, healthcare providers, researchers, and cancer care and climate interest groups, then a final decision on how to implement these recommendations may be difficult to achieve. Furthermore, reactive approaches and focus on treatment may take higher priority than proactive preventative public health measures in cancer care.

The Canadian UV Index forecast is an incredibly useful tool; however, some improvements can be made.[13] Firstly, Canada is a vast country with diverse geographical locations. The UV Index levels can vary across different locations and may not be available for rural or remote regions, making it difficult to provide robust UV forecasts. Forecasts can also change throughout the day, making real-time updates challenging. Secondly, despite the availability of UV Index forecasts, users may not be aware of this tool and the risks associated with UV exposure. Knowledge translation and user outreach could be prioritized, so individuals make use of this tool. Lastly, the UV Index website mentions the use of the Fitzpatrick skin type classification scale. Although this scale is widely used, it has been criticized for being too subjective, having limited representation for darker skin

tones, and may not account for other factors that can affect sun sensitivity (e.g., aging, medications, genetic predispositions, etc.). Some alternatives to this scale are von Luschan's chromatic scale (has 36 colour options to match skin colour), the Glogau scale (focuses on skin aging), and the Baumann skin type indicator (categorizes skin in terms of various factors such as oiliness, sensitivity, pigmentation etc.).[10]

Next Steps and Recommendations

The current understanding of exposure to UV radiation, its health implications, and gaps in existing initiatives highlight the need for comprehensive strategies to address this pressing public concern. Based on the previously described context, the CFMS makes the following recommendations to minimize risks associated with UV radiation and promote public health and safety:

1. Promote Sun Safe Behaviours and Education by Health Professionals

- Encourage physicians and allied healthcare professionals to integrate sun safety education into routine patient care
- Create and disseminate evidence-based resources and training to healthcare providers to effectively communicate sun safety recommendations to patients, tailored to specific populations and risk factors
- Develop specified educational materials and public health initiatives targeting high-risk populations, including women and gender minorities, parents of young children, low-income populations, outdoor workers, and individuals with lighter skin pigmentation, to raise awareness of the risks of UV exposure and promote sun-safe behaviours

2. Advocate for Canada to join the INTERSUN Programme

- Advocate to federal politicians and policymakers for Canada's participation in the WHO's INTERSUN programme to receive empirical information and guidance on the health impact of UV exposure and accountability to take action to reduce UV-induced health risks
- Contribute to the further improvement of the INTERSUN programme by addressing existing initiative gaps, including implementation challenges and cultural and regional variations in rural and remote communities
- Encourage Canadian government agencies, particularly the Public Health Agency of Canada, Environment Canada, and Health Canada, to develop practical ways of monitoring change in UV-induced health effects in Canada over time
- Collaborate with international countries and organizations to leverage resources for comprehensive advice and information on the health and environmental effects of UV exposure and measures to protect the general public, workers, and the environment against the adverse effects of increasing UV radiation levels

3. Enhance Occupational Health and Safety Regulations for High-Risk Occupations

- Implement comprehensive sun safety programs and protocols for all workplaces that require employees to work outdoors that include regular assessment of UV radiation exposure risk and sun safety control measures
- Provide education and training for employees who work outdoors to recognize and mitigate UV-related hazards in the workplace, including personal protective equipment and administrative measures such as rescheduling outdoor work tasks outside of peak UV times
- Establish partnerships between public health agencies, Occupational Health and Safety groups, labour unions, and employers to develop and implement evidence-based sun safety policies tailored to high-risk occupations, including construction, agriculture, defence, land transportation, and the military

4. Address Existing Gaps in UV Index Information and Education

- Improve the accuracy and accessibility of UV index forecasts by expanding real-time and regular coverage to include remote and less populated areas
- Enhance public awareness and understanding of the UV Index Forecast system through targeted public health educational campaigns and increased educational materials on existing UV Index websites
- Advocate to federal, provincial, and municipal public health units to utilize more accurate skin type classification scales, such as the von Luschan's chromatic scale and/or the Lancer Ethnicity Scale, to account for all skin tones, incorporate other factors that can affect sun sensitivity, and promote inclusive sun safety messaging

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