Short wavelengths filtering properties of sunglasses on the Canadian market: are we protected?

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ABSTRACT •

Background: Exposure to solar radiation is a risk factor for multiple ocular pathologies. Ultraviolet (UV) radiation is involved in ocular diseases, including pterygium, ocular surface squamous neoplasia, and cataracts. High-energy visible light (HEV) is associated with age-related macular degeneration. Ocular protection against solar radiation seems essential to protect our eyes against the adverse effects of those harmful rays. Australia, New Zealand, Europe, and the United States are the only regions with mandatory standards for UV transmission for sunglasses. Adherence to Canadian standards by sunglasses manufacturers is not mandatory. In this study, we evaluated the UV and visible transmission of sunglasses in the Canadian market to test their compliance with Canadian standards.

Methods: The transmittance of 207 pairs of sunglasses, divided in 3 categories according to their price range, was measured.

Results: We show that close to 100% of the sunglasses tested respect the Canadian standards. The average HEV transmittance is around 10%, regardless the price range.

Conclusions: Our study demonstrated that even if following Canadian standards is optional, most sunglasses sold on the Canadian market follow national and international standards. We also found that sunglasses filter around 90% of HEV. With the recent findings on the potential effects of HEV in retinal pathologies, we can ask whether this filtering capacity is sufficient to protect eyes from harmful HEV light. More work needs to be done to determine acceptable HEV light transmission limits to the existing Canadian standards.

The solar electromagnetic spectrum includes ultraviolet radiation (UVR; 100–400 nm), visible light (400–750 nm), and infrared radiation (>750 nm). UV wavelengths can be subdivided into UVA (315–400 nm), UVB (280–315 nm), and UVC (100–280 nm) (International Commission on Non-Ionizing Radiation Protection).[1,2] High-energy visible light (HEV) corresponds to the visible light between 400 and 500 nm.

Anterior ocular structures have their own UV absorption properties. The cornea absorbs 100% of radiation under 280 nm.[3–5] The corneal epithelium and Bowman's layer have a good absorption of UV below 310 nm compared with the stroma, and the peripheral cornea absorbs more than the central cornea.[4,6] The crystalline lens also absorbs UV. Indeed, it absorbs virtually all wavelengths under 400 nm. Of note, crystalline lens absorption varies with age. The lens in younger individuals is more permissive to UV and HEV light than in adults and elderly people. At 8 years old, the lens absorbs nearly all wavelengths under 365 nm, whereas this absorption cutoff shifts to 450 nm at 65 years of age.[6]

A variety of ocular diseases are related to acute and chronic exposure to UV radiation, including pterygium, pinguecula, photokeratitis, climatic droplet keratopathy, and ocular surface squamous neoplasia.[7–11] Many epidemiologic studies have linked cataract formation to UV exposure.[12–17] Also, some epidemiological evidence has shown that solar exposure represents a risk factor for uveal melanoma.[18–22] Multiple studies have shown the association between HEV and cumulative solar light exposure and age-related macular degeneration (AMD), the most common cause of blindness in industrialized countries. AMD is a retinal disease characterized by the loss of retinal pigment epithelium (RPE) cells and accumulation of drusen with aging, which is accompanied by loss of central vision.[23–25]

In 2003, Gies had raised a concern about UV exposure in Australia.[26] Indeed, compared with countries in the Northern Hemisphere, for the same latitude, Australia receives 15% more UV radiation. This phenomenon is explained by the fact that the sun is closer to Australia during summer compared with sun proximity in northern countries during their summer season. Furthermore, ozone depletion and a decrease in cloud cover were observed between 1979 and 1992. This resulted in an increase of 4% in UV dose in Northern Australia.[26] This increasing burden of UV exposure has motivated Australia and some countries to increase UV protection standards.

Efficient ocular protection against solar radiation may help decrease the progression or development of the pathologies discussed above. Indeed, reducing ocular UV light exposure using sunglasses represents the most efficient way to protect eyes from the adverse effects of sun

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rays. Most countries do not have standards for sunglasses filtering properties. The United States, Europe, Australia, and New Zealand are the only regions with mandatory standards for marketed sunglasses. In Canada, the standards are not regulated (see Table 1). Surprisingly, even if evidence is growing about the toxicity of HEV light, none of these standards have specification for HEV transmission by general-purpose sunglasses. Standards in Europe and Australia/New Zealand specify a maximum of blue light transmission allowed, if blue light absorption is claimed on the sunglasses, but there are no standards in general-purpose sunglasses. The current study aims to report the percentage of general-purpose sunglasses on the Canadian market that abide by the standards and to report their average HEV transmission, according to their price range.

Materials and Methods

We conducted a study on the Canadian sunglasses market between January 2015 and June 2015. Our sample of 207 pairs of sunglasses were provided by 4 optometry and ophthalmology clinics in Quebec city, Canada: Centre oculaire de Québec, Centre visuel Nathalie Picard, Clinique médicale le Campanile, and Vision Beaulieu. Some sunglasses were also purchased from various stores to complete the sampling, especially in the low-price range. Sunglasses of various brands available across Canada were obtained. Although it is virtually impossible to determine the proportion of the sample on the overall market (i.e., how many different sunglasses are available on the Canadian market), 207 pairs represent a decent picture of the sunglasses that can be found in this market.

We included brand-new, unicolour, undamaged sunglasses in our study. Damaged, polarized, photochromic, and graded sunglasses were excluded. Indeed, damaged lens material and different shades present in the lens can lead to variation in our measurements for that same lens. We divided the sunglasses into 3 price-range categories: low, \$0–\$20; medium, \$21–\$120; and high, > \$120. A sample of 207 pairs of sunglasses was used to achieve a confidence interval of 95%, a power of 80%, and an alpha-error of 5%. The sunglasses were randomly selected from different brand names and shades of colour in order to obtain a random sampling of the market. Different models of each selected brand were included. The spectrophotometer Varian Cary 50 UV/Visible, with a sunglasses holder, was used to measure the spectral transmission of sunglasses (UV/visible%) with a resolution of 1 nm. For each wavelength, the spectrophotometer measured the percentage of transmission. For each pair of sunglasses, we determined whether they respected the requirements of the different standards: European, American, Australian and New Zealand, and Canadian.

A one-way logistic regression was used to test the effect of price range (low, medium, and high) on the proportion of sunglasses respecting the standards. A one-way ANOVA was used to test the effect of price on the average percentage filtration of HEV.

Results and Discussion

In Canada, adherence to Canadian sunglasses standards by manufacturers is optional. However, the Canadian government advises consumers to look for a UV protection label because they should not rely solely on price, colour, or transparency of the lenses. The most recent updates of the Canadian standards regarding UV filtering properties of general-purpose sunglasses were published in 2010 and are shown in Table 1.

The purpose of this study was to determine whether the general-purpose sunglasses available on the Canadian market comply with Canadian standards. A comparison of the Canadian standards to those in different regions, including the United States, New Zealand, Australia, and Europe, has also been performed. We measured the UV/visible transmittance (200–800 nm) in 207 randomly chosen pairs of sunglasses classified in the "General Purpose" category of the Canadian standards. They were

Table 1—Standards for general-purpose sunglasses

	Canadian Standards, 2010[40]	
Visible Light Transmittance (T) (%), 400–750 nm	UVA Transmittance (%), 320–400 nm	UVB Transmittance (%), 280–320 nm
8–40	8–40	1–5
	American Standards: ANSI Z80.3–2015[41]	
Visible Light Transmittance (T) (%), 400–750 nm	UVA Transmittance (%), 315–380 nm	UVB Transmittance (%), 280–315 nm
8–40	50%–100% T	1%–12.5% T
	Australian and New Zealand Standards: AS/NZS 1067:2003[42]	
Visible Light Transmittance (T) (%), 400–750 nm	UVA Transmittance (%), 315–400 nm	UVB Transmittance (%), 280–315 nm
8–43	50%–100% T	5% T
	European Standards: EN ISO 12312–1:2013[43]	
Visible Light Transmittance (T) (%), 400–750 nm	UVA Transmittance (%), 315–380 nm	UVB Transmittance (%), 280–315 nm
8–43	50% T	1% of absolute transmission or 5% T