Original Article

Quality of sunglasses available in the Iranian market; a study with emphasis on sellers' license

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Context: Sunglasses should follow minimum requirements to sufficiently protect eyes. It is not known whether all items obtainable from the market are appropriately designed. **Aims:** To compare ultraviolet (UV)-protective properties of commercially available sunglasses obtained from authorized and unauthorized Iranian sellers. **Settings and Study Design:** An analytic-descriptive study performed in a metropolitan area (Tehran). **Materials and Methods:** Using a UV-visible standard spectrophotometer, the percentage transmittance was scanned between 280 and 400 nm in 348 pairs of nonprescription sunglasses (price range: 20–80 US$) obtained anonymously and randomly from authorized (permitted by the Ministry of Health, 189 pairs) and unauthorized (159 pairs) sellers in the Iranian capital city, Tehran. The Australian/New Zealand Standard (AS/NZS) and the American National Standards Institute [ANSI] standards were followed. **Statistical Analysis:** Chi-square test, independent samples *t*-test or Mann–Whitney U-test. **Results** UV-protective properties of the sunglasses obtained from authorized sellers complied with AS/NZS and ANSI guidelines in 92.6% and 95.2% of items, respectively. The corresponding rates for sunglasses obtained from unauthorized sellers were 0% and 8.2%, respectively ($P < 0.001$ for both). The rate of defective polarizing capability of lenses was 27.4% in sunglasses obtained from authorized sellers versus 90.4% in sunglasses obtained from unauthorized sellers ($P < 0.001$). Neither brand nor price played significant contributions to UV protection/lens polarizing capability of sunglasses obtained from authorized sellers. **Conclusions:** Sunglasses provided by unauthorized sellers are alarmingly unreliable and could be potentially hazardous for the eye. Brand and price do not guarantee optimal protection against UV radiation or polarizing performance of the lens.

Key words: Permit, seller, sunglasses, ultraviolet radiation

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Whether for glamor, comfort against sun glare or protection of the eyes from excessive solar ultraviolet (UV) radiation, sunglasses are world widely used in the present modern era.[1]

Ultraviolet rays comprise only a narrow window of the whole solar spectrum (200–400 nm). While almost 100% of the UVC (200–280 nm) and over 90% of the UVB rays are blocked in the atmosphere by the ozone layer, UVA rays reach the earth surface almost completely. Ozone depletion has led to a significant increase in UV transmission to the earth surface.[2]

Both UVB and UVA radiations can impair lens structure and function[3] and induce significant problems in the cornea and retina.[2,4]

Although sunglasses can attenuate ocular exposure to UV radiation, improperly protected lenses may cause increases in UV exposure to the eye by disabling its natural mechanisms of pupil constriction and lid closure.[2]

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Because of increasing awareness regarding the hazardous effects of solar UV radiation on the eyes in recent decades,[5] the general public tends to opt for lenses that protect against UV radiation.[6]

Finding a pair of suitable sunglasses, however, is not a straightforward task, because brands, price, and polarizing lens do not guarantee the suitability of sunglasses for providing adequate protection.[7] Furthermore, it has been documented that a considerable portion of the general population, even in modern societies, are not aware of protective properties of proper sunglasses against UV radiation.[8] As a result, reliance on sellers is usually considered the last resort for most consumers to pick up a good pair of sunglasses.[9]

Many sunglasses currently on the market, however, are being sold by unauthorized distributors/sellers including shops ran by nonprofessionals or street vendors. Surprisingly, whether or not such unauthorized/unlicensed sunglasses providers are reliable has been very rarely investigated in the literature.[10]

The principal aim of this study was to compare the performance of sunglasses obtained from authorized and unauthorized sellers in an Iranian metropolitan area in protection against UV radiation.

Materials and Methods

From February 2013 through to June 2014, 348 pairs of branded and unbranded nonprescription sunglasses (price range: 20–80 US$) were anonymously obtained from randomly selected

authorized (n = 9) and unauthorized (n = 12) vendors in a metropolitan area (Tehran, Iran). Tehran is the capital of Iran, the largest city in this country with over 12 million population. The price range was determined by tracking consumers' past purchasing behavior in the target market (data not shown). A vendor was considered authorized when it had a permit issued by the Ministry of Health to sell sunglasses. In this group the channel that a pair of sunglasses is obtained through is clear and under the control of the Ministry of Trade. Sellers without such license and street vendors were designated as the unauthorized group. Actual origin of many sunglasses cannot be determined in this group.

Only sunglasses with labels indicating UV protection were included.

Samples from the two groups were placed in two different boxes. To ensure blinding the grouping was disclosed to the investigators only after completion of data analysis.

All examinations were carried out by two skilled opticians (with over 20 years of experience) worked cooperatively.

Using a standard spectrophotometer (Thermo-Spectronic, UV-1 model, Thermo Electron Corporation, USA) sensitive to both UVB and UVA rays (290–400 nm) against standard UVA and UVB light sources the transmission of lens and maximum wavelength absorption were measured. Both the Australian/New Zealand Standard [AS/NZS] 1067:2003 (<1% transmission of UVB and <5% transmission of UVA)[11] and the American National Standards Institute [ANSI] Z80.3:2001 standard (<1% transmission of UVB and UVA transmittance of < 0.3 times the visual light transmittance)[12] were followed.

Lenses with printed claim of polarizing capability were tested by rotating them against a standard Polaroid filter in both clockwise and counter-clockwise directions and a particular pattern of color change described by the manufacturer of the filter was looked for. Documentation of not such a pattern denied the claim.

Coloration of lens was also documented. When different colors of a particular product were available sunglasses with gray/brown lenses were selected.[4]

Collected data were compared between sunglasses obtained from the two groups of vendors, as well as between branded and unbranded products for samples obtained from authorized sellers.

Statistical analysis

The SPSS Software for Windows (version 18.0, SPSS Inc., IL, USA) was used for analysis. Chi-square (χ^2) test for categorical data, and independent samples t-test or independent samples Mann–Whitney U-test for numerical data were used. A $P \leq 0.05$ was considered statistically significant.

Results

Characteristics of sunglasses according to vendors are set out in Table 1.

The two groups were comparable in terms of type (branded, unbranded) and price. The proportion of sunglasses with claimed polarizing lenses was significantly higher in the group obtained from unauthorized sellers (52.2% vs. 38.6%; Chi-square test $P = 0.01$).

Study variables in two groups of sunglasses obtained from authorized and unauthorized sellers are summarized in Table 2.

According to AS/NZS 1067:2003, the failure rates of sunglasses against both UVA and UVB, only UVA, and only UVB were 7.4%, 7.4%, and 0% in the group obtained from authorized sellers, respectively. The corresponding rates in the group obtained from unauthorized group were 100%, 90.6%, and 19.4%, respectively (Chi-square test $P < 0.001$ for all comparisons).

According to ANSI Z80.3:2001 the corresponding rates were 4.8%, 4.8% and 0% in the former group, and 91.8%, 82.4%,

Table 1: Characteristics of sunglasses obtained from authorized and unauthorized sellers

Variable	From authorized sellers (n=189)	From unauthorized sellers (n=159)	P
Type			
Branded	74 (39.2)	67 (42.1)	0.57
Unbranded	115 (60.8)	92 (57.9)	
Price (US$)	53.2±22.1 (20-80)	51.6±19.2 (20-80)	0.38
With polarizing lenses	73 (38.6)	83 (52.2)	0.01*

Data are presented as frequency (%) or mean±SD (range). *P<0.05 is statistically significant. SD: Standard deviation

Table 2: Study variables in sunglasses obtained from authorized and unauthorized sellers

Variable	From authorized sellers (n=189)	From unauthorized sellers (n=159)	P
Failed UV protection			
AS/NZS 1067:2003			
UVA+UVB	14 (7.4)	159 (100)	<0.001*
UVA	14 (7.4)	144 (90.6)	<0.001*
UVB	0 (0)	15 (19.4)	<0.001*
ANSI Z80.3:2001			
UVA+UVB	9 (4.8)	146 (91.8)	<0.001*
UVA	9 (4.8)	131 (82.4)	<0.001*
UVB	0 (0)	15 (19.4)	<0.001*
Transmission rate (in failed cases, %)			
UVA	6.54±0.34	12.90±5.13	<0.001*
UVB	-	2.3±1.15	-
Standard polaroid test			
Performed	73	83	-
Failed	20 (27.4)	75 (90.4)	<0.001*
Lens coloration			
Brown/gray	147 (77.8)	75 (47.2)	<0.001*
Other	42 (22.2)	84 (52.8)	

Data are presented as number (%) or mean±SD. *P<0.05 is statistically significant. UV: Ultraviolet, SD: Standard deviation, AS/NZS: Australian/New Zealand Standard

and 19.4%, in the latter group, respectively (Chi-square test $P < 0.001$ for all comparisons).

The mean transmission rate of UVA was significantly higher in sunglasses obtained from unauthorized sellers (12.90% vs. 6.54%; independent samples *t*-test $P < 0.001$).

A failed standard Polaroid test result was significantly more common among sunglasses obtained from unauthorized sellers (90.4% vs. 27.4%; Chi-square test $P < 0.001$).

Frequency of sunglasses with brown/gray lenses was significantly higher among those obtained from authorized sellers (77.8% vs. 47.2%; Chi-square test $P < 0.001$).

Characteristics of branded and unbranded sunglasses from authorized sellers only are summarized Table 3. The two groups were comparable for the proportion of sunglasses with failed UV protection, failed Polaroid test result, and with gray/brown lenses.

The mean price of the branded items, however, was significantly higher than the mean price of unbranded sunglasses (72 US$ vs. 32.9 US$; independent samples *t*-test $P < 0.001$). In addition, unbranded sunglasses had polarizing lenses more frequently than the branded ones (53.9% vs. 14.9%; Chi-square test $P < 0.001$).

Among the sunglasses obtained from authorized sellers the median prices of those with failed and passed UV protection were 55US$ and 50US$, respectively (independent samples Mann–Whitney U-test $P = 0.49$). In the same group, the mean prices of sunglasses with passed and failed standard Polaroid test were 55.8 ± 20.3US$ and 52.1 ± 22.7US$, respectively (independent samples *t*-test $P = 0.32$).

Discussion

Among required testing items for safety, protection against UV radiation, proper polarizing capability, and standard lens coloration are among important characteristics that suitable sunglasses posses.[13] Protection against UV radiation, inter alia, seems to be the most important feature.[14]

Excessive UV radiation exposure to the eye may induce a variety of harmful consequences[2,4] such as squamous and basal cell cancer on the eyelid and periorbital skin,[15] pterygium,[14] photokeratoconjunctivitis,[16] cataract[17] and maculopathy.[18]

Colored lenses without adequate UV protection cause the pupils to dilate because of decreased visible light, while the amount of UV radiation remains unchanged. Hence, more UV radiation reaches the lens compared to the time that sunglasses with such lenses are not used.[19] Although it has been shown that the human crystalline lens absorbs almost all lights below 400 nm,[20] the excess UV exposure could still increase the risk of cataract.[17] In addition, the ability of the crystalline lens in absorbing UV radiation decreases with age and may vary significantly between individuals.[20] Besides the increased risk of UV ray exposure in using nonstandard sunglasses, generally people wearing sunglasses tended to be more exposed to sunlight, assuming that they are protected by the sunglasses.[21]

In 1991, Werner[22] reported that despite the presence of labels reading appropriate protection, some of the commercially available sunglasses do not provide complete protection against UV radiation.

Although such misleading labels are now less frequent than before,[23] mass production of fake, low-quality sunglasses that in many cases distinguishing between genuine items and these replicas is hard even for experts, has led to mushroom-like popping of unauthorized shops and street vendors even in modern countries. Lower price of these crafty products, on the other hand, make many regular customers irresistible to the temptation of purchase. For example, in an Indian series by Velpandian *et al*.[6] over 75% of the 20 lenses studied failed to offer 95% protection against UVA and 35% of the lenses failed to offer 99% protection against UVB.

It is now being consistently emphasized that any sunglasses used should conform to a national standard.[24] We used both the AS/NZS[11] and the American[12] standards in this work because the first provides the most rigorous criteria among the available guidelines and the second is more inclusive and popular than the European standards.[25]

Our findings showed alarmingly high noncompliance rate among the sunglasses purchased from unauthorized sellers (100% according to the AS/NZS 1067:2003, 91.8% according to the ANSI Z80.3:2001). Majority of failures were against UVA. The overall failure rates among sunglasses obtained from authorized sellers were trivial (7.4% according to the AS/NZS 1067:2003, 4.8% according to the ANSI Z80.3:2001). All the failures occurred against UVA in this group.

To the best of the authors' knowledge, only one study has ever tested the association between vendor's license and appropriateness of sunglasses. In this study by Keshtkar-Jafari *et al*.[10] a total of 353 pairs of sunglasses available in Iranian market was examined in terms of UV protection. According to their findings, all of the sunglasses obtained from Iranian optician trade union shops met ANSI standards in transmission of UVA and UVB, whereas the corresponding rates were 92.1% and 95.8% for those obtained from other miscellaneous vendors.

Table 3: Branded versus unbranded sunglasses obtained from authorized sellers

Variable	Branded (*n*=74)	Unbranded (*n*=115)	*P*	OR	95% CI
Failed UV protection†	4 (5.4)	10 (8.7)	0.40	1.7	0.5-5.5
Price (US$)	72.3±4.2	32.9±18.6	<0.001*	-	-
With polarizing lenses	11 (14.9)	62 (53.9)	<0.001*	6.7	3.2-14.0
Failed Polaroid test	2 (18.2)	18 (29)	0.72	0.5	0.1-2.8
Gray/brown lens	61 (82.4)	86 (74.8)	0.22	0.6	0.3-1.3

Data are presented as frequency (%) or mean±SD. *P<0.05 is statistically significant, †According to AS/NZS 1067:2003. AS/NZS: Australian/New Zealand Standard, CI: Confidence interval, OR: Odds ratio, UV: Ultraviolet, SD: Standard deviation

Their findings are in contrast to ours, maybe because of using different criteria for categorizing vendors and more importantly, different times of the studies.

By increasing public awareness regarding the importance of sunglasses in protecting eyes from solar radiation, particularly in recent years,[1] the industries in relation with eyeglasses have turned into a highly profitable businesses. There is usually lack of strict quality control over the most of the products manufactured in small-scale industrial units, so many of them usually do not provide the protection they claim to offer.[6] Therefore, and unlike in the past, more low quality products are encountered on the present market, as the findings of the current study suggest.

Providing a very high degree of protection against UVB by our sunglasses in both groups is a finding in line with a previous report from the polish market.[26] Although both UVA and UVB rays are harmful for the eye, the latter is particularly hazardous in younger population under 30 years old because of their immature crystalline lens structure.[18]

Good polarizing lenses can significantly attenuate or prevent glare.[16] Well-functioning polarizing lenses were significantly more common among sunglasses obtained from authorized sellers in the present study.

True color rendition usually is provided by gray and brown lenses.[4] In conformity with an American report[8], 78% of our sunglasses obtained from authorized sellers had gray/brown lenses. This rate was only 47.2% in the group obtained from unauthorized sellers.

It is advisable to either establish a mandated standard in using lens coloration, or lenses out of prescribed coloration limits should carry a warning label.[27]

In the present study, both branded and unbranded sunglasses obtained from authorized sellers were comparable in terms of UV protection, quality of polarizing lenses, and standard lens coloration. These findings are in line with previous reports in the literature.[7,28] In addition, although branded sunglasses, as expected, were significantly more expensive than unbranded ones, in conformity with a previous report[7] no advantage was found for more expensive sunglasses over the others.

Shape, size, wearing position and reflection from the posterior lens surface are other important factors that may affect the appropriateness of sunglasses.[29] In addition, retention, optical quality, uniformity and matching of lens, as well as overall robustness and construction of sunglasses are advised to be considered during a standard quality/safety check.[14,27]

Although in the beginning we planned to check all these factors in this study, surprising findings relating to UV protection deemed their evaluation unnecessary. Nevertheless, examining the mentioned parameters is imperative when sunglasses from authorized sellers are being evaluated; a suggestion that needs to be considered in future studies.

Using mandatory standards and imposing substantial fines on violating companies may prevent inappropriate sunglasses to access the market; as tested previously with success in Australia.[5,14]

Consulting an ophthalmologist or eye-care specialist when selecting eyeglasses is another good advice for consumers.[30]

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