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AIR POLLUTION IMPACT ON ULTRA VIOLET INDEX (UVI)

Hamidreza Shamsollahi[1], Masoud Masinaei[2], Niaz Mahdi Esfahani[1], Shahrokh Nazmara[1]*

[1] Department of Environmental Health Engineering, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
[2] Department of Epidemiology and Biostatistics, Tehran University of Medical Sciences, Tehran, Iran

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CORRESPONDING AUTHOR:

snazmara@gmail.com
Tel: (+98 21) 88954914
Fax: (+98 21) 88950188

ABSTRACT:

Introduction: UV index is a precaution index that shows level of exposure to sunlight UV. UV index can be calculated by the related formula according to solar spectral irradiance (Eλ). But this formula and others like this are mostly used when sky is clear. The aim of this investigation is determination of effect of $PM_{2.5}$ and NO_2 concentration on UV index.

Material and methods: Two points with the same altitude were chosen and the $PM_{2.5}$ and NO_2 concentrations, and UV index were measured 4 h every day from 11am to 3 pm, in these points during one month from 15 October till 15 November 2016.

Results: Simple and interaction regression models showed significant reverse relationship between contaminants concentration and UVI ($P_{value} \leq 0.05$), although the effect of $PM_{2.5}$ concentration was more significant than NO_2 ($P_{value} \leq 0.001$), in both point.

Conclusions: There is a strong correlation between $PM_{2.5}$ concentration and decrease in UV index. Also a significant correlation between NO_2 concentration and UV index was found and any significant correlation between UV index and interaction effect of NO_2 - $PM_{2.5}$ was not appeared. Results of this study showed that air pollutants concentration can reduce UV index, thus it can change the risk of skin eczema and skin cancer.

INTRODUCTION

From the total spectrum of sunlight Ultra violet (UV) radiation, almost entire UVA spectrum (315 - 400 nm) can be received by the earth surface [1]. Small amount of UV radiation may be beneficial for medical supervision such as vitamin D generation, or treatment of some dermal disease such as eczema and psoriasis [2]. But, long time exposure to UV radiation can lead to a lot of health effects such as sunburn, tanning; degenerative changes in dermal cells induced by UV radiation, eye's inflammatory reactions such as photokeratitis could occur, besides, exposure to UV radiation can induce skin cancer [3 - 4]. As result, for protection of public health from UV radiation effects, the UV index (UVI) must be calculated and announced by the related agencies in several countries as a caution to the public for health protection [5]. The UVI can be determined by Eq. (1), suggested by the International Commission on Illumination (CIE) reference action spectrum for UV induced erythema on the human skin [6] (ISO 17166:1999/CIES 007/E-1998) :

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$$I_{UV} = k_{er} \cdot \int_{250nm}^{400nm} E_{\lambda} \cdot S_{er}(\lambda)\, d\lambda \quad (1)$$

(UVI calculation formula)

I_{UV}: UV index
Eλ : solar spectral irradiance ($W/m^2.nm$) at wavelength λ
dλ : wavelength
S_{er} : erythma reference action spectrum
K_{er}: 40 m^2/W (constant)
Also another formula was suggested and applied to calculate UVI [7]. A little part of UVB spectrum (280 to 315 nm) can be received by the earth surface, therefore some parts of the formula using for UVI calculation can also take to account for this spectrum either [8]. As the result, the main differences between different formulas are in range of measured wavelength. All of the formula in this issue is applicable for clear sky, but air pollutants concentration may effect on UVI as mentioned by several studies.
The concentration of anthropogenic pollutants in the urban areas, in different seasons is different because of several meteorological conditions such as air temperature, humidity and wind speed [9]. So, UVI must be determined by taking to account of pollutants effect. As the result, the main aim of this study is to determine NO_2 and $PM_{2.5}$ concentrations on UV index.

MATERIALS AND METHODS

In a clear atmosphere, the received UV to the earth surface in areas where have same altitude , are the same [10]. In addition, the points with different altitudes, have achieved different values of UV [11]. Therefore, for prevention from these confounding effects on measurements, two points with the partially same altitude and latitude were chosen. The first point was in: 35.69" N, 51.39 " E and 1194:00 m elevation and the second point was in: 39.70" N, 51.28" E and 1180 m elevation. The measurement period was from 15 October 2016 to 15 November 2016. As world health organization (WHO) reported, dangerous hours for UV exposure are from 11am to 3 pm [6]. So, the UV radiation intensity was measured every day in this time period. These measurements were done simultaneously in both points by Hand-held-lux-UV-IR meter (LABOLD, Germany) device. For measurement of the NO_2 the Griess- Saltzman method was applied. The impingers contents were unloaded every hour and were renewed. In addition for measurement of $PM_{2.5}$ concentration, the Grimm fine particle analyzer (environ check 1165) was used. The sampling periods were 4 h continuously (11am to 3 pm every day). The UV index (UVI) was calculated by mean of measured UV radiation intensity values (every day) using Eq. (1). For determination correlation between UVI and two air pollutant concentration, and for comparison of UVI value in these points, the achieved data were analyzed by R i386 3.4.1.

RESULTS AND DISCUSSION

The calculated UVI, NO_2 and $PM_{2.5}$ concentrations in both points were reported in Table 1.
The relationship between NO_2 and $PM_{2.5}$ concentration and UVI was examined by interaction multiple regression and simple regression models. The summary of these statistic exams were mentioned in Table 2.
For the comparison of UVI values in different places the paired t- test was used. The P_{value} of the t- test was < 0.001, that shows significant differences between UVI in two difference points.
As shown in Table 2, there is a significant correlation between $PM_{2.5}$ and NO_2 concentrations in the air and UVI value in both of point1 and point 2 ($P_{value} < 0.05$), also the effect of interaction of $PM_{2.5}$ and NO_2 was significant at 0.9 confidence interval. In analysis of AIC was shown that in the first point, the best regression model is interaction model, while in second point, there was not any differences between two fitted models for prediction UVI. On the other hand the paired t-test result shows significant differences between UVI in the two measurement points. In this study, for elimination of time and place confounding effects the UV radiation was measured in both of points simultaneously and also was tried that latitude of both points be the same. The result of this study shown there are reverse relationship between UVI and $PM_{2.5}$ and NO_2 concentration in the atmosphere.

Table 1. UVI values and NO_2 and $PM_{2.5}$ concentrations in measurement periods

Days of sampling	Point 1			Point 2		
	NO_2 concentration ($\mu g/m^3$)	$PM_{2.5}$ concentration ($\mu g/m^3$)	UVI	NO_2 concentration ($\mu g/m^3$)	$PM_{2.5}$ concentration ($\mu g/m^3$)	UVI
1	29.87	57.29	5	11.95	20.05	3
2	41.79	88.16	3	16.72	30.86	2
3	46.5	102.54	2	18.60	35.89	1
4	40.91	104.41	2	16.36	36.54	1
5	37.2	91.37	2	14.88	31.98	1
6	43.45	91.25	4	17.38	31.94	2
7	37.08	69.33	4	14.83	24.27	2
8	30.58	26.83	9	12.23	9.39	5
9	41.37	56.7	4	16.55	19.85	2
10	52.33	81.12	3	20.93	28.39	2
11	44.54	89.29	2	17.82	31.25	1
12	46.7	93.62	2	18.68	32.77	1
13	31	49.41	9	12.40	17.29	5
14	30.95	22.25	9	12.38	7.79	5
15	28.83	18.04	9	11.53	6.31	5
16	30.95	26.95	8	12.38	9.43	4
17	46.7	62.2	4	18.68	21.77	2
18	52.25	87.16	3	20.90	30.51	2
19	56.2	103.62	1	22.48	36.27	1
20	54.83	106.75	1	21.93	37.36	1
21	40.33	59.04	3	16.13	20.66	2
22	48.95	80.04	4	19.58	28.01	2
23	42.25	57.7	5	16.90	20.20	3
24	37.54	61.25	5	15.02	21.44	3
25	31.33	34.54	8	12.53	12.09	4
26	31.75	39.45	8	12.70	13.81	4
27	37.58	59.79	5	15.03	20.93	3
28	41.04	57.58	5	16.42	20.15	3
29	43.58	65.37	5	17.43	22.88	3
30	44.29	79.04	4	17.72	27.66	2

Table 2. Summary of regression models between UVI value and pollutants concentration

Variables	Point 1				Point 2			
	Interaction model		Simple regression model		Interaction model		Simple regression model	
	Estimate	P_{value}	Estimate	P_{value}	Estimate	P_{value}	Estimate	P_{value}
Intercept	16.56	> 0.001	12.22	> 0.001	22.75	> 0.001	17.68	> 0.001
$PM_{2.5}$	- 0.13	> 0.001	- 0.07	> 0.001	- 0.42	0.002	- 0.29	> 0.001
NO_2	- 0.18	0.02	- 0.06	0.09	- 0.61	0.04	- 0.25	0.06
$PM_{2.5}$ * NO_2	0.001	0.07	-	-	0.01	0.17	-	-
R^2	0.89		0.88		0.88		0.87	
AIC	82.03		83.66		117		117	

Many of the related studies reported UV significant effect on increasing the incidence rate of skin eczema. Many researchers demonstrated the reverse correlation between UVI and skin eczema incidence [12]. As the result, reduction of UVI by $PM_{2.5}$ and NO_2 can increase the risk of eczema. But about the skin cancer, the effects are different. It was reported by some researchers the significant relationship between UVI and incidence of all the tree types of skin cancer including squamous cell carcinoma (SCC), basal cell carcinoma (BCC) and cutaneous melanoma (CM) [13].

As IARC mentioned, UV spectrum from sunlight is major part of background radiation that exposure to this sources is unavoidable [14]. But in case of UV spectrum, the exposure could be decreased by suitable clothing, anti sunlight cream and also as a major protection method, avoiding exposure to sunlight in critical time so the well and valid information about UVI is important for choosing the best protection strategy. Therefore, report of UVI from correspond agencies must be by attention to the air quality. Also, the calculation of UVI should not be performed according to default values of Eλ (calculated from altitude) and must be measured by UV meter.

CONCLUSIONS

The UVI can be affected by the ambient air pollutants such as $PM_{2.5}$ and NO_2. These pollutants and maybe others can decrease UVI level. So, the report of UVI for public health protection must be by attention to these pollutants effect on UVI. In the urban area with long time periods of elevated concentrations of $PM_{2.5}$ and NO_2 , exposure of people to the UV could be significantly lower than an area with the same altitude and longitude, where have higher air quality.

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COMPETING INTERESTS

The authors hereby declare that, they had no competing interests in conducting this study.

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ETHICAL CONSIDERATIONS

Ethical issues (including plagiarism, informed consent, misconduct, data fabrication and / or falsification, double publication and / or submission, redundancy, etc.) have been completely observed by the authors.

REFERENCES

[1] Gies P, Roy C, Javorniczky J, Henderson S, Lemus-Deschamps L, Driscoll C. Global solar UV index: Australian measurements, forecasts and comparison with the UK. Photochemistry and Photobiology. 2004;79(1):32-9.

[2] Gloster HM, Neal K. Skin cancer in skin of color. Journal of the American Academy of Dermatology. 2006;55(5):741-60.

[3] Ramos J, Villa J, Ruiz A, Armstrong R, Matta J. UV dose determines key characteristics of nonmelanoma skin cancer. Cancer Epidemiology and Prevention Biomarkers. 2004;13(12):2006-11.

[4] Schmalwieser AW, Janouch M, Nunez M, Koskela T, Berger D, Karamanian G, et al. Global validation of a forecast model for irradiance of solar, erythemally effective ultraviolet radiation. Optical Engineering. 2002;41(12):3040-50.

[5] De Backer H, Koepke P, Bais A, de Cabo X, Frei T, Gillotay D, et al. Comparison of measured and modelled UV indices for the assessment of health risks. Meteorological Applications. 2001;8(3):267-77.

[6] Organization WH, Protection ICoN-IR. Global solar UV index: a practical guide. 2002.

[7] Cordero RR, Seckmeyer G, Damiani A, Labbe F, Laroze D. Monte Carlo-based uncertainties of surface UV estimates from models and from spectroradiometers. Metrologia. 2013;50(5):L1.

[8] Wenny B, Saxena V, Frederick J. Aerosol optical depth measurements and their impact on surface levels of ultraviolet-B radiation. Journal of Geophysical Research: Atmospheres. 2001;106(D15):17311-9.

[9] Elminir HK. Dependence of urban air pollutants on meteorology. Science of the Total Environment. 2005;350(1):225-37.

[10] Krotkov N, Bhartia P, Herman J, Fioletov V, Kerr J. Satellite estimation of spectral surface UV irradiance in the presence of tropospheric aerosols: 1. Cloud-free case. Journal of Geophysical Research: Atmospheres. 1998;103(D8):8779-93.

[11] Tilstra L, Wang P, Stammes P. Surface reflectivity climatologies from UV to NIR determined from Earth observations by GOME-2 and SCIAMACHY. Journal of Geophysical Research: Atmospheres. 2017;122(7):4084-111.

[12] Fuertes E, Flohr C, Silverberg JI, Standl M, Strachan DP, Group IPTS. Global associations between UVR exposure and current eczema prevalence in children from ISAAC Phase Three. Journal of Investigative Dermatology. 2017;137(6):1248-56.

[13] Moan J, Grigalavicius M, Baturaite Z, Dahlback A, Juzeniene A. The relationship between UV exposure and incidence of skin cancer. Photodermatology, photoimmunology & photomedicine. 2015;31(1):26-35.

[14] McGuire S. World cancer report 2014. Geneva, Switzerland: World Health Organization, international agency for research on cancer, WHO Press, 2015. Advances in Nutrition: An International Review Journal. 2016;7(2):418-9.