



Contents lists available at ScienceDirect

Contact Lens and Anterior Eye

journal homepage: www.elsevier.com/locate/clae

Influence of air quality on the selection tendency of contact lens wearers

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ARTICLE INFO

Keywords:

Contact lens

Haze

Air pollution

ABSTRACT

Objective: This study aimed to investigate whether air quality influences ocular comfort when wearing contact lenses and the selection tendency of myopic populations who wears contact lenses.

Methods: Questionnaires were distributed to one hundred and twenty corneal contact lens wearers to understand whether the respondents would reduce or stop the use of contact lenses according to air quality and to evaluate and compare their ocular status under different air quality conditions.

Results: Forty-three point eight percent of the respondents were concerned about reduced oxygen permeability of contact lenses and increased contact lens-associated complications caused by the adsorption and accumulation of haze particles on the contact lens. Thirteen point four percent of the respondents stated that they would stop using contact lenses during moderate to severe air pollution and switch to glasses. Twenty-eight point six percent of respondents remarked that they would reduce the use of contact lenses depending on the situation during moderate to severe air pollution. However, this study did not find statistically significant differences in the ocular comfort while wearing contact lenses and in the eye scores of contact lens wearers under different air quality conditions.

Conclusion: Air quality has an impact on the selection tendency of some contact lens wearers. However, whether moderate or more severe air pollution causes ocular discomfort or contact lens-associated complications in contact lens wearers awaits further investigation.

1. Introduction

Due to the increasing energy demand, the greater number of motor vehicles and the rapid expansion of industry, the air quality in some countries has deteriorated severely. According to the “National Environmental Analysis of the People’s Republic of China” published by the Asian Development Bank and Tsinghua University in 2012, less than 1 % of the 500 large cities in China reached the air quality standards set by the World Health Organization, and 7 of the 10 most polluted cities in the world are in China [1].

In recent years, air quality in China has been effectively improved. However, moderate to severe air pollution is still very common in northern China during the winter. The main air pollutants in China are suspended particulate matter (PM), such as PM10 and PM2.5 [2]. This raises some interesting questions: when a contact lens wearer is in an environment with severe haze, will suspended particles adsorb and deposit on contact lenses and thus reduce the oxygen permeability of the contact lens and ocular comfort while wearing contact lenses? Does air quality influence the selection tendency of ametropic individuals

who wear contact lenses [3]?

2. Subjects and methods

2.1. Subjects

This study included 120 soft contact lens wearers, 48 males and 72 females, aged between 17 years old and 41 years old, who underwent eye exams at the Department of Ophthalmology and the Optometry Clinic of the Second Hospital of Hebei Medical University or at those of the People’s Hospital of Hebei Province from August 2018 to February 2019. The spherical equivalent refraction was -1.00 to -6.00 D. The average daily duration of contact lens use was longer than 6 h. All respondents did not have contraindications to contact lens use and did not have eye diseases that might affect the survey results.

2.2. Air quality

Three months when the average air quality was good and 2 months

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<https://doi.org/10.1016/j.clae.2019.11.011>

Received 5 September 2019; Received in revised form 3 October 2019; Accepted 18 November 2019

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Table 1
Air quality data for the selected months.

Month	Air quality	AQI	Range	PM2.5	PM10	SO2	CO	NO2	O3
2018-08	Good	90	36~157	33	59	10	0.713	26	141
2018-09	Good	73	44~122	37	75	15	0.813	43	99
2018-10	Good	96	49~260	61	121	16	1.019	63	83
2019-01	Moderate pollution	187	63~403	145	232	39	2.335	82	30
2019-02	Moderate pollution	162	59~350	124	194	21	1.507	49	64

* The data is collected from the Ministry of Environmental Protection of China. The degree of pollution was determined in accordance with Chinese standards.

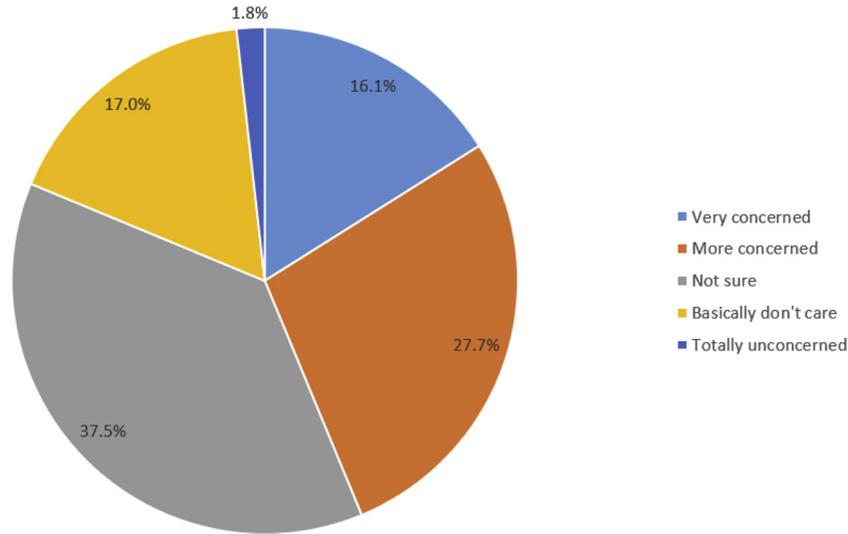


Fig. 1. Attitudes of contact lens wearers towards air pollution.

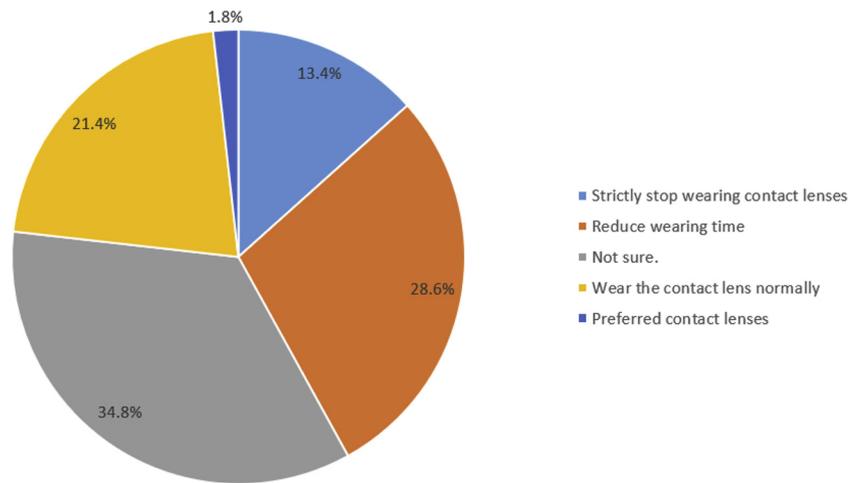


Fig. 2. The influence of air quality on the selection tendency of contact lens wearers.

Table 2
Ocular comfort scores for contact lens wearers during different air quality conditions.

	Good	Moderate pollution	p-value
Itchy eyes or foreign-body sensation	1.48 ± 0.814	1.67 ± 1.317	0.499
Eye fatigue	1.62 ± 1.024	1.81 ± 1.209	0.521
Double image	0.81 ± 0.602	1.00 ± 0.775	0.248
Congestion and secretions	0.81 ± 0.750	1.33 ± 1.278	0.101
Eye pain	1.14 ± 0.910	1.24 ± 1.221	0.791
Average score	1.86 ± 0.964	2.43 ± 1.832	0.172

Table 3
Anterior eye segments scores for contact lens wearers during different air quality conditions.

	Good air quality	Moderate pollution	p-value
Conjunctival congestion	0.71 ± 0.717	0.81 ± 0.750	0.675
Corneal staining	0.29 ± 0.561	0.52 ± 0.680	0.059
Tear film rupture time	0.76 ± 0.768	0.81 ± 0.680	0.705
Corneal edema	0.14 ± 0.359	0.19 ± 0.402	0.564
Corneal ulcer	0.05 ± 0.218	0.00 ± 0.000	0.317

when the average air quality was moderate pollution were selected for comparison. The specific air quality indicators are provided in Table 1.

2.3. Investigation method

Questionnaires were distributed to the selected patients, and the main content of the investigation includes 4 items: general information, influence of air quality on the selection tendency of contact lens wearers, evaluation of the ocular comfort while wearing contact lenses under different air quality conditions; and evaluation of the anterior ocular segment of contact lens wearers under different air quality conditions. (1) The general information included gender, age, spherical equivalent refraction, years of contact lens use, and average daily duration of contact lens use. (2) The influence of air quality on the selection tendency of contact lens wearers was examined using the following questions: Do you worry that haze will increase contact lens-associated complications? Does air quality affect your choice of wearing contact lenses or glasses? Do you reduce or stop the use of contact lenses on hazy days? (3) For the evaluation of ocular comfort while wearing contact lenses under different air quality conditions, a contact lens comfort evaluation scale was distributed to 21 respondents who wore contact lenses under good air quality and moderate air pollution. The scale included 5 items. Each item was divided into 5 levels corresponding to scores of 0–4 points. The sum of the score for each item was divided by the number of items answered to obtain the average ocular comfort score. (4) For the evaluation of the anterior ocular segment of contact lens wearers under different air quality conditions, 21 respondents who wore contact lenses during times with good air quality and moderate air pollution underwent anterior ocular segment examinations, including slit lamp examinations, corneal staining, and corneal central thickness examinations. The examination results under different air quality conditions were compared. This study complied with the Declaration of Helsinki and was approved by the ethics committees of the hospitals.

2.4. Statistical analysis

A total of 120 questionnaires were distributed in this study. The returned questionnaires were screened, and 112 valid questionnaires were included in the study. The 112 valid questionnaires, the 21 completed contact lens comfort evaluation scales, and the anterior eye segment examination data from 21 patients were input into Excel 2016 and SPSS 20.0 for statistical analysis. Ocular comfort scores and anterior eye segment examination results were compared using the Wilcoxon rank-sum test of 2 correlated samples. A significance level of $P < 0.05$ was used.

3. Results

In the survey of the influence of air quality on selection tendency of contact lens wearers, 43.8 % of contact lens wearers had different degrees of concern that haze particles would adsorb and deposit on contact lenses, reducing the oxygen permeability of contact lenses and increasing the contact lens-associated complications (Fig. 1); 13.4 % of respondents indicated that they would stop using contact lenses during moderate to severe air pollution and switch to glasses; and 28.6 % of respondents indicated that they would reduce the use of contact lenses depending on the situation during times of moderate to severe air pollution. 21.4 % of the respondents believed that air quality should not be taken into consideration under normal usage and that they would not reduce or stop the use of contact lenses during times with poor air quality. Only 1.8 % of respondents would still prefer contact lenses

during times with moderate to severe air pollution (Fig. 2).

Ocular comfort scores for contact lens wearers during different air quality conditions are shown in Table 2; the differences in the scores were not statistically significant ($P > 0.05$).

The anterior eye segment scores for contact lens wearers during different air quality conditions are shown in Table 3. The scores showed no statistically significant difference ($P > 0.05$). No serious complications, such as corneal ulcers with sequelae, were found in any of the examined subjects.

4. Discussion

The survey results showed that a large percentage of contact lens wearers were worried about the adsorption of a large amount of suspended particles on contact lenses in moderate to severe air pollution, thus affecting the permeability of the contact lenses, irritating the eyes, and inducing inflammation and other complications [4,5]. Air quality does affect the selection tendency of some contact lens wearers. However, this small-scale survey did not find that moderate air pollution could lead to increased contact lens intolerance or increased complications. Here are some possible reasons. (1) Although contact lenses do adsorb some pollutants, the total amount of adsorbed pollutants may be limited, which will not affect the performance of the contact lenses. (2) During times of air pollution, the subjects who still wear contact lenses may have better tolerance to the lenses, resulting in smaller differences in scores. (3) The sample size is too small, resulting in false-negative results.

In the analysis of the survey results, a small number of respondents and optometrists proposed a hypothesis: contact lenses can protect the eyes from air pollutants, like a mask protecting the respiratory system, by preventing these pollutants (microparticles) from directly stimulating the cornea and conjunctiva. Therefore, it is not harmful but beneficial to use daily disposable contact lenses during times of air pollution. Whether this view is correct still awaits further validation.

Although many ophthalmologists and optometrists would advise patients not to use contact lenses when air pollution is severe, this suggestion is based more on subjective speculation than objective evidence because the number of relevant studies is limited. To provide patients with scientific guidance, larger-scale, prospective, and multi-centre studies are necessary. Because PM pollutants are tiny, they cannot be directly observed using conventional methods. In further studies, researchers may use electron microscopy to observe the deposition of PM pollutants on different types of contact lenses, thereby providing direct and objective evidence for the aforementioned issues.

Financial disclosure

None.

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