Analysis Of Effects Of Ultraviolet (Uv) And Air Conditioning (Ac) On Cornea In Urban Population

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ABSTRACT:

Background: Corneal health is greatly influenced by environmental variables. Long-term exposure to ultraviolet (UV) radiation and air-conditioned (AC) surroundings has become widespread due to urbanization, although the relative effects on the cornea are still not well understood.

Aim: To assess the effects of air conditioning (AC) use and ultraviolet (UV) exposure on ocular surface health in an urban population.

Method: The participants in this observational analytical study were those who visited an urban eye care facility. Participants were divided into two groups according to their major environmental exposure: an outdoor group that was primarily exposed to UV radiation, and an indoor group that was exposed to air conditioning for extended periods of time. Specular microscopy was used to measure corneal characteristics, such as endothelial cell density, corneal thickness, proportion of hexagonal cells, and corneal cell shape. A p value of less than 0.05 was deemed statistically significant when the independent two-sample t test was used to evaluate the data.

Results: The corneal morphology of the indoor (AC-exposed) and outdoor (UV-exposed) groups was similar. None of the assessed characteristics, including as endothelial cell count, corneal density, hexagonality, or corneal thickness, showed statistically significant variations between the two groups. Despite small numerical differences, there was no discernible correlation between environmental exposure and anatomical alterations in the cornea.

Conclusion: In healthy individuals, routine exposure to urban surroundings, such as UV radiation and air conditioning, does not seem to result in clinically or statistically significant changes in corneal morphology. To investigate the possible cumulative effects of long-term environmental exposure on corneal structure and function, larger studies with objective exposure assessment and long-term follow-up are advised.

Keywords: Cornea, Urban population, Ultraviolet radiation, Air-conditioning.

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INTRODUCTION:

Urban populations are increasingly exposed to environmental conditions that negatively influence corneal health. Due to the cornea's high sensitivity to environmental influences, two typical exposures—ultraviolet (UV) radiation and air-conditioned environments—have a major impact on the health of the ocular surface. In addition to longterm degenerative changes like pterygium, climatic droplet keratopathy, and oxidative damage to corneal tissues, UV radiation, especially in the UV-B spectrum, can cause acute epithelium damage like photokeratitis(1).

Long-term exposure to air conditioning simultaneously lowers ambient humidity, which increases tear film evaporation, desiccates the ocular surface, and aggravates dry eye disease(2). A significant section of the working population spends a lot of time outside or in air-conditioned settings due to rising urbanization and lifestyle changes, yet little is known about the combined and separate impacts of UV radiation and AC exposure on corneal health. With objective assessment of corneal parameters such endothelial cell density, shape, and corneal thickness in regular urban settings, the majority of the material currently in research concentrates on occupational exposure or dry eye symptoms(3).

Through inflammatory alterations, tear film instability, and epithelial stress, both factors weaken corneal integrity (4). In order to identify at-risk persons early on and to design preventative methods, such as workplace adjustments, public awareness campaigns, and protective interventions, it is crucial to comprehend how chronic UV exposure and prolonged AC use affect corneal structure and function. Developing preventative measures, enhancing patient outcomes, and directing public health recommendations pertaining to eye protection all depend on understanding their impact. Therefore this study aims to compare the effects of UV radiation and AC on corneal health to better understand their impacts to provide evidence to support clinical practice and public health recommendations.

AIM:

To evaluate and compare the impact of ultraviolet (UV) exposure and air conditioning (AC) use on corneal surface health in the urban population.

METHODOLOGY:

This was an observational study conducted in the department of ophthalmology in a tertiary health care centre in Chennai. The study duration was a period of 2 months.

Inclusion criteria:

- Patients of 40 - 60 years of age
- Both genders
- Willing to give informed consent
- Urban population who have an exposure to continuous exposure to indoor (AC) and outdoor work for atleast 10 years ranging between 6- 12 hours a day .
- No planned ocular surgery during the study period.

Exclusion Criteria:

- Urban Population who had an exposure to indoor and outdoor work below 10 years.
- Not willing to give an informed consent.
- Current contact lens wearers or those who have worn contact lenses within the past 4 weeks.
- Any ocular surgery (including refractive surgery) within the past 6 months.
- Active ocular infection or inflammation at the time of enrollment (e.g., keratitis, conjunctivitis, uveitis).
- History of corneal dystrophy, severe ocular surface disease (e.g., severe dry eye previously diagnosed, Stevens–Johnson syndrome), or ocular chemical injury.
- Use of topical ocular medications (other than lubricating drops) within the past 4 weeks (e.g., glaucoma drops, topical steroids, topical NSAIDs).

Based on the previous studies, prevalence of corneal changes due to UV and AC exposure of 50% ($p = 50$) and an allowable error (precision) of 16% ($d = 16\%$),the sample size calculated for this study was 40. The patients who attended the regular ocular screening were explained about the study and who gave the informed consent were included. The patients were asked questions to collect data on their demographic details and daily exposure to UV radiation and AC using a questionnaire. Based on environmental exposure, participants were divided into an indoor group (air-conditioning exposure) and an outdoor group (ultraviolet radiation exposure). The parameters for corneal health such as endothelial cell morphohology , thickness, Corneal density, percentage of hexagonal cells, endothelial cell count were analysed by specular microscopy.

Statistical Analysis: Data was collected and coded in the Microsoft Excel version 2010. The Statistical analyses were conducted to identify correlations between exposure variables and corneal health outcomes. Independent two sample t test was used to compare the effects of Ultraviolet (Uv) And Air Conditioning (Ac) on Cornea in urban Population. P-value of <0.05 was considered as statistically significant.

RESULTS:

A total of forty individuals from an urban community were recruited and divided into groups according to their primary environmental exposure: indoor (air-conditioned) and outdoor (ultraviolet exposure). Endothelial cell count, corneal density, proportion of hexagonal cells and central corneal thickness were the four measures used to assess corneal morphology. An independent two-sample t-test was used for statistical analysis. Mean values were used to express the data, and a p-value of less than 0.05 was regarded as statistically significant. The data included the sum of cells of both eyes for an individual patient for the analyses of the different corneal parameters. The indoor group had a lower mean endothelial cell count (395.45) than the outdoor group (424.15), although this difference was not statistically significant (p = 0.1827)(Figure 1 & Table 1). Corneal density was also somewhat greater in the indoor group (5366.55 cells/mm²) than in the outdoor group (5268.05 cells/mm²), but this difference was not statistically significant (p = 0.3004) (Figure 1 & Table 1). These results show that neither UV radiation nor air conditioning had a discernible impact on the quantity or density of endothelial cells in the group under study. The percentage of hexagonal cells in corneal endothelium morphology was similar in both groups, with an average of 134.4% in the indoor group and 136.6% in the outdoor group. The fact that the difference was not statistically significant ($p = 0.1373$) indicates that endothelial cell shape and structural integrity were not significantly impacted by environmental exposure. The indoor group had a little thinner central corneal thickness (1004.8 µm) than the outdoor group (1018.95 µm), but this difference was not statistically significant ($p = 0.4897$) (Figure 1).

Subgroup analyses based on duration of working years (10–20 years and 21–40 years) showed comparable patterns in both exposure groups. Endothelial cell count, corneal density, hexagonality, and corneal thickness mean values within the years varied very little between indoor and outdoor individuals, and none of the comparisons were statistically significant ($p > 0.05$ for all parameters). This suggests that the association between environmental exposure and corneal morphology in this group was not substantially altered by duration of working years (Figure 2 & 3).

No consistent association was seen after further stratification by daily exposure length (6–12 hours). In indoor group people were found to work between 6,8 and 12 hours whereas in outdoor group the working hours were 6,8,9,10 and 12 hours .Corneal metrics showed slight numerical variations as exposure hours increased, but these variations were neither statistically significant nor progressive(Figure 4 & Figure 5). Corneal thickness and hexagonality did not change over the course of exposure, indicating that short- to moderate-term environmental exposure did not result in detectable structural changes to the cornea. Even in the patients who worked for 10–20 years , increasing daily work duration from 6 hours (415.33 cells, 5359.66 cells/mm², 135.33% HEX, 966 µm) to 12 hours (409 cells, 5268 cells/mm², 132.5% HEX, 1007 µm) is associated with a progressive reduction in endothelial cell density and hexagonality, along with increasing corneal thickness, suggesting that longer working hours may negatively impact corneal endothelial health (Figure 4).

In the patients who worked for 21–40 years, increasing daily working duration from 6 hours (393.57 cells, 5178.7 cells/mm², 132.7% HEX, 985 µm) to longer hours such as 10 hours (339 cells, 4796 cells/mm², 140% HEX, 1078 µm) and 12 hours (414.2 cells, 5328.7 cells/mm², 137.4% HEX, 1041.5 µm) is associated with greater endothelial stress, reflected by fluctuations in cell count and hexagonality and a consistent increase in corneal thickness, suggesting a cumulative adverse effect of prolonged working hours on corneal health (Figure 5).

Overall, there were no statistically significant differences between the indoor and outdoor exposure groups in any of the assessed corneal characteristics, including endothelial cell count, corneal density, percentage of hexagonal cells, or corneal thickness (Table 2). Even while there were slight numerical differences, these were not enough to show a significant correlation between exposure to UV light or air conditioning and structural alterations in the cornea of the urban population under study.

DISCUSSION:

By measuring endothelial cell count, corneal density, percentage of hexagonal cells, and central corneal thickness, the current study examined the effects of ultraviolet (UV) exposure and air-conditioned (AC) environments on corneal morphology in an urban population. In contrast to the study premise, no statistically significant differences were found for any of the assessed parameters between the indoor and outdoor exposure groups. These results imply that regular exposure to urban environments does not result in discernible structural changes in the cornea.

Previous studies on long-term UV exposure has been linked to oxidative stress, degenerative changes, and damage to the ocular surface, while long-term AC exposure is frequently linked to tear film instability and dryness of the ocular surface (5). However, rather than deeper corneal layers like the endothelium, these impacts primarily affect the ocular surface. The idea that the corneal endothelium is comparatively resistant to major environmental stresses experienced in daily urban living is supported by the current study's lack of substantial changes in endothelial cell count, hexagonality, and corneal thickness.

The existence of behavioral and physiological defenses may possibly account for the lack of a meaningful correlation as evident from the previous studies(6). Under mild stress, the corneal endothelium can sustain corneal deturgescence because to its robust metabolic activity and compensating ability (7). Additionally, the environmental impact may have been lessened by elements including reduced cumulative UV exposure, intermittent exposure, interior humidity control, and the use of protective eyewear. Additionally, compared to people in rural or high-altitude outdoor activities, the urban study sample may receive relatively less UV intensity, which lowers the possibility of detectable corneal damage(8).

There was no consistent association was found in number of working years-based and exposure-duration subgroup studies. Even though there were slight alterations as exposure hours increased, these changes lacked a progressive trend and were not statistically significant. This implies that daily exposure to UV light or AC conditions for brief to moderate periods of time may not be sufficient to cause structural or endothelial changes in the cornea that are clinically significant. Only long-term cumulative exposure over a long period of time might produce noticeable effects. It also supports the possible mechanism that simulated tears dramatically decreased DNA damage caused by UV-C in corneal cells as evident from a study on scientific report utilizing a human cornea model. This suggests that tear film and surface layers can lessen UV effects under actual exposure settings(9).

When evaluating these findings, some limitations should be taken into account. The statistical power to identify minute variations may have been constrained by the small sample size (n = 40). Furthermore, the study concentrated on morphological indicators rather than assessing functional outcomes that would indicate early subclinical impacts of environmental stress, such as corneal sensitivity, tear film stability, or endothelial pump performance.

Despite these drawbacks, this study shows that regular urban exposure to UV light and air conditioning does not substantially alter the thickness or shape of corneal endothelium in healthy people. The results demonstrate the cornea's resistance to common environmental stressors and emphasize the need for more extensive, long-term studies that include objective exposure assessment, sophisticated imaging methods, and functional corneal evaluation to ascertain whether long-term exposure causes cumulative corneal alterations.

CONCLUSION:

The current study emphasizes how environmental factors, particularly exposure to air conditioning and UV radiation, affect ocular health in an urban population. This study demonstrates that exposure to ultraviolet radiation and air-conditioned environments in an urban population does not result in statistically significant alterations in corneal endothelial cell count, corneal density, hexagonality, or central corneal thickness. Although minor numerical differences were observed between indoor and outdoor groups, these variations were not clinically or statistically meaningful. The findings suggest that routine environmental exposure in urban settings does not adversely affect corneal morphology in healthy individuals. Future research with larger sample sizes, objective exposure measurement, and long-term follow-up is recommended to evaluate the potential cumulative effects of chronic environmental exposure on corneal structure and function(10).

TABLES & FIGURES:

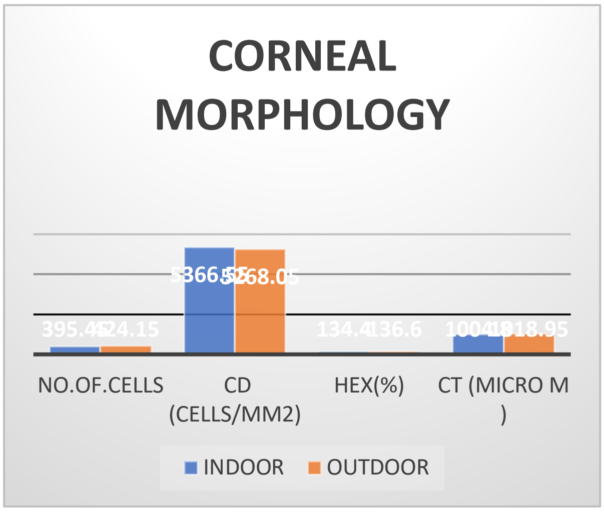

Figure 1: Bar chart showing the mean endothelial cell count, corneal density (cells/mm²), percentage of hexagonal cells, and central corneal thickness in indoor and outdoor exposure groups.

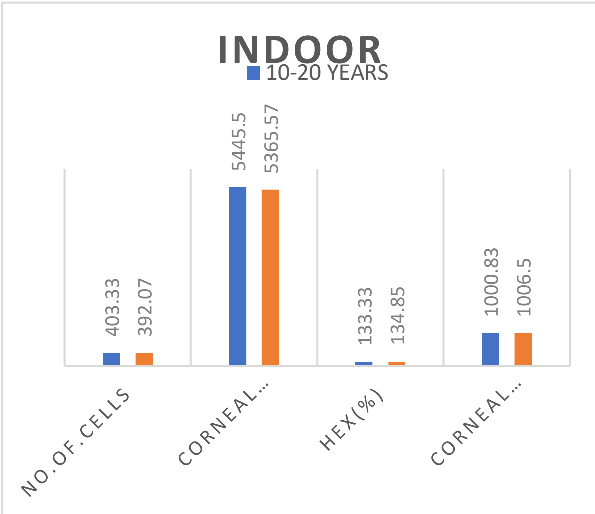

Figure 2: Comparison of corneal morphology parameters between duration of working years (10–20 years and 21–40 years) in indoor environment.

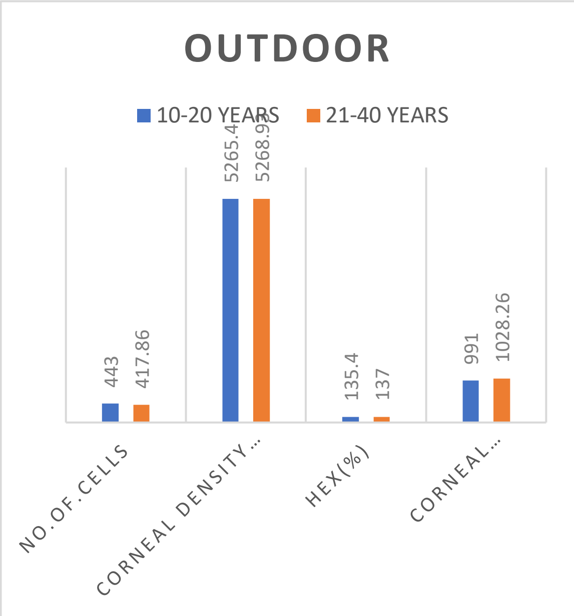

Figure 3: Comparison of corneal morphology parameters between duration of working years (10–20 years and 21–40 years) in outdoor environment.

Corneal morphology	p Value
Number of cells	0.182739149
CD(CELLS/MM2)	0.300415253
HEX(%)	0.137264637
CT(MICRO M)	0.489704424

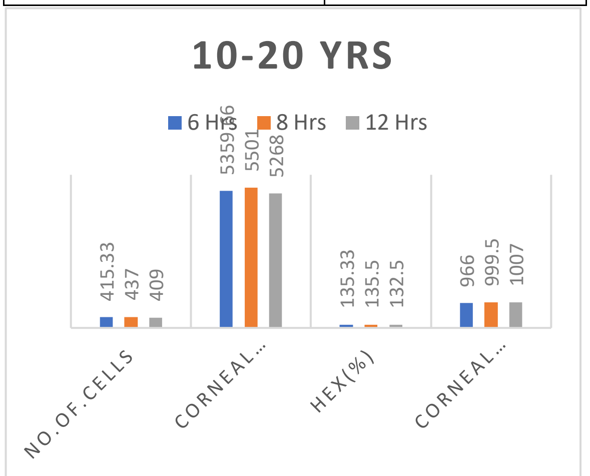

Figure 4: Comparison of corneal morphology parameters who have worked for 10–20 years with different working hours.

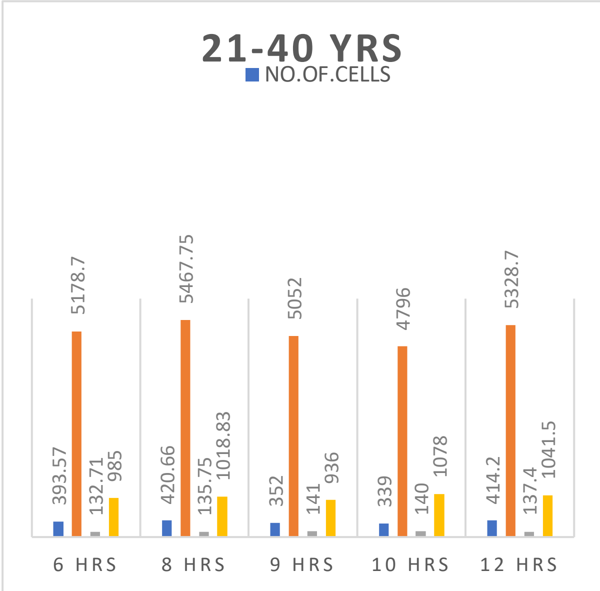

Figure 5: Comparison of corneal morphology parameters who have worked for 21-40 years with different working hours.

Table 1: P values comparing the exposures of two groups and the corneal parameters.

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