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Impact of cosmetic products on epiphora and ocular health in female patients – a cross-sectional study

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Abstract:

Purpose: This study evaluates the effect of cosmetic use on ocular health and the frequency of epiphora symptoms in female patients.

Method: This cross-sectional study included 206 female patients who visited the Department of Ophthalmology at J.N. Medical College and Hospital, AMU, Aligarh, Uttar Pradesh, India. Data were collected using a proforma, which consisted of age, gender, occupation, address, patient's history, nature, and duration of epiphora. All patients underwent regurgitation on pressure over the lacrimal sac (ROPLAS) test and lacrimal syringing. The analysis was performed using RStudio version 4.3.3 and Python version Jupyter Notebook.

Result: The chi-square test of independence was conducted to examine the association between cosmetic use and ROPLAS – chi-square statistic (χ^2): 8.33 with degree of freedom (df):1 and p-value = 0.0039. Although cosmetic use and the type of discharge (watery vs. mucous) revealed (χ^2): 8.641 with (df):1 and p-value 0.0033. Patients who use cosmetics appear more likely to report watery discharge compared to non-users. Similarly, for cosmetic use and tearing pattern (occasionally vs. continuous) shown – (χ^2): 11.2043 with (df):1 and p-value 0.0008, which is a highly significant result. However, there is no statistically significant association between cosmetic use and the other six symptoms, including pain, burning, blurred vision, redness, gritty sensation, and itching.

Conclusion: Statistical analysis revealed that cosmetic use does not significantly aggravate epiphora severity or associated inflammatory symptoms, but it does influence the pattern and nature of tearing, which suggest the functional and irritation rather than obstructive mechanism.

Key words: cosmetics, chi-square, epiphora, ROPLAS, tearing.

1. Introduction

Epiphora, also known as excessive tearing or watering of the eyes, is a common complaint in ophthalmology and oculoplastic clinical settings [1]. Although epiphora does not affect vision, it significantly reduces quality of life (QOL) by affecting daily activities. Tears are produced by the lacrimal gland, spreading across the eyes through regular blinking to form the tear film. They drain through the lacrimal drainage system, enter a small opening called the puncta located at the inner side of the eyelid, and then the lacrimal sac and nasolacrimal duct, and finally drain into the nose. The aetiology of the tearing can be divided into two parts: reflex tearing and reduced tear outflow. Reflex tearing often occurs due to inflammation, dry eye, allergy, or any ocular surface disorders, while reduced tear outflow can be due to eyelid malposition, tear pump dysfunction, or obstruction at any part of the nasolacrimal drainage system [2]. Cosmetic products such as eyeliner, kajal, mascara, eyeshadows, eyelash adhesives, and eyebrow products are widely used by females, especially in younger age groups, to enhance beauty, eye appearance, and facial attractiveness in daily life. Studies have documented that cosmetic eye products can disrupt the delicate balance of the tear film and may cause excessive tear production or insufficiency of drainage issues [3]. For instance, a study demonstrated that eyeliner application at the inner eyelash line is more likely to be responsible for tear film contamination and ocular discomfort than application at the outer periocular skin [4]. Furthermore, a study showed ocular surface migration of hydroxy cellulose gel and fluorescein mixture following cosmetic application. Also, tear film contamination levels were found to be significantly higher with product application at the inner eyelash line [5]. Use of these cosmetics around the eyes has been reported to cause adverse effects such as irritation, inflammation, itching, and burning. Sometimes the condition exacerbates due to the long and continuous exposure to these cosmetic products. For example, a traditional eye cosmetic product, Kohl, which is very popular in Indian and Arabic cultures, causes toxicity and pigmentation of the conjunctiva in some cases; however, several studies have shown its potential as a natural antimicrobial agent and it greater effectiveness at reducing the symptoms of blepharitis than erythromycin [6]. The preservative benzalkonium chloride (BAK), found in eye cosmetics, can potentially disrupt the lipid layer of the tear film due to detergent-like properties [7]. It has been recorded that the addition of some toxic preservatives in certain eye cosmetics may trigger allergic reactions, epithelial damage, and inflammation of ocular adnexa [3]. Some of the most commonly used cosmetic preservatives are BAK, formaldehyde (FA)--releasing compound, parabens, phenoxyethanol, and chlorphenesin [8]. BAK is a bactericidal quaternary ammonium compound widely utilised as a preservative in cosmetics and topical ophthalmic solutions [9]. Several research studies have demonstrated the toxic effects of such preservatives and chemicals added to many

cosmetic products [8]. For example, a study conducted by Wang et al. (2020) revealed that cosmetic preservatives such as methylparaben, ethylparaben, and chlorphenesin are toxic to human meibomian gland epithelial cells (HMGECs). Even a short exposure of 30 minutes could suppress Akt signalling at low concentrations. Furthermore, 24-hour treatment with these agents resulted in marked cellular atrophy and cell death, with no evidence of enhanced proliferation or successful differentiation. These findings highlight that several widely used preservatives can exert severe cytotoxic effects on ocular surface epithelial cells [10]. Furthermore, a clinical report involving 55 adult female patients showed that prolonged use of eye cosmetics and facial wipes containing preservatives led to toxic conjunctivitis presenting with epiphora [11]. Previous studies documented the effects of eye cosmetics, primarily focusing on dry eye and allergic conditions, but the effects of different types of cosmetics and the frequency of their use have not been fully recognised yet. Our study aims to evaluate the effect of cosmetic use on ocular health and the frequency of epiphora symptoms in female patients. This study systematically examined 206 patients, analysing the correlation between epiphora caused by cosmetic products in females.

2. Methods

A cross-sectional study was conducted to evaluate the association between the use of cosmetic products and the occurrence of epiphora among female patients.

2.1 Sample Size and Duration

This study involved a cross-sectional analysis of 206 patients who visited the Department of Ophthalmology, Jawaharlal Nehru Medical College (a tertiary care hospital in the western region of North India) with complaints of epiphora at the Eye OPD between January and July 2025.

2.2 Inclusion Criteria

The study included patients aged 20–70 years who had persistent epiphora for over one month and a history of exposure to dusty environments, particularly those residing near industrial areas or employed as factory workers and labourers. Additionally, patients were included who continuously used cosmetic products for more than 6 months.

2.3 Exclusion Criteria

The exclusion criteria encompassed patients with other ocular diseases, a history of ocular surgery, congenital anomalies affecting the lacrimal system, or medications that influence tear secretion.

2.4 Data collection method

Data were collected using a structured questionnaire (proforma), based on previously published studies [12, 13] and approved by experienced ophthalmologists and the Ethics Committee of J.N. Medical College and Hospital to ensure its validity and reliability. It addresses the most common and relevant problems experienced by the patients as given in Fig. 1. This proforma was used to collect demographic details (age, gender, occupation, address) and to evaluate the impact of epiphora on the patient's QoL and their daily life activities. A thorough torchlight examination was performed to assess the anterior segment and ocular surface abnormalities, such as conjunctival or corneal changes that may influence excessive tearing, and to identify other factors contributing to tear secretion. Furthermore, all patients underwent regurgitation on pressure over the lacrimal sac (ROPLAS), a clinical diagnostic procedure used to assess the condition of dacryocystitis and the patency of the nasolacrimal drainage system, as well as nasolacrimal duct obstruction (NLDO). In this procedure, gentle pressure is applied over the lacrimal sac area (medial canthus) with a sanitised fingertip to evaluate the discharge from the puncta or lacrimal drainage system. The interpretation of findings is as follows: ROPLAS positive – the presence of mucopurulent or clear fluid reflux from the punctum indicates lacrimal sac infection (chronic dacryocystitis) or obstruction of the nasolacrimal duct; ROPLAS negative – the absence of discharge or clear fluid indicates an unobstructed nasolacrimal drainage system (patent system). ROPLAS tests were systematically recorded. Subsequently, all participants underwent the lacrimal syringing procedure to evaluate the opening of the puncta to detect any obstruction, determining whether the pathway drains tears normally from the eye or there is a blockage in the lacrimal drainage system.

2.4 Statistical analysis

We used the chi-square test for this analysis to check if there was a significant association between the variables being studied. The analysis was performed using RStudio version 4.3.3 and Python in version Jupyter Notebook.

2.5 Ethical considerations

This study was approved by the Institutional Ethics Committee (IECJNMC/1855) of Jawaharlal Nehru Medical College and Hospital, Aligarh Muslim University, Aligarh, Uttar Pradesh, India. The participants were enrolled in the study after providing their informed consent. To ensure the confidentiality of the respondents, no personal information was recorded during the survey, as every aspect of the study was anonymous.

Performa

1. Demographic Information

Name: _____ Age/Sex: _____

Occupation: _____ Address: _____

Date of Examination: _____

2. Past History

History of eye trauma and surgery:	YES [ ]	NO [ ]
Diabetes:	YES [ ]	NO [ ]
Hypertension:	YES [ ]	NO [ ]
On Medication:	YES [ ]	NO [ ]
Any congenital anomalies:	YES [ ]	NO [ ]

3. Chief Complaint

Duration (months): _____

Onset of Epiphora: Acute / Chronic

Side Involved: Unilateral / Bilateral

Tearing: Continuous/Occasionally

4. Impact on daily life

Number of wiping times: _____

Blur vision: YES/NO

Worse during: Morning/ Evening /Specific activities

Difficulty in: Driving [ ] Reading [ ] Mobile/Laptop [ ] Other activity [ ]

Emotional effect: Embarrassment [ ] Frustration [ ] Social Withdrawal [ ]

5. Consent: "I have been informed of the procedure in my language. I voluntarily consent to the epiphora examination study. The information provided is accurate, and I sign without duress. I'm willing to be enrolled in this study.

Signature: _____

Fig. 1. Questions and answers from the questionnaire (answers provided by participants were anonymous).

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3. Results

The results of this study emphasise the outcomes related to prevalence, symptoms, and the risk factors, whether associated with cosmetic products leading to epiphora or not, among the North Indian population. The distribution of patients who used cosmetic products is shown in Fig. 2. A chi-square test of independence was conducted to examine the association between cosmetic use and ROPLAS, cosmetic use and the type of discharge (watery vs. mucous), cosmetic use and the type of tearing (continuous vs. occasionally), and similarly for cosmetic use and other factors including pain, burning, blurred vision, redness, gritty sensation, and itching.

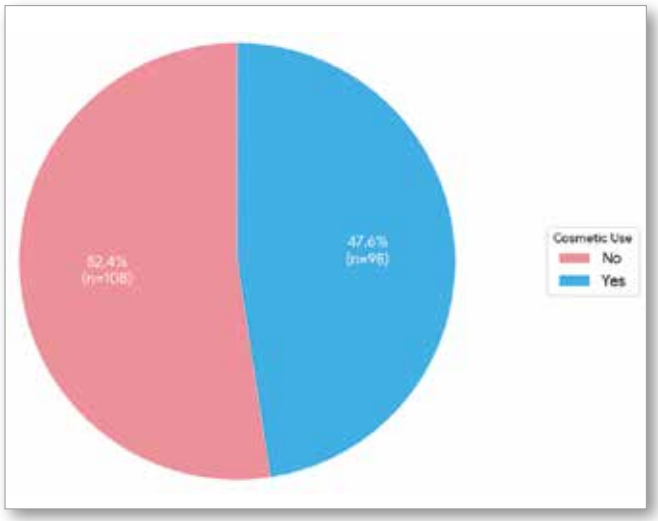

Fig. 2. Distribution of cosmetic use among patients.

3.1 The association between cosmetic use and ROPLAS

Hypothesis:

- **Null Hypothesis (H_0):** There is no significant association between cosmetic use and ROPLAS results. The two variables are independent of each other.
- **Alternative Hypothesis (H_1):** There is a significant association between cosmetic use and ROPLAS results. The two variables are dependent on each other.

The chi-square test was applied for the observed frequencies mentioned in Table I, and the test result showed chi-square statistics (χ^2) of 8.33 with degree of freedom (df) of 1 and p-value of 0.0039. Since the P-value (0.0039) was less than the significance level of 0.05, we rejected the null hypothesis. This suggests that there is a statistically significant association between cosmetic use and ROPLAS. It shows that individuals who do not use cosmetics appear to have a proportionally higher rate of positive ROPLAS compared to those who do use cosmetics (Fig. 3 and Fig. 4).

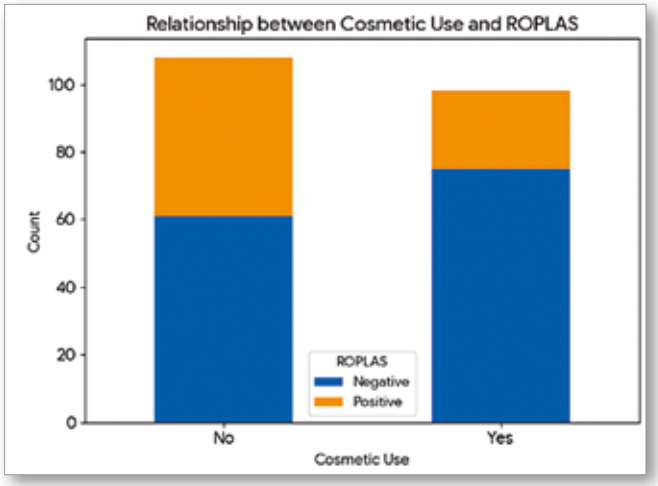

Fig. 3. Depicts the comparative frequency of ROPLAS-positive and ROPLAS-negative findings among cosmetic users and non-users.

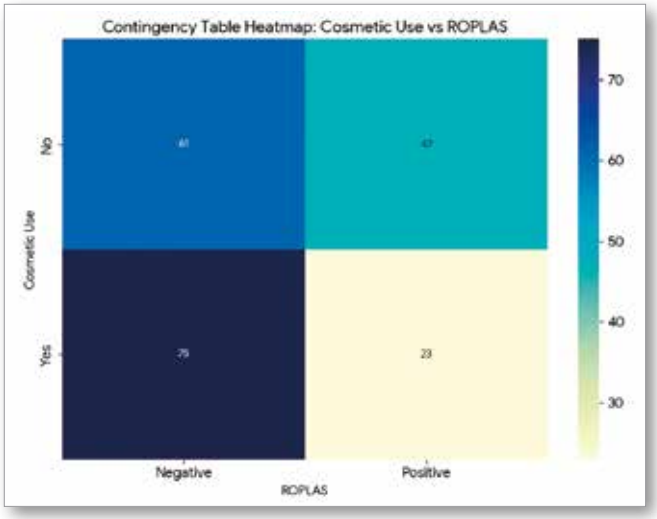

Fig. 4. Heatmap showing the association between ROPLAS results and cosmetic use patterns. Colour gradients represent the frequency of ROPLAS-positive and ROPLAS-negative findings within each cosmetic-use category.

3.2 The association between cosmetic use and the type of discharge (watery vs. mucous)

Hypothesis:

- **Null Hypothesis (H_0):** Cosmetic use and the type of discharge are independent. There is no statistically significant association between using cosmetics and the type of discharge experienced.
- **Alternative Hypothesis (H_1):** Cosmetic use and the type of discharge are dependent. There is a statistically significant association between the two variables.

Cosmetic Use	ROPLAS Negative	ROPLAS Positive	Total
No	61	47	108
Yes	75	23	98
Total	136	70	206

Tab. I. Distribution of ROPLAS outcomes (positive vs. negative) across cosmetic-use categories.

Cosmetic Use	Discharge: watery	Discharge: mucous	Row Total
No	70	36	106
Yes	84	16	100
Column Total	154	52	206 (Total)

Tab. II. This contingency table shows the counts for each category combination of type of discharge.

The chi-square test was applied for the observed frequencies mentioned in Table II, and the test result showed a chi-square statistic (χ^2) of 8.641 with degree of freedom (df) 1 and p-value 0.0033. Since the p-value is less than the significance level (0.05), the null hypothesis was rejected. It means there is a significant association between cosmetic use and the type of discharge reported by patients based on the observed counts; patients who use cosmetics appear more likely to report watery discharge (84 watery vs. 16 mucous) compared to non-users (70 watery vs. 36 mucous), as shown in Fig. 5 Furthermore, Fig. 6 perfectly illustrates the significant p-value of 0.0033; for "no" cosmetic use, the bar shows that patients who do not use cosmetics report 67.6% watery discharge and 32.4% mucous discharge, and for "yes" cosmetic use, the bar for cosmetic users looks very different – 82.7% of patients report watery discharge, and only 17.3% report mucous discharge.

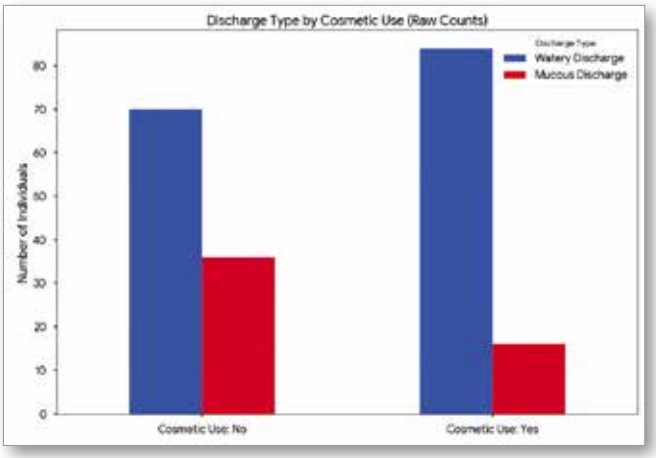

Fig. 5. Comparison of ocular discharge types between cosmetic users and non-users (raw counts).

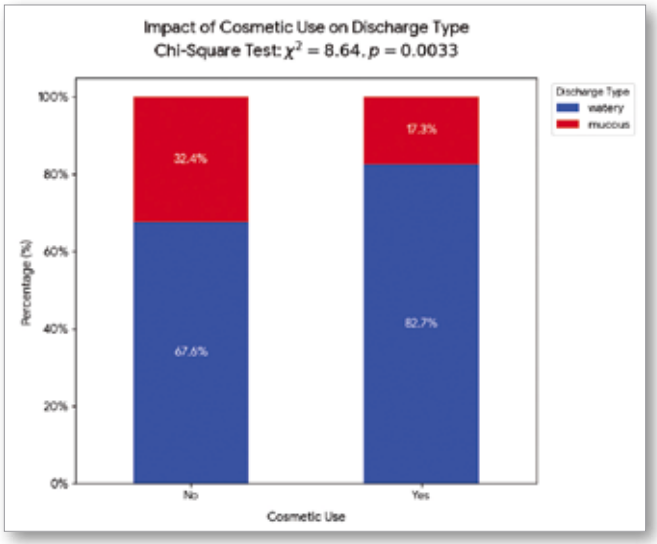

Fig. 6. Depicts a significant association between cosmetic use and ocular discharge type as determined by the chi-square test ($\chi^2 = 8.64$, p = 0.0033).

3.3 The association between cosmetic use and type of tearin g

Hypotheses:

The null hypothesis (H_0) states that cosmetic use and tearing are independent. There is no statistically significant association between using cosmetics and the type of tearing. Similarly, the alternative hypothesis (H_1) states the cosmetic use and tearing are dependent. There is a statistically significant association between the two variables.

Cosmetic Use	Tearing: Continuous	Tearing: Occasionally	Row Total
No	37	71	108
Yes	13	85	98
Column Total	50	156	206 (Total)

Tab. III. Frequency distribution of participants according to cosmetic use and discharge type.

Similarly, the chi-square test was applied for cosmetic use vs. type of tearing, to check if there was a significant association between whether a patient used cosmetics and the type of tearing they experienced (continuous vs. occasional) and their distribution, as given in Fig. 7, and the observed frequencies are shown in Table III. The test result showed a chi-square statistic (χ^2) of 11.2043 with degree of freedom (df) 1 and p-value 0.0008. Since the p-value is less than the significance level (0.05), the null hypothesis was rejected. This means there is a highly statistically significant association between cosmetic use and tearing. Non-users were much more likely to experience "continuous" tearing (37 patients) than users (13 patients). Cosmetic users were more likely to report "occasional" tearing (85 patients) compared to non-users (71 patients). Figure 8 shows "no" cosmetic use (top bar): Patients who did not use cosmetics reported continuous tearing far more

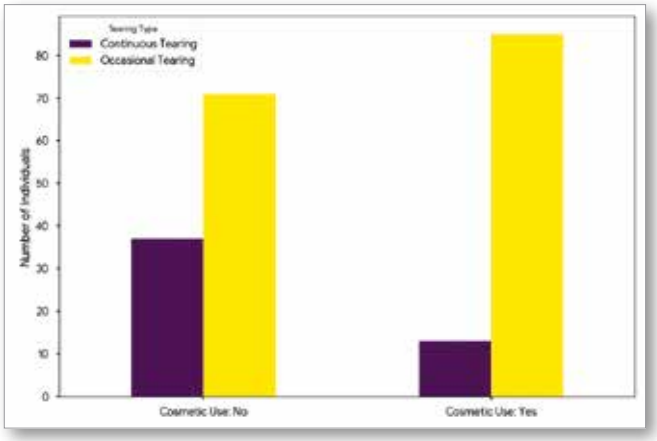

Fig. 7. Distribution of tearing frequency in relation to cosmetic use (raw counts).

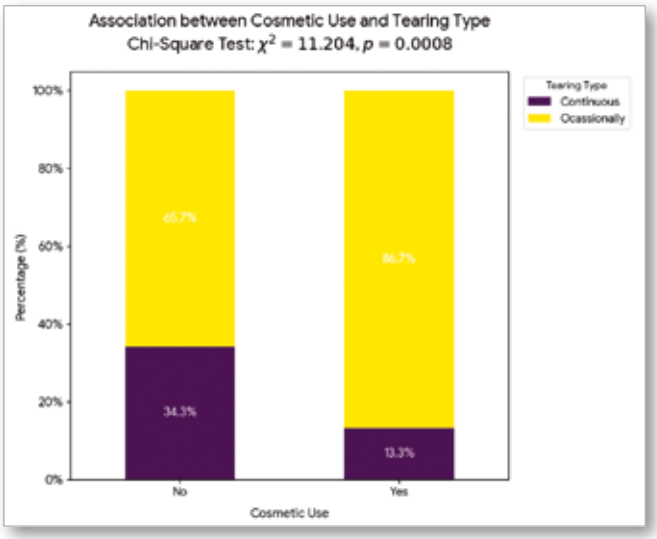

Fig. 8. Association between cosmetic use and tearing type based on chi-square test ($\chi^2 = 11.204$, p = 0.0008).

often. In this group, 34.3% of patients had continuous tearing. "Yes" cosmetic use (bottom bar): Patients who did use cosmetics had a much lower rate of continuous tearing. Only 13.3% of this group reported continuous tearing. Patients in our study who did not use cosmetics were significantly more likely to experience continuous tearing.

A summary of the significant variables is shown in Table IV. For all of the following variables given in Table V, we failed to reject the null hypothesis. This means that any differences seen in the data were probably due to random chance because there was no statistically significant association with cosmetic use. The key finding from all six chi-square tests is that **there is no statistically significant association** between cosmetic use and the other six symptoms, including pain, burning, blurred vision, redness, gritty sensation, and itching, as shown in Fig. 9. Based on the data, a person's choice to use cosmetics does not make them statistically more or less likely to report any of these symptoms.

Variable Tested	Chi-Square (χ^2) Value	P-value	Degrees of Freedom (df)	Result
ROPLAS	8.33	0.0039	1	Statistically Significant
Tearing	11.204	0.0008	1	Statistically Significant
Discharge	8.641	0.0033	1	Statistically Significant

Tab. IV. Summary of variables showing statistically significant associations based on the chi-square test ($\alpha = 0.05$).

Symptom	Chi-Square (χ^2) Statistic	P-value
Pain	0.0000	1.0000
Burning	0.0377	0.8460
Blur vision	0.0398	0.8419
Redness	0.0559	0.8130
Gritty sensation	0.2629	0.6081
Itching	2.2225	0.1360

Tab. V. Summary of variables showing no statistically significant association based on the chi-square test ($\alpha = 0.05$).

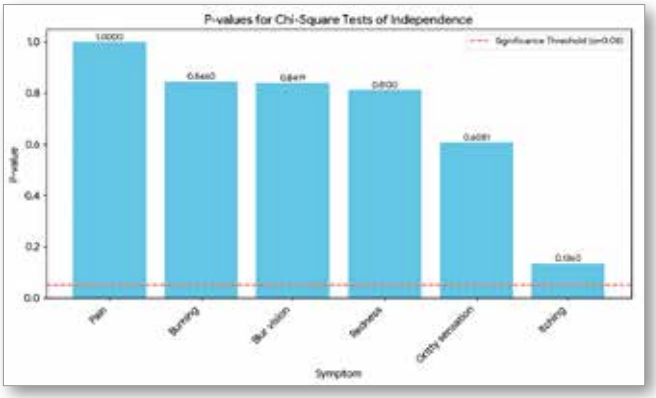

Fig. 9. P-values from the chi-square test of independence show no statistically significant association with cosmetic use.

4. Discussion

The objective of this study was to determine the correlation between epiphora caused by cosmetic products in females. The majority of previous studies demonstrating cosmetic product effects on ocular health focused on symptoms such as ocular surface irritation, allergic reactions, and disruption of the tear film [14]. Pre-ocular cosmetic products used by the female patients, especially products applied to the lid margins like mascara, eyeliner, and kohl, block the meibomian glands, leading to dysfunction and thus interfering with the tear drainage system in the eye. Wang MTM et al. reported that eyeliner and other cosmetic products can contaminate the tear film and lead to increased tearing, but this mainly affects the ocular comfort and does not cause chronic epiphora [3]. The results of our study suggest that watery discharge is more prevalent than the mucous discharge seen in most of the female patients who use cosmetic products. 82.7% of patients reported watery discharge and only 17.3% reported mucous discharge; this is a statistically significant result (p-value = 0.0033). It can be due to irritation of the ocular surface from various preservatives such as BAK or fragrances, and small ingredients in these products may partially or fully block the upper/lower puncta, leading to excessive tearing [15]. Additionally, occasional tearing is more prevalent than continuous tearing in patients who use more cosmetic products in their daily life, while continuous tearing is seen in patients who have nasolacrimal duct obstruction. However, in our study, cosmetics use and the type of tearing (continuous vs. occasional) showed a highly significant result (p-value = 0.0008).

Furthermore, the other factors such as pain, burning, blurred vision, redness, gritty sensation, and itching mentioned in Table V have no statistically significant results. Cosmetic products commonly contain different harmful chemicals such as DMDM-hydantoin, quaternium-15, imidazolidinyl urea, and 2 bromo-2 nitropropane -1,3 diol release few amounts of formaldehyde [16]. It can negatively affect to ocular surface of the cell, conjunctiva, and meibomian gland epithelial cells in vitro. Parabens include methylparaben, ethylparaben, propylparaben, and butylparaben, used as preservatives in over 22,000 cosmetic products in the USA. Methylparaben and ethylparaben are the most frequently used parabens (as preservatives) in various products [17]. Harmful effects and allergic problems were observed after exposing human corneal and conjunctival cells to methylparaben and ethylparaben. These can also cause antiandrogenic activity and result in meibomian gland dysfunction, leading to dry eye disease [18]. Makeup products with heavy or creamy formulations can block the small openings called puncta (superior puncta and inferior puncta) and obstruct the nasolacrimal duct pathway due to harmful ingredients like fragrances, synthetic dyes, and preservatives that disrupt tear film stability, resulting in either dryness or reflex tearing [19]. It is important to educate people about the proper use and removal of eye cosmetics, such as mascara, eyeliner, and eyeshadow. Every cosmetic user should be aware of the side effects of cosmetics, even in the absence of obstruction, which can impair tear drainage. Expired cosmetics should be avoided because they can trigger severe allergic reactions [20]. Consumers and patients should enhance their awareness when using cosmetic products.

Conclusion

Globally, eye makeup products are used mainly by females and across a broad age spectrum. In our study, statistical analysis revealed that cosmetic use does not significantly aggravate epiphora severity or associated inflammatory symptoms, but it does influence ROPLAS, the pattern of tearing, and the type of discharge, which suggests a functional and irritative rather than an obstructive mechanism. Additionally, we observed that there is no significant aggravation of the other six symptoms, including

pain, burning, blurred vision, redness, gritty sensation, and itching, which were found to be worsened by the use of pre-ocular cosmetic products. Many products in the market lead to excessive tearing. Epiphora in some individuals may result from chemicals found in cosmetic products, which can cause irritation and allergic reactions. Cosmetic products such as eyeliner and mascara can enter the lacrimal drainage system, causing nasolacrimal duct blockage. Some people have allergies to these products, which can lead to tearing. It is advised that individuals avoid these products. Patients who complain of tearing should inform their eye care practitioners about any cosmetic products they use. The view of our study suggests there are two factors that affect the pre-ocular surface of the eye, either when products are applied near to the eye or when used often. The most important task is to improve awareness about the cosmetic products' application and removal. Eye care practitioners should be introduced to newly released products for patients/consumers. The existing literature on epiphora and eye cosmetic products is notably sparse. More research should be conducted in collaboration with eye care practitioners and dermatologists.

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Author contributions

A.W.: Conceptualisation, Data collection: A.A.: Conceptualisation, Data sorting; I.M.: Data collection, Data editing; S.K. Statistical analysis; S.N.: Review and editing; A.K.: Review and editing; M.F.: Proofreading; M.F.: Writing original draft; K.A.: Writing original draft, Proofreading; M.A.: Supervision, Proofreading

Data availability

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

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Declarations

Ethical approval and consent to participate

The work was duly approved by the Institutional Ethics Committee (IEC), Jawaharlal Nehru Medical College and Hospital, Faculty of Medicine, Aligarh Muslim University, India. Under National Ethics Committee Registry for Biomedical and Health Research, NECR-BHR DHR ICMR and Central Drugs Standard Control Organisation (CDSCO) Ministry of Health and Family Welfare, Govt. of India. (IEC, D. No. IECJNMC/1855 dated: 10-06-2025). The IEC committee has reviewed and approved all the questionnaires that were given to human subjects. The study followed all the relevant guidelines/regulations involving human subjects and was performed in accordance with the Declaration of Helsinki. All participants were informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time without any negative consequences. Informed consent was obtained from each participant prior to data collection. Participants were assured of the confidentiality and anonymity of their responses, and the data were used solely for research purpose.

Consent for publication

Participants consented to the use of anonymised data for publication. The authors, on behalf of all contributors, also consent to the publication of this manuscript and affirm that the work has not been published previously and is not under consideration elsewhere.

Competing interests

The authors declare no competing interests.

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