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Toxicological Effects of Polyacrylate-Based Eyelash Glue on Tear Cytokine Levels: A Quasi-Experimental Study

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ABSTRACT

***Background*:** Polyacrylate-based eyelash glue, widely used for aesthetic eyelash extensions, may pose ocular health risks by altering tear cytokine levels. This study aimed to evaluate its toxicological effects on tear cytokines in young Nigerian women.

***Methods*:** A quasi-experimental study involved 10 healthy females (aged 18–24 years) with no prior glue exposure. Tear samples, collected at baseline and after one month of daily polyacrylate-based glue application, were analysed for IL-1β, IL-6, and IL-10 levels using ELISA. Paired t-tests and ANOVA assessed changes ($p < 0.05$).

***Results*:** IL-6 levels significantly decreased from 35.45 ± 21.31 pg/ml to 8.21 ± 4.31 pg/ml ($p = 0.0028$; ANOVA $p = 0.000914$). IL-1β (338.64 ± 174.69 to 230.02 ± 109.49 pg/ml, $p = 0.1163$) and IL-10 (44.13 ± 27.52 to 40.01 ± 12.31 pg/ml, $p = 0.6736$) showed non-significant reductions. ***Conclusion*:** Polyacrylate-based eyelash glue selectively suppresses tear IL-6, potentially increasing ocular infection risk, necessitating safer adhesives and stricter cosmetic regulations in Nigeria.

***Keywords*:** cosmetic safety, eyelash extensions, ocular immunology, polyacrylate adhesive, tear cytokines

1. INTRODUCTION

Eyelash extensions, driven by aesthetic trends, are increasingly popular in Nigeria, with the global market projected to reach $1.6 billion by 2025 [1]. These extensions use polyacrylate-based glues, valued for durability, but potentially toxic due to residual monomers like formaldehyde, which may cause ocular irritation or immunosuppression [2,3]. Reported adverse effects include conjunctivitis and dermatitis [4,5]. In Nigeria, unregulated cosmetics amplify these risks [6]. The tear film, critical for ocular homeostasis, contains cytokines like IL-1β and IL-6 (pro-inflammatory) and IL-10 (anti-inflammatory), which maintain immune balance [7,8]. Alterations in these cytokines may signal ocular stress from chemical exposure [9]. This study investigates the impact of polyacrylate-based eyelash glue on tear cytokine levels in young Nigerian women, addressing a gap in ocular health research.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Biological Materials

Tear samples were collected from 10 healthy female participants (aged 18–24 years) at the University of Ilorin, Nigeria. Participants had no history of ocular diseases or allergies, confirmed by clinical examination. No biological materials required herbarium authentication.

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2.1.2 Chemicals and Reagents

Polyacrylate-based eyelash glue (LashFix, ethyl cyanoacrylate-based, BeautyPro Ltd.) was applied under controlled conditions (50–60% humidity, 22–25°C). High-sensitivity Sandwich-ELISA kits (Abcam, Cambridge, UK; catalog numbers ab46052, ab178013, ab46034) were used to measure cytokine levels (IL-1β, IL-6, IL-10).

2.1.3 Equipment and Other Materials

Tear samples were collected using sterile microcapillary tubes (Sigma-Aldrich, USA). Cytokine levels were measured with a Bio-Rad iMark microplate reader (450 ± 2 nm absorbance).

2.2 Methods

A quasi-experimental study was conducted with approval from the University of Ilorin Ethics Committee, adhering to the Declaration of Helsinki. Informed consent was obtained. Basal tears were collected from the left eye using 10 µL sterile saline, with blinking every 5 seconds to minimize reflex tears. Samples were stored in ice-filled coolers and analyzed within 24 hours. Glue was applied daily for one month by a trained technician. Tear samples (5 µL) were diluted 1:2 in assay buffer and analyzed via ELISA, following Enríquez-de-Salamanca et al. [10]. Absorbance was measured after incubation with capture antibodies, biotinylated detection antibodies, streptavidin-horseradish peroxidase, and tetramethylbenzidine substrate.

2.3 Statistical Analysis:

Descriptive statistics summarized baseline characteristics. Paired t-tests and one-way ANOVA compared pre- and post-exposure cytokine levels ($p < 0.05$). Data were analyzed using SPSS version 27 (IBM Corp., Armonk, NY, USA). Standard deviations provided error bars.

RESULTS

3.1 Baseline Cytokine Levels

Baseline tear cytokine levels (Table 3.1) showed mean IL-1β at 338.64 ± 174.69 pg/ml (range: 145.17–617.51 pg/ml), IL-10 at 44.13 ± 27.52 pg/ml (range: 18.19–92.48 pg/ml), and IL-6 at 35.45 ± 21.31 pg/ml (range: 17.64–83.22 pg/ml).

Table 1: Baseline Cytokine Levels before Eyelash Glue Use

Statistic	IL-1β (pg/ml)	IL-10 (pg/ml)	IL-6 (pg/ml)
Mean	338.64	44.13	35.45
Standard Deviation	174.69	27.52	21.31
Minimum	145.17	18.19	17.64
Maximum	617.51	92.48	83.22

3.2 Post-Exposure Cytokine Levels

After one month of daily glue application, cytokine levels (Table 3.2) were: IL-1β at 230.02 ± 109.49 pg/ml (range: 124.70–487.05 pg/ml), IL-10 at 40.01 ± 12.31 pg/ml (range: 27.33–68.87 pg/ml), and IL-6 at 8.21 ± 4.31 pg/ml (range: 3.78–17.25 pg/ml).

Table 2: Cytokine Levels After One Month of Eyelash Glue Use

Statistic	IL-1β (pg/ml)	IL-10 (pg/ml)	IL-6 (pg/ml)
Mean	230.02	40.01	8.21
Standard Deviation	109.49	12.31	4.31
Minimum	124.70	27.33	3.78
Maximum	487.05	68.87	17.25

3.3 Differences in Cytokine Levels

After one month, IL-6 significantly decreased from 35.45 ± 21.31 pg/ml to 8.21 ± 4.31 pg/ml ($t = 3.9621$, $p = 0.0028$; ANOVA $F = 15.698$, $p = 0.000914$) (Figure 3.1). IL-1β decreased from 338.64 ± 174.69 pg/ml to 230.02 ±

109.49 pg/ml (t = 1.6660, p = 0.1163; ANOVA F = 2.654, p = 0.120), and IL-10 from 44.13 ± 27.52 pg/ml to 40.01 ± 12.31 pg/ml (t = 0.4313, p = 0.6736; ANOVA F = 0.177, p = 0.679), both non-significant.

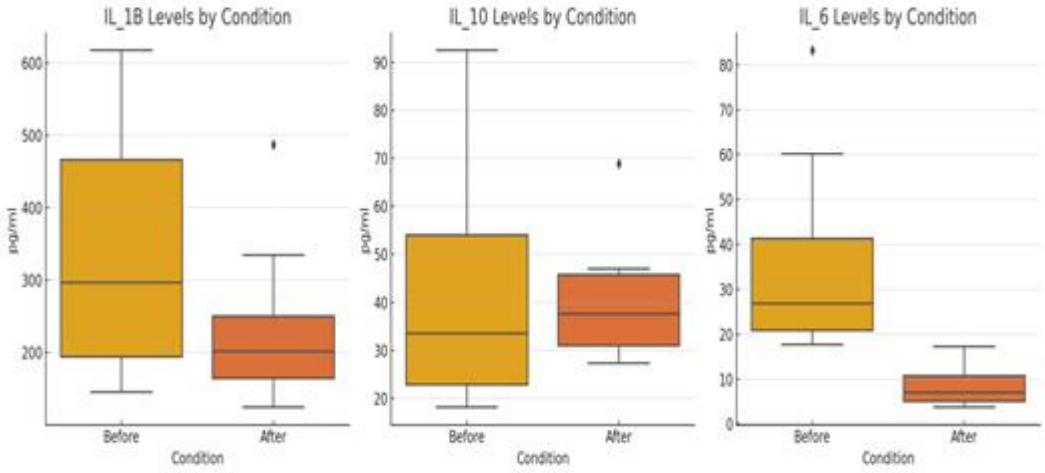

Figure 3.1: Mean tear cytokine levels (IL-1β, IL-6, IL-10) before and after daily polyacrylate-based eyelash glue application for one month in 10 healthy female participants, with error bars representing standard deviations. *p < 0.05 for IL-6 (paired t-test and ANOVA)

4. DISCUSSION

This study demonstrates that daily polyacrylate-based eyelash glue use significantly reduces tear IL-6 levels (p = 0.0028), suggesting selective immunosuppression. IL-6, crucial for ocular immune defense, may be suppressed by cytotoxic components like formaldehyde or residual monomers, potentially increasing infection risk [3,11]. Non-significant reductions in IL-1β and IL-10 suggest limited impact on other inflammatory pathways, possibly due to individual variability or short exposure duration. Unlike studies showing elevated IL-6 with irritants [12], this suppression aligns with acrylate-induced apoptosis in corneal cells [3]. In Nigeria's unregulated cosmetic market, these findings highlight risks for young women and salon workers [6]. Stricter regulations and safer adhesives are needed. Future studies should assess larger cohorts, longer exposures, and additional cytokines (e.g., IL-8, TNF-α).

5. CONCLUSION

Polyacrylate-based eyelash glue significantly suppresses tear IL-6, potentially compromising ocular immunity. Safer adhesives and regulatory oversight are critical for Nigeria's beauty industry.

DECLARATIONS

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Conflict of Interest

The authors declare no conflict of interest.

Contribution of Authors

Ayodeji E. Ige: Conceptualized study, designed methodology, supervised research, collected and analyzed data, drafted and revised manuscript.Oluwasola M. Ojo: Proofread and revised manuscript for intellectual content. Ezeaku Chukwuma David: Assisted in study design, data interpretation, and manuscript preparation. All authors approved the final manuscript.

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