

Impact of Using Contact Lenses with Hygiene Rules in Saudi Arabia

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ABSTRACT

Background and Objectives: this study aimed at assessing the level of compliance among contact lens wearers with hygiene rules, the prevalence of associated eye complaints, to determine the demographic factors of compliance and eye complications.

Material and Methods: this is cross-sectional study on 500 subjects' contact lens wearers at three ophthalmology clinics in Saudi Arabia (King Abdul-Aziz University Hospital in Jeddah, King Khalid University Hospital in Riyadh and King Fahad University Hospital in Khobar) during the period between July 2017 and March 2018. A semi-structured questionnaire was administered to investigate 10 items with a compliance score (0-10) was calculated as the number of rules to which the participant is fully compliant. Socio-demographic data were analyzed as factors for compliance and correlation of compliance scores with the presence and number of ocular complaints.

Results: contact lenses were used for cosmetic purpose (47.8%), and for refractive errors (38.6%); and most frequent lens type was monthly (42.6%). Results showed that 22.6% of participants changed sterile solution daily; 15.8% changed the lens box monthly, 81.2% washed their hands before, 89.6% washed lens before and 33.2% after wearing the lenses, and 37.2% followed the correct washing method. The mean (SD) compliance score was 4.67 (1.60) and females had a moderately higher score than men. The majority of participants (93.0%) reported eye complaints and 73.6% had two or more concomitant symptoms.

Conclusion: contact lens wearers have poor compliance with several hygiene rules resulting in the high prevalence of eye complaints. Therefore, it is important to teach contact lens wearers the specific hygienic rules of the target population to prevent serious eye complications.

Keywords: Compliance; Hygiene Rules; Contact Lenses Wearers

INTRODUCTION

In 2005, the numbers of contact lens users worldwide were reported to be 140 million and the trend is increasing since last two decades⁽¹⁾. In Saudi Arabia, a survey among Saudi women estimated that 70.2% of women were using contact lenses, majorly (approximately 2 out of 3) for cosmetic purpose⁽²⁾. According to the data from the U.S. reports, approximately 41 million adult contact lens wearers were reported in 2015, representing 16.7% of U.S adults in the same year⁽³⁾. Although the use of contact lenses is a practical and aesthetic solution due to its ability to provide an effective vision correction and comfort, users are exposed to increased risk of complications because of inadequate related-hygiene⁽³⁾. Wearing contact lenses represents an important risk factor for developing microbial keratitis⁽⁴⁾. It is incriminated in several eye infection outbreaks, with a rise of atypical infections such as Acanthamoeba keratitis and Fusarium keratitis that were reported in several countries⁽⁵⁻⁷⁾. These eye complications are known to affect 2 out of 1,000 contact lens users; leading severe outcomes like blindness, in addition to consequent care expenditures^(4, 8,9). Studying contact lens-related eye complications and their associated risk factors have enabled determining safe lens wear modalities and hygiene rules, which are generally well known by eye specialists

and practitioners⁽¹⁾. These modalities include general hygiene rules such hand cleaning before wearing lenses, as well as specific rules like lens rinsing, disinfection, storage, replacement frequency, etc. Compliance with these rules was demonstrated to improve contact lens-related eye symptoms and associated complications⁽¹⁰⁾. However, majority of studies have reported poor compliance with these rules among 40% to almost 100% of users, which constitutes a supplemental challenge for the prevention against these eye complications⁽¹¹⁻¹⁴⁾. A high proportion of contact lens users do not consult an eye specialist prior to begin its use⁽²⁾, which might be limiting awareness about the related hygienic rules thereby increasing the risk of further complications. Therefore, it is crucial to assess the level of awareness and compliance with hygienic rules among contact lens users and the associated eye outcomes and to investigate the factors of poor compliance. Studying these factors may help define the relevant preventive measures and targeted awareness rising campaigns within a particular population, to reduce the rate of related eye complications.

AIM OF THE WORK

This study aimed at assessing the level of compliance among contact lens users with related hygienic rules in Saudi Arabia; and to determine the prevalence of associated eye complaints, as

well as the demographic and clinical factors of compliance with hygiene rules.

PATIENTS AND METHODS

A cross-sectional study was carried out among cosmetic and therapeutic contact lens users, during the period between July 2017 to March 2018. Participants (N=500) were recruited among patients attending the ophthalmology clinics of three hospitals (King Abdul-Aziz University Hospital (KAUH) in Jeddah, King Khalid University Hospital (KKUH) in Riyadh and King Fahad University Hospital (KFUH) in Khobar, Saudi Arabia). A semi-structured questionnaire was administered to investigate the compliance with general hygienic rules related to contact lens wearing, such as change of sterile solution, change of solution can, lens washing before and after usage, hand washing, etc. (10 items). A compliance score (0-10) was calculated as the number of rules to which the participant is compliant. Ocular symptoms including eye pain, redness, dryness, tearing, blurred vision, and photophobia were investigated. The eye outcome was defined as the number of symptoms and divided into three categories: 1) none; 2) 1; 3) 2 symptoms or more. Participants were also interviewed about the presence and severity of an eye irritation and patient's attitude in case of irritation (go to doctor, wait next day, do nothing, or remove lenses). Demographic and socioeconomic factors such as age, gender, and educational level, as well as lens type, frequency of use and purpose (cosmetic, therapeutic, or both) were analyzed as factors for both compliance and eye complications. In addition, correlation of compliance and compliance score with incidence and number of ocular symptoms were analyzed. The study was approved by the institutional review board of (KKUH). **Statistical Methods:** Statistical analysis was performed with the Statistical Package for Social Sciences version 21.0 for Windows (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to present participants characteristics, contact lens usage pattern, compliance levels with different hygiene rules and the number of eye complaints. For each hygiene rule, a compliance rate was calculated as the percentage of participants who declared being strictly compliant with the given rule and results were presented as a frequency and percentage in a bar chart. Analytical statistics was used to study the factors of compliance with hygienic rules, as well as factors of eye outcomes and correlation between compliance and eye outcomes. Compliance score

showed a bell-shaped distribution and was analyzed using independent *t*-test and OneWay Analysis of Variance (ANOVA), as appropriate. Results were presented as mean \pm standard deviation (SD). Variables used to analyze eye outcome included presence of eye complaints (yes/no) and number of eye complaints (0, 1, 2 or more). Chi-square test was used to analyze the correlation between these two categorical variables. A *p* value of <0.05 was considered to reject the null hypothesis.

RESULTS

Participants' Characteristics: Majority of the participants were females (95.8%), aged 21-40 years (89.2%) with high educational level (university+; 85.4%). Pattern of contact lens use showed that 30.2% of participants were regular users, mostly using yearly (31.4%) or monthly (42.6%) lenses; with cosmetic purpose being the first usage purpose in 47.8% followed by refractive error in 38.6%. Contact lenses price ranged between 151-300 Saudi Riyal (approximately US\$40-80) in 34.2% of the users (Table 1). **Compliance with Hygienic Rules and Ocular Outcomes:** Analysis of compliance with hygiene rules showed that 60.6% used specific sterile solution for lens disinfection, 22.6% only changed sterile solution daily, 15.8% changed the lens box regularly (monthly), and 10.6% only wetted lens regularly. On the other hand, 81.2% declared washing their hands and 89.6% washing the lenses before use; however, only 37.2% followed the appropriate lens washing method. Furthermore, 3.4% declared sleeping with their lens and 65.0% declared using make-up after lens wear (Table 2). Compliance rates to all investigated hygiene rules are depicted in Figure 1. Regarding ocular outcomes, prevalence of eye complaints was 93.0% (95% CI=90.4; 95.1%) and 73.6% reported having or having experienced 2 or more relevant symptoms. Eye irritation was reported in 18.8% cases and moderate to severe irritation in 52.4%, ultimately resulting in removal of lenses in 76.0% and doctor visit in only 5.4% (Table 2). **Factors of Compliance with Hygienic Rules:** Compliance score (min=0; max=10) was relatively higher among female participants (mean [SD]=4.70 [1.59]) when compared with male participants (3.95 [1.77]) and the difference was statistically significant ($P=0.036$). No significant difference in compliance score was observed across other demographic parameters such as age ($P=0.144$) or educational level ($P=0.807$). No significant difference was found

reported between different lens types ($P=0.500$), regular and irregular users ($P=0.847$), usage purpose ($P=0.238$) and lens price ($P=0.449$) (Table 3).

Factors of Eye Complications: Participants of Saudi nationality had a higher prevalence of eye complaints (94.9% versus 81.8%; $p=0.004$), with 2 or more eye complaints reported in 74.8% versus 59.1% ($P=0.002$) in non-Saudi participant. The prevalence of eye complications among contact lens users was relatively higher among females and old age people (21+ year old), as compared to their counterparts; however, the differences were not statistically significant. No remarkable difference in prevalence of eye complications was observed between use of different lens types ($P=0.786$), regular and irregular users ($P=0.870$), usage purpose ($P=0.251$) or lens price ($P=0.389$). As to the number of eye complaints, no statistically significant association was observed with the previous factors (Table 4). **Correlation between Eye Outcomes and Compliance with Hygienic Rules:** The prevalence of eye complications was 100% among contact lens users who declared that they never change the solution, while it ranged between 88.1% and 94.9% among those who declared changing the solution at least every 6 months and the difference was statistically significant ($P=0.027$). Paradoxically, participants who declared always sleeping with the contact lenses were less likely to have an eye complication (76.5%; versus 93.1% and 96.7%; $P=0.015$) and complained less frequent 2 or more symptoms (70.6% versus 72.3% and 83.6%; $P=0.017$), when compared to those who never or sometimes sleep with the lenses, respectively. Analysis of compliance with other hygiene rule showed no statistically significant correlation with the prevalence of eye complications or number of eye complaints (Table 5). Additionally, no statistical significant difference in compliance score was observed between participants who reported eye complications (mean=4.69/10) and those who reported having no eye complications (4.34/10; $P=0.210$); as well as between those who reported none (4.34/10), one (4.80/10) and 2 or more (4.67/10) symptoms ($P=0.343$).

Table 1: Participants characteristics (n=500) and pattern of contact lens wearing.

| Parameter | Category | Frequency | Percentage |
|---------------------|--------------------|-----------|------------|
| Gender | Male | 21 | 4.2 |
| | Female | 479 | 95.8 |
| Age (years) | 15-20 | 40 | 8.0 |
| | 21-40 | 446 | 89.2 |
| | 41-60 | 14 | 2.8 |
| | >60 | 0 | 0 |
| Educational level | Up to primary | 0 | 0 |
| | Middle school | 5 | 1.0 |
| | Secondary | 68 | 13.6 |
| | University+ | 427 | 85.4 |
| Nationality | Saudi | 429 | 85.8 |
| | Non-Saudi | 44 | 8.8 |
| | Not Specified | 27 | 5.4 |
| Residency | Popular house | 9 | 1.8 |
| | Apartment | 231 | 46.2 |
| | Villa | 255 | 51.0 |
| Career | Field | 305 | 61.0 |
| | Office | 164 | 32.8 |
| | Not Specified | 31 | 6.2 |
| Lens type | Daily | 101 | 20.2 |
| | Weekly | 19 | 3.8 |
| | Monthly | 213 | 42.6 |
| | Yearly | 157 | 31.4 |
| | More than one type | 7 | 1.4 |
| Wearing frequency | Regular | 151 | 30.2 |
| | Irregular | 349 | 69.8 |
| Usage purpose | Refractive error | 193 | 38.6 |
| | Cosmetic | 239 | 47.8 |
| | Therapeutic | 12 | 2.4 |
| | Multiple purposes | 56 | 11.2 |
| Cost (SAR per pair) | 30-60 | 4 | 0.8 |
| | 61-150 | 95 | 19.0 |
| | 151-300 | 171 | 34.2 |
| | > 300 | 32 | 6.4 |

Because of missing data, all frequencies do not sum up to the total; SAR: Saudi Riyal.

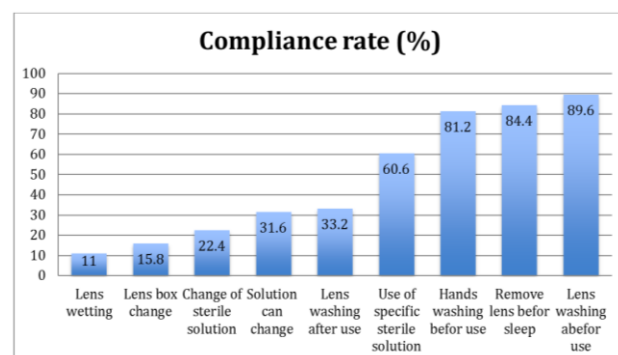


Figure 1: Compliance rates to all investigated hygiene rules

Table 2: Compliance with hygiene rules and eye complications among contact lens wearers.

| Parameter | Category | Frequency | Percentage |
|--------------------------------------|---------------------|-----------|------------|
| Compliance with hygiene rules | | | |
| Sterile solution used | Specific | 303 | 60.6 |
| | Generic | 197 | 39.4 |
| Frequency of solution change | Everyday | 113 | 22.6 |
| | Every 2 days | 45 | 9.0 |
| | Every 3 days | 80 | 16.0 |
| | >3 days | 258 | 51.6 |
| Frequency of lens box change | Monthly | 79 | 15.8 |
| | Every 2 months | 52 | 10.4 |
| | Every 3 months | 96 | 19.2 |
| | >3 months | 265 | 53.0 |
| Frequency of solution can change | < 3 months | 158 | 31.6 |
| | 3-6 months | 162 | 32.4 |
| | >6 months | 159 | 31.8 |
| | Never | 17 | 3.4 |
| Lens wetting | Always | 53 | 10.6 |
| | Sometimes | 34 | 6.8 |
| | No | 411 | 82.2 |
| Hand washing before lens wearing | Yes | 406 | 81.2 |
| Lens washing before use | Yes | 448 | 89.6 |
| | No | 47 | 9.4 |
| | Not specified | 5 | 1.0 |
| Lens washing method | Correct | 186 | 37.2 |
| | Incorrect | 261 | 52.2 |
| | Not applicable | 47 | 9.4 |
| Lens washing after usage | Regularly | 166 | 33.2 |
| | Sometimes | 59 | 11.8 |
| Sleep with lens | Yes | 17 | 3.4 |
| | No | 78 | 15.6 |
| Using make-up | Before lens wearing | 148 | 28.6 |
| | After lens wearing | 325 | 65.0 |
| Swimming with lens | Never | 399 | 79.8 |
| | Sometimes | 38 | 7.6 |
| Long nails | Yes | 63 | 12.6 |
| | No | 235 | 47.0 |
| Ocular Outcomes and Attitude | | | |
| Eye complaint | (Prevalence) | 465 | 93.0 |
| Number of eye symptoms | None | 35 | 7.0 |
| | One | 97 | 19.4 |
| | 2 or more | 368 | 73.6 |
| | | | |
| Lens-induced eye irritation | Yes | 94 | 18.8 |
| | No | 141 | 28.2 |
| | Moderately | 262 | 52.4 |
| Attitude regarding irritation | Go to doctor | 27 | 5.4 |
| | Wait next day | 48 | 9.6 |
| | Do nothing | 45 | 9.0 |
| | Remove lens | 380 | 76.0 |

Because of missing data, all frequencies do not sum up to the total

Table 3: Factors of compliance with hygiene rules

| Parameter | Category | Compliance (score) | | |
|---------------------|----------------------------|--------------------|------|---------|
| | | Mean | SD | P value |
| Gender | Male | 3.95 | 1.77 | .036* |
| | Female | 4.70 | 1.59 | |
| Age (years) | 15-20 | 5.03 | 1.37 | .144 |
| | 21+ | 4.64 | 1.62 | |
| Educational Level | Up to secondary | 4.71 | 1.62 | .807 |
| | University+ | 4.66 | 1.60 | |
| Nationality | Saudi | 4.69 | 1.62 | .458 |
| | Non-Saudi | 4.50 | 1.58 | |
| Residency | Popular house | 5.67 | 0.87 | .160 |
| | Apartment | 4.66 | 1.49 | |
| | Villa | 4.63 | 1.71 | |
| Career | Field | 4.70 | 1.55 | .336 |
| | Office | 4.55 | 1.71 | |
| Lens type | Daily | 4.79 | 1.95 | .500 |
| | Weekly | 4.58 | 1.39 | |
| | Monthly | 4.63 | 1.59 | |
| | Yearly | 4.59 | 1.40 | |
| | More than 1 type | 5.57 | 1.27 | |
| Wearing frequency | Regular | 4.65 | 1.65 | .847 |
| | Irregular | 4.68 | 1.57 | |
| Usage purpose | Cosmetic | 4.58 | 1.43 | .238 |
| | Therapeutic (+/- cosmetic) | 4.75 | 1.74 | |
| Cost (SAR per pair) | Up to 150 | 5.03 | 1.50 | .449 |
| | 151-300 | 5.06 | 1.49 | |
| | > 300 | 5.41 | 1.64 | |

*Statistically significant result ($P < 0.05$); statistical tests used; independent t-test or Oneway ANOVA as appropriate.

Table 4: Factors of eye complications among contact lens wearers.

| Parameter | Category | Eye complaints | | P value | Number of eye symptoms | | | | | | P value |
|---------------------|----------------------------|----------------|-------|--------------------|------------------------|------|-----|------|-----------|------|---------|
| | | Freq. | % | | 0 | | 1 | | 2 or more | | |
| Gender | Male | 18 | 85.7 | .175 ^F | 3 | 14.3 | 2 | 9.5 | 16 | 76.2 | .249 |
| | Female | 447 | 93.3 | | 32 | 6.7 | 95 | 19.8 | 352 | 73.5 | |
| Age (years) | 15-20 | 35 | 87.5 | .185 ^F | 5 | 12.5 | 10 | 25.0 | 25 | 62.5 | .191 |
| | 21+ | 430 | 93.5 | | 30 | 6.5 | 87 | 18.9 | 243 | 74.6 | |
| Educational Level | Up to secondary | 68 | 93.2 | 1.000 ^F | 5 | 6.8 | 12 | 16.4 | 56 | 76.6 | .778 |
| | University+ | 397 | 93.0 | | 30 | 7.0 | 85 | 19.9 | 312 | 73.1 | |
| Nationality | Saudi | 407 | 94.9 | .004 ^{F*} | 22 | 5.1 | 86 | 20.0 | 321 | 74.8 | .002* |
| | Non-Saudi | 36 | 81.8 | | 8 | 18.2 | 10 | 22.7 | 26 | 59.1 | |
| Residency | Popular house | 8 | 88.9 | .625 | 1 | 11.1 | 1 | 11.1 | 7 | 77.8 | .865 |
| | Apartment | 218 | 94.4 | | 13 | 5.6 | 46 | 19.9 | 172 | 74.5 | |
| | Villa | 236 | 92.5 | | 19 | 7.5 | 50 | 19.6 | 186 | 72.9 | |
| Career | Field | 288 | 94.4 | .056 | 17 | 5.6 | 58 | 19.0 | 230 | 75.4 | .139 |
| | Office | 147 | 89.6 | | 17 | 33 | 33 | 20.0 | 114 | 69.5 | |
| | Daily | 95 | 94.1 | .786 | 6 | 5.9 | 16 | 15.8 | 79 | 78.2 | .306 |
| Lens type | Weekly | 18 | 94.7 | | 1 | 5.3 | 3 | 15.8 | 15 | 78.9 | |
| | Monthly | 199 | 93.4 | | 14 | 6.6 | 36 | 16.9 | 163 | 76.5 | |
| | Yearly | 143 | 91.1 | | 14 | 8.9 | 39 | 24.8 | 104 | 66.2 | |
| | More than 1 type | 7 | 100.0 | | 0 | 0.0 | 3 | 42.9 | 4 | 57.1 | |
| | Wearing frequency | Regular | 140 | 92.7 | .870 | 11 | 7.3 | 25 | 16.6 | 115 | 76.2 |
| Usage purpose | Irregular | 325 | 93.1 | | 24 | 6.9 | 72 | 20.6 | 253 | 72.5 | |
| | Cosmetic | 219 | 91.6 | .251 | 20 | 8.4 | 46 | 19.2 | 173 | 72.4 | .516 |
| | Therapeutic (+/- cosmetic) | 246 | 94.3 | | 15 | 5.7 | 51 | 19.5 | 195 | 74.7 | |
| Cost (SAR per pair) | Up to 150 | 93 | 93.9 | .389 | 6 | 6.1 | 22 | 22.2 | 71 | 71.7 | .150 |
| | 151-300 | 168 | 97.1 | | 5 | 2.9 | 22 | 12.7 | 146 | 84.4 | |
| | > 300 | 30 | 93.8 | | 2 | 6.3 | 6 | 18.8 | 24 | 75.0 | |

Because of missing data, all frequencies do not sum up to the total; * statistically significant result ($P < 0.05$); statistical significance calculated using Fisher's exact test.

Table 5: Correlation of eye outcomes with compliance with hygiene rules among contact lens wearers.

| Parameter | Category | Eye complaints | | | Number of eye symptoms | | | | | | P value |
|----------------------------------|----------------|----------------|-------|---------|------------------------|------|-------|------|-----------|------|---------|
| | | Freq. | % | P value | 0 | | 1 | | 2 or more | | |
| | | | | | Freq. | % | Freq. | % | Freq. | % | |
| Sterile solution used | Specific | 279 | 92.1 | 0.317 | 24 | 7.9 | 62 | 20.5 | 217 | 71.6 | .409 |
| | Generic | 186 | 94.4 | | 11 | 5.6 | 35 | 17.8 | 151 | 76.6 | |
| Frequency of solution change | Everyday | 107 | 95.5 | 0.233 | 5 | 4.5 | 22 | 19.6 | 85 | 75.9 | .178 |
| | Every 2 days | 46 | 95.8 | | 2 | 4.2 | 6 | 12.5 | 40 | 83.3 | |
| | Every 3 days | 76 | 95.0 | | 4 | 5.0 | 12 | 15.0 | 64 | 80.0 | |
| | >3 days | 234 | 90.7 | | 24 | 9.3 | 57 | 22.1 | 177 | 68.6 | |
| Frequency of lens box change | Monthly | 73 | 92.4 | 0.440 | 6 | 7.6 | 15 | 19.0 | 58 | 73.4 | .491 |
| | Every 2 months | 53 | 98.1 | | 1 | 1.9 | 7 | 13.0 | 46 | 85.2 | |
| | Every 3 months | 90 | 93.8 | | 6 | 6.3 | 22 | 22.9 | 68 | 70.8 | |
| | >3 months | 244 | 92.1 | | 21 | 7.9 | 52 | 19.6 | 192 | 72.5 | |
| Frequency of solution can change | < 3 months | 150 | 94.9 | 0.027* | 8 | 5.1 | 25 | 15.8 | 125 | 79.1 | .008* |
| | 3-6 months | 154 | 95.1 | | 8 | 4.9 | 42 | 25.9 | 112 | 69.1 | |
| | >6 months | 140 | 88.1 | | 19 | 11.9 | 27 | 17.0 | 113 | 71.1 | |
| | Never | 17 | 100.0 | | 0 | 0.0 | 1 | 5.9 | 16 | 94.1 | |

Because of missing data, all frequencies do not sum up to the total;
* statistically significant result ($P < 0.05$).

DISCUSSION

The present study investigated the compliance with hygiene rules among contact lens users and reported the high percentage of noncompliance (up to 89.0%, as per the rule), resulting in a high prevalence (93.0%) of self-reported eye complications. Demographic characteristics showed clear females predominance (95.8%) and relatively young age (97.2% aged ≤ 40 years) among the participants. This is concordant with the demographic picture of contact lens users in literature; such as *Cope et al.*⁽³⁾, *Bhandari & Hung*⁽¹⁵⁾, and *de Oliveira et al.*⁽¹³⁾, who reported 82%, 74% and 69.2% of females among contact lens wearers, respectively^(3,13,15). While *Wu et al.*⁽¹⁶⁾ showed only 55% of females. Regarding age, there is a significant discrepancy in available literature. *Oliveira et al.*⁽¹³⁾ reported young mean age 23.5 years, while *Wu et al.*⁽¹⁶⁾ reported 33.8 years. Moreover, in the study by *Bhandari & Hung*⁽¹⁵⁾, 75% of the participants were age between 20-29 years; while 62% of the participants were older (aged > 40 years) in the study by *de Oliveira et al.*⁽¹³⁾. These observations indicated that the young females of the Saudi population are the most interested candidates for contact lens use.

Regarding the pattern of wearing lenses, most of the participants were irregular users (69.8%), and cosmetic purpose accounted for 47.8% of the usage. These figures are fairly comparable with those of *Abahussin et al.*⁽²⁾, who reported 50% of part-time users and 63.3% of cosmetic use. However, *Abahussin et al.*⁽²⁾ included only female university students aged between 16 and 31 years. In the study by *Bhandari and Hung*⁽¹⁵⁾, 70% of respondents used contact lens to correct myopia. Other pattern of use showed that majority of participants used lenses monthly (42.6%) or yearly (31.4%) disposable lenses, while only 20.2% used daily. This pattern is somewhat different from that reported by *Bhandari and Hung*⁽¹⁵⁾, showing 53% of monthly disposable lens users and 35% of daily lens users. A study by *Dart et al.*⁽⁴⁾ demonstrated that risk of microbial keratitis was significantly increased among daily disposal users, probably because of relatively higher risk of forgetting to change the lenses. Compliance was best for regular washing of lenses before wear, which was reported in 89.6% of the cases followed by removal of lenses before sleep in 84.4% and washing of hands before wear in 81.2%. These three actions constitute the basic hygiene rules and may be intuitively perceived as important and easy to implement in the daily practice, regardless of the level of awareness of the individual. Literature has shown a high compliance with these three rules. According to *Abahussin et al.*⁽²⁾, 89.4% of the respondents declared adequately washing their hands before handling contact lenses, and 92.3% declared removing the lenses before sleep. Similarly, study by *Wu et al.*⁽¹⁶⁾ reported adequate hand hygiene and adequate lens cleaning among 89% and 87% of the participants, respectively. In study by *Bhandari & Hung*⁽¹⁵⁾, compliance with hand washing before handling lenses was as high as 98%, while adequate lens rinsing was reported in 73.8%. Levels of compliance were lower for other hygiene rules including the use of specific lens solution (60.6%), washing lenses after use (33.2%), regular change of sterile solution (22.4%), lens box change (15.8%) and lens wetting (11.0%). According to *Abahussin et al.*⁽²⁾, better compliance regarding sterile solution change was reported in 72.7% of the cases. Data reported in the study by *Bhandari & Hung*⁽¹⁵⁾ showed higher compliance with lens washing after use (75.4%), whereas compliance with lens box change was only 6.2%.

Cope et al. ⁽³⁾ reported a compliance with the use of specific lens solution in 64.5%, which is similar to the observations of our study, while the remaining 35.5% declared using tap water to rinse the lens. However, the previous study reported that 50.1% replaced the lens box at recommended replacement frequency, which represents a higher compliance rate than that observed in our study ⁽³⁾. Other risk behaviors reported in literature such as swimming or showering in contact lenses, returning for aftercare, and sharing the contact lens with other persons were not investigated in the present study ^(2,3,15,16). Nevertheless, all these studies reported insufficient level of compliance, which represents a great risk of eye complications. Commonly, noncompliance with contact lens-related hygiene rules has been demonstrated to be superior to that with other medical recommendations. Statistics reported up to 99% of noncompliance in some cases ⁽¹⁷⁾, or at least one hygiene-related risk behavior found in almost 100% of the participants ^(3, 18). Male gender was demonstrated to be the only factor significantly associated with poor compliance; however, the difference between the respective compliance scores was moderate (-0.75/10 points). Age, educational level, or pattern of wearing lenses were not significant factors of noncompliance with hygiene rules in the present study. These results are similar to those observed by *Bhandari and Hung* ⁽¹⁵⁾, who reported no significant association of compliance to hygiene rules with demographic factors. Absence of impact of demographics may be explained by the homogeneity of the population of contact lens users; which is essentially composed of young, highly educated women, as previously demonstrated. The second important finding of the present study is the very high prevalence of eye complaints, reported in 93% of the participants, and 73.6% of them had 2 or more concomitant symptoms. However, association of eye complication with compliance could not be demonstrated using compliance score, although it was only established with two hygiene rules (frequency of solution replacement and sleeping with the lenses). In the first association, the highest prevalence of eye complications (100%) was observed in participants who declared never changing the can; while the second one showed a paradoxical result, as participants who declared sleeping with their lenses had the lowest

prevalence of eye complications. Although symptoms investigated in this study do not accurately inform about the nature of the eye affection, the correlation between eye complications and noncompliance with a number of hygiene rules such as frequency of lens replacement, adequate storage and use of sterile solution, exposure to tap water or swimming with lens, sleeping with lens, etc., is established through several studies ^(4,10,19,20). In addition, the low levels of compliance with hygiene rules are probably a major cause of the rise of atypical lens-related infections, such as *Acanthamoeba keratitis* and *Fusarium keratitis* ⁽⁶⁾. Furthermore, contact lens-related infection outbreaks were demonstrated to be associated with the use of inadequate contact lens disinfection system ⁽⁷⁾. In view of the potential severity of eye complications, practitioners should emphasize on compliance with hygiene rules as a pillar in the prevention and aftercare of contact lens users. Compliance to medical regimens is a complex behavior that depends on several factors including patient's awareness level, knowledge, perception, and attitudes, in addition to personality factors like risk-taking, which is likely to explain 24% of noncompliance ^(17,21). However, patient's educations to standard hygiene rules are generally sufficient to ensure the adequate levels of compliance ⁽²²⁾. This indicates that practitioners should keep an awareness-raising attitude by means of simple recommendations. In addition, contact lens-related hygiene rules and lens care regimen may be perceived as inconvenient by a number of individuals and can constitute a reason for discontinuation of contact lens use ⁽²³⁾. This urges manufacturers to invest in designing of contact lenses with less constraining care regimen to enhance compliance and help in the prevention against eye complications. The major limitation of this study is the subjective measurement of eye complaints relying only on self-reported symptoms, which may result in over- or underestimation of the eye morbidity among some participants. This may also explain the absence of statistical significance with noncompliance. Assessment of eye complication should be carried out using clinical examination and appropriate diagnostic methods for each affection.

CONCLUSION

There was poor compliance with hygiene rules among contact lens users in Saudi Arabia, ranging between 11% and 89.6% per hygiene rule, along with a high prevalence of eye complaints reported by 93% of the participants. Failure to replace the lenses was associated with higher prevalence of eye complications, whereas no significant correlation was demonstrated with the other hygiene rules or with overall compliance. There is urgent need to educate contact lens users all the hygienic rules to prevent serious eye complications, by means of providing optimal aftercare with simple awareness raising strategy. Further studies are warranted to assess the clinical significance of the reported eye complaints among contact lens users, using objective methods to accurately measure the associated eye morbidity. Subjective measurement of eye complaints was carried out relying only on self-reported symptoms.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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