Contact Lens Use Patterns and Safety Determinants among Adolescents in Western Saudi Arabia

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Abstract

Background: Besides medical use, cosmetic contact lens (CL) use, associated with several ophthalmological risks, is gaining substantial popularity, especially among the young.

Objective: This study aimed to estimate eye risk extent related to CL use among adolescents and understand the association between risk level and CL use patterns and adherence to hygiene and maintenance instructions.

Method: A population-based, cross-sectional study was conducted among adolescents aged 14–19 years residing in the Western region of Saudi Arabia. A structured online questionnaire was used to explore the demographic data, CL use patterns, levels of adherence to safety behaviors in CL use, and experienced eye complaints.

Result: Of 350 participants, 248 (70.9%) used CLs. There was an overwhelming female predominance (93.1%) among users, with occasional, cosmetic, and combined cosmetic-medical uses without prescription or follow-up being the most frequent pattern. Practices in CL hygiene and care were unsatisfactory, with poorer adherence to maintenance instructions. Clinically significant complications (CSC), defined as the presence of at least one of the clinically significant symptoms or any two other symptoms, were reported in 38.7% of CL users (95% CI = 32.6%–45.1%). CSC risk independently increased after 5 years of use (OR = 3.59, 95% CI = 1.51–8.52) and in double-purpose use (OR = 3.34, 95% CI = 1.52–7.37) by reference to cosmetic use only, while adherence levels to CL removal during sleep (OR = 0.21, 95% CI = 0.05–0.92) and not using CLs after the expiration date (OR = 0.28, 95% CI = 0.11–0.73) were protective factors against CSC.

Conclusion: Young Saudi adolescents are highly exposed to unregulated CL use with significant ophthalmological risks. This has several clinical, public health, and policy-making implications.

Keywords: Contact lenses, habits, teenagers, Jeddah, cosmetic, refractive

Introduction

Contact lens (CL) use is becoming highly popular, accounting for a huge market of more than $US12 million, with a nearly 7% of growth rate globally(1,2). In the past 15 years, there was a significant increase in CL use to control myopia and other eye conditions among children and adolescents, achieving notable clinical success(3–5). Other health advantages of CLs are represented by improved psychological and social well-being due to improvements in self-esteem and quality of life(6,7).

However, besides medical use, cosmetic tinted CLs use is gaining substantial popularity among the young, especially in Saudi Arabia(8,9). A local study in 2014 involving female students from three universities in Riyadh showed a high CL use prevalence of 70%, with cosmetic use representing 63.3% of the cases, while exclusive medical use was reported in only 19.1%, and the remaining 17.7% comprised combined medical and cosmetic uses(10). The same study reported that approximately 40% purchased and used CLs without prescription or prior ophthalmological examination. A more recent study involving school children and adolescents aged 11–20 years in Riyadh, Saudi Arabia, showed that 15% of the participants had CLs, and less than 10% of them had been prescribed by an eye care professional for a medical indication. The authors also reported low knowledge levels and poor practice regarding hygiene and safety instructions(11).

Despite the advances in design and manufacturing and the ongoing research and innovation, (12,13) CL safety in children is still concerning(14). Several ophthalmological risk factors that can have an impact on children and adolescents have been identified, particularly in the case of cosmetic and/or unregulated use(15,16). These include factors related to the lens material nature and physical properties, protein deposits and bacterial contamination, and user's behavior, including use patterns, adherence to hygiene instructions and maintenance practices, and other behaviors, such as smoking and psychotropic drug use(16,17).

This study aimed to estimate eye risk extent related to CL use in adolescents and understand the association between risk level and CL use patterns and adherence to hygiene and maintenance instructions.

Methods

Design and setting

A population-based cross-sectional study was conducted among the residents of the Western region of Saudi Arabia between September 2020 and January 2021. The study was approved by the Biomedical Ethics Research Committee at King Abdulaziz University, Jeddah, Saudi Arabia (Reference No. 743-19).

Participants and sampling

The study targeted male and female adolescents aged 14–19 years. Participants with sensorial impairment, psychiatric comorbidity, or end-stage disease were not included.

The sample size was calculated to detect an expected CL use prevalence of 70%,(10) with a 95% confidence interval, 5% type 1 error, and 80% statistical power. The calculated sample size (N = 318) was increased to 350. The study sample was selected conveniently according to participants' accessibility and willingness to participate. Consent was obtained from all participants after informing them about the study purpose. There were no personal questions or identifier collection in the questionnaire.

Tool

A structured questionnaire was designed by the author to explore the following dimensions:

1) Demographic data, including age, gender, and nationality.
2) CL use, using a single question "do you use contact lenses?"
3) CL use patterns for its users, including the age when they started using CLs, duration in years, whether the user received education regarding CL care, main knowledge source about CL, the purpose of use (medical, cosmetic, or both), type of CL used, frequency of use, daily wearing regimen, whether the use is prescribed by an ophthalmologist or optician, and follow-up by a professional.
4) Safety measures in CL use exploring adherence level with 12 safety-related behaviors, including seven unsafe behaviors, such as wearing CLs during sleep or shower, and five safe behaviors, such as handwashing before and after wearing, solution and container change, etc. For both unsafe and safe behaviors, answers used a frequency scale, such as "never, rarely, sometimes, and always", or a dichotomous "yes/no" answer. In three items, the option "does not apply" was added.
5) Ophthalmological complications exploring a set of six symptoms, including itchy watery eye, swollen red eyes, eye pain or discomfort, photosensitivity, trouble seeing, and corneal abrasion.

Scoring

The questionnaire subset related to safety was used to calculate a safety adherence score (SAS). The scoring method followed the assumption that adherence ranged from no adherence (rated as 0) to complete adherence (rated as 1), while incomplete adherence was scored 0.25 or 0.5 depending on the level (e.g., rarely vs. sometimes). For the variables related to container wash, solution change, and container change frequency, values referring to the option "do not apply" were deleted and replaced using the mean imputation. The SAS was computed as the sum of the adherence scores of the 12 measures, yielding a score range of 0–12.

Variables

Complications incidence was analyzed as the dependent variable in the present study. A clinically significant complication (CSC) was defined as the occurrence of at least one of the symptoms considered clinically significant, including swollen red eye, trouble seeing or corneal abrasion, or two or more of any of the other symptoms.

Procedure

The questionnaire was translated into the Arabic language. An electronic version was edited using Google Forms. The link was disseminated via social media, including Twitter and WhatsApp. The link for the questionnaire was maintained active for five months.

Statistical methods

Statistical analysis was performed with Statistical Package for Social Sciences version 21.0 for Windows (SPSS Inc., Chicago, IL, USA). Categorical variables are presented as frequency and percentage, while numerical variables are presented as mean ± standard deviation (SD) or median and interquartile range (IQR), as applicable. The normality distribution of SAS was tested using Kolmogorov-Smirnov and Shapiro-Wilk tests. Since the score was not normally distributed, the first quartile (Q1) value was used as a cutoff to define poor adherence to safety measures (SAS < Q1). Each complication and CSC prevalence was calculated with an estimation of 95% CI. Chi-square and Fisher's exact tests were used, as applicable, to analyze the association of CSC with categorical variables factors. Independent t-test was used to compare the mean and variance of age and age of when the participant started using CLs across the outcome groups (CSC vs. no CSC). A multivariate binary logistic model was carried out to analyze the independent factors associated with CSC. A p value of <0.05 was considered to reject the null hypothesis.

Results

Participants' characteristics

The study sample consisted of 350 adolescents, of whom 248 (70.9%) declared using CLs while the remaining 102 (29.1%) denied wearing them. Most CL users were females, accounting for 96.4% of the group, compared with 78.4% in the nonuser group ($p < 0.001$) (Table 1).

Patterns of CL use

Users started wearing CLs at a mean age of 14.25 (SD = 1.91) years, and 23.0% have been using them for five years or more. Cosmetic CL use was the most frequent purpose for wearing CL, either separately (45.2%) or combined with the medical purpose (30.2%). However, two-thirds (69.8%) declared wearing their CLs less than two days per month or lesser, on average. Most users (84.7%) declared being educated for CL care; however, the most frequent knowledge source was a family member (40.7%), followed by Internet and social media (33.9%). Only 8.9% declared seeking knowledge about CL care from their ophthalmologist or optometrist. A small number of participants use CLs with a prescription (27.8%) and are followed up by a professional 21.4% (Table 2).

Safety parameters in CL use

Adherence to 12 safety measures showed the three highest rates for rigorous compliance in the following dimensions: abstinence from wearing CL while swimming (81.5%), avoidance of using CL during sleep (79.0%), and avoiding sharing CLs with others (79.0%). The lowest rates for rigorous compliance concerned container maintenance frequency, including change (12.9%) and wash (30.6%), followed by CL solution change frequency (41.5%). These observations were confirmed by the mean adherence scores measured (Table 3). The overall SAS showed a mean (SD) of 8.31 (1.59) out of 12, a range of 3.25–12.0, and a median (IQR) of 8.50 (2.25). Normality testing showed non-normal distribution with Kolmogorov-Smirnov (0.092, $p < 0.001$) and Shapiro–Wilk tests (0.982, $p = 0.003$) (Figure 1).

Ophthalmological complications in CL users

Eye pain or discomfort (51.2%), itchy watery eye (34.7%), and swollen red eye (16.9%) were the most commonly reported symptoms by CL users, and 29.0% reported having two or more symptoms. CSCs, defined as the presence of at least one of the clinically significant symptoms or any two other symptoms, was reported in 38.7% (95%CI = 32.6%–45.1%) (Table 4).

Association of safety instructions with eye complaints

Bivariate correlations between adherence scores to 12 safety measures and different eye complaints demonstrated several significant results (Supplemental Table). Swollen red eye was negatively associated with adherence to instructions on CL use during shower ($R = -0.153$, $p = 0.016$) and after the expiration date ($R = 0.268$, $p < 0.001$). Eye pain or discomfort was inversely associated with adherence to instructions on CL use during sleep ($R = -0.136$, $p = 0.032$) and after the expiration date ($R = -0.138$, $p = 0.029$). Photosensitivity was negatively correlated with adherence to instructions related to sleep ($R = -0.165$, $p = 0.009$), shower ($R = -0.233$, $p < 0.001$), swimming ($R = 0.246$, $p < 0.001$), expiration date ($R = -0.148$, $p = 0.020$), and sandstorm ($R = -0.178$, $p = 0.005$). Difficult vision was negatively correlated with adherence to instructions related to sleep ($R = -0.154$, $p = 0.015$) while it paradoxically showed a positive correlation with compliance to handwashing ($R = 0.179$, $p = 0.005$) and container wash frequency ($R = 0.303$, $p < 0.001$).

Factors associated with CSCs

Of the explored safety measures, only frequency of CL use during sleep ($p = 0.010$, Mann-Whitney U test) and CL use after the expiration date ($p = 0.012$, Mann-Whitney U test) were significantly associated with CSC risk in unadjusted analysis (results not presented). Furthermore, CSC risk was increased in cases of using CL for ≥5 years (61.4% vs. 25.8–35.2%, $p < 0.001$), double-purpose (53.3%) or medical (52.6%) use vs. 26.8% for cosmetic use ($p = 0.001$), and among participants with inadequate adherence to safety measures (SAS < 7.25, 50.8% vs. 34.8%, $p = 0.025$) (Table 5).

Predictors of CSCs

Two logistic regression models were carried out. The first model included CL use duration, CL use purpose, and the safety adherence level using SAS Q1 as the cutoff. In this model, CSC risk independently increased after 5 years of CL use (OR = 3.22, 95% CI = 1.43–7.28) and in double-purpose CL use (OR = 2.50, 95% CI = 1.29–4.85) by reference to cosmetic CL use only. The model explained 11.5% of the outcome variance. The level of adherence with safe CL use measures did not show significance in this model.

The second model included use duration, use purpose, and 12 adherence measures scores. The model showed that CSC risk independently increased after 5 years of CL use (OR = 3.59, 95% CI = 1.51–8.52) and in double-purpose CL use (OR = 3.34, 95% CI = 1.52–7.37) by reference to cosmetic CL use only, while adherence levels to CL removal during sleep (OR = 0.21, 95% CI = 0.05–0.92) and not using CLs after the expiration date (OR = 0.28, 95% CI = 0.11–0.73) were protective factors against CSC (Table 6).

Table 1. Demographic characteristics of contact lens users versus nonusers (N=350)

		Nonusers (N=102)		Users (N=248)		
Parameter	Level	Mean	SD	Mean	SD	p-value
Age	(years)	17.44	1.63	17.50	1.59	.719
Parameter	Level	N	%	N	%	p-value
Gender	Male	22	21.6	9	3.6	
	Female	80	78.4	239	96.4	<.001*
Residence	Baha	0	0.0	2	0.8	
	Jeddah	84	82.4	199	80.2	
	Madinah	1	1.0	1	0.4	
	Mecca	13	12.7	43	17.6	
	Riyadh	4	3.9	2	0.8	
	Yanbu	0	0.0	1	0.4	.241
Nationality	Saudi	94	92.2	231	93.1	
	Non-Saudi	8	7.8	17	6.9	.744

Table 2. Patterns of contact lens use (N=248)

Parameter	Level	Mean	SD
Starting age	(years), range = 11-18	14.25	1.91
Parameter	Level	N	%
Duration of use	Less than a year	66	26.6
	1-4 years	125	50.4
	5 years or more	57	23.0
Education for contact lens care	No	38	15.3
	Yes	210	84.7
Main source of knowledge on how to use the contact lens	Ophthalmologist or optometrist	22	8.9
	Family member	101	40.7
	Friend	21	8.5
	Internet or social media	84	33.9
	Other	2	0.8
	NA / no answer	18	7.3
Purpose of use	Medical	61	24.6
	Cosmetic	112	45.2
	Both medical and cosmetic	75	30.2
Type of contact lens used*	Daily disposable soft CL	61	24.6
	Weekly disposable soft CL	12	4.8
	Monthly disposable soft CL	123	49.6
	Extended wear soft CL	97	39.1
Number of types used	Not answered	2	0.8
	1	207	83.5
	2	32	12.9
	3	6	2.4
	4	1	0.4
Frequency of use	Daily	29	11.7
	4-6 days a week	20	8.1
	1-3 days a week	26	10.5
	1-2 days a month	51	20.6
	Only a few days per year	122	49.2
Wearing regimen	<6 hours	87	35.1
	6-11 hours	139	56.0
	12-24 hours	17	6.9
	>24 hours	5	2.0
Prescription by ophthalmologist or optician	No	179	72.2
	Yes	69	27.8
Follow up by professional	None	195	78.6
	Once a year	37	14.9
	Every 6 months	16	6.5

* A participant may use more than one type

Table 3. Safety parameters in contact lenses use

Parameter	Level (safety score out of 1)	N	%	Mean safety score
Wearing CL while sleeping	Never (1)	196	79.0	
	Rarely (0.5)	38	15.3	
	Sometimes (0.25)	9	3.6	
	Always (0)	5	2.0	0.88 (0.25)
Wearing CL while showering	Never (1)	192	77.4	
	Rarely (0.5)	26	10.5	
	Sometimes (0.25)	19	7.7	
	Always (0)	11	4.4	0.85 (0.30)
Wearing CL while swimming	Never (1)	202	81.5	
	Rarely (0.5)	11	4.4	
	Sometimes (0.25)	19	7.7	
	Always (0)	16	6.5	0.86 (0.31)
Sharing own CL with others	Never (1)	196	79.0	
	Rarely (0.5)	19	7.7	
	Sometimes (0.25)	29	11.7	
	Always (0)	4	1.6	0.83 (0.35)
Storing or washing CL in other solutions	Never (1)	185	74.6	
	Rarely (0.5)	39	15.7	
	Sometimes (0.25)	21	8.5	
	Always (0)	3	1.2	0.85 (0.27)
Using CL after their expiration date	Never (1)	136	54.8	
	Rarely (0.5)	51	20.6	
	Sometimes (0.25)	49	19.8	
	Always (0)	12	4.8	0.70 (0.35)
Wearing the CL longer than their designed duration of use	Never (1)	151	60.9	
	Rarely (0.5)	28	11.3	
	Sometimes (0.25)	48	19.4	
	Always (0)	21	8.5	0.71 (0.37)
Handwashing pre and post wearing CL	Never (0)	1	0.4	
	Rarely (0.25)	12	4.8	
	Sometimes (0.5)	81	32.7	
	Always (1)	154	62.1	0.81 (0.24)
Frequency of container wash	Never (0)	16	6.5	
	Rarely (0.25)	26	10.5	
	Sometimes (0.5)	97	39.1	
	Always (1)	76	30.6	
	Does not apply (imputed = 0.61)	33	13.3	0.61 (0.30)
Frequency of solution change	Never (0)	34	13.7	
	Rarely (0.25)	35	14.1	
	Sometimes (0.5)	28	11.3	
	Always (1)	103	41.5	
	Does not apply (imputed = 0.28)	48	19.4	0.28 (0.33)
Frequency of container change	Never (0)	151	60.9	
	Every 6 months (0.5)	29	11.7	
	Every 3 months (1)	32	12.9	
	Does not apply (imputed = 0.22)	36	14.5	0.22 (0.34)
Abstinence from wearing CL during sandstorm	No (0)	68	27.4	
	Yes (1)	180	72.6	0.73 (0.45)

Figure 1. Distribution of safety adherence score

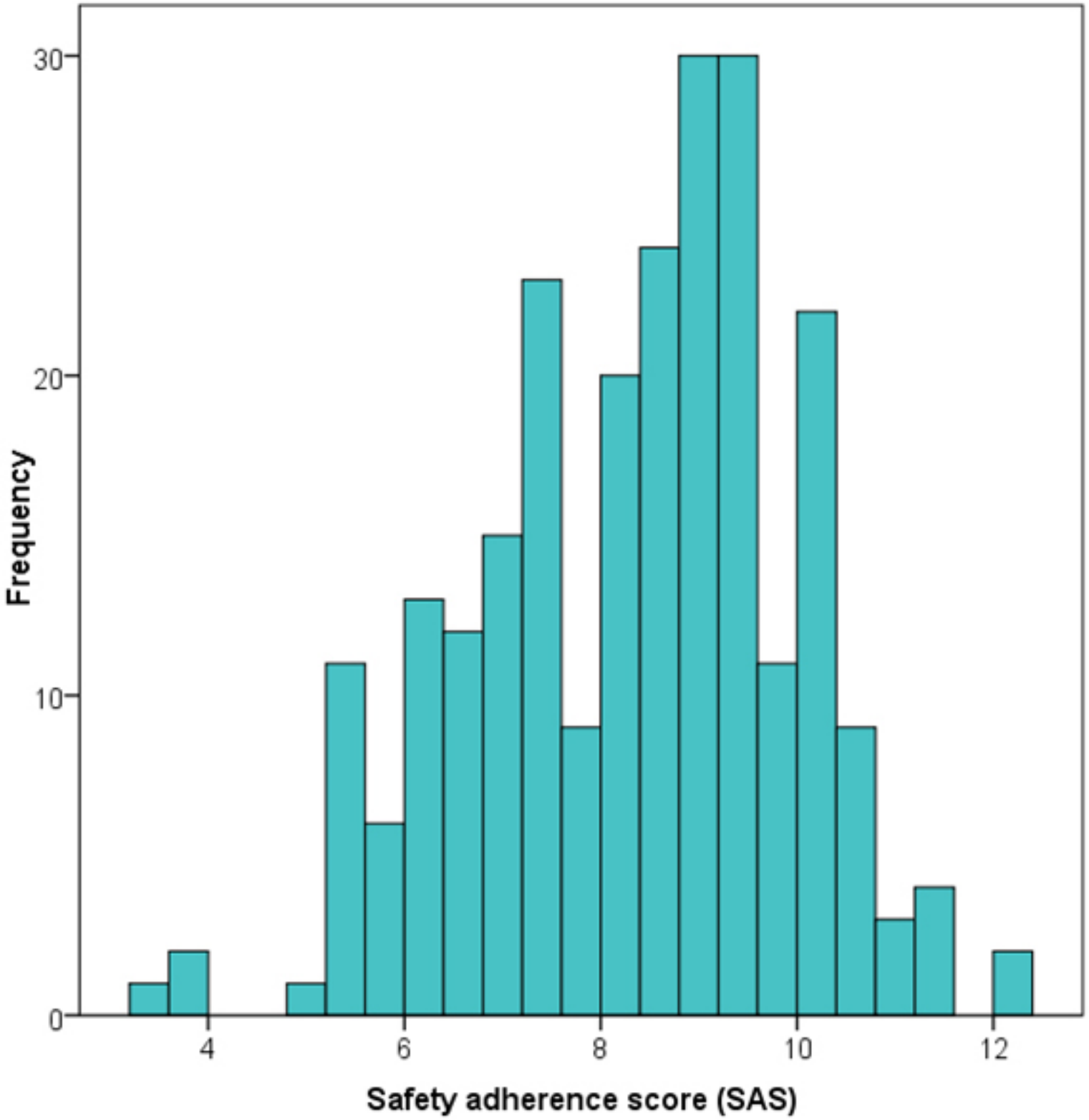

Table 4. Ophthalmological complications in contact lens users (N=248)

Complication	Frequency	Prevalence (%)	95%CI
Itchy watery eyes	86	34.7	28.8 – 41.0
Swollen red eyes*	42	16.9	12.5 – 22.2
Eye pain or discomfort	127	51.2	44.8 – 57.6
Photosensitivity	31	12.5	8.65 – 17.3
Trouble seeing*	25	10.1	6.63 – 14.5
Corneal abrasion*	7	2.8	1.14 – 5.73
No. cumulative complications			
0	85	34.3	
1	74	29.8	
2	42	16.9	
3	30	12.1	
4+	17	6.8	
Clinically significant complication			
Yes	96	38.7	32.6 – 45.1%
No	152	61.3	

* Symptoms considered as clinically significant
Clinically significant complication is defined as the presence of at least one of the clinically significant symptoms or any 2 other symptoms or more.

Supplemental Table 1. Correlations between adherence to different safety measures and eye complaints

Instruction dimension	Itchy watery eye	Red swollen eye	Pain or discomfort	Photo-sensitivity	Trouble seeing	Corneal abrasion
Sleep	-0.062 (.333)	-0.076 (.230)	**-0.136 (.032*)**	**-0.165 (.009*)**	**-0.154 (.015*)**	-0.061 (.338)
Shower	-.049 (.442)	**-.153 (.016*)**	-.105 (.098)	**-.233 (<.001*)**	-.051 (.423)	-.075 (.241)
Swimming	-.084 (.187)	-.101 (.112)	-.102 (.110)	**-.264 (<.001*)**	-.060 (.349)	-.077 (.226)
Sharing	-.006 (.921)	-.101 (.112)	-.028 (.656)	.063 (.323)	.087 (.171)	-.056 (.383)
Storage in other container or solution	-.030 (.633)	-.118 (.063)	.017 (.787)	.068 (.286)	.017 (.785)	.051 (.420)
Expiry date	-.103 (.104)	**-.268 (<.001*)**	**-.138 (.029*)**	**-.148 (.020*)**	.047 (.457)	-.063 (.321)
Overuse	-.014 (.823)	-.114 (.072)	.029 (.646)	-.029 (.655)	-.012 (.847)	.000 (.997)
Handwashing	-.094 (.138)	-.090 (.156)	-.014 (.822)	.019 (.768)	**.179 (.005*)**	-.068 (.289)
Container wash	-.011 (.859)	.028 (.657)	-.046 (.473)	.015 (.808)	.006 (.930)	.110 (.085)
Solution change	.036 (.568)	-.042 (.515)	.088 (.169)	.089 (.163)	**.303 (<.001*)**	-.047 (.459)
Container change	-.078 (.224)	-.007 (.907)	-.060 (.350)	-.002 (.981)	-.013 (.842)	-.094 (.142)
Sandstorm	.030 (.638)	-.036 (.575)	-.039 (.537)	**-.178 (.005*)**	-.064 (.312)	-.004 (.945)

Results are Pearson's correlation coefficient R (p-value)
* Statistically significant correlation (p<0.05)

Table 5. Factors associated with clinically significant complications

Factor	Level	No CSC		CSC		p-value
		Mean	SD	Mean	SD	
Age	(years)	17.36	1.67	17.73	1.43	.076
Age of CL start	(years)	14.41	1.82	13.98	2.01	.080
Factor	Level	N	%	N	%	p-value
Gender	Male	5	55.6	4	44.4	
	Female	147	61.5	92	38.5	.738F
Duration of use	Less than a year	49	74.2	17	25.8	
	1-4 years	81	64.8	44	35.2	
	5 years or more	22	38.6	35	61.4	<.001*
Education	No	22	57.9	16	42.1	
	Yes	130	61.9	80	38.1	.640
Main source of knowledge	Ophthalmologist or optometrist	16	72.7	6	27.3	
	Relative or friend	75	61.5	47	38.5	
	Internet or none	61	58.7	41.3	41.3	.468
Purpose of use	Medical	35	57.4	26	52.6	
	Cosmetic	82	73.2	30	26.8	
	Both	35	46.7	40	53.3	.001*
Frequency of use	Daily	13	44.8	16	55.2	
	4-6 days a week	13	65.0	7	35.0	
	1-3 days a week	15	57.7	11	42.3	
	1-2 days a month	37	72.5	14	27.5	
	A few days/year	74	60.7	48	39.3	.177
Wearing regimen	<6 hours	56	64.4	31	35.6	
	6-11 hours	85	61.2	54	38.8	
	12-24 hours	10	58.8	7	41.2	
	>24 hours	1	20.0	4	80.0	.263
On prescription	No	111	62.0	68	38.0	
	Yes	41	59.4	28	40.6	.707
Follow up by professional	None	120	61.5	75	38.5	
	Once a year	20	54.1	17	45.9	
	Every 6 months	12	75.0	4	25.0	.352
Safety adherence (SAS)	Inadequate (SAS<7.25)	30	49.2	31	50.8	
	Adequate (SAS≥7.25)	122	65.2	65	34.8	.025*

* Statistically significant result (p<0.05).

Table 6. Predictors of clinically significant complications

Model / Predictor	Level	OR	95%CI		p-value
Model 1					
Duration of use	Less than a year	Ref	-	-	.004*
	1-4 years	1.26	0.63	2.53	.519
	5 years or more	**3.37**	**1.51**	**7.55**	**.003***
Purpose of use	Cosmetic	Ref	-	-	.006*
	Medical	1.88	0.94	3.75	.074
	Both	**2.81**	**1.48**	**5.34**	**.002***
Safety adherence level	Inadequate	1.68	0.89	3.17	.112
	Adequate	Ref	-	-	-
Model 2					
Duration of use	Less than a year	Ref	-	-	.003*
	1-4 years	1.10	0.52	2.35	.804
	5 years or more	**3.59**	**1.51**	**8.52**	**.004***
Purpose of use	Cosmetic	Ref	-	-	.011*
	Medical	2.45	0.99	6.08	.054
	Both	**3.34**	**1.52**	**7.37**	**.003***
No wearing during sleep	**(Score 0-1)**	**0.21**	**0.05**	**0.92**	**.039***
No wearing during shower	(Score 0-1)	1.21	.27	5.49	.805
No wearing while swimming	(Score 0-1)	0.71	0.19	2.63	.607
No sharing of CL	(Score 0-1)	0.56	0.21	1.50	.252
No storing in inappropriate solution or container	(Score 0-1)	0.79	0.25	2.51	.689
No use after expiry date	**(Score 0-1)**	**0.28**	**0.11**	**0.73**	**.009***
No prolonged wearing	(Score 0-1)	2.02	0.78	5.22	.145
Handwashing	(Score 0-1)	0.96	0.26	3.51	.953
Container washing frequency	(Score 0-1)	1.85	0.64	5.34	.255
Solution change frequency	(Score 0-1)	1.03	0.36	2.96	.960
Container change frequency	(Score 0-1)	0.39	0.14	1.07	.068
No wearing during sandstorm	(Score 0-1)	2.06	0.99	4.32	.055

Discussion

This study explored CL use patterns and related safety behaviors among adolescents in Western Saudi Arabia. It also estimated clinically significant ophthalmological complication prevalence and their associations with CL use patterns and level of adherence to safety behaviors. Females are the predominant gender among CL users, and occasional cosmetic CL use without medical prescription or follow-up was the most common pattern. The overall compliance to safety measures was suboptimal-to-acceptable; however, a remarkably poor practice was observed regarding the solution and container maintenance. Ophthalmological complaints were frequent, reported by up to 51.2% of users, depending on the symptom, and showed many significant negative correlations with different safety behaviors. CSC prevalence was estimated to be 38.7% (95% CI = 32.6–45.1%). Longer CL use duration (≥5 years) and combined medical-cosmetic CL use were significant predictors for CSC, associated with approximately 3.6 and 3.3 odd ratios, respectively. On the other hand, adherence to safety and hygiene instructions were protective factors, especially not wearing CLs during sleep and after the expiration date, associated with approximately 70%–80% reduction in CSC risk. Findings from the present study are consistent with those from the literature and have significant public health, clinical, and policy implications that will be discussed in this section.

Although this study was not designed to estimate CL use prevalence among the young population, some demographic and epidemiological figures have been noted. The most important features are female predominance and frequent cosmetic CL use. Our findings compare well with the local studies that showed a high prevalence of CL use among children and adolescents with increasingly frequent cosmetic CL use, especially among females(10,11). These observations, combined with poor practice regarding hygiene and maintenance instructions and CL market issues, are the source of several ophthalmological risks among this population.

CL complications are higher in the young population compared to adults. For example, a literature review including nine prospective studies involving children and adolescents using CLs identified that corneal infiltrative events incidence was estimated to be up to 3.4%, while such complication can be asymptomatic in several cases(14). This indicates that, in the absence of adequate follow-up and screening strategy, the clinical incidence of CL-induced eye complications is likely to be underestimated.

In the present study, CL users reported different eye complaints at variable frequency. The most common complaint was eye discomfort. Eye discomfort is very common, particularly among new users, with a prevalence that may reach 94%(18,19). Eye discomfort is defined as occasional or persistent adverse sensation associated with CL wear, which results from a conflict of CL shape and material with the eye environment and anatomy. Although it is considered benign, improving with time and eye lubricants use, eye discomfort may impact CL use, which constitutes an issue in the case of medical CL use(19,20).

By focusing on symptoms that were clinically significant, the swollen red eye was reported by 16.9% of the participants. Such a complaint could indicate vasodilatation due to physical and chemical stress exerted on the eye, which results in a local inflammatory response(17). On the other hand, such a symptom may be consistent with genuine conjunctivitis that may go undiagnosed and/or untreated without follow-up by an eye care professional(21). One of the clinical forms of CL-induced conjunctivitis is papillary conjunctivitis, which involves focal or generalized inflammation of the upper palpebral conjunctiva. It is to note that patients with papillary conjunctivitis may remain asymptomatic or complain of eye discomfort, itchiness, or blurred vision. These symptoms resolve rapidly after eye cleaning and CL discontinuation, and proper management may require changing CL type or material(21). This stresses the importance of adequate patient education and follow-up with an eye care professional to enhance the prevention and diagnosis of such complications and prevent future related complications. By consequence, such preventive measures are less likely to have place in case of unprescribed and unregulated CL use.

However, in an interesting approach, Efron N. supported that “contact lens wear is intrinsically inflammatory in nature”, meaning that evidence of clinical or subclinical inflammation is found in all CL users, regardless of CL type. This is due to the exogenous material introduction in the intimate eye environment. The other authors’ thesis supported that, although such an inflammatory state is fundamentally disruptive for the eye homeostasis, its presence may have an indirect protective influence against corneal infiltration by inducing both preventive behaviors among users and adaptive changes in the eye(22). However, such observations and hypotheses should be contextualized with regards to the level of CL use necessity, which should weigh the indication or purpose of CL use with such risks. In other terms, such risks may be acceptable in the case of medical CL use but highly controverted in purely cosmetic CL use.

The other risk of CL-induced conjunctivitis is the progression to bacterial infection, especially in case of poor-quality, unsafe material, or poor adherence to disinfection instructions. A study by Chan et al. (2014) tested bacterial adherence to commercial tinted CL considering pigment detachment. The experiment showed that pigments were detachable in 13 out of 15 of the tested brands, which was associated with increased Pseudomonas aeruginosa proliferation(23). In line with this, a meta-analysis including 871 CL users confirmed that corneal staining was one of the complications observed during the ophthalmological examination(9). This demonstrates the disparity in safety across the CL brands, owing to their quality, which further emphasizes professional counseling and follow-up importance. Additionally, such observations highlight

the importance of adherence to disinfection guidelines among the users. In adolescents examined in this study, CL disinfection and storage yielded the lowest adherence levels. On the other hand, CSC risk was independently associated with adherence level to handwashing before and after CL wear.

The other clinically significant complaint was corneal abrasion, reported by 2.8% of the participants. Reporting such a symptom is conceivably indicative of a medical diagnosis of corneal epithelial erosion, which would have been motivated by a warning symptom. By extrapolation, asymptomatic forms may remain undiagnosed, notably in our population characterized by the predominance of over-the-counter CL use without proper follow-up by an eye specialist. Corneal erosions are a mechanical complication of CL wearing, most frequently observed in poor-quality CL(21). They are characterized by corneal epithelium discontinuity in variable area, depth, and location, which can be detected by a fluorescein test. Corneal erosions may present with symptoms that range from foreign body sensation to severe pain. However, in many cases, they remain asymptomatic(17). This emphasizes eye care specialists' role in the prevention, education, and screening for such complications.

Another serious risk that was not reported by the participants in the present study is microbial keratitis. This is potentially the most dreaded CL use complication, with an incidence of 2 per 10,000 CL users(24). It is a multifactorial condition due to microtrauma and a hypoxic environment favoring microbial growth, especially in case of contamination due to poor practice of CL care or unregulated product use(9,15,25). The most frequently responsible microorganisms are gram-negative bacteria(26). A Saudi study explored 46 patients with CL-induced keratitis and found bacterial growth in 19.5% of the patients, with P. aeruginosa representing the most frequently isolated microorganism, followed by Staphylococcus aureus. These cases resulted in an average 3-month medical follow-up with persistent visual acuity impairment requiring correction spectacles prescription(8). Another review article involving 70 cases of complications related to CL use from unregulated suppliers showed that microbial keratitis represented 61% of the complications, resulting in chronic eye damage in the majority of the affected patients. The same study reported that CLs were purchased over-the-counter or via the Internet in most cases, associated with a significant delay in consultation after the onset of symptoms among the concerned patients(15). These observations emphasize the relevance of reinforcing control by suppliers' authorities and their products compliance with the safety standards. On the other hand, it is critical to raise awareness among the population, and more specifically, the potential users, about the risks related to poor-quality CLs use and enhance timely care seeking behavior at onset of symptoms.

Limitations

The present study is mainly limited by the sampling method that might have introduced selection bias, in addition to reliance on self-reported symptoms and subjective scales use to assess adherence to safety measures. These limitations may impact both the internal and external validity of the findings.

Conclusion and Implications

In conclusion, CL use among adolescents accumulates several ophthalmological risk factors, including rising popularity and accessibility of CLs and their cosmetic use, high propensity to use pigmented CL, even for medical indications, frequent unprescribed CL use, unregulated supply with poor-quality CL material and design, low knowledge levels on safe CL use instructions, untrusted information sources use, poor practices in CL use and maintenance, and inadequate follow-up.

The implications of these risks can be categorized into three different perspectives, including clinical, public health, and policy and decision-making. From a clinical standpoint, eye professionals, including ophthalmologists, optometrists, and opticians, should be aware of CL use extent among the young population and the risk of complications resulting from poor CL maintenance and usage practice. This should translate into enhanced screening and prevention strategies against eye problems among CL users, CL use systematic consideration in the differential diagnosis of eye complaints, and patient education about the health risks, optimal CL use, and specialized follow-up importance.

From the public health perspective, the increasing figures of non-medical and unhealthy CL use patterns among the young population should be further evaluated, considering the potentially substantial morbidity and economic burden. The populations' awareness should be raised about the risks related to over-the-counter and Internet-purchased CL, especially from unregulated suppliers. The specialist prescription and/or follow-up are critically important to reduce the risk of severe complications, as well as the knowledge about and adherence with safety guidelines. CL-related ophthalmologic concerns should be integrated into the health education and awareness programs that target the young populations, especially via social media and school health pathways.

From the decision makers' perspective, policies should be implemented to regulate and control CL commercialization by implementing a certification process based on rigorous safety assessments, enhancing access to relevant information among end-users, and improving the compliance of commercial practices with safety measures. Specific regulation measures should be implemented to protect adolescents and children, considering their high vulnerability to commercial campaigns, especially via the Internet.

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