



## Is purchasing lenses from the prescriber associated with better habits among soft contact lens wearers?



Robin L. Chalmers, OD<sup>a,\*</sup>, Heidi Wagner, OD, MPH<sup>b</sup>, Beth Kinoshita, OD<sup>c</sup>, Luigina Sorbara, OD, MS<sup>d</sup>, G. Lynn Mitchell, MAS<sup>b</sup>, Dawn Lam, OD, MSc<sup>e</sup>, Kathryn Richdale, OD, PhD<sup>f</sup>, Aaron Zimmerman, OD<sup>b</sup>

<sup>a</sup> Clinical Trial Consultant, 2097 East Lake Rd., Atlanta, GA 30307, United States

<sup>b</sup> The Ohio State University College of Optometry, Columbus, OH, United States

<sup>c</sup> Pacific University College of Optometry, Forest Grove, OR, United States

<sup>d</sup> University of Waterloo School of Optometry and Vision Science, Waterloo, Ontario, Canada

<sup>e</sup> Marshall B. Ketchum University Southern California College of Optometry, Fullerton, CA, United States

<sup>f</sup> State University of New York College of Optometry, New York, NY, United States

### ARTICLE INFO

#### Article history:

Received 24 February 2016

Received in revised form 1 August 2016

Accepted 7 August 2016

#### Keywords:

Contact lens compliance

Internet purchase

### ABSTRACT

**Purpose:** To compare the habits of United States (US) soft contact lens (SCL) wearers who bought SCLs from their eye care practitioner (ECP), on the internet/telephone, or at retail (not where they were examined) to test the effect of proximity to the prescriber on SCL wear and care practices.

**Methods:** Adult SCL wearers completed an adapted Contact Lens Risk Survey (CLRS) online that queried items related to risk factors for SCL-related complications. Responses from subjects who purchased at the ECP, via the internet/telephone, or at a retail store were compared (Chi-Square).

**Results:** Purchase sources were: ECP 646 (67%, 44 ± 12 yrs, 17% male), Retail 104 (11%, 45 ± 13 yrs, 28% male), and Internet/telephone 218 (23%, 45 ± 12 yrs, 18% male); age ( $p = 0.51$ ), gender ( $p = 0.021$ ). Internet purchasers had fewer annual eye exams (79% ECP, 83% retail, 66% internet/telephone,  $p = 0.007$ ), purchased more hydrogel SCLs (34% ECP, 29% retail, 45% internet/telephone,  $p = 0.0034$ ), and paid for SCLs with insurance less often (39% ECP, 29% retail, 19% internet/telephone,  $p < 0.0001$ ). Other behaviors were similar across groups ( $p > 0.05$ ).

**Conclusions:** In this sample, the purchase location of SCL wearers had limited impact on known risk factors for SCL-related complications. Internet purchasers reported less frequent eye exams and were more likely to be wearing hydrogel SCLs. Closer access to the ECP through in-office SCL purchase did not improve SCL habits or reduce the prevalence of risk behaviors.

© 2016 British Contact Lens Association. Published by Elsevier Ltd. All rights reserved.

### 1. Introduction

Internet purchase of soft contact lenses (SCLs) has been cited in a number of case reports involving patients with serious eye infections [1–3] and has been associated with poorer compliance and less frequent eye exams [4–6]. More importantly, internet purchase has been proven as a risk factor for SCL-related microbial keratitis (MK) in large epidemiology studies [7]. In addition to increasing risk of sight-threatening SCL complications such as MK, overnight wear, use of reusable lenses, young age, and internet purchase of soft contact lenses (SCLs) have recently been

associated with an increase in the risk of corneal infiltrative events (CIEs) [8,9].

In late 2014, an adapted version of the previously published Contact Lens Risk Survey (CLRS), with additional questions about knowledge and understanding of risk behaviors related to SCL use was fielded to a convenience sample of 1141 online rigid gas permeable (RGP) and SCL wearers aged 20–76 years old [10,11]. That recent survey showed a substantial degree of non-compliance to the instructions for use of most contact lenses and lens care systems, regardless of the type of contact lenses used.

With increasing access to SCLs over the internet and telephone, it is important to probe the range of SCL-related behaviors and attitudes that may differ between wearers who purchase their lenses remotely over the internet or telephone with those who purchase lenses closer to the prescribing source, their ECP. The purpose of this analysis was to compare behaviors of SCL wearers

\* Corresponding author.

E-mail address: [Chalmers2097@gmail.com](mailto:Chalmers2097@gmail.com) (R.L. Chalmers).

**Table 1**  
Demographics of study population by contact lens purchase location.

Question	ECP N = 646	Other Retail N = 104	Internet N = 218	p-value
Age Mean (SD) years	44.0 (11.7)	45.3 (13.3)	44.7 (11.8)	0.51
Range	20–76	22–70	21–70	
% Male	107 (16.6)	29 (27.9)	40 (18.4)	<b>0.02</b>
Years of CL wear	24.1 (11.0) 0–57	24.4 (12.0)	23.8 (11.1)	0.88
Mean (SD) years		2–52	0–51	
Range				
Lens Material	203 (33.6)	28 (28.6)	93 (45.2)	<b>0.003</b>
Hydrogel	402 (66.4)	70 (71.4)	113 (54.8)	
Silicone Hydrogel				
Prior red eye	197 (30.5)	35 (33.7)	69 (31.7)	0.80

who purchased lenses from their eye care practitioner (ECP), at retail (not where examined) or on the internet/telephone to test the effect of proximity to the prescriber on factors related to SCL wear and care practices.

**2. Methods**

In this analysis, the responses from the adapted CLRS [11] from the SCL wearers were analyzed to compare the responses from those who had purchased SCLs from their ECP, at a retail setting other than the ECP (Retail) or on the internet or telephone (Internet). Participants were recruited via a marketing research company (Schlesinger Associates, Iselin, NJ) from participants who had agreed to take surveys via the internet, e-mail or phone calls. The survey was fielded online in late Fall of 2014. Eligible participants were current RGP or SCL lens wearers ≥18 years of age. The study followed the Declaration of Helsinki and received approval from The Ohio State University Institutional Review Board.

Known risk factors (i.e., overnight wear, [7,12–14] use of reusable lenses [15]) and behaviors that were potentially associated with increased risk of MK or CIEs (i.e., lens disinfection, irregular replacement of lens storage cases, frequent exposure to tap water) [7,16] were evaluated using Chi-square analysis and tests of symmetry. Where appropriate, only responses from wearers who stated that they used a contact lens storage case

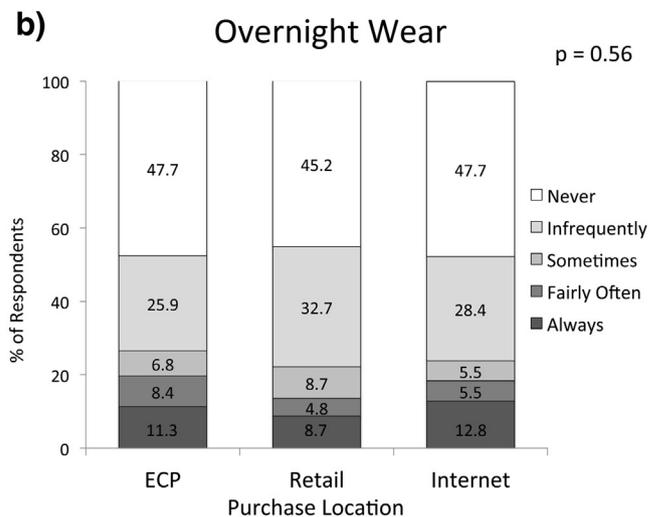
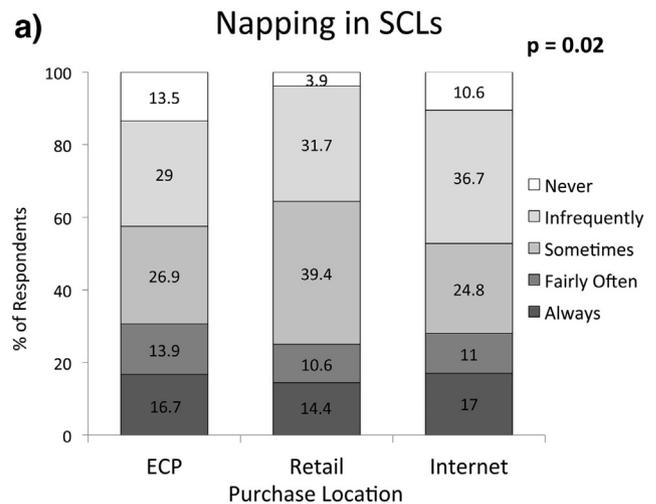
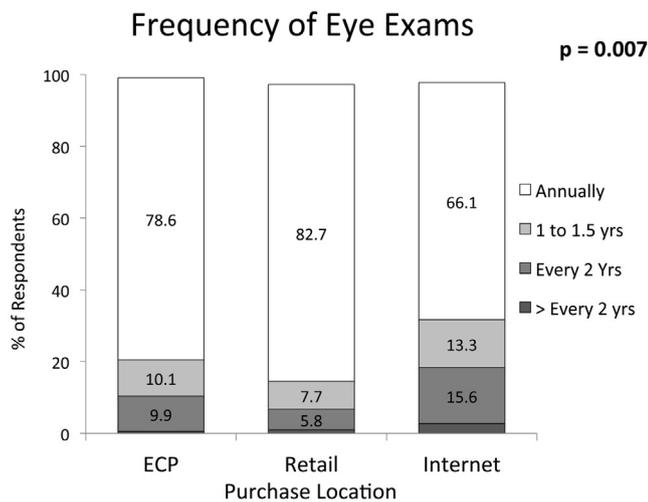
were analyzed. Statistical analysis was performed using SAS (version 9.3)

**3. Results**

The demographics of the SCL wearers from the online convenience sample are shown in Table 1, where gender is the only factor that differed by purchase location. More males bought lenses in Retail settings away from where they received their eye exam (27.9% Retail, 16.6% ECP and 18.4% Internet, p = 0.02). Wearers who bought their lenses on the internet were also significantly more likely to wear hydrogel lenses (not silicone hydrogel) compared to the other groups (Table 1, p = 0.0034).

**4. Factors that differed by purchase location**

The frequency of eye exams is shown in Fig. 1. Only 66.1% of the wearers who purchased on the internet reported annual eye exams, while the proportions among the other groups were significantly higher (p = 0.007). In a separate question, subjects were asked to cite aspects of non-compliance that they were likely to practice and 28.4% of the internet purchasers said they did not



**Fig. 1.** Frequency of eye exams by location of lens purchase. ECP n = 646, Retail n = 104, Internet n = 218. Colors shown in legend, darker colors show lower frequency of eye exams. (Label not shown, eye exams less often than every 2 years were reported by 0.5% of wearers who purchased from the ECP, 1.0% of Retail purchasers and 2.8% of Internet/telephone buyers.)

**Fig. 2.** (a) Frequency of napping while wearing SCLs by location of lens purchase. ECP n = 646, Retail n = 104, Internet n = 218. Colors shown in legend, darker colors show higher frequency. (b) Frequency of overnight wear of SCLs by location of lens purchase. ECP n = 646, Retail n = 104, Internet n = 218. Colors shown in legend, darker colors show higher frequency.

go to the eye doctor at least once per year, while only 17.8% of the ECP purchasers and 16.8% of the retail purchasers reported that behavior ( $p=0.0003$ ).

Napping was reported significantly more often by wearers who bought their lenses at retail locations, as shown in Fig. 2a ( $p=0.02$ ), although there was no difference in the frequency of overnight wear by purchase location with about half reporting some overnight wear (Fig. 2b,  $p=0.56$ ).

## 5. Replacement frequency

The groups were similar in the manufacturer's recommended replacement frequency of their lenses (Fig. 3a,  $p=0.43$ ), their actual reported replacement frequency ( $p=0.72$ , data not shown) and in their reported compliance with the manufacturer's recommended replacement frequency, which ranged from 51 to 55% across the groups (Fig. 3b,  $p=0.56$ ).

## 6. Other known or potential risk factors for SCL inflammation and infection

There were no differences between groups for a number of behaviors that are proven risk factors for SCL inflammation and

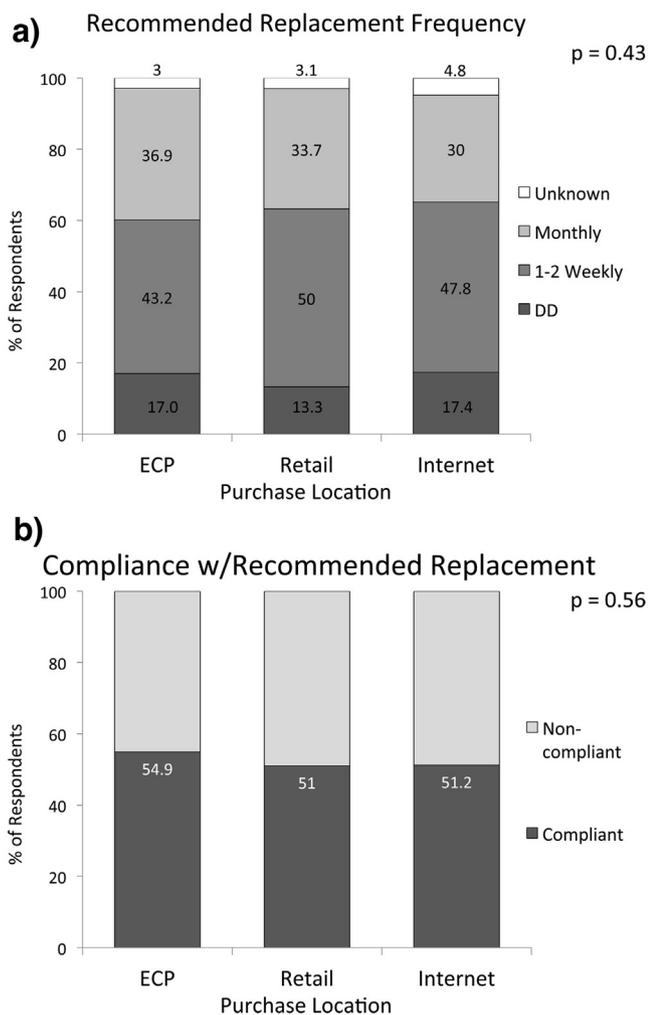
infections. For example, Table 2 shows the similarity across groups in known risk behaviors; frequency of discarding all remaining disinfection solution in the lens case ( $p=0.67$ ), frequency of "topping off" ( $p=0.12$ ), wearing SCLs in water other than while showering ( $p=0.67$ ), rinsing ( $p=0.59$ ) or storing ( $p=0.91$ ) SCLs in tap water. Tables 3 and 4 show SCL wearing patterns, hand washing and questions about SCL storage cases that have potential to affect SCL complications, but are not known risk factors. Wearers who purchased at the ECP were most likely to pay with some form of insurance to cover their SCLs ( $p<0.0001$ ), which was the only difference in wear patterns overall (Table 3). There were no differences in the degrees of non-compliance with hand washing instruction across groups and but results show that use of soap does not always accompany hand washing (Table 4). In all groups, there were also many fewer wearers who washed hands upon lens removal, with or without soap, compared to the proportions who did so as they applied their lenses. There were some differences across groups in terms of their proper handling of the lens storage case, but over 40% of wearers in all groups were using tap water to rinse their lens case.

## 7. Discussion

The CLRS survey was designed to systematically capture behaviors and lens wearing patterns that may put young SCL wearers at risk for inflammatory or infectious complications and to measure factors that related to non-compliance [10]. In 2014, the CLAY study group collaborated with epidemiologists from the Centers for Disease Control and Prevention to add questions that would assess knowledge of and attitudes toward SCL hygiene habits [11]. In this first online fielding of the adapted CLRS survey to contact lens wearers across a broad age range, we found a pattern of extensive non-compliance with instructions for proper wear and care of SCLs, similar to reports from many earlier studies [4,6,10]. The novel findings of this current analysis revealed very few significant differences in risk behaviors related to inflammatory and infectious SCL-related complications between groups that bought their SCL supply from their ECP, from a retail outlet or from the internet or telephone. Apparently, closer access to the ECP who prescribed their SCLs did not improve wear and care habits among wearers who bought lenses directly from the ECP. This new information is clinically relevant to ECPs who in many instances control the amount of training or retraining that is offered to SCL wearers as they are fit or periodically refit with SCLs.

Different frequency of eye exams was the most important distinction between groups, where internet or telephone purchasers had significantly longer time between eye exams. Only 66% of internet purchasers reported receiving annual eye exams compared to 79% of those who bought at their ECP and 83% of wearers who purchased lenses at a retail outlet other than where they got their eyes examined ( $p=0.0007$ ). This finding is in agreement with a study from Wu et al. in which younger SCL wearers who purchased on the internet were 3.8 times more likely to forget their aftercare schedule than those who purchased contact lenses from the optometrists (95% CI = 1.2–12.2,  $p=0.024$ ) [6]. The internet purchase seems to weaken the relationship between the patient and their ECP.

Although it would have been desirable due to the varying periods between eye exams between groups, this study could not assess the validity of any wearer's CL prescription. In the United States, with internet/telephone purchase, there is a possibility that consumers could order their contact lenses without a valid prescription through "passive verification" [17]. In 2003, the United States enacted the Fairness to Contact Lens Consumers Act that requires the prescriber to release a written finalized prescription to the patient [18]. The remote seller must obtain



**Fig. 3.** (a) Recommended manufacturers' lens replacement frequency by location of lens purchase. ECP  $n=646$ , Retail  $n=104$ , Internet  $n=218$ . Colors shown in legend, darker colors show higher frequency of replacement. (b) Compliance to manufacturers' lens replacement frequency by location of lens purchase. ECP  $n=646$ , Retail  $n=104$ , Internet  $n=218$ .

**Table 2**  
Behaviors proven as risk factors for development of inflammatory events by contact lens purchase location.

Question	Response	ECP	Other Retail	Internet	p-value
Handling Disinfection Solution in Lens Case Discard Leftover Solution n = 874 <sup>a</sup>	<b>Always</b>	<b>392 (67.8)</b>	<b>70 (70.7)</b>	<b>145 (73.6)</b>	0.67
	Fairly Often	113 (19.6)	16 (16.2)	29 (14.7)	
	Sometimes	49 (8.5)	10 (10.1)	17 (8.6)	
	Infrequently	17 (2.9)	2 (2.0)	6 (3.0)	
	Never	7 (1.2)	1 (1.0)	0	
ToppingOff Solution in Case N = 874 <sup>a</sup>	Always	135 (23.4)	13 (13.1)	35 (17.8)	0.12
	Fairly Often	87 (15.1)	12 (12.1)	22 (11.2)	
	Sometimes	60 (10.4)	14 (14.1)	21 (10.7)	
	Infrequently	48 (8.3)	8 (8.1)	23 (11.7)	
	<b>Never</b>	<b>248 (42.9)</b>	<b>52 (52.5)</b>	<b>96 (48.7)</b>	
Exposures to Tap Water Wear CLs in Water (other than shower) n = 968	Daily	19 (2.9)	2 (1.9)	11 (5.1)	0.67
	Weekly	43 (6.7)	8 (7.7)	13 (6.0)	
	Monthly	49 (7.6)	11 (10.6)	14 (6.4)	
	Less than Monthly	295 (45.7)	46 (44.2)	92 (42.2)	
	<b>Never</b>	<b>240 (37.2)</b>	<b>37 (35.6)</b>	<b>88 (40.4)</b>	
Rinse CLs in Tap Water w/removal n = 967	Always	43 (6.7)	5 (4.8)	17 (7.8)	0.59
	Fairly Often	18 (2.8)	6 (5.8)	8 (3.7)	
	Sometimes	40 (6.2)	5 (4.8)	10 (4.6)	
	Infrequently	97 (15.0)	21 (20.2)	31 (14.2)	
	<b>Never</b>	<b>447 (69.3)</b>	<b>67 (64.4)</b>	<b>152 (69.7)</b>	
Store CLs in Tap Water n = 874 <sup>a</sup>	Always	8 (1.4)	1 (1.0)	2 (1.0)	0.91
	Fairly Often	8 (1.4)	1 (1.0)	2 (1.0)	
	Sometimes	6 (1.0)	2 (2.0)	3 (1.5)	
	Infrequently	72 (12.5)	12 (12.1)	17 (8.6)	
	<b>Never</b>	<b>484 (83.7)</b>	<b>83 (83.8)</b>	<b>173 (87.8)</b>	

<sup>a</sup> Subjects who reported that they do not use a contact lens case have been removed.

or verify the SCL prescription prior to dispensing the lenses. Passive verification happens when the patient provides the information to the seller prior to verification of a valid prescription and if the ECP does not respond within a specified period of time, the dispenser may fill the prescription. This passive verification process allows for expired or improper SCL prescriptions to be filled and provides a mechanism for delaying the eye exam while maintaining a supply of SCLs. It is likely that other countries have some gap in their regulations that allow for expired prescriptions to be filled by remote sources.

In most US states, the SCL prescription should be updated annually in conjunction with a comprehensive eye exam. This exam provides an opportunity for reinforcement of optimal wear

and care practices, refitting to new contact lens materials as the patient's need dictates and as new contact lens designs become available, and ensuring that there are no underlying vision-threatening conditions. Especially for this sample of more mature SCL wearers, with an average age in the mid 40s, lengthening the time between eye exams could have a permanent deleterious effect on general eye health well beyond the success of their SCL use. Comprehensive eye exams include screening for glaucoma and other rare irreversible changes in eye health, many of which begin to occur in later middle age. For example, a recent meta-analysis found that primary open angle glaucoma alone doubles with every decade of life and increases among people of different races at different rates (Hispanics increase 2.3 times per decade and whites

**Table 3**  
Contact lens wear patterns, spectacles and vision insurance by contact lens purchase location.

Question	Response	ECP N = 646 (%)	Other Retail N = 104 (%)	Internet N = 218 (%)	p-value
Days/week SCL wear n = 968	<1/week	27 (4.2)	2 (1.9)	6 (2.8)	0.64
	1–3 days/week	99 (15.3)	16 (15.4)	30 (28.0)	
	4–6 days/week	146 (22.6)	25 (24.0)	61 (33.8)	
	Every day	374 (57.9)	61 (58.7)	121 (55.5)	
Wear CLs > 18 h/day n = 968	Almost Always	91 (14.1)	12 (11.5)	31 (14.2)	0.77
	Fairly Often	100 (15.5)	11 (10.6)	33 (15.1)	
	Sometimes	137 (21.2)	29 (27.9)	46 (21.1)	
	Infrequently	235 (36.4)	42 (27.9)	81 (37.2)	
	Never	82 (12.7)	10 (9.6)	27 (12.4)	
Own spectacles with good Rx? n = 968	No	108 (16.7)	13 (12.5)	29 (13.3)	0.43
	Yes, see clearly	476 (73.7)	84 (80.8)	171 (78.4)	
	Yes, vision blurry	62 (9.6)	7 (6.7)	18 (8.3)	
Who pays for CLs n = 968	Self	378 (58.5)	72 (69.2)	171 (78.4)	<0.0001
	Self + Insurance	167 (25.9)	20 (19.2)	32 (14.7)	
	Insurance	84 (13.0)	10 (9.6)	10 (4.6)	
	Someone Else	17 (2.6)	2 (1.9)	5 (2.3)	

**Table 4**  
Hand-washing and lens storage case care by contact lens purchase location.

Question	Response	ECP N = 646	Other Retail N = 104	Internet N = 218	p-value
Hand Washing					
Wash hands before lens insertion n = 967	Always	432 (67.0)	71 (68.3)	161 (73.9)	0.32
	Fairly Often	134 (20.8)	25 (24.0)	43 (19.7)	
	Sometimes	52 (8.1)	5 (4.8)	8 (3.7)	
	Infrequently/Never	27 (4.4)	3 (2.9)	6 (2.8)	
Use soap with lens insertion n = 960 <sup>a</sup>	Always	403 (63.1)	62 (59.6)	150 (69.2)	0.49
	Fairly Often	135 (21.1)	26 (25.0)	42 (19.4)	
	Sometimes	64 (10.0)	9 (8.7)	18 (8.3)	
	Infrequently/Never	37 (5.8)	7 (6.8)	7 (3.3)	
Wash hands before lens removal n = 968	Always	303 (46.9)	46 (44.2)	109 (50.0)	0.34
	Fairly Often	147 (22.8)	32 (30.8)	48 (22.0)	
	Sometimes	106 (16.4)	16 (15.4)	38 (17.4)	
	Infrequently/Never	90 (14.0)	10 (9.6)	23 (10.6)	
Use soap w/removal n = 935 <sup>a</sup>	Always	321 (51.9)	41 (39.4)	117 (55.2)	0.08
	Fairly Often	132 (21.3)	35 (33.7)	47 (22.2)	
	Sometimes	96 (15.6)	13 (12.5)	31 (14.6)	
	Infrequently/Never	70 (11.3)	15 (14.4)	16 (8.1)	
Lens Storage Case					
Use CL Case n = 968	Yes	578 (89.5)	99 (95.2)	197 (90.4)	0.19
	No	68 (10.5)	5 (4.8)	21 (9.6)	
What do you do with your case after putting CLs in your eyes? n = 874 <sup>b</sup> (Mark all that apply)	Rinse w/water	236 (40.8)	36 (36.4)	92 (46.7)	0.56
	Rinse w/solution	147 (25.4)	22 (22.2)	55 (27.9)	0.18
	Dry with tissue/towel	55 (9.5)	14 (14.1)	17 (8.6)	0.29
	Put caps back on	269 (46.5)	37 (37.4)	70 (35.5)	<b>0.01</b>
	Air dry w/o caps	203 (35.1)	41 (41.4)	90 (45.7)	<b>0.02</b>
Replace CL case n = 874 <sup>b</sup>	>Every 3 months	103 (17.8)	20 (20.2)	39 (19.8)	0.44
	3–6 months	148 (25.6)	16 (16.2)	51 (25.9)	
	<Every 6 months	108 (18.7)	21 (21.2)	37 (18.8)	
	Damaged/lost/dirty	207 (35.8)	42 (42.4)	65 (33.0)	
	Never	12 (2.1)	0 (0)	5 (2.5)	
How important is it to you personally to replace the CL case every 3 months? n = 837 <sup>b, c</sup>	Not at all important	60 (12.2)	5 (5.1)	23 (12.2)	<b>0.02</b>
	2	77 (14.0)	22 (22.5)	19 (10.1)	
	3	125 (22.7)	20 (20.4)	34 (18.1)	
	4	104 (18.9)	23 (23.5)	53 (28.2)	
	5 Very important	185 (33.6)	28 (28.6)	59 (31.4)	
How important is it to replace the CL case every 3 months to prevent infection? n = 837 <sup>b, c</sup>	1 Not at all important	38 (6.9)	2 (2.0)	13 (6.9)	0.08
	2	36 (6.5)	13 (13.3)	14 (7.5)	
	3	113 (21.4)	21 (21.4)	26 (13.8)	
	4	128 (23.2)	23 (23.5)	55 (29.3)	
	5 Very important	236 (42.8)	39 (39.8)	80 (42.6)	

<sup>a</sup> Excludes subjects who reported “never” washing hands on insertion or removal.

<sup>b</sup> Subjects who reported that they do not use a contact lens case have been removed.

<sup>c</sup> 37 subjects are missing a response to this question.

2.0 times per decade) [19]. Although these studies on health risk from delayed eye exams have been conducted in North America, the health risk to SCL wearers is a relevant issue regardless of the country where the SCL care is received.

In order to encourage safe sourcing of supplies online, the US Food and Drug Administration (FDA) has specific guidance available for consumers ordering drugs and medical devices from an on-line pharmacy. These include ordering from sites that require a valid prescription, employ a licensed pharmacist or appropriate professional to answer questions, and have a physical address in the United States with a phone number. The FDA also advises consumers to beware of cure-all claims, ask the seller whether the FDA has approved this product for sale in the US, and discuss with their health professional any devices they have found on the internet prior to purchase [20–22]. Other countries, including the United Kingdom, Australia, and Canada, have disseminated similar recommendations [23–25]. This study cannot

predict whether the similarities in habits between wearers who purchased from their ECP or elsewhere would replicate if the research were conducted in other countries.

Against this backdrop of regulation in the US, 22.5% of the respondents to this survey reported internet purchase of their SCLs. This is a higher proportion relative to other recent studies, especially considering the older age of our participants, who we assume would not be “early adopters” of alternate purchase sources. For example, a multi-country survey conducted in 2012 through ECP practices found the rate of internet purchase to range from 2 to 14% across countries, with 7% in the United States [4]. In that same survey the proportion of wearers who purchased SCLs from an optical store ranged from 5% to 8%, with the US figures at 6%. The prevalence for internet purchase from that study is 1/3 the proportion in the current study in which participants were contacted independent of their ECP office through an online study. It is also possible that internet purchase has become a more

mainstream behavior that is practiced more widely even among older SCL wearers. Also, the online recruitment of this sample may present an inherent oversampling of those SCL wearers who are comfortable purchasing on the internet or telephone. A recent business report suggests that 1 in 5 baby boomers (adults born between 1946 and 1964) have a smart phone, that over 50% of men and women made a purchase on the internet in 2013, and that older boomers had the same online purchase prevalence as younger boomers [26].

The higher proportion of hydrogel SCLs purchased on the Internet or telephone in this study may be related to the longer interval between exams and therefore fewer opportunities to be refit with new products, since the United States' current prescribing patterns favor silicone hydrogel lenses [27]. Alternatively, the wearer who purchases on the internet may be more price sensitive and therefore reluctant to pay for the professional services related to refitting or for the newer and often more expensive lens materials. They may also be more time sensitive and may find the time related to refitting burdensome, as described by Fogel [5].

Even though this sample had a relatively small proportion ( $n = 176$  or 18%) of male participants, they were significantly more likely to purchase from Retail settings away from the ECP (28% males in Retail purchase group vs 17% and 18% in other groups,  $p = 0.02$ ). This demographic pattern has not been shown before and may represent the generally higher utilization and spending among females for medical care, thus they continue to purchase lenses from their ECP [28,29].

A 2008 study of 151 college students found that those who purchased lenses on the internet exhibited more pressure on their schedules through higher Time Pressure Scores and that they also were more lax in their adherence to FDA instructions for purchase of SCLs online [5]. The current study did not survey non-compliance to FDA rules about Internet purchase, per se. Instead we focused on behaviors and practices that have been proven to be, or have face validity as, risk factors for MK or CIEs with SCL wear. Unexpectedly, SCL wearers who purchased lenses on the internet or telephone were no more likely than wearers who purchased in person at an ECP or at a retail store to report known risk behaviors with their SCLs. Evidently, the potential access to re-training on the best habits for safe SCL use at the ECP office either did not result in re-training or the training had no impact on SCL wearers' behaviors. An earlier study by the CLAY study group found that the first year of SCL wear was protective against complications that interrupted SCL wear but the risk did not rise linearly with more years of wear [30]. It may be that training from the ECP on best practices for SCL use occurs primarily when the patient first begins to use lenses, evidenced by the fact that subsequent years of wear did not change the risk for complications.

The findings from this cross-sectional survey of SCL wearers should not be construed to indicate that there is no increased risk of complications among those who purchase SCLs on the internet, but only that their self-reported behaviors in this study are similar to wearers who purchase at their ECP or retail source. Stapleton and co-workers reported a non-significant 2.8 times increase in risk of MK in a 2005 study, though the finding was not significant most likely due to fairly low penetration of internet purchase at that time [7]. In addition, many case reports have described poor safety outcomes when SCLs are purchased through unregulated sources [1–3,31,32]. Especially worrisome is the sale of cosmetic (tinted non-prescription) contact lenses through unlicensed distributors [33,34] who are unlikely or possibly unable to provide proper guidance. Of particular concern are the presumed youth and inexperience of cosmetic lens purchasers [32] and the association of cosmetic lenses from unauthorized providers with vision-threatening conditions [31,32].

In conclusion, in this survey sample of SCL wearers in the US, purchase location had little influence on known risk factors for inflammatory complications with SCLs; frequency of overnight wear, improper lens replacement schedule, or exposures to tap water. The time between eye exams was significantly longer for SCL wearers who purchased SCLs on the internet or telephone, but that remote purchase pattern did not result in significantly more "risky" patterns of SCL use.

## Acknowledgments

We acknowledge the substantial collaboration with staff from the Centers for Disease Control and Prevention; Jennifer R. Cope MD, MPH, Sarah A. Collier MPH, Amanda K. MacGurn, MPH, Maya M. Rao, MPH, Michael J. Beach, PhD, Jonathan S. Yoder, MPH, MSW. This study was partially supported via a grant from the Contact Lens Institute (CLI) to the Centers for Disease Control and Prevention. The CLRS was developed from an unrestricted grant from Alcon Research, Ltd.

## References

- [1] G. Young, A.G.H. Young, C. Lakkis, Review of complications associated with contact lenses from unregulated sources of supply, *Eye Contact Lens* 40 (2014) 58–64.
- [2] S.S. Tseng, W.W. Yang, J.C. Hsiao, Bilateral corneal erosion due to retail purchase of unfitted prescription contact lenses: a case report, *Cornea* 27 (10) (2008) 1179–1181.
- [3] J.S. Lee, T.W. Hahn, S.H. Choi, H.S. Yu, J.E. Lee, Acanthamoeba keratitis related to cosmetic contact lenses, *Clin Experiment Ophthalmol.* 35 (8) (2007) 775–777.
- [4] K.A. Dumbleton, D. Richter, C.A. Woods, B.M. Aakre, A. Plowright, P.B. Morgan, L.W. Jones, A multi-country assessment of compliance with daily disposable contact lens wear, *Contact Lens Anterior Eye* 36 (2013) 304–312.
- [5] J. Fogel, C. Zidile, Contact lenses purchased over the internet place individuals potentially at risk for harmful eye care practices, *Optometry* 79 (2008) 23–35.
- [6] Y. Wu, N. Carnt, F. Stapleton, Contact lens user profile, attitudes and level of compliance to lens care, *Contact Lens Anterior Eye* 33 (2010) 183–188.
- [7] F. Stapleton, L. Keay, K. Edwards, T. Naduvilath, J.K. Dart, G. Brian, B.A. Holden, The incidence of contact lens-related microbial keratitis in Australia, *Ophthalmology* 115 (2008) 1655–1662.
- [8] L. Sorbara, A. Zimmerman, B. Kinoshita, D. Lam, G. Mitchell, H. Wagner, K. Richdale, R. Chalmers, Contact lens assessment in youth: multi-center testing of a risk assessment survey for soft contact lens wearers with adverse events, *Optom. Vis. Sci.* 91 (2014) E-abstract 140054.
- [9] K. Richdale, H. Wagner, A. Zimmerman, B. Kinoshita, R. Chalmers, et al., Case control pilot study of soft contact lens wearers with corneal infiltrative events and healthy controls, *Invest. Ophthalmol. Vis. Sci.* 57 (2016) 47–55.
- [10] H. Wagner, K. Richdale, G.L. Mitchell, D.Y. Lam, M.E. Jansen, B.T. Kinoshita, L. Sorbara, R.L. Chalmers, the CLAY Study Group, Age, behavior, environment and health in the soft contact lens risk survey, *Optom. Vis. Sci.* 91 (2014) 252–261.
- [11] J.R. Cope, S.A. Collier, M.M. Rao, R. Chalmers, G.L. Mitchell, K. Richdale, H. Wagner, B.T. Kinoshita, D.Y. Lam, L. Sorbara, A. Zimmerman, J.S. Yoder, M.J. Beach, Contact lens wearer demographics and risk behaviors for contact lens-related eye infections—United States, 2014, *Morb. Mortal. Wkly. Rep.* 64 (2015) 865–870.
- [12] R.L. Chalmers, J. McNally, O.D. Schein, J. Katz, J. Tielsch, E. Alfonso, M. Bullimore, D. O'Day, J. Shovlin, Risk factors for corneal infiltrates with continuous wear of contact lenses, *Optom. Vis. Sci.* 84 (2007) 573–579.
- [13] R.L. Chalmers, H. Wagner, G.L. Mitchell, D.Y. Lam, B.T. Kinoshita, M.E. Jansen, K. L. Richdale, L. Sorbara, T.T. McMahon, Age and other risk factors for corneal infiltrative and inflammatory events in young soft contact lens wearers from the contact lens assessment in youth (CLAY) study, *Invest. Ophthalmol. Vis. Sci.* 52 (2011) 6690–6696.
- [14] A.B. Zimmerman, A.J. Emch, J. Geldis, G.J. Nixon, G.L. Mitchell, Contact lens corneal inflammatory events in a university population, *Optom. Vis. Sci.* 93 (2016) 42–49.
- [15] R.L. Chalmers, L. Keay, J. McNally, J. Kern, Multicenter case-control study of the role of lens materials and care products on the development of corneal infiltrates, *Optom. Vis. Sci.* 89 (2012) 316–325.
- [16] D.V. Seal, C.M. Kirkness, H.G. Bennett, M. Peterson, Keratitis Study Group, Acanthamoeba keratitis in Scotland: risk factors for contact lens wearers, *Contact Lens Anterior Eye* 22 (1999) 58–68.
- [17] Park Slope Eye (2010). The 1800CONTACTS Game. Retrieved July 21, 2015, from <https://parkslopeeye.wordpress.com/2010/02/11/the-1800-contacts-game/>.
- [18] Federal Trade Commission, (2005). Complying with the contact lens rule. Retrieved July 21, 2005, from <https://http://www.ftc.gov/tips-advice/business-center/guidance/complying-contact-lens-rule> (accessed 02.11.15).
- [19] V.V. Kapetanakis, M.P. Chan, P.J. Foster, D.G. Cook, C.G. Owen, A.R. Rudnicka, Global variations and time trends in the prevalence of primary open angle

- glaucoma (POAG): a systematic review and meta-analysis, *Br. J. Ophthalmol.* 100 (2016) 86–93.
- [20] United States Food and Drug Administration, (2015) Buying Medical Devices and Diagnostic Tests Online from <http://www.fda.gov/medicaldevices/resourcesforyou/consumers/buyingmedicaldevicesanddiagnostictestsonline/default.htm>.
- [21] U.S. Food and Drug Administration Combating Counterfeit Drugs: A report of the Food and Drug Administration February 2004. [http://www.fda.gov/oc/initiatives/counterfeit/report02\\_04.html](http://www.fda.gov/oc/initiatives/counterfeit/report02_04.html) (accessed 15.12.15).
- [22] United States Food and Drug Administration, (2015). Know Your Online Pharmacy. <http://www.fda.gov/Drugs/ResourcesForYou/Consumers/BuyingUsingMedicineSafely/BuyingMedicinesOvertheInternet/BeSafeRxKnowYourOnlinePharmacy/ucm318487.htm>.
- [23] Health Canada Buying medical devices on the internet. [http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/med/med\\_mat-eng.php](http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/med/med_mat-eng.php).
- [24] Australian Government Department of Health, Buying medicines and medical devices over the internet. <https://www.tga.gov.au/community-qa/buying-medicines-and-medical-devices-over-internet>.
- [25] Medicines and Healthcare products Regulatory Agency (MHRA), Medicines & Medical Device Regulation: What You Need to Know. <http://www.mhra.gov.uk/home/groups/comms-ic/documents/websiteresources/con2031677.pdf>.
- [26] <http://www.businessinsider.com/the-surprising-demographics-of-who-shops-online-and-on-mobile-2014-6> (accessed 08.12.15).
- [27] P.B. Morgan, C.A. Woods, I.A. Trannoudis, International contact lens prescribing in 2014, *Contact Lens Spectr.* (January 1) (2015) accessed online 07.07.16.
- [28] K.D. Bertakis, R. Azari, L.J. Helms, E.J. Callahan, J.A. Robbins, Gender differences in the utilization of health care services, *J. Fam. Pract.* 49 (2000) 147–152.
- [29] J. Cylus, M. Hartman, B. Washington, K. Andrews, A. Catlin, Pronounced Gender And Age Differences Are Evident In Personal Health Care Spending Per Person <http://content.healthaffairs.org/content/early/2010/12/07/hlthaff.2010.0216> (accessed 12.08.15).
- [30] H. Wagner, R. Chalmers, G.L. Mitchell, M.E. Jansen, B.T. Kinoshita, D.Y. Lam, T.T. McMahon, L. Sorbara, CLAY Study Group, Risk factors for interruption to soft contact lens wear in youth, *Optom. Vis. Sci.* 88 (2011) (2011) 973–980.
- [31] T.L. Steinemann, M. Fletcher, A.E. Bonny, R.A. Harvey, D. Hamlin, P. Zloty, M. Besson, K. Walter, M. Gagnon, Over-the-counter decorative contact lenses: cosmetic or medical devices? A case series, *Eye Contact Lens* 31 (2005) 194–200.
- [32] T.L. Steinemann, U. Pinninti, L.B. Szczotka, R.A. Eiferman, F.W. Price Jr., Ocular complications associated with the use of cosmetic contact lenses from unlicensed vendors, *Eye Contact Lens.* 29 (2003) 196–200.
- [33] Federal Trade Commission, (2006). FTC alleges illegal internet sales of contact lenses. Retrieved July 21, 2015, from <https://http://www.ftc.gov/news-events/press-releases/2006/08/ftc-alleges-illegal-internet-sales-contact-lenses>.
- [34] Federal Trade Commission, (2011). FTC requires three internet marketers to stop selling Circle cosmetic contact lenses without prescriptions as part of settlement. Retrieved July 21, 2105, from <https://http://www.ftc.gov/news-events/press-releases/2011/11/ftc-requires-three-internet-marketers-stop-selling-circle>.