Factors Influencing on Dry Eye Symptoms of University Students Using Smartphone

Jung-hyun Choi¹, Kyung-sook Kim¹, Hee-jeong Kim¹, Se-jin Joo¹ and Hye-gyeong Cha¹

¹Department of Nursing, Namseoul University, Cheonan, 31020, South Korea

Abstract

This study is a descriptive study to investigate relevance of dry eye symptoms and physical symptoms of university students using smartphones and to identify the factors affecting dry eye symptoms. We collected data from university students in C province of Korea on March 3-29, 2016. They responded questionnaires of general characteristics, physical symptoms, and eye dry symptoms. 315 questionnaires were collected and 310 questionnaires were analyzed except for the incomplete one. Data were analyzed using t-test, one-way ANOVA, Scheffe test, Descriptive analysis, Pearson’s correlation coefficients, and multiple regression analysis. The participants’ dry eye symptoms according to general characteristics showed statistically significant differences in gender (t=-3.306, p=.001), whether to wear contact lenses (t=-3.386, p=.001), smartphone use time (F=5.133, p=.002), and computer use time (F=5.137, p=.002). We were found that 68 (21.9%) were normal, 80 (25.8%) were mild, 58 (18.7%) were moderate and 104 (33.5%) were severe, and that 78.1% of 310 students had dry eye. And OSDI (Ocular Surface Disease Index) showed a significant correlation with turtle neck syndrome (r=.343, p<.001), wrist tunnel syndrome(r=.252, p<.001), and eye fatigue(r=.681, p<.001), and OSDI was significantly affected by eye fatigue (β=.668, t=16.042, p<.001),
and computer use time ($\beta=.111$, $t=2.656$, $p=.008$), these variables explained 47.2% of OSDI among university students. It is necessary a program that will reduce the unnecessary computer use time and make the students interested in the importance of proper use of smartphone to reduce eye fatigue.

**Key Words**: Dry eye symptoms, OSDI, Turtle neck symptoms, Wrist tunnel symptoms, Eye fatigue

1 **INTRODUCTION**

In 2007, Dry Eye Workshop defined Dry Eye as a multifactorial disease of the tears and ocular surface that results in symptoms of discomfort, visual disturbance, and tear film instability with potential damage to the ocular surface. It is accompanied by increased osmolarity of the tear film and inflammation of the ocular surface (Foulks et al., 2007).

According to the Health Insurance Review and Assessment Service statistics (Health Policy Insurance Service, Disease Statistics, 2005-2015), the number of patients treated with dry eye symptoms has steadily increased from 1.4 million to 2.4 million for the last 10 years (2005~2015).

Dry eye symptom is one of the most common ophthalmic diseases in clinical practice, and its symptoms are reported to include a foreign body feeling like sand in the eye, stiffness, blurred object, easily tired eye, burning, heavy eyelid, irregular eye congestion, and sticky eye mucus, etc. (Stern and Pflugfelder, 2004). In addition, although left untreated despite severe symptoms, it is reported that it causes corneal damage and severely impairs visual acuity (Her and Kim, 2014), and is associated with attention deficit hyperactivity disorder, sleep disorder, and depression (Cho et al., 2015).

The causes of dry eye symptoms are indoor environmental pollution (Kim et al., 2011), air pollution (Hwang et al., 2016), contact lens wear and myopia correction (Beth, 2007), long smartphone use, TV, computer and reading (Park et al., 2014), specific agents (antihistamines, antidepressants, antiarrhythmics, hormones, anti-Parkinson’s drugs, etc.) or using artificial tears (Chia et al., 2003).

With the increasing use of computers and mobile-phones and
the Internet, as young adults have become more active in using documents, lectures, games, and Internet searches, previously, dry eye symptoms, which are common in older adults, are increasingly occurring in young adults (Yun et al., 2012).

As a result of studying domestic and foreign previous researches, there were many studies on cases of occurrence of dry eye symptoms, but studies to analyze the influence factors to prevent dry eye symptoms were rare. In particular, the use of smartphones and computers, which have recently become widely available, can lead to various physical symptoms (Lee et al., 2013, Yun et al., 2011) as well as dry eye symptoms.

This study attempted to investigate the relationship between dry eye symptoms and physical symptoms, and factors affecting dry eye symptoms in young university students, and to use it as basic data to prevent the dry eye symptoms and physical symptoms of university students.

2 MATERIALS AND METHODS

A. Research Design

This study is a descriptive study to investigate relevance of dry eye symptoms and physical symptoms that are rapidly increasing in university students using smartphones and to identify the factors affecting dry eye symptoms.

B. Data Collection

The participants for this paper were university students in C Province of Korea, and the survey was conducted in 2016. 315 university students participated in the survey after informed consent. The required sample size was estimated by G*power 3.1.2 Program. The minimum required sample size was 138 with significance level ($\alpha$) 0.05, power of test $(1-\beta)$ 0.95, effect size (p) 0.3, and the number of predictors 5. In considering the dropout rate, out of a total of 315 questionnaires collected, and except for the 5 questionnaire that had missing values and were responded improperly, a total of 310 questionnaires were used for the data analysis of this study.
C. Measurements

The questionnaire consisted of research participants' general characteristics, risk factors, physical symptoms, and dry eye symptoms. The general characteristics included gender, age, grade, smoking, drinking, and caffeine intake, the risk factors included contact lens wear, sleep time, smartphone use time, computer use time, reading time, and the physical symptoms included turtle neck, carpal tunnel, and eye fatigue self-test. The turtle neck subjective symptom had a total of 14 items, ranging from 0 to 31 points, at a scale of 1 to 4 points. And 0 point is a healthy condition without problems, 1-5 points is attention, 6-9 points is warning, and 10 or more points is the risk of turtle neck syndrome. The subjective symptoms of the carpal tunnel were total 5 items, with 1 point in yes and 0 point in no, and if the total score was 4 points or more, it was measured as the carpal tunnel syndrome risk group. Eye fatigue subjective symptoms were measured on a total of 10 items, ranging from 1 point to 3 points, with 10-15 points being normal, 16-20 points being warning, and 21-30 points being ophthalmic.

Dry eye symptoms were measured using the Ocular Surface Disease Index (OSDI) developed by (Schiffman et al., 2000). The OSDI scores were calculated as follows with the 4 point scale of 12 items related to the perceived symptoms of the subjects on the eyeball surface, from 0 point for 'not at all' to 4 points for 'always.'

\[
\text{OSDI score} = \frac{\text{total score of items answered} \times 25}{\text{number of items answered}}
\]

The OSDI score ranged from 0 to 100, with higher scores indicating severer dry eye symptoms. According to the OSDI score, 0-12 points were classified as normal, 13-22 as mild dry eye, 23-32 as moderate dry eye, and 33-100 as severe dry eye. Reliability was Cronbach’s $\alpha=.92$ at the study of 14, and reliability in this study was Cronbach’s $\alpha=.89$.

D. Data Analysis

This study used SPSS Win 22.0 for statistical analysis of the data, and conducted descriptive statistics for the general characteristics, physical symptoms, OSDI. For difference analysis of vari-
ables, we used t-test, one-way ANOVA, and analyzed the relation between variables with Pearson correlation coefficients. We used a stepwise multiple regressions for finding affecting factors of dry eye syndrome.

E. Ethical Consideration

Prior to data collection, this study considered the ethical aspects by providing participants with the purpose and method of research, utilization of research results, survey data to be used only for the study purpose, anonymity and confidentiality of research participants, and a description of stopping during the creation of the questionnaire, and by receiving the consent from participants. It took 10 to 15 minutes to complete the survey questionnaire items, and after the questionnaire items were fulfilled, a predetermined gift was provided for participants.

F. Limitations

This study was constricted by convenience sampling, which limited generalization to a broad population.

3 RESULTS AND DISCUSSION

A. Dry Eye Syndrome according to general Characteristics

The Dry Eye Symptoms according to general characteristics of the participants are shown Table 1.

<table>
<thead>
<tr>
<th>Variables*</th>
<th>Categories</th>
<th>n(%)</th>
<th>M±SD</th>
<th>OSDI M±SD</th>
<th>t(p) F(p)/ scheffe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male♂</td>
<td>83(26.8)</td>
<td>21.44±18.31</td>
<td>29.37±18.85</td>
<td>3.306(0.01)* a=b</td>
</tr>
<tr>
<td></td>
<td>Female♀</td>
<td>227(73.2)</td>
<td>25.94±19.26</td>
<td>29.71±18.44</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>Average</td>
<td>20.82±5.66</td>
<td>25.94±19.26</td>
<td>25.44±19.19</td>
<td>0.993(0.396)</td>
</tr>
<tr>
<td></td>
<td>18-19</td>
<td>131(42.3)</td>
<td>25.91±19.26</td>
<td>29.71±18.44</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20-21</td>
<td>110(35.5)</td>
<td>25.44±19.19</td>
<td>27.08±20.06</td>
<td></td>
</tr>
<tr>
<td></td>
<td>22-23</td>
<td>52(16.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥24</td>
<td>17(5.5)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Of the participants, 83 students (26.8%) were male and 227 students (73.2%) were female, and there was a significant difference between the two groups ($t=0.993$, $p=.001$). That is, the mean score of dry eye symptoms was higher in women than in men, which is consistent with the results of previous studies (Yun et al., 2012, Lee et al., 2002). This suggests that women prefer to use contact lenses rather than eyeglasses and that they are affected by frequent eye makeup and hormones. The average age of them was 20.82 years, 111 students (35.8%) were freshmen, 69 (22.3%) were sophomores,
72 (23.2%) were juniors, and 58 (18.7%) were seniors. There was no significant difference in dry eye symptoms between the ages and the grades, and there was no significant difference in smoking, drinking and caffeine use. However, there was a significant difference in wearing contact lenses. The average wearing time was 31.62 ± 18.45 in 125 patients (40.3%), and 185 patients (59.7%) in non-wearing contact lenses were found to be mean 24.29 ± 18.85. This was consistent with the results of previous studies (Yun et al., 2012, Begley et al., 2001, Guillon and Maissa, 2005) in which dry eye symptoms are more severe and more frequent when wearing contact lenses. This may be due to the increase in the number of people wearing color contact lenses for cosmetic purposes as well as the recent correction of eyesight, resulting in a higher rate of dry eye symptoms in the younger age group.

Sleep time and reading time did not differ among groups, but smartphone use time and computer use time differed by group. In other words, the dry eye symptom score in the group using more than 3 hours was higher than the group using less than 3 hours in the smartphone use time (t=5.133, p=.002), and the group using the computer for more than 3 hours had a higher dry eye symptom score than the group using less than 3 hours (t=5.137, p=.002). Excessive use of video devices such as computers and smartphones can cause visual display terminal (VDT) syndrome. That is, while using these, the number of flicker is reduced, and the evaporation of the tears occurs well, which can lead to symptoms such as conjunctival hyperemia, foreign body sensation, tearing, headache, dry eye, etc. (Cho et al., 1996). In a study of 3549 white-collar office workers in Japan (Uchino et al., 2008), long-term use of VDT for more than 4 hours was reported to increase the risk of dry eye symptoms, but in this study, dry eye symptoms were significantly different in the group using computer and smartphone for more than 3 hours. Therefore, the education program for the prevention of VDT syndrome of university students should include recommendations to decrease the use of video equipment such as computer and smartphone to less than 3 hours.

B. The distribution of Ocular Surface Disease Index (OSDI) score

In a study (Yun et al., 2012) to investigate the prevalence of dry
eye for a total of 263 university students, it is reported that dry eye was seen in 133 students (50.5%) as shown in figure 1. However, in this study, it was found that 68 (21.9%) were normal, 80 (25.8%) were mild, 58 (18.7%) were moderate and 104 (33.5%) were severe, and that 78.1% of 310 students had dry eye, which is higher than the previous studies. This is a result reflecting the tendency that the dry eye is increasing in the younger age group, though there is a difference between the subjects and the time of the investigation, and follow-up research is required.

![OSDI score bar chart](image)

Fig. 1. The distribution of Ocular Surface Disease Index (OSDI) score

**C. OSDI According to Physical symptoms of Participants**

Table 2 shows the correlations between dry eye symptoms and physical symptoms appearing in the participants. That is, There was a positive correlation in OSDI and turtle neck symptoms (r=.343, p<.001), carpal tunnel syndrome (r=.252, p<.001), and eye fatigue (r=.681, p<.001). Visual Display Terminal (VDT) syndrome is a typical problem that can arise when the use of smartphone by university students increases due to popularization of smartphone. The most common symptoms of VDT syndrome are eye diseases and musculoskeletal disorders. In a study on university students’ smartphone addiction and health problems (Yun et al., 2011), university students who used smartphones for a long time reported that
the eye fatigue was 31%, the wrist and finger pain was 15%, and neck and shoulder stiffness were 15%. When staring at the same screen such as smartphone for a long time, it reduces the blink of the eye, and due to bad posture, as well as dry eye symptoms, eye fatigue, turtle neck, and carpal tunnel symptoms can appear. Also, since university students are at the highest level of physical health during the life cycle, it would be easy to overlook the awareness or risk of their physical symptoms. Therefore, to reduce the dry eye symptoms of university students, it is necessary to incessantly remind them about the correct posture and usage of the smartphone. Dry eye symptoms were significantly correlated with eye fatigue, carpal tunnel symptoms, and turtle neck symptoms. Therefore, it is necessary to introduce education program to manage these physical symptoms as well as dry eye symptoms.

### D. Factors Influencing on Organ Donation Attitude of University Students

Table 3 shows the participants’ dry eye symptoms was affected significantly by eye fatigue ($\beta=.668$, $t=16.042$, $p<.001$), and computer use time ($\beta=.111$, $t=2.656$, $p=.008$), and these variables explained 47.2% ($F=139.210$, $p<.001$).
Prolonged use of the smartphone as well as the computer has been shown to be the most important factor affecting eye fatigue and affecting dry eye symptoms. Therefore, to prevent dry eye symptoms that may occur when using a smartphone, university students need to improve their posture and computer habits to reduce eye fatigue. In other words, it is necessary to keep the distance between the smartphone and the eyes at about 40cm and avoid using it continuously for more than 30 minutes to prevent eye fatigue. It is also necessary to reduce unnecessary computer use time and to have a break time frequently when using the computer.

**4 CONCLUSION**

This study was conducted to propose a method to prevent the dry eye symptoms of university students by analyzing factors affecting rapidly increasing dry eye symptoms among college students using smartphones. The results of this study showed that dry eye symptoms was significantly higher for women, contact lens users, and those who used computer for more than 3 hours, and It was also found that they could be accompanied by dry eye symptoms as well as turtle neck symptoms, carpal tunnel symptoms, and eye fatigue. In addition, eye fatigue and computer use time were the most influential factors for dry eye symptoms. Therefore, to prevent the dry eye symptoms of university students using smartphones, it is necessary to have a program that will reduce the unnecessary computer use time and make the students interested in the importance of proper use of smartphone to reduce eye fatigue. There is a limit to generalization of this study because this study is a convenience sampling study on university students in one area of Korea.

**TABLE III**

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>S.E.</th>
<th>β</th>
<th>t</th>
<th>p</th>
<th>Adj. R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-21.117</td>
<td>3.075</td>
<td>-6.867</td>
<td>&lt;.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eye Fatigue</td>
<td>2.876</td>
<td>.179</td>
<td>.668</td>
<td>16.042</td>
<td>&lt;.001</td>
<td>.462</td>
</tr>
<tr>
<td>Computer use time</td>
<td>2.036</td>
<td>.767</td>
<td>.111</td>
<td>2.656</td>
<td>.008</td>
<td>.472</td>
</tr>
</tbody>
</table>

F=139.210, p<.001
Therefore, it is necessary to elucidate the prevalence and influencing factors of dry eye symptoms which are rapidly increasing in young ages through repeated research in future. These studies will enable university students to be more interested in and active in managing their health care in using smartphones and computers, and this study can be used as a basic data for the development of preventive programs that minimize the negative effects of long time use of smartphones and computers.

5 ACKNOWLEDGMENT

Funding for this paper was provided by Namseoul University.

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