A CROSS SECTIONAL STUDY ON CORRELATION BETWEEN TEAR QUANTITY AND QUALITY WITH SYMPTOMS OF DRY EYE

Rizky Eka Adeliani, Anggraeni Adiwardhani

Abstract—Smoking causes health problem. Exposure to cigarette smoke in the environment increases evaporation which causes hyperosmolarity and instability of tears resulting in dry eyes. Subjects and methods. The study used a cross sectional design, involving 111 Trisakti University Faculty of Economics students consisting of 56 smokers and 55 non smokers. Subject were selected by consecutive non random sampling. Data analysis used SPSS version 25.0 with Chi Square and Fisher test with significance level p<0.05. Results. Tear quantity test with Schirmer I on the smokers students shows the majority were found to be abnormal (<10mm) with symptoms of dry eye as many as 7 people (87.5%) with a value of p=0.019. In the non smoker students, it was found a majority of abnormalities (<10mm) with symptoms of dry eye as many as 5 people (100%) with a value of p=0.006, and in tear quality test results with Tear Film Break Up Time (TBUT) in smokers students found a majority of abnormalities (<10 seconds) with symptoms of dry eye as much as 100%, with a value of p=0.464. The majority of non-smokers students had normal TBUT test (>10 seconds) and asymptomatic as many as 17 people (85%) with a value of p=0.007. Conclusion. There is a relationship between the quantity of tears with symptoms of dry eye p=0.019, but there is no relationship between the quality of tears with symptoms of dry eye p=0.464.

Index Terms: Quantity of tears, quality of tears, dry eye symptoms, Tear Film Break Up Time (TBUT), Schirmer I, dry eye, smokers.

1. INTRODUCTION

Cigarettes are tobacco products, which emit nicotine, tar, and other poisonous chemical substances when burned and inhaled. [1] It is usually cylindrical between 70 to 120 mm length which varies with country and contains chopped tobacco leaves. [2] In 2013, WHO ranked Indonesia third in the world, with the highest number of smokers after China and India with a prevalence of 36.1%. [3] Based on the Global Adults Tobacco Survey (GATS) in 2015, the prevalence of daily cigarette users in male and female adults greater than 15 years was 76.2% and 3.6%, respectively. While in boys and girls between the ages of 10-14 years it was 3% and 0.39% respectively. [3] Furthermore, in 2009, the Thai National KS in Phanucharas & Chalongsu found that the average age of smokers initiation was 18 years, which was the same age as the average student. [4] The increased rate of cigarette consumption has an impact on the rise in diseases and mortality due to its tobacco content, which consists of 2,500 chemical contents and 4,800 component when burned/smoked. From this, its chemical component, tar, nicotine, CO gas, and NO are identified as endangering health. Furthermore, some residual materials such as fertilizer residues, pesticides, TSNA (tobacco-specific nitrosamine), BaP (benzo) -a-pyrene, and NTRM (non-tobacco related material) are formed during planting, processing, and serving in trade. [5]

In 2008, Physician for a Smoke-Free Canada, it was stated that the effect of each cigarette smoke content irritates the eyes. [6] This result was supported by Khalil H et al. 2016 [7] with the title "Comparative study between smokers and non-smokers regarding dry eye," which stated that there is a strong relationship between smoking and tear production with an adverse effect on the pre-corneal tear layer. However, Thomas J et al. 2012 [8] stated that there is no relationship between smoking and tear production. The main symptoms of dry-eye are dryness and grittiness in addition to burning, itching, foreign body sensation, excessive tears, pain, redness, and photophobia. This is sometimes followed by visual impairment, which worsens in low and high humidity. [9] Its diagnosis is made with a complete historical analysis, clinical symptoms, decreased Schirmer I results, and tear film breakup time (TBUT). Furthermore, some questionnaires used in its diagnosis include the Ocular Surface Disease Index (OSDI), Impact of Dry Eye on Everyday Life (IDEE), McMonnies, and Women's Health Study. However, OSDI is the most frequently used questionnaire for the diagnosis of dry eye disease when the value is above 30. [10,11] Furthermore, the yearly rise in the number of young adult smokers in Indonesia has led to an increase in health problems caused by smoking and its components. For instance, NO and CO cause dry eyes by affecting the quality and quantity of tears. Therefore, this research is aimed at examining the relationship between the quantity and quality of tears on dry eye symptoms of smokers and non-smokers students.

2. METHOD

Observational analytic was used in this study with consecutive sampling and the cross-sectional data collection sequentially using OSDI and GATS questionnaire, TBUT, Schirmer I tests as a measurement tool. It took place at PMT (Medical Centre of Trisakti University) and economics faculty of Trisakti University. Eye infection and regularly use artificial tears were excluded. The Quantity of tear production assess with Schirmer I. Without anesthetic, filter paper fluorescein was placed on the cul-de-sac of the lower eyelid, and the patient's eyes were closed for 5 minutes. The wet paper's length was assessed, and the diagnostic threshold found to be less than 10 mm. The Quality of tears was determined with TBUT test. TBUT is the time required for the tear film to break following the blink of an eye. The normal time for TBUT is greater than 10 seconds and less for dry eyes. Dry eye diagnosis is based on
symptoms that arise using the OSDI questionnaire, which is
equivalent when the value is above 30.[10,11]

3. RESULTS

This study included 111 students. The smoking behavior of 56
smoker students obtained through consecutive sampling was
assessed using questionnaires from GATS. The SPSS
version 25 was used to analyze the process with the Fisher
test and Chi-square at a significant level less than 0.05.

3. RESULTS
From the 111 students, 76 (68.5%) were men with 56 (50.5%)
smokers and 55 (49.5%) non-smokers. Furthermore, from the
56 students, 30 (53.6%) have been smoking for less than 5
years, while 36 (64.3%) consumed less than 10 cigarettes
daily. The Schirmer I test was used to examine the quantity of
tears with 98 (88.3%) of the students having normal results
(≥10 mm). Furthermore, the Tear Break Up Time (TBUT) test,
with 90 students (81.1%) was abnormal (<10 seconds). The
use of OSDI questionnaire showed that 64 students (57.7%)
had no symptoms of dry eye. The tear quantity results in
smoker students, using the Schirmer I test had the largest
percentage, which was less than 10 mm with symptoms of dry
eye on 7 (87.5%) students. The results in Table 1 show that
there is a relationship between the quantity and symptoms of
dry eye (p = 0.019).

TABLE 1

Relationship of Tear Quantity and Quality with Symptoms
of Dry Eye in Smoker Students

<table>
<thead>
<tr>
<th>Variable</th>
<th>Dry Eye Symptoms</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes (%)</td>
<td>No (%)</td>
</tr>
<tr>
<td>Tears Quantity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥10 mm</td>
<td>19 (39.6)</td>
<td>29 (59.4)</td>
</tr>
<tr>
<td>&lt;10 mm</td>
<td>7 (87.5)</td>
<td>1 (12.5)</td>
</tr>
<tr>
<td>Tears Quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥10 delik</td>
<td>1 (100)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>&lt;10 delik</td>
<td>25 (45.5)</td>
<td>30 (54.5)</td>
</tr>
</tbody>
</table>

Notes: *: Fisher Test

By using the smoking behavior questionnaire, the highest
percentage of smokers with a duration of ≤ 5 years without
symptoms was 20 people (66.7%). The results in Table 3 show
a relationship between smoking duration and symptoms of dry
eye. Approximately 61.1% smoked ≤10 cigarettes per day with
no symptoms of dry eye on 22 students. It was found that
there was no relationship between the numbers of cigarettes
consumed per day with symptoms of dry eye. (P = 0.129)

TABLE 2

Relationship of Tear Quantity and Quality with Symptoms
of Dry Eye in Non-Smoker Students

<table>
<thead>
<tr>
<th>Variable</th>
<th>Dry Eye Symptoms</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes (%)</td>
<td>No (%)</td>
</tr>
<tr>
<td>Tears Quantity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥10 mm</td>
<td>16 (32)</td>
<td>34 (68)</td>
</tr>
<tr>
<td>&lt;10 mm</td>
<td>5 (100)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Tears Quantity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥10 delik</td>
<td>3 (15)</td>
<td>17 (85)</td>
</tr>
<tr>
<td>&lt;10 delik</td>
<td>18 (51.4)</td>
<td>17 (48.6)</td>
</tr>
</tbody>
</table>

Notes: *: Fisher Test

In the tear quantity test with the Schirmer I, in non smoker
students, the largest percentage was abnormal (<10 mm) with
symptoms on 5 (100%) students. While in the quality test
using the TBUT, the largest percentage was normal (≥10
seconds) without symptoms on 17 (85%) students. The
results in Table 2 show a relationship between the quantity and
quality of tears in non-smokers, with p values of 0.006 and
0.007, respectively.

4. DISCUSSION

4.1 Effect of cigarette smoke on dry eye

Exposure of cigarette smoke released from the mouth and the
results of burning tobacco causes direct eye irritation. This is
because most of the active substances in cigarettes are
present in the air when burnt.[6] The 2010 tobacco bulletin
stated that almost all of the descriptions in it tends to irritate
the eyes.[5] The study of Thomas J et al. (2012)[8], also supports
this result, which reported that smoking causes a bad effect on
the precorneal tear layer, thereby, leading to dry eyes. Exposure
to smoke irritates the eyes, which causes
inflammation and damage to the corneal epithelial cells. This
leads to the loss of the mucous layer of tears resulting in
instability of its layer. Inflammation is the activation of innate
pathways on ocular surface cells, such as cytokines produced
by T helper (Th). Cytokines are produced by infiltrating Th
cells, thereby altering its normal balance and causing
pathological epithelium on the eye surface. In the study of Pfugfelder SC, et al., [14] changes in Th levels of cytokines were found in patients with dry eyes. It has been recognized that inflammation is a cause and also an effect of dry eye disease. Smoke particles and harmful gases in a cigarette such as nicotine and carbon monoxide also interfere with vasospasm, platelet aggregation, lead to oxidative damage to lipids, proteins, and cellular DNA. [15,16] The toxins from smoking can reduce blood flow and contribute to the formation of clots in ocular capillaries. This reduces the nutrients needed for eye cell growth and causes ocular diseases. [6] Smokers also have higher lipid peroxidation rates compared to non-smokers. Tar and cigarette smoke contain many oxidizing agents with complex chemical composition and free radicals such as aldehydes, peroxides, nitrogen oxides, peroxy radicals, and prooxidants. [17,18] Free radicals, to contribute to the disease process due to smoking. [19]

4.2 Individual characteristics, tears, and symptoms of dry eye
This research using 111 students of the Faculty of Economics at Trisakti University, with 76 men (68.5%), was conducted in line with Khalil et al [7]. The data obtained were in accordance with research conducted by Thomas J [8] using 65 smokers and 55 non-smokers. All respondents of both research, Khalil [7] and Thomas [8], had symptoms of dry eye, these data are not in line with this research due to the location of the study.

4.3 Tear quantity test results with symptoms of dry eye
Non-smokers, acquired the largest percentage using Schirmer I results with abnormal (<10mm) results. Probably this was due to environmental factors that affected the amount of tears, such as the length of time in an air-conditioned room, riding a motorcycle without helmets/protective glasses and spending long hours in front of a computer (which can reduce blinking reflex). On the other hand in smokers, the largest percentage obtained was also abnormal (<10mm) which is in accordance with the hypothesis. Statistical tests of the quantity of tears in smokers and non-smokers found p-value <0.05, which showed the influence of cigarette smoke exposure on the quantity or amount of aqueous in the tear layer. These results are in line with the study of Khalil H, et al. (2016) [7], which stated that smoking had a bad effect on the layer of precorneal tears and strong relationship between smoking and tear production. The conjunctival mucosa is the outermost layer of the eye, always exposed to the environment. However, this layer is very sensitive to chemicals released in the air from tobacco smoke. This causes redness of the conjunctiva, excessive lacrimation, and discomfort due to the stimulation of the free nerve endings in the conjunctiva. [17]

4.4 Tear quality test results with symptoms of dry eye
In smokers students, the largest percentages with TBUT were normal (≥ 10 seconds). This occurred maybe because the respondents are still young so they still have a good ability to compensate disturbed tear layers. In non-smoking students, the highest percentage with TBUT was normal (≥10 seconds) without symptoms, which is in accordance with the hypothesis. The statistical test found no relationship between tear quality and symptoms of dry eye in smokers. This was in accordance with the research of Yoon et al. [20], which found no significant difference in tear quality due to the small number of samples. However, in this study, respondents who had normal quality (≥ 10 seconds) but with symptoms of dry eye, due to driving without protection, prolonged use of the computer and prolonged air conditioner exposure. Interestingly, no symptoms were found in respondents with below normal quality (<10seconds), this maybe because respondents feel they have experienced the same symptoms often, so respondents do not feel the complaint as a symptom. In non-smokers, there was a strong correlation between tear quality and symptoms of dry eye. Smoking also causes damage to the ocular surface epithelium due to direct contact. Satici et al [21] reported that there was a higher number of squamous metaplasia in the conjunctival surface epithelium in smokers than in the control group. This was due to the increased inflammation and toxic irritation of cigarette smoke. Polymorphonuclear leukocytes and the number of squamous epithelial cells increases after exposure to cigarette smoke. Conjunctival epithelium damage can cause a decrease in tear quality. [22] By conducting an electrophoretic analysis of tear protein, Grus et al. [23] observed that changes in tear protein were greater and more severe in smokers than in the control group. Significantly more protein reaches the maximum amount in heavy smokers than non-smokers. It indicates a change with an increase in subjective symptoms associated with smokers. Doane et al. [24] reported that the lipids, aquos, and mucin components of tears interacted with each other to achieve an even distribution of the lipid layer. Therefore, the cornea is moistened and allowdeter stability to be within normal limits. Matsumoto et al. [25] reported that chronic smoking-induced typical quantitative and qualitative disorders with damages to the ocular surface health and precorneal tear film.

4.5 The relationship between the duration of smoking and the number of cigarettes smoked per day with symptoms of dry eye
Based on the analysis, the duration of smoking with complaints of dry eye symptoms obtained p = 0.035 (p <0.05), which means that there is a significant relationship. Based on the results of the study, the number of respondents that smoke for ≤5 years without symptoms of dry eye is above respondents that smoke >5 years with symptoms. The exposure of cigarette smoke affects the surface of tears. [20] Therefore, the longer the exposure, the more symptoms appear. The analysis of the number of cigarettes smoked per day with complaints to dry eye symptoms obtained p-value = 0.129 (p> 0.05). This means that there was no significant relationship between the number of cigarettes smoked per day with complaints of dry eye symptoms. Although not significant, it is seen from the research that those that consumed less than 10 cigarettes per day, were asymptomatic, while those that consumed more than 10 cigarettes have symptoms of dry eye. The analysis results were in line with Yoon et al. [19], which stated that the assessment of complaints was not related to the number of cigarettes smoked per day with a relationship between the grade of the corneal squamous metaplasia and the number of cigarettes smoked per day. Therefore, the number of cigarettes or exposure to cigarette smoke affects the tear film layer.

5. CONCLUSION
Based on the research, it is concluded that there is a relationship between the quantity of tears with symptoms of dry eye in smokers, with none in the quality. It is also found
that a relationship exists between the duration of smoking and symptoms of dry eye, with none in the number of cigarettes consumed per day. While in non-smokers, there is a relationship between the quantity and quality of tears with symptoms of dry eye.

6. SUGGESTIONS
The number of research subjects needs to be increased, while the number of confounding factors such as motorcycle users without protection, the duration of computer usage, and the duration of air-conditioned exposure needs to be reduced because these factors can also affect the stability of tears.

ACKNOWLEDGMENT
The author is grateful to Dr. dr. Raditya Wratangka, SpOG (K) dean of the Faculty of Medicine, Trisakti University and also grateful to Prof. Dr. Bambang Sudaryono Ak., MBA., CA., CPA as dean of the Faculty of Economics, Trisakti University for permission to conduct this research.

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