

The Influence of Perceived Stress on Subjective Levels of Dry Eye:  
A Correlational study

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### Abstract

The following is a correlational investigation of the influence of perceived stress on subjective levels of dry eye. Due to the physiology inherent to the autonomic nervous system (ANS), increases in stress levels should both theoretically and literally produce a decreased secretion of the aqueous layer of the tear film. Therefore, it was hypothesized that the individuals with a significantly higher stress level would have higher levels of dry eye due to the disruption of the tear quantity and/or quality. For that reason, it was expected that perceived stress levels would be positively correlated with increased levels of dry eye. A survey sample of 78 individuals over the age of 21 years of age was collected using the Perceived Stress Scale (P.S.S.) and the Ocular Surface Disease Index<sup>®</sup> (O.S.D.I.). Analysis of the data showed significant support for the hypothesis ( $p < .05$ ), which stated that increased levels of perceived stress would be positively correlated with higher levels of dry eye. Even though some steps were taken to reduce study confounds, limitations exist largely because a number of known correlations with dry eye were not effectively eliminated from the data.

## The Influence of Perceived Stress on Levels of Dry Eye: A correlational study

The symptoms and clinical manifestations of dry eyes affect millions of Americans. It is estimated that around 10% of the population between ages 30 and 60 years suffer its effects, with the prevalence in those over the age of 65 years increasing to 15%.<sup>5</sup> The condition affects more than 3.2 million American women middle-aged and older alone.<sup>9</sup> Dry eye is thus a very prevalent condition that needs to be understood by the eye physician, as nearly 25% of all ophthalmic patients have some level of dry eye signs or symptoms.<sup>2</sup>

The National Eye Institute has defined dry eye as a “disorder of the tear film due to tear deficiency or excess tear evaporation, which causes damage to the interpalpebral ocular surface and is associated with symptoms of ocular discomfort.”<sup>10</sup> The role of tears in the eye is to serve as a necessary lubricant, provide for a smooth refractive surface, trap debris and prevent infection, and to nourish the underlying corneal tissue.<sup>2</sup> Tear composition is made up of three layers, and the central level of the tear film is the thickest portion. This level is known as the aqueous layer, and is produced by the main and accessory lacrimal glands.<sup>8</sup> Dry eye symptoms may be produced when any of the three layers are deficient or abnormal. Common ocular symptoms of dry eye syndrome include burning, foreign body sensation, scratchiness, and burning.<sup>11</sup> Although normal aging can decrease tear production, other causes may include contact lens wear, allergies, systemic conditions, autoimmune diseases, and medication side effects, amongst others.

Coupling the mechanisms of tear production with accepted autonomic nervous

system (ANS) functioning, it is hypothesized that a physiological link exists between an individual's perceived stress level and their subjective dry eye symptoms. The ANS is divided into two parts: the parasympathetic nervous system and the sympathetic nervous system. Most organs including the lacrimal gland receive dual innervation from the two antagonistic systems.<sup>12</sup> This gland receives secretomotor parasympathetic innervation, and is responsible for aqueous-layer tear production. Typically the hypothalamus regulates the balance of the two divisions of the ANS by activating one system while inhibiting the other. In theory, this means that the lacrimal gland would increase the volumetric output of tears when the parasympathetic system is stimulated. Conversely, when the sympathetic system takes over, aqueous tear production should be reduced due to simultaneous inhibition of the parasympathetic division.<sup>12</sup>

During either physical or emotional stress, the sympathetic system overtakes the parasympathetic, eliciting a number of systemic effects commonly referred to as the "fight or flight" response. During this response, systemic blood pressure rises through generalized peripheral vasoconstriction, including within nonessential organs.<sup>12</sup> It is hypothesized that this vasoconstrictive effect is exhibited within the lacrimal artery, which is directly responsible for the blood supply to the lacrimal gland. Since this effect will lead to a diminished blood supply, the result will be suppressed lacrimal gland activity, which directly acts to decrease the production of the aqueous layer of the tear film.

Since this layer accounts for 90% of the total 7-10um thickness of the tears<sup>8</sup>, the tear film volume and consistency are greatly disrupted. Thinning of this (the thickest) segment of the precorneal tear film results in aqueous deficiency, leading to a premature contamination

of the mucin layer of the tear film.<sup>10</sup> This may be observed clinically as rapid tear-break-up-time (TBUT).<sup>10</sup> We predict that the end result of this cascade of events will be an increase in dry eye symptoms in individuals who have chronically elevated levels of perceived stress.

**Hypothesis:** Level of subjective dry eye will be positively correlated with the level of perceived stress that the participant experiences; as perceived stress levels increase, so will levels of subjective dry eye.

## Method

### Participants

The data sample consisted of 78 individuals being twenty-one years of age or older. Of the 78 participants, 15 were males and 57 were females. Six participants failed to indicate their gender in the appropriate question.

### Procedure

The participants were provided with informed consent forms to indicate their willingness to participate in the study. The consent forms were separated from the actual surveys so that all responses of all subjects would remain anonymous and thus ensure confidentiality.

Two valid research surveys were used in this project, and permission was obtained in order to use them. The first was the Perceived Stress Scale (Cohen, 1983), which consisted of ten questions measuring the frequency of feelings and thoughts related to the individual's level of perceived stress over the past month. The second survey was the Ocular Surface Disease Index© (Allergan, 1995), which consisted of a twelve-item FDA accepted

questionnaire related to the individual's subjective ocular irritation symptoms during the past week. Three supplemental questions (A-C) were added to the survey to assess the prevalence of individuals wearing contact lenses, use of certain medications including a few antihistamines and decongestants, and to see how many participants had doctor visits pertinent to dry eye symptoms in the recent past. The Ocular Surface Disease Index<sup>®</sup> was used as the measure for subjective dry eye assessment.

The survey was distributed at multiple locations, not limited to any certain domain. Optometric and ophthalmologic practices were targeted, but participation was not limited to those at an eye care facility. At any location where subjects were obtained, participants were simply asked if they were willing to participate in the research by filling out a brief survey.

Involvement was on a strict volunteer basis for the purpose of furthering educational knowledge, and participants received no immediate benefit. The only risk to subjects was being burdened with the inconvenience of taking the time to fill out the two surveys.

### Results

Using Pearson Correlation, support for the hypothesis was found. As Table 1 below illustrates, the interaction between perceived stress level and subjective dry eye symptoms was significant ( $r = 0.233$ ,  $p < 0.05$ ,  $N=78$ ). More simply stated, as the stress level increased, so did the level of dry eye.

Table 1: Pearson Correlation Matrix using all data

	Gender	Age	Stress	Dry Eye	A	B	C
Gender	1.000	.001	.379**	.152	-.138	-.073	-.058
Age		1.000	-.356**	-.173	.319**	.214	.032

<b>Stress</b>			1.000	.233*	-.247	-.160	-.093
<b>Dry Eye</b>				1.000	-.187	-.270*	-.075
<b>A</b>					1.000	.278*	-.034
<b>B</b>						1.000	-.150
<b>C</b>							1.000

\* Correlation is significant at the 0.05 level

\*\* Correlation is significant at the 0.01 level

Other significant relationships revealed that stress was significantly higher for females in the population set ( $r = .378, p < 0.001$ ), that increasing age provided an increased perceived stress level ( $r = -.356, p < 0.01$ ), and that younger patients wore contact lenses more frequently than elder ( $r = .319, p < 0.01$ ). There was a significant negative correlation between stress level and contact lens wear ( $r = -.247, p < 0.05$ ). This is likely due to the significant correlations and interactions between age and contact lens wear, along with the correlation between stress and age. Or, people who wear contacts tend to be younger, and our data showed that the “younger” people had less perceived stressed in the sample population than those “older”.

Analysis of the auxiliary questions (A-C) showed that there was a significant correlation between perceived levels of dry eye and seeing a doctor and/or using artificial tears in the past month ( $r = -.270, p < 0.05$ ). This can essentially be interpreted to say that patients with perceived dry eyes use artificial tears or go to the doctor more often than those without this perceived dry eye level. Additionally, it was revealed that there was an association between contact lens wear and seeing a doctor and/or using artificial tears in the past month ( $r = .278, p < 0.05$ ). Simply, those who wear contacts use artificial tears or see a doctor more often than those not wearing lenses. Interestingly, we found that the use those

antihistamines or decongestants included in the survey was not significantly correlated with higher perceived dry eye levels.

Because auxiliary question "B" was the only supplementary question that had a significant effect on the level of subjective dry eye, the data was re-analyzed using only those subjects who had not used artificial tears and/or been to a doctor for dry eyes in the past month. By doing this, we were effectively removing the relationship between answering "yes" to question B with an increased level of subjective dry eye because of the significant interactions of the two variables. At this point the data sample size was decreased to  $n=51$ , allowing the data set to be visually inspected for any obvious outliers. In order to analyze a more valid representative sample population, two outliers (perceived stress scores of 32 and 26, both with subjective dry eye scores of 0), were removed and the relationship recalculated.

At this point, it was found that a significant Pearson correlation existed between the subjective dry eye and perceived stress levels ( $r = 0.302$ ,  $p < 0.05$ ,  $n = 49$ ). This shows even stronger evidence for the support of the experimental hypothesis.

#### Discussion

In support of our hypothesis, an elevated perceived level of stress as evaluated by the Perceived Stress Scale (Cohen 1983) is significantly correlated with perceived levels of symptomatic discomfort as assessed by the Ocular Surface Disease Index<sup>®</sup> (Allergan 1995).

Interactions between the immune and nervous systems play an important role in modulating resistance to inflammatory and infectious disease.<sup>11</sup> Increased stress causes over-action of the hypothalamic-pituitary-adrenal axis, which produces excessive glucocorticoids that act to inhibit inflammation.<sup>11</sup> This results in an immunosuppressive



state that leads to increased susceptibility to disease.<sup>11</sup> As a result of this physiology, it is proposed that dry eye syndrome, or keratoconjunctivitis sicca, are examples of conditions caused by such stress-induced vulnerability of the body's natural defenses.

Like any research based study, there are confounds of this investigation. Although two validated research surveys were used, this study's findings were based solely on the subjective symptoms of each individual. This was so because it is our belief that the majority of dry eye management decisions are made based on subjective patient symptoms. This belief is supported by studies that have found that doctors and the patients who present with the condition often don't see eye to eye on the severity of the symptoms.<sup>4</sup> However, further study in this area could be pursued which included accepted objective assessment measures such as Schirmer's test, red cotton thread test, instillation and analysis of fluorescein or Rose Bengal dye staining, tear breakup time (TBUT) measurements, and lid examination.<sup>3</sup> It is possible that a combination of subjective and objective measures may provide even stronger support for the finding that stress levels significantly impact levels of dry eye.

Further study into this area should involve only subjects with confirmed dry eye syndrome. In this study other possible causes of dry eye were not entirely ruled out. This list includes previous ocular surgery, menopause, lid disease, autoimmune disease, and certain medication, among others. A more thorough patient profile is needed to eliminate as many of these possible variables as comprehensively as possible.

Additionally, the temporal sequence of the two surveys did not directly correspond. The OSDI<sup>®</sup> was specific for symptoms "during the past week", and PSS was "in the past month." As a result of this, subjective dry eye symptoms might not be directly coinciding

with times when subjects were experiencing the highest perceived stress levels. Or, it is possible that a greater positive correlation existed but was not found because the stress levels peaked before the time frame that dry eye symptoms were measured within.

Another factor possibly skewing the results was the oversight that participants were aware of the survey titles, which were inadvertently left at the top of both questionnaires. For instance, because the subjects knew they were answering questions that were designed to gauge their stress levels, they could have downplayed or exaggerated their responses to indicate a result that they deemed appropriate. They could thus appear more or less stressed, based on their desired projection. This would naturally lower the validity of the survey as to their actual perceived stress level. The same theory could also be applied to the dry eye survey since the title was again evident to all participants.

Effectively managing dry eye syndrome is a complex task that requires an understanding of the inherent pathophysiology. There are many possible conditions and factors involved in dry eye, which may include tear film changes, systemic involvement, ocular and adnexal changes, and lacrimal secretion and drainage apparatus abnormalities.<sup>7</sup> Changes in environment such as decreases in ambient humidity are also suggested.<sup>11</sup> Examples of additional surrounding elements that have the potential to cause or exacerbate dry eyes would be use of air conditioning, extended use of computers wherein normal blink rate is decrease, decreased fluid intake, or the use of diuretics such as caffeine or prescription medications which may produce dehydration.

There are also many possible treatments for dry eyes. These include the use of artificial tears, punctual occlusion, topical hormone therapy, retinoic acid, oral antioxidants,

supplemental flax seed oil, and anti-inflammatory agents.<sup>3,7</sup> While the treatment of dry eye is already complex and multifactorial, the findings of this study propose another possible tool in managing the patient with dry eye disease. As such, it may be beneficial to educate patients on the importance of decreasing stress levels to help reduce or alleviate dry eye symptoms. We hope that these findings can be further investigated and utilized on a practical level to aid in the management of this prevalent clinical entity.

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