Dry eye and dry skin - is there a connection?

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ABSTRACT

Aim: To enquire whether patients with dry eye symptoms also report dry skin, whether their perception could be corroborated with objective measurement, and whether dry eye disease might be suspected based on patients' complaints.

Methods: This cross-sectional study included 50 subjects, 25 with and 25 without dry eye symptoms. Schein questionnaire was used to determine the severity of dry eye symptoms. Ocular signs were assessed by monitoring conjunctival hyperemia, ocular surface staining, meibomian gland expression, tear film lipid layer thickness, tear break-up time, lid parallel conjunctival folds, Schirmer test, and meibometry. Skin dryness was assessed by noting patients' self-perception of their facial skin dryness and measured by sebumeter.

Results: Subjects without dry eye symptoms had self-reported oilier facial skin than those with dry eye symptoms (p < .001). Sebumetry scores measured on the forehead and cheek were significantly higher in subjects without dry eye symptoms than dry eye subjects (p = .003). After adjustment for age and gender in a logistic regression analysis, dry eye was independently and significantly associated with dry skin (AOR 0.69, p = .040), higher LIPCOF score of both eyes (AOR 2.28, p = .028), lower sebumetry score of the forehead (AOR 0.98, p = .041) and cheek (AOR 0.98, p = .041), and shorter TBUT score after gland expression (AOR 0.90, p = .018).

Conclusion: This study showed that ocular dryness was subjectively and objectively positively correlated to facial skin dryness. Patients reliably described their skin condition. People with dry facial skin also had drier eyes.

Introduction

The eye's primary function is to see, and in that role, all its parts form a single organ. However, it is frequently ignored that the ocular surface is also part of the overall body surface, which predominantly consists of skin. The eye with tear film protects itself from drying, and so does the skin for the rest of the body, which enables the body to retain its hydration. In that sense, both parts of the body surface perform the same task.

Dry eye is a medical problem of epidemic proportions. In the last three decades, awareness of dry eye disease (DED) has risen considerably worldwide. It is a growing public health concern causing ocular discomfort, fatigue, and visual disturbance that interferes with quality of life (QoL), including physical, social, psychological functioning, daily activities, and workplace productivity. According to the literature, the prevalence of dry eye ranges from 5% to 30% in individuals over the age of 50, with women consistently having a 1.3–1.5 times higher prevalence rate than men in all studies that measured both signs and symptoms. On the other hand, dry skin (xerosis cutis) is the most common skin disorder, more frequently among women and older people, with prevalence ranging from 5.4% to 85.5%, presenting in over 50% of individuals aged ≥65 years. DED is defined by Tear Film and Ocular Surface Society (TFOS) Dry Eye Workshop (DEWS) and amended by the TFOS DEWS II. In recognition of the current understanding of dry eye pathophysiology, an evaporative component to DED is more common than an aqueous deficient component. Indeed, meibomian gland dysfunction (MGD), a contributor to evaporative dry eye, is the leading cause of dry eye in the clinic and population-based studies. MGD is a chronic abnormality of meibomian glands (MG), where changes in meibomian lipid chemistry play a crucial part in MG obstruction, atrophy, and

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qualitative and quantitative changes of meibum. This results in the tear lipid layer changes, which plays an essential role in stabilizing the tear film and providing a barrier to tear evaporation.6

At the same time, millions of people, especially women, complain of dry skin and use cosmetics to alleviate this discomfort. However, dry skin is not labeled as a disease, nor do people who have it experience it as a disease but as a condition. It is characterized by the lack of appropriate water in the most superficial layer of the skin, the stratum corneum (SC) of the epidermis.3,7 It is not inflamed or diseased, just dry. Overall, there is a lack of reports describing it at all. It is known that dehydration of the skin can lead to scaly, rough, and cracked skin, superficial skin lines and wrinkles, and skin aging. It might be accompanied by discomfort and itch, which are physically uncomfortable and affect patients psychologically.3 Some studies reported sebum, skin sebaceous glands product, to be most important for skin and hair coat waterproofing, and its antioxidative and antimicrobial properties to play an essential role in the epidermal barrier function.7,8 In a study recently published by Moniaga et al., multiple skin changes were related to dry skin, especially in the elderly: alterations in the barrier function of SC; pH variations; alterations in SC proteases; and most of all, reduced activity of sebaceous and sweat glands; and decreased levels of estrogen and androgens.3 De Melo and Maia Campos evaluated oily and dry skin characteristics using biophysical and skin imaging techniques. They found that the oily skin group of patients differed from the dry skin group mainly according to significantly higher sebum content and the higher activity of the sebaceous glands.5 Therefore, sebaceous glands play a significant role in the development of dry skin, the same as MGs play a vital role in the pathophysiology of DED. Actually, MGs are so-called free or ectopic modified sebaceous glands.

When eye care practitioners examine the dry eye patients and ask them about their skin type, very frequently, such patients also complain of having dry skin, especially women.

Having this in mind, is there a connection? Do people with dry skin also have dry eyes, and if they do, what may be the cause – the same for both parts of the body surface?

As MGs produce meibum, the skin’s sebaceous glands produce an oily substance called sebum to protect the outer layer of skin from losing water. If the skin does not have enough sebum, it loses water and feels dry, like DED. The new definition recognizes dry eye as a multifactorial disease resulting from numerous interacting causes that influence tear film homeostasis, e.g., age, sex, gender, hormone imbalance, environmental causes, inflammation, neurogenic, iatrogenic, low blink rate, lid disorders, vitamin A deficiency, allergies, and psychological causes.5 Many of them also result in dry skin.7 Aging decreases sebum production. Excessive bathing, showering, or scrubbing of the skin also excessively removes sebum. Dry indoor air, exposure to wind and sun, diabetes or skin allergies, thyroid gland disorders, Sjogren’s syndrome, and various medications also cause the same condition.10 So, both conditions have much in common.

One of the most prominent DED and dry skin features is that both conditions occur more frequently in women than men and older people. Moreover, the female gender by itself is a significant risk factor for the development of DED.

Sex hormones, especially androgens, are essential in regulating lacrimal, meibomian, and sebaceous glands function, imbalance of which is associated with both aqueous-deficient, evaporative DED,11–14 and dry skin.25 The role of androgens has been investigated the most, both in the pathophysiology of MGD and sebaceous glands dysfunction. It is shown that androgens regulate over 1000 genes in MGs and promote normal MGs function and suppress MGs keratinization, obstruction, and atrophy.14–23 Androgen deficiency, in turn, is a risk factor for MGD and evaporative DED.11,16,19–23 Such hormone insufficiency typically occurs during menopause in women, aging in both sexes (decline in the total androgen pool), the use of anti-androgen medications, and some autoimmune diseases.16,24,25 The exact role of estrogens and progesterone in MG function regulation is yet to be discovered.16 Interestingly, it is found that estrogen opposes some actions of androgen in the MG. Estrogen suppresses genes associated with support of lipid production and upregulates genes that have the opposite effects.17,26 Similar to MGs, sebaceous glands are also regulated by sex hormones. In their recent study, Chen et al. confirmed that androgens and estrogens predominantly regulate sebocytes, and the change of its relative quantity causes the trend change on sebum lipids.27 Same as the regulation of MG function, androgens directly stimulate sebocytes to produce sebum while estrogens have antagonistic action to androgens. However, the common regulatory mechanism of multiple hormones on sebaceous glands is still not completely clear.27 Another common cause that impacts both MG and sebaceous gland function in aging.24,28,29 During the aging process, secretion of both meibum and sebum decreases due to involutive changes in the glands and androgen deficiency. Growth hormone and insulin-like growth factor 1 positively regulate the growth and
function of MGs and sebaceous glands. Many other hormones (hypothalamic-pituitary hormones) modulate and control the function of both MG and sebaceous glands in a similar fashion. Still, those hormones’ complete mechanisms of action are yet to be found. Environmental factors also impact the function of both glands; body temperature (similar melting ranges), outdoor temperature, and relative humidity. That explains why dry eye and dry skin are more frequent and more severe during winter. Ultimately, sex-related differences in brain organization, cognitive ability, pain perception, etc., are responsible for dry eye sex-related prevalence differences and may play an important role in dry skin prevalence differences. Keeping in mind all the above mentioned, the authors were surprised to find only one study in the literature comparing ocular and skin dryness, published by Ito et al. in 2017 and conducted using a web-based questionnaire among females. In that study, authors found a significant correlation between self-reported vaginal, mouth, ocular, and skin dryness and proposed that dryness may be caused by factors affecting the autonomic nervous system or by hormonal changes in menopause and that it has yet to be investigated. However, this study was only questionnaire-based and did not corroborate findings by objective measurements.

In their two previous works, the first and second authors also found a positive correlation between dry eye symptoms and self-reported facial skin dryness in women, especially older. Therefore, based on these findings, they wanted to investigate that connection more objectively in the present study.

Dry skin is most commonly caused by decreased secretion of sebaceous glands, and dry eye by dysfunction of MG, modified sebaceous glands that secrete tear film meibum. Both glands have similar hormonal regulatory pathways. Therefore, the authors hypothesized that dry skin and dry eye are positively correlated.

The purpose of this study was to enquire whether patients with dry eye symptoms also report having dry skin and whether their perception could be corroborated with objective measurement. These answers could help DED diagnose and treat and prevent disease complications impacting patients’ vision, daily activities, QoL, and working abilities.

**Subjects and methods**

This cross-sectional study included 50 subjects examined by the first author during his routine clinical work in his adult general ophthalmology outpatient practice. Twenty-five subjects were with and twenty-five without dry eye symptoms. The study protocol was approved by the Institutional Ethics Committee and was performed according to the guidelines of the Declaration of Helsinki. The subjects received both written and oral information about the study and signed written informed consent.

Inclusion criteria required subjects to be 18 or older and have normal other anterior ocular surface findings. Subjects wearing contact lenses, using any topical ophthalmic medication, with previous ocular trauma, acute infection, glaucoma, ocular surgery in the past years, any other ocular surface diseases and irregularities were not included in the study. Also excluded were those with severe dermatological diseases, systemic diseases, or medications that would alter the ocular surface or skin and subjects who cooperated poorly.

Clinical parameters screened were severity of dry eye symptoms using Schein questionnaire. Schein questionnaire is the one commonly used in authors’ routine clinical work, and therefore they have the most experience in using it. Furthermore, this test is validated for use in Croatian translation. The first author performed the questionnaire. It is a disease-specific questionnaire used to measure patient-reported symptoms of dry eye. Schein subscale scores can range from 0 to 20. It is simple, practical, short, and understandable to all the patients, including the elderly. This questionnaire’s disadvantage is that it does not evaluate the impact of dry eye symptoms on patients’ vision, everyday activities, and quality of life. It has no cut-off value for DED. In contrast, some other questionnaires do, e.g., Ocular Surface Disease Index (OSDI) and 5-Item Dry Eye Questionnaire (DEQ-5). In that manner, the authors asked additional questions regarding the impact of DED symptoms on daily activities (watching TV, driving the car, working on the computer) and quality of vision.

Ocular signs were measured by conjunctival hyperemia, fluorescein surface staining, MG expression (EGM), tear film lipid layer thickness (LLT) using a handheld tool, tear break-up time (TBUT) before and after MG expression, lid parallel conjunctival folds (LIPCOF), and Schirmer test (double void).

Conjunctival hyperemia was assessed using Cornea and Contact Lens Research Unit (CCLRU) grading scale. LLT was measured before any eye manipulation and after MG expression using a slit lamp and a handheld lipid layer examination instrument.

TBUT was measured using standardized fluorescein strips (Biotech, Fluorescein Sodium Ophthalmic Strip USP). The upper lid of the eye was slightly lifted, and
the fluorescein strip was moistened with saline. The excess fluid was shaken off from the strip, and it was then used to stain the ocular surface. The procedure was repeated after MG expression.28

LIPCOF was observed, without fluorescein, on the bulbar conjunctiva in the area perpendicular to the temporal and nasal limbus, above the lower lid with a slit lamp microscope using ~25 magnification and scored counting the number of folds (0–4).38

The Schirmer test (double void) was assessed by folding the Schirmer paper strip (5 x 35 mm) at the notch, hooking the folded end over the temporal one-third of the lower lid margin, measuring the wetting length from the notch after 5 min. The procedure was performed with topical anesthetic and eyes closed.39

Meibometry was performed using a commercially available meibometer (Courage + Khazaka Electronic GmbH, Germany). In assessing the skin dryness, subjects were asked how they felt their facial skin, dry or oily, on a scale from 1 (dry) to 10 (oily). Facial skin oiliness was measured using a commercially available sebometer, a standard diagnostic tool manufactured by Courage@Khazaka GmbH, Germany. Using this instrument requires no special skills, is entirely automated and noninvasive, and could be performed by non-medical personnel. Despite this, prior to conducting this study, we consulted a dermatologist on how to perform this measurement. Both instruments use the photometric method: when oiled, the matte-surfaced synthetic tape becomes transparent and thus lets more light through it. The more light is transmitted through the strip, the higher lipid content is.40–42 Both measurements were performed as recommended by the manufacturer: sebometry from the clean, untreated, and unwashed forehead and cheek skin, and meibometry from lower left eyelid margin, first unmanipulated and then after MG expression. Meibometry uses a strip that touches lower eyelid MG orifices to absorb gland excretions, and by doing that alters the lipid layer on that eye and can also affect other ocular surface parameters. In order to perform other tests, we needed unaltered ocular surface conditions, and therefore we performed them on the right eye. Dry eye is a bilateral condition, so that tests can be performed on only one eye.43

Statistical analysis was performed by Statistica software package version 13.3 (TIBCO Inc., USA). The normality of data distribution was tested by the Shapiro–Wilks test and homogeneity of variance by the Leven test. Results of descriptive analyses were expressed as median (minimum-maximum) for continuous and ordinal data and numbers for categorical data. Differences in continuous and ordinal data distributions were evaluated by the Mann–Whitney test for independent variables and the Wilcoxon test for dependent variables. The nonparametric tests were used to analyze the differences between ordinal and continuous data since the assumption of homogeneity of variance for tested variables was not met. Differences in distributions of categorical data were assessed by the Chi-square test. The Spearman rank correlation test was used. Binary univariate and multiple logistic regression analyses were used to

**Table 1. Basic characteristic, skin type and dry eye signs in subjects divided into two groups according to dry eye symptoms evaluated by Schein questionnaire.**

|                               | Dry eye group (n = 25) | Control group (n = 25) | Z* Ch** | p        |
|-------------------------------|------------------------|------------------------|---------|----------|
| Age (years)*                  | 62 (20–78)             | 34 (20–64)             | −3.59** | <.001**  |
| Gender (m/f)**                | 2/24                   | 8/17                   | 6.64**  | .010**   |
| Self-reported skin type (1 dry – 10 oily)* | 2 (1–9)               | 5 (3–8)                | 4.12**  | .001**   |
| CCLRU right eye (0–4)*        | 0 (0–2)                | 0 (0–0)                | −0.72*  | .473*    |
| CCLRU left eye (0–4)*         | 0 (0–2)                | 0 (0–0)                | −0.72*  | .473*    |
| LIPCOF right eye (0–3)*       | 2 (0–3)                | 1 (0–2)                | −2.96*  | .003*    |
| LIPCOF left eye (0–3)*        | 2 (0–3)                | 1 (0–2)                | −2.96*  | .003*    |
| Meibometry prior to gland expression Max* | 374 (201–698)       | 325 (152–745)          | −1.29*  | .193*    |
| Meibometry prior to gland expression Area* | 2164 (965–5291)   | 1920 (976–4880)        | −0.52*  | .600*    |
| Meibometry after gland expression Max* | 483 (194–822)         | 504 (82–764)           | 0.23*   | .816*    |
| Meibometry after gland expression Area* | 3220 (903–9252)    | 2654 (482–9230)        | 0.12*   | .907*    |
| Sebometry forehead*           | 160 (29–265)           | 208 (97–240)           | 2.95*   | .003*    |
| Sebometry cheek*              | 93 (9–202)             | 158 (28–231)           | 2.89*   | .003*    |
| LLT before gland expression*   | 3 (2–5)                | 3 (2–5)                | 0.09*   | .930*    |
| LLT after gland expression*    | 3 (5–3)                | 5 (3–5)                | 0.13*   | .899*    |
| TIBUT before gland expression* | 3 (0–25)               | 10 (2–35)              | 3.26*   | .001*    |
| TIBUT after gland expression*  | 4 (0–25)               | 18 (2–40)              | 3.29*   | <.001**  |

* median (min-max) ** numbers * Mann–Whitney test b Chi-square test df = 1.

Abbreviations: Dry eye group – subjects with dry eye symptoms (Schein questionnaire score 1 or >1) and Control group – subjects without dry eye symptoms (Schein questionnaire score 0); CCLRU – Cornea and Contact Lens Research Unit; LIPCOF – Lid Parallel Conjunctival folds; LLT – Lipid Layer Thickness; TIBUT – Tear Film Break-up Time.
assess the strength and independence of associations. p-value of less than 0.05 was considered statistically significant.

**Results**

This study included 50 subjects (9 males/41 females) with a median age of 49.5 (min 20 – max 78) years. According to the dry eye symptoms evaluated by the Schein questionnaire, subjects were divided into two groups: dry eye group – subjects with dry eye symptoms (Schein questionnaire score 1 or >1), and control group – subjects without dry eye symptoms (Schein questionnaire score 0).

Descriptive statistics of basic characteristics, skin type, and dry eye signs of subjects included in the study are presented in Table 1. Subjects with dry eye symptoms were older than those in the control group (62 vs. 34 years, p < .001). More women were in the dry eye group than in the control group (24 vs. 8, p = .010). Subjects without dry eye symptoms had self-reported oilier facial skin than those with dry eye

Table 2. Correlation between self-reported skin type and dry eye signs.

| Self-reported skin type (1 dry – 10 oily) | Spearman R | t(N-2) | p |
|------------------------------------------|------------|--------|---|
| CCLRU right eye (0–4)                   | −0.056     | −0.389 | .699 |
| CCLRU left eye (0–4)                    | −0.056     | −0.389 | .699 |
| LIPCOF right eye (0–3)                  | −0.293     | −2.121 | .039[^1] |
| LIPCOF left eye (0–3)                   | −0.293     | −2.121 | .039[^1] |
| Meibometry before gland expression Max  | −0.193     | −1.362 | .180 |
| Meibometry before gland expression Area | −0.153     | −1.073 | .289 |
| Meibometry after gland expression Max   | −0.049     | −0.337 | .737 |
| Meibometry after gland expression Area  | −0.160     | −1.122 | .267 |
| Sebumetry forehead                      | 0.296      | 2.149  | .039[^1] |
| Sebumetry cheek                         | 0.270      | 1.941  | .058[^1] |
| LLT before gland expression             | 0.161      | 1.127  | .265 |
| LLT after gland expression              | −0.001     | −0.006 | .995 |
| TBUT before gland expression            | 0.194      | 1.369  | .177 |
| TBUT after gland expression             | 0.129      | 0.902  | .372 |

Abbreviations: CCLRU – Cornea and Contact Lens Research Unit; LIPCOF – Lid Parallel Conjunctival folds; LLT – Lipid Layer Thickness; TBUT – Tear Film Break-up Time.

Figure 1. Sebumetry forehead and cheek scores in subjects divided into two groups according to the self-reported skin type test.
symptoms (p < .001). The two groups did not significantly differ in the right and left eye’s conjunctival hyperemia (CCRLU) (p = .473). Dry eye subjects had higher LIPCOF scores of the right and left eye than subjects without dry eye symptoms (p = .003). No differences in CCRLU and LIPCOF scores between the right and left eye within the examined groups were found (Wilcoxon test, Z = 0.000, p = 1.000; table not shown). There were no differences in meibometry scores before and after expression between groups. Sebumetry scores measured on the forehead and cheek were significantly lower in subjects with dry eye symptoms than control subjects (p = .003). In both groups sebumetry score of the forehead was higher than sebumetry score of the cheek (Wilcoxon test, dry eye group: Z = 4.060, p < .001, control group: Z = 4.372, p < .001; table not shown). There were no differences in LLT scores before and after expression between the groups (p = .930; p = .899). TBUT scores both before and after MG expression were significantly shorter in subjects with dry eye symptoms than those without symptoms (3 seconds vs. 10 seconds, p = .001; 4 seconds vs. 18 seconds, p < .001).

Self-reported skin type (1 dry – 10 oily) was significantly negatively correlated with LIPCOF score of both eyes (p = .039), significantly positively with sebumetry score of the forehead (p = .037) and marginally positively with sebumetry score of the cheek (p = .058). No significant correlation was observed between the skin type and the presence of conjunctival hyperemia, meibometry score, LLT score, and TBUT score before and after gland expression (Table 2). Figure 1 presents the median (min-max) values of sebumetry forehead and cheek scores in subjects divided into groups according to the self-reported skin type. Subjects with self-reported dry skin type (1–3) had significantly lower sebumetry forehead score (p = .024) and marginally lower sebumetry cheek score (p = .053) than those with self-reported normal to oily skin type (4–10) (Figure 1, Table 3).

Self-reported skin type (1 dry – 10 oily) was significantly negatively correlated with all investigated dry eye symptoms except for no significant correlation between the type of the skin and the presence of dry eye symptoms during winter (Table 4).

**Table 3.** Sebumetry forehead and cheek scores in subjects divided into two groups according to the self-reported skin type test.

| Self-reported skin type (1–10) | Dry skin (1–3) | Normal to oily skin (4–10) | Z | p |
|-------------------------------|----------------|---------------------------|---|---|
| Sebumetry forehead            | 171 (9–250)    | 208 (126–239)             | -2.26 | .024 |
| Sebumetry cheek               | 112 (9–230)    | 145 (28–231)              | 1.99 | .053 |

Table 4. Correlation between self-reported skin type and dry eye symptoms.

| Self-reported skin type (1 dry – 10 oily) | Spearman R | t(N-2) | p |
|----------------------------------------|------------|--------|---|
| Dryness (0–4)                          | -0.425     | -3.249 | .003 |
| Grittiness (0–4)                       | -0.365     | -2.717 | .009 |
| Burning (0–4)                          | -0.422     | -3.228 | .002 |
| Redness (0–4)                          | -0.463     | -3.621 | <.001 |
| Crusts (0–4)                           | -0.427     | -3.270 | .002 |
| Difficult opening eyes (0–4)           | -0.474     | -3.729 | <.001 |
| More symptoms in winter (yes/no)       | 0.240      | 1.713  | .093 |
| More symptoms in wind (0–4)            | -0.428     | -3.278 | .002 |
| More symptoms at computer (0–4)        | -0.395     | -2.982 | .004 |
| More symptoms at TV (0–4)              | -0.395     | -2.982 | .004 |
| More symptoms during driving (0–4)     | -0.349     | -2.582 | .013 |
| Visual acuity fluctuations (0–4)       | -0.433     | -3.329 | .002 |

Table 5. Basic characteristics, skin type, and dry eye signs associated with dry eye by means of logistic regression analysis.

| OR (95%CI)                          | p     | AOR (95%CI)* | p* |
|-------------------------------------|-------|--------------|----|
| Age (years)                         | 1.07  | .001         | /  |
| Gender (female)                     | 1.129 | .011         | /  |
| Self-reported drier or oiler facial skin (1–10) | 0.57  | .002         | /  |
| LIPCOF right eye (0–3)              | 2.73  | .002         | /  |
| LIPCOF left eye (0–3)               | 2.73  | .002         | /  |
| Meibometry before gland expression Max | 1.00  | .518         | .546 |
| Meibometry before gland expression Area | 1.00  | .950         | .574 |
| Meibometry after gland expression Max | 1.00  | .878         | .777 |
| Meibometry after gland expression Area | 1.00  | .009         | .044 |
| Sebumetry forehead                  | 0.98  | .005         | .044 |
| Sebumetry cheek                     | 0.98  | .005         | .044 |
| LLT before gland expression         | 0.96  | .892         | .797 |
| LLT after gland expression          | 1.00  | 1.00         | .546 |
| TBUT before gland expression        | 0.88  | 0.92         | .096 |
| TBUT after gland expression         | 0.87  | 0.90         | .018 |

* OR adjusted for age and gender.  
Abbreviations: LIPCOF – Lid Parallel Conjunctival folds; LLT – Lipid Layer Thickness; TBUT – Tear Film Break-up Time.
Table 5 presents basic characteristics, skin type, and dry eye signs associated with dry eye by means of binary logistic regression analyses. The strongest associations were found for older age (OR 1.07, p = .001) and female gender (OR 11.29, p = .001), while significant relations were found for dry skin (OR 0.57, p = .002), higher LIPCOF score of both eyes (OR 2.73, p = .002), lower sebumetry score of the forehead (OR 0.98, p = .007) and cheek (OR 0.98, 0.005), and shorter TBUT score before (OR 0.88, p = .008) and after gland expression (OR 0.87, p = .002). After adjustment for age and gender, most of the associations remained independently and significantly associated with dry eye, except TBUT score before gland expression (AOR 0.92, p = .096).

Discussion

Is there a correlation between gender, age, DED, and facial skin oiliness? In this study, subjects without dry eye symptoms reported oilier facial skin than those with dry eyes and had higher sebumetry scores. Women, especially older ones, more frequently had dry eye symptoms, complained of dry skin, and had lower sebumetry scores.

Zlatogorski and Dikstein have shown in their study performed on 270 male and 382 female subjects aged 20–95 that sebum quantity, measured by sebumeter on the forehead and face, does not change in male subjects but decreases in female subjects, especially in age groups older than 40. The postulated reason for that was a decrease in circulating androgens.64

Another issue is how accurate patients are in their assessment of their facial skin type. Laufer and Dikstein performed research in 1996 on 103 female subjects aged 19–82.45 After being asked to self-assess their skin type, sebumetry was performed on their foreheads, cheeks, and necks. There was a statistically relevant correlation between self-reported skin type and sebumetry measurement: 95% of women who reported dry skin had low sebumetry values on their forehead, 100% on the cheek, and 87% neck. Also, a more significant number of women reported drier skin after menopause, and sebumetry measurements corroborated their self-assessment.

The present study similarly showed that skin dryness self-assessment reliably describes its actual condition due to a significant positive correlation with sebumetry scores, especially in older women who predominantly have dry eyes.

Surprisingly, in the literature, authors found only one study investigating the association between self-reported dryness from different body regions, published by a group of gynecologists.33 They proposed a new concept stating that dryness from various areas, such as the eyes, nose, mouth, vagina, and skin, represents a common ‘dryness syndrome’. They conducted a study using a web questionnaire of subjective feeling of dryness of the eyes, nose, mouth, skin, and vagina on 310 women of different ages. The results showed that subjects who feel dryness in a specific region might also feel dryness in the other areas. They suggested that it may be caused by factors affecting the autonomic nervous system or hormonal changes in menopause. The main drawback of this study was that the authors used only subjective data reported by the patients themselves to investigate this connection without using any objective test.

The present study’s authors investigated the correlation between DED symptoms and self-reported skin type in their previous two papers.28,29 In his study conducted on 200 subjects, 100 with dry eye symptoms and 100 without, the first author found similar results among his female subjects: women with dry eye symptoms more frequently reported skin dryness, and this correlation neatly corresponded with age – older women had drier eyes and drier skin. No such correlation was found among men.28

This finding corroborates data from the research done in 2013 by Luebberding, Krueger, and Kerscher.46 A total of 300 healthy male and female subjects (20–74 years) were selected following strict criteria, including age, sun behavior, or smoking habits. Hydration level, sebum production, and pH values were measured at the forehead, cheek, neck, volar forearm, and dorsum of the hand. Sebum production in male skin was always higher and stayed stable with increasing age, whereas sebum production in women progressively decreased over a lifetime. Authors concluded that skin physiological distinctions between the sexes exist and are particularly remarkable concerning sebum production and pH value.

This skin data remarkably mirrors dry eye epidemiology – it is more frequent among women, significantly older ones. However, this similarity is usually ignored, and dry eye is usually regarded and treated as an exclusively ocular disorder.

The second author of this study researched 108 patients, 56 with DED symptoms and 52 without, as part of her doctoral thesis.25 In that study, she found a statistically significant negative correlation between self-reported facial skin type and dry eye symptoms obtained by the Schein questionnaire. She also found self-reported skin type to be significantly positively connected with noninvasive tear break-up time test
(NIBUT) values and a strong indicator of dry eye symptoms. In their previous works, authors used only the self-reported skin type test to assess skin dryness. Therefore, to evaluate dry skin and dry eye and investigate their correlation more objectively, in the present study, they used sebumetry to assess sebaceous gland function and meibometry to obtain MG function.

There were no differences between the groups in meibometry scores before and after gland expression in the present study. Meibometry is a method described in several published papers. However, when performed as instructed by the manufacturer, it produced low repeatability values, which eventually failed to detect dry eye patients or correlate with other measured parameters.

Finally, multiple regression analysis highlighted self-reported skin type, older age, female gender, lower forehead and cheek sebumetry, TBUT, and LIPCOF, as significant predictors and indicators of ocular dryness. Therefore, a self-reported skin type can be used to suspect or detect dry eye.

This study strongly suggested that dry eye and dry skin accompany each other and that subjects who complain of skin dryness might simultaneously suffer from ocular dryness and vice versa. Paying attention to these symptoms might be essential for the early detection and relief of ocular or skin dryness with subsequent improvement in patients’ quality of life.

Despite bringing crucial new insight, there are limitations to this study. First of all, the authors used the Schein questionnaire, which does not evaluate the impact of dry eye symptoms on patients’ vision, everyday activities, and quality of life. There are no established cut-off values for DED compared to OSDI and DEQ-5. Schein questionnaire was chosen for this study because authors use it routinely in their clinical work and are more familiar. Also, the questionnaire is validated for use in Croatian. Second, since the pathophysiology of dry skin is unclear by now, and it is still not recognized as a disease, there are no recommendations on how to diagnose it accurately, neither which questionnaire nor diagnostic test to use to evaluate the condition. The authors used skin self-reported dry eye type similar to those used in several more studies. Laufer and Dikstein and de Melo and Maia Campos found a positive correlation between sebum secretion measured by sebumeter and skin dryness, so the authors used the same sebumeter to assess sebaceous gland function and skin dryness. At the end, in this study, we found a significant connection between ocular and skin dryness; however, the exact mechanism of that connection is still unknown. It is suggested that it may be on the hormonal level. Indeed, more investigations on genetic and molecular levels are needed to confirm and clarify that connection.

**Conclusion**

This study showed that ocular dryness is correlated to facial skin dryness. People with dry skin also have drier eyes. Both being parts of the body surface, it is clear that the ocular dryness could not be observed as the solely ocular condition but as the general body surface problem. As both body surface parts play the same role in dehydration prevention, there has to be the same function regulator.

As this study showed that patients reliably assessed their facial skin condition, this information may be important to practitioners lacking necessary equipment to objectively examine the ocular surface, like in family medicine, to help their patients: patients with chronic ocular symptoms who also report dry skin may have them due to dry eye. This information may also be helpful to eye care professionals. The simultaneous presence of dry eye and dry skin symptoms should raise suspicion of DED, and therefore, DED should be considered a cause of the patient’s complaints. Early diagnosis and treatment of DED could relieve dry eye symptoms, alleviate the disease severity and, consequently, improve life quality, including physical, social, psychological, and workplace productivity.

**Disclosure statement**

No author has a financial or proprietary interest in any material or method mentioned.

**Authorship**

All authors mentioned fulfill the criteria for authorship as per ICMJE guidelines. Anyone who does not meet the criteria has not been included.

**Informed consent**

Informed consent was obtained from all individual participants included in the study.

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