The prevalence of dry eye in a very old population

Mukharram M. Bikbov,1 Gyulli M. Kazakbaeva,1 Ellina M. Rakhimova,1 Iuliia A. Rusakova,1 Albina A. Fakhretdinova,1 Azaliia M. Tuliakova,1 Songhomitra Panda-Jonas,2 Timur R. Gilmanshin,1 Rinat M. Zainullin,1 Natalia I. Bolshakova,1 Kamilia R. Safiullina,1 Ainur V. Gizzatov,1 toolbox M. Kazakbaeva,1 Ainur V. Gizzatov,1 Ellina M. Rakhimova,3,4 and Nikolay A. Nikitin1

1Ufa Eye Research Institute, Ufa, Bashkortostan, Russia
2Privatpraxis Prof Jonas und Dr Panda-Jonas, Heidelberg, Germany
3Department of Ophthalmology, Medical Faculty Mannheim of the Ruprecht-Karls-University of Heidelberg, Mannheim, Germany
4Institute of Molecular and Clinical Ophthalmology, Basel, Switzerland

ABSTRACT.

Purpose: To assess the prevalence of dry eye disease (DED) and Meibomian gland dysfunction (MGD) in a very old population.

Methods: The Ural Very Old Study (UVOS), a population-based cohort study performed in rural and urban Bashkortostan/Russia, included 1526 (81.1%) out of 1882 eligible individuals aged 85+ years. The participants underwent a detailed medical and ophthalmological examination including Schirmer’s test, slit-lamp based assessment of the Meibomian glands and an interview.

Results: The study included 1493 (97.8%) individuals with available information about DED (mean age: 88.3 ± 2.9 years). Schirmer’s test was ≤5 mm in 388 individuals (34.3%; 95% confidence interval (CI): 31.5, 37.1), and the mean score of subjective dry eye symptoms was 7.52 ± 2.14 (median: 6; range: 6–18; 95% CI: 7.41, 7.63). An MGD grade 1, 2, 3 and 4 was diagnosed in 367 (31.4%), 309 (26.4%), 89 (7.6%) and 39 (3.3%) eyes, respectively. The prevalence of DED diagnosis definition #2 (dry eye score ≥8, Schirmer’s test ≤5 mm) and definition #4 (dry eye score ≥7, Schirmer test ≤5 mm, MGD grade 1+), were 164/1132 (14.5%; 95% CI: 12.4, 16.5), and 167/1131 (14.8%; 95% CI: 12.7, 16.8), respectively. In multivariate analysis, higher DED prevalence was associated with female sex (odds ratio (OR): 2.36; 95% CI: 1.18, 4.71; p = 0.02), rural region of habitation (OR: 2.72; 95% CI: 1.10, 6.70; p = 0.03), longer axial length (OR: 1.30; 95% CI: 1.04, 1.62; p = 0.02), higher hearing loss score (OR: 1.03; 95% CI: 1.01, 1.05; p = 0.001) and lower self-reported salt consumption (OR: 0.64; 95% CI: 0.54, 0.75; p < 0.001).

Conclusions: In this population-based recruited very old study sample aged 85+ years, higher DED prevalence (dry eye score ≥8, Schirmer’s test ≤5 mm; mean: 14.5%) and MGD prevalence (any grade:68.8%) was associated with female sex, rural region of habitation, longer axial length, higher hearing loss score and lower salt consumption.

Key words: dry eye – epidemiology – Meibomian gland dysfunction – Russia – Ural Very Old Study

Introduction

As recently formulated by experts in the field, dry eye disease (DED) is a multifactorial disease of the ocular surface characterized by a loss of tear film homeostasis, with increased tear film instability, tear hyperosmolarity, ocular surface inflammation and neurosensory abnormalities (Bron et al. 2017; Craig et al. 2017; Jones et al. 2017). Dry eye disease is often accompanied and caused by a Meibomian gland dysfunction (MGD) as a chronic, diffuse abnormality of the Meibomian glands, commonly characterized by terminal duct obstruction and/or qualitative/quantitative changes in the glandular secretion (Green-Church et al. 2011; Knop et al. 2011; Nelson et al. 2011; Tomlinson et al. 2011). Both DED and MGD belong to the most common causes of patient visits to ophthalmologists and optometrists (Craig et al. 2017a; Wolffsohn et al. 2017). In previous studies, the prevalence of DED varied, depending on the diagnostic criteria and techniques applied, between 9% and 30% when both symptoms and signs were considered, and it ranged from 7% to 52% when only symptoms were taken into account (No authors listed (2007); Stapleton et al. 2017; Wolffsohn et al. 2017). Patients with moderate to severe DED often complain about significant ocular discomfort, with limitations in carrying out routine activities, in association with a reduced quality of life, reduced general health and depression (Craig et al. 2017b). The prevalence of
MGD has been estimated in a previous meta-analysis in which the pooled MGD prevalence was 36% (95% confidence interval (CI): 24, 50) in clinical and in population-based studies, with men more than women being affected (odds ratio (OR): 1.24; 95% CI: 1.01, 1.52) (Amano & Inoue (2017); Hashemi et al. 2017; Hassanzadeh et al. 2020; Schaumberg et al. 2011). The MGD prevalence rate was lowest in Africans (21.2%) and Caucasians (29.5%) and highest in Hispanics (67.5%) and Arabs (71.0%) (Hassanzadeh et al. 2020). Most of the previous studies on the prevalence and associations of DED and MGD included relatively small study populations, and only a few medical disorders were assessed for an association with DED and MGD. In particular, none of the previous investigations was focussed on a very old study population, and none of them examined the DED and MGD prevalence and associations in a population from Russia, one of the most populous countries globally. Therefore, the present study was conducted on a very old group of individuals in Russia, who were recruited in a population-based manner and who additionally underwent a detailed ophthalmological and medical examination.

Methods

The Ural Very Old Study is a population-based study performed in the rural region of Kirovskii in the Karmaskalinsky District at a distance of 65 km from the capital Ufa in the Republic of Bashkortostan / Russia, and in an urban region in Ufa. The study was approved by the Ethics Committee of the Academic Council of the Ufa Eye Research Institute and informed written consent was obtained from all participants. Inclusion criteria were an age of 85+ years and living in the study regions. The Republic of Bashkortostan has a population of about 4.07 million people and it is geographically located in the west of the southern Ural Mountains, about 1300 km east of Moscow. Its capital Ufa is an economic, scientific and cultural centre and has a population of 1.1 million inhabitants including Russians, Bashkirs, Tatars, Ukrainians and other ethnicities.

Out of 1882 eligible inhabitants aged 85+ years and living in the study regions, 1526 (81%) persons participated in the study. The participation rate did not vary markedly between the urban group (1238 (81.3%) out of 1523 individuals) and the rural group (288 (80.2%) out of 359 individuals). According to the census carried out in Russia in 2010, the composition of the population of the Ural Very Old Study with respect to gender and age corresponded to the gender and age distribution in the Russian population beyond an age of 85+ years, with a marked preponderance of females (Federal State Statistic Service, 2010).

All study participants underwent a standardized interview conducted by trained social workers in personal meetings. The questionnaire included 293 questions on the socioeconomic background, smoking, alcohol consumption, physical activity, quality of life and quality of vision, symptoms and histories of medical diseases, depression, suicidal ideas, anxiety, cognitive function and hearing loss. The questions included in the interview had been validated in previous investigations such as the Folstein test, Zung’s self-rated depression scale, and the National Eye Institute Visual Functioning Questionnaire—25 (VFQ-25; Zung 1965; Folstein et al. 1975; Klein et al. 2001). The clinical examinations included measurement of the anthropomorphic parameters, arterial blood pressure and pulse rate, dynamometric assessment of the handgrip strength, and biochemical examinations of blood samples taken under fasting conditions. Arterial hypertension was defined as recommended by the American College of Cardiology/American Heart Association (Whelton et al. 2018). Diabetes mellitus was characterized by a fasting glucose concentration of ≥7.0 mmol/l or a self-reported history of physician diagnosis of diabetes mellitus or a history of drug treatment for diabetes (insulin or oral hypoglycemic agents). Depression was assessed applying the Center for Epidemiological Studies Depression Scale (CES-D) Scoresheet (Thomas et al., 2001). The estimated glomerular filtration rate (eGFR) was calculated using the chronic kidney disease (CKD) Epidemiology Collaboration (CKD-EPI) equation (Levey et al. 2009). The Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER statement guidelines; Stevens et al. 2016) were applied. The design of the Ural Very Old Study was similar to the design of the Ural Eye and Medical Study which has been described in detail previously (Bikbov et al. 2019, 2020).

The ophthalmological examinations consisted of the measurement of presenting, uncorrected and best corrected visual acuity, automated refractionometry, static perimetry (PTS 1000 Perimeter, Optopol Technology Co., Zawercie, Poland; screening test programme: 50° in all directions; 82 test points), anterior segment imaging using the Scheimpflug camera (Pentacam HR, Typ70900, OCULUS, Optikgeräte GmbH Co., Wetzlar, Germany), slit-lamp biomicroscopy of the anterior and posterior ocular segment, non-contact tonometry (Tonometer Kowa KT-800, Kowa Company Ltd., Hamamatsu City, Japan, Tonoref III, Nidek, Japan, PT 100 Recharging Base, Reichert, Depew, NY, USA), examination for the presence of pseudoxefoliation of the lens after medical mydriasis, photography of the cornea and lens (Topcon slit lamp and camera, Topcon Corp., Tokyo, Japan) and photography of the optic disc and macula (VISUCAM 500, Carl Zeiss Meditec AG, Jena, Germany, Optomed smartscope EY4, Finland), spectral-domain optical coherence tomography (RS-3000 Edvance, NIDEK co., Ltd., Aichi Japan, DRI OCT Triton (plus), Topcon, Japan) of the optic nerve head and macula, and measurement of the axial length by sonography (Ultra-compact A/B/P ultrasound system, Compact touch; Quantel Medical, Cournon d’Auvergne, France, US-4000, Nidek, Japan).

The Meibomian glands were assessed by examining the gland orifices and their secretion upon slit-based examination of the anterior segment. It was differentiated between ‘normal’ (grade 0), ‘no obstruction of the Meibomian gland orifices but telangiectasias’ (grade 1), ‘plugged Meibomian gland orifices with translucent serous secretion when the lid margin was compressed’ (grade 2), ‘plugged Meibomian gland orifices with viscous or waxy white secretion when the lid margin was compressed’ (grade 3), and ‘plugged Meibomian gland orifices and no secretion when the lid margin was compressed’ (grade 4). Both eyes
of each study participant were examined, and the data of the worse eye were used for the statistical analysis.

The prevalence and degree of a DED were assessed by specific questions in the questionnaire and by additional physical examinations. The questions were: (1) Do your eyes feel dry; (2) Do you ever feel a gritty or sandy sensation in your eye; (3) Do your eyes ever have a burning sensation; (4) Are your eyes ever red; (5) Do you notice much crusting on your lashes; and (6) Do your eyes ever get stuck in the morning. All questions were answered using a scale of grade 0 for ‘never’, grade 1 for ‘rarely or sometimes’, and grade 2 for ‘frequently or always’. A quantitative grading score of the subjective dry eye symptoms was obtained by summarizing the grades of the answers to the six questions (0–12). As described by Wolfssohn and colleagues, a Schirmer test was performed without the use of a topical anaesthetic drug (Knop et al. 2011). A Schirmer paper strip (5 x 35 mm) was folded at the notch and hooked the folded end over the temporal one-third of the lower lid margin. The participants were asked to close their eyes, and after five minutes, the strip was removed and the length of wetting from the notch was measured. The participants were asked to notice much crusting on the lashes and (6) Do your eyes ever get stuck in the morning. The participants were asked to close their eyes, and after five minutes, the strip was removed and the length of wetting from the notch was measured. For the diagnosis of a DED, several definitions were used. Definition #1 was made with a dry eye symptom score of ≥7 and a Schirmer’s test ≤5 mm. In definition #2, the dry eye symptoms score was ≥8 and Schirmer’s test ≤5 mm, and in definition #3, the dry eye symptoms score was ≥9 with a Schirmer’s test of ≤5 mm. In definition #4, the dry eye symptoms score was ≥7, with a Schirmer test ≤5 mm and an MGD grade of 1 (telangiectasia at the lid margin) or higher. In definition #5, the dry eye symptoms score was ≥7, Schirmer test ≤5 mm and the MGD grade was 2 (plugged Meibomian gland orifices with translucent serous secretion when the lid margin was compressed) or higher.

The statistical analysis was conducted using a commercially available statistical software package (SPSS for Windows, version 25.0, SPSS, Chicago, IL, USA). The mean values (presented as mean and 95% confidence intervals (CI) or as mean ± standard error) of the main outcome parameters were calculated and a univariate analysis was conducted of the associations between the presence of a DED or MGD and other ocular and systemic parameters. A subsequent binary multivariable regression analysis included the presence of DED and MGD as the dependent parameter and as independent parameters all those variables that were associated significantly with the DED and MGD presence in the univariate analyses. In a step-by-step manner, those variables were dropped out of the list of independent parameters that were no longer significantly associated with the DED and MGD prevalence. The odds ratios (ORs) and their 95% CIs were determined. All p-values were two-sided and considered statistically significant when the values were less than 0.05.

Results
Out of 1526 individuals primarily participating in the Ural Very Old Study, the present investigation included 1493 (97.8%) individuals (1111 (74.4%) women; 382 (25.6%) men) for whom the symptoms of DED were examined as part of the interview. The study population was composed of 542 (36.3%) individuals of Russian ethnicity, 657 (44.0%) Tatars, 169 (11.3%) Bashkirs, 49 (3.3%) Chuvash, 8 (0.5%) Mari and 68 (4.5%) others. The mean age was 88.3 (median: 88; range: 85–103) years of the worse eyes (defined as the eye with the smaller Schirmer test result). The mean score of the subjective dry eye symptoms was 7.52 ± 2.14 (median: 6; range: 6–18; 95% CI: 7.41, 7.63) (Fig. 1). An MGD grade 1, 2, 3 and 4 in the worse eye was diagnosed in 367 (31.4%), 309 (26.4%), 89 (7.6%) and 39 (3.3%) eyes, respectively (Tables 1 and 2). The prevalence of MGD of any degree was 68.8% (95% CI: 66.1, 71.4). The prevalence of DED diagnosis 1, 2, 3, 4 and 5 were 206/1132 (18.2%; 95% CI: 16.0, 20.5), 164/1132 (14.5%; 95% CI: 12.4, 16.5), 92/1132 (8.1%; 95% CI: 6.5, 9.7), 167/1131 (14.8%; 95% CI: 12.7, 16.8) and 84/1131 (7.4%; 95% CI: 5.9, 9.0), respectively (Figs. 2 and 3).

Fig. 1. Histogram showing the distribution of the total score of the dry eye symptoms in the Ural Very Old Study.
In univariate analysis, the prevalences of DED definitions #2 and 4 were associated with the parameters of older age, rural region of habitation, lower body mass index, lower level of education, lower number of daily meals, lower number of days per week with vegetable or fruit intake, use of animal fat (butter) instead of vegetable oil for cooking, lower self-reported salt consumption, higher diastolic and mean blood pressure, higher hearing loss score, higher depression score, higher State-Trait Anxiety Inventory score, lower dynamometric hand force, longer axial length, higher cylindrical refractive error, higher intraocular pressure, and lower prevalence of previous cataract surgery (Table 3).

In the multivariate analysis with the prevalence of DED definition #2 as the dependent variable, we dropped, due to lack of statistical significance, the parameters of type of cooking oil (p = 0.78), diastolic blood pressure (p = 0.71), body mass index (p = 0.81), number of days with the intake of vegetables (p = 0.65), number of meals per day (p = 0.25), status after cataract surgery (p = 0.33), level of education (p = 0.80), number of days with fruit intake (p = 0.27), depression score (p = 0.73), anxiety score (p = 0.51), age (p = 0.48), cylindrical refractive error (p = 0.13), dynamometric handgrip force (p = 0.09). In the final model, after adding the parameter of gender and dropping the parameter of intraocular pressure, a higher prevalence of DED (definition #2) was associated with female sex (OR: 3.64; 95% CI: 1.18, 4.71; P = 0.02), rural region of habitation (OR: 2.72; 95% CI: 1.10, 6.70; p = 0.03), lower axial length (OR: 1.30; 95% CI: 1.04, 1.62; p = 0.02), higher hearing loss score (OR: 1.72; 95% CI: 1.01, 1.05; p = 0.001) and lower self-reported salt consumption (OR: 0.64; 95% CI: 0.54, 0.75; p < 0.001). If the parameters of age (p = 0.08), depressions core (p = 0.54) or anxiety score (p = 0.45) were added to the model, each of these parameters was not significantly associated with the prevalence of DED (definition #2).

If definition #4 for the DED diagnosis was taken, a higher DED prevalence was associated with rural region of habitation (p = 0.001), lower salt consumption (p < 0.001) and higher hearing loss score (p = 0.001), whilst the relationships with sex (p = 0.20) and with axial length (p = 0.11) were not statistically significant.

### Discussion

In the present study population recruited in a population-based manner and aged 85+ years, 34.3% of the participants had a Schirmer’s test of ≤5 mm, and the mean prevalence of MGD grade 1, 2, 3, 4 and of any grade was 31.4%, 26.4%, 7.6%, 3.3% and 68.8%, respectively. The prevalence of DED using the diagnosis definition #1 to #5 was 18.2%, 14.5%, 8.1%, 14.8% and 7.4%, respectively. In multivariate analysis, a higher DED prevalence (definition #2) was associated with female sex, rural region of habitation, longer axial length, higher hearing loss score and lower self-reported salt consumption. A higher prevalence of DED in association with an MGD (definition #4) was correlated with rural region of habitation, lower salt consumption and higher hearing loss score.

The observations made in the present very old study population cannot directly be compared with the findings obtained in previous studies since the present study is the first investigation on a population with a minimum age of 85 years. In the Shahroud Eye Cohort...
Study conducted in 2014 in Iran, the prevalence of MGD based on the classification of the International Workshop on MGD was 26.3% in the study population with a mean age of 55.9 ± 6.2 years. The MGD prevalence increased significantly correlated with a higher prevalence of pinguecula and arterial hypertension, lower prevalence of diabetes mellitus, lower serum concentrations of high-density lipoprotein and less years of education (Hashemi et al. 2017). In a hospital-based study on Japanese patients aged 50+ years and undergoing cataract surgery, the prevalence of MGD (defined by lid margin abnormalities and signs of occlusion of the Meibomian glands) 18.0% and 47.5% for symptomatic MGD and symptomatic combined with asymptomatic MGD (Amano & Inoue, 2017). The MGD prevalence increased with older age. In the most comprehensive meta-analysis of globally available population-based studies on the DED prevalence, the latter ranged between 5% and 50% (Stapleton et al. 2017).

In the present study population, DED was more common in females and in the rural region as well as in eyes with longer axial length. The DED prevalence was furthermore correlated with a higher hearing loss score and a lower self-reported salt consumption. In previous studies on younger populations, the DED prevalence increased with older age (Stapleton et al. 2017).

The prevalence of MGD of any grade was 68.8% (95% CI: 66.1, 71.4) (Tables 1 and 2). That figure was higher than the prevalence rates reported in previous studies on younger populations, in which the MGD prevalence, pooled in a meta-analysis, was 36% (Schaumberg et al. 2011; Amano & Inoue 2017; Hashemi et al. 2017; Hassanzadeh et al. 2020). The reasons for the higher MGD prevalence in the present study may have been the markedly older age as compared to the study groups of previous investigations, and interethnic differences (Hassanzadeh et al. 2020).

When the results of the present study are discussed, its limitations should be taken into account. First, we did not assess the break-up time of the tear film, a parameter that has been included in previous studies on the prevalence of DED. Second, although 1526 (81%) out of 1882 eligible individuals participated in the Ural Very Old Study and although 1493 (97.8%) out of the 1526 participants took part in the study, we did not assess the break-up time of the tear film, a parameter that has been included in previous studies on the prevalence of DED. Second, although 1526 (81%) out of 1882 eligible individuals participated in the Ural Very Old Study and although 1493 (97.8%) out of the 1526 participants took part in the study.
in the questionnaire and provided answers for the symptoms of DED, only 1139 (76.3%) out of the 1493 persons came to the clinical examinations into the hospital. Interestingly, individuals with clinical examinations and those without did not vary in demographic variables. If one considers the relatively old age of this study population and the multimorbidity often occurring in that age, the participation rate of 76% for participating in the clinical examinations appears to be acceptable. Third, the study regions of the Ural Very Old Study were

| Parameter                                      | Definition #2 | p-value | Definition #4 | p-value |
|------------------------------------------------|---------------|---------|---------------|---------|
| Age                                            | 0.08          | 0.007   | 0.04          | 0.19    |
| Gender                                         | 1.45 (0.97, 2.17) | 0.09 | 1.04 (0.72, 1.52) | 0.92    |
| Region of habitation (urban / rural)           | 2.65 (1.87, 3.76) | <0.001 | 2.64 (1.87, 3.74) | <0.001 |
| Ethnicity (non-Russian / Russian)               | 0.71 (0.49, 1.01) | 0.06 | 0.76 (0.53, 1.08) | 0.14    |
| Body height                                    | 0.08          | 0.81    | 0.06          | 0.06    |
| Body weight                                    | −0.07         | 0.02    | −0.04         | 0.19    |
| Body mass index                                 | −0.09         | 0.006   | −0.10         | 0.002   |
| Waist circumference                             | −0.009        | 0.03    | −0.11         | 0.001   |
| Hip circumference                               | −0.08         | 0.01    | −0.08         | 0.01    |
| Waist/hip circumference ratio                   | −0.03         | 0.28    | −0.05         | 0.09    |
| Level of education                              | −0.12         | <0.001  | −0.14         | <0.001  |
| Smoking, currently                              | 0.04          | 0.19    | 0.04          | 0.19    |
| Alcohol consumption, any                        | −0.05         | 0.08    | −0.07         | 0.02    |
| Number of daily meals                           | −0.08         | 0.01    | −0.06         | 0.04    |
| In a week how many days do you eat fruits?      | −0.09         | 0.002   | −0.11         | <0.001  |
| In a week how many days do you eat vegetables?  | −0.06         | 0.06    | −0.10         | 0.001   |
| Type of oil for cooking used: vegetable cooking oil – animal fat (butter) | 0.008 | 0.005 | 0.06 | 0.04 |
| Food containing whole grains (no/yes)           | 0.06          | 0.06    | 0.04          | 0.22    |
| Salt consumed per day (g)                       | −0.15         | <0.001  | −0.15         | <0.001  |
| Degree of processing meat (weak – medium – strong) | −0.03         | 0.40    | −0.06         | 0.03    |
| Number of cups of coffee taken daily            | −0.06         | 0.28    | 0.03          | 0.31    |
| Number of cups of tea taken daily               | 0.03          | 0.31    | 0.03          | 0.31    |
| Preference of green or black tea                | 0.04          | 0.18    | 0.05          | 0.15    |
| Prevalence of diabetes mellitus                 | 0.60 (0.34, 1.05) | 0.08 | 0.60 (0.34, 1.05) | 0.08 |
| Prevalence of known chronic kidney disease      | 1.12 (0.63, 1.98) | 0.78 | 0.91 (0.53, 1.54) | 0.68 |
| Anaemia (serum haemoglobin concentration <140 g/l in men, <130 g/l in women) | 1.17 (0.83, 1.64) | 0.39 | 1.30 (0.92, 1.83) | 0.14 |
| Blood pressure, systolic (SBP)                  | 0.04          | 0.22    | 0.09          | 0.004   |
| Blood pressure, diastolic (DBP)                 | 0.07          | 0.03    | 0.11          | <0.001  |
| Blood pressure, mean                            | 0.06          | 0.053   | 0.11          | <0.001  |
| Arterial hypertension                           | 0.74 (0.44, 1.26) | 0.31 | 1.04 (0.59, 1.85) | 1.00 |
| Arterial hypertension, stages                   | 0.1           | 0.64    | 0.06          | 0.04    |
| History of prevalence of chronic obstructive pulmonary disease | 0.91 (0.50, 1.66) | 0.76 | 1.27 (0.66, 2.43) | 0.54 |
| Hearing loss score                              | 0.07          | 0.02    | 0.05          | 0.09    |
| Depression Score                                | 0.09          | 0.002   | 0.08          | 0.008   |
| State-Trait Anxiety Inventory                   | 0.07          | 0.03    | 0.07          | 0.02    |
| Manual dynamometry, right hand                  | −0.14         | <0.001  | −0.13         | <0.001  |
| Manual dynamometry, left hand                   | −0.16         | <0.001  | −0.14         | <0.001  |
| Refractive error, spherical equivalent           | −0.03         | 0.47    | −0.03         | 0.34    |
| Refractive error, cylindrical value             | 0.11          | 0.001   | 0.06          | 0.08    |
| Refractive error, axis of the cylindrical value | 0.1           | 0.75    | −0.02         | 0.54    |
| Axial length                                    | 0.08          | 0.03    | 0.06          | 0.09    |
| Corneal refractive power                        | −0.03         | 0.50    | −0.03         | 0.50    |
| Central corneal thickness                       | −0.07         | 0.07    | −0.03         | 0.43    |
| Topical glaucoma therapy                        | 0.75 (0.47, 1.21) | 0.24 | 0.93 (0.57, 1.53) | 0.80 |
| Intraocular pressure                            | 0.19          | <0.001  | 0.18          | <0.001  |
| Cataract surgery                                | 0.55 (0.38, 0.78) | 0.001 | 0.49 (0.34, 0.71) | <0.001 |

Table 3. Associations (binary univariate analysis) between the prevalence of dry eye disease using definition #2 (dry eye symptoms score was ≥8 and Schirmer’s test of <5 mm) or definition #4 (dry eye symptoms score was ≥7, Schirmer test ≤5 mm, and a Meibomian gland dysfunction grade of 1 (telangiectasia at the lid margin) or higher) with systemic and ocular parameters in the Ural Very Old Study.
characteristic for the Southern Russia in terms of demography, geography and climate. In terms of the ethnic background, the percentage of Russians was lower in the present study population than in North-Western Russia and Central Russia. In the multivariable analysis, however, the ethnic background was not associated with the prevalence of DED and MGD, so that the relatively high percentage of non-Russians on the total study population may not have markedly influenced the results. Fourth, various definitions of DED and MGD have been used in previous investigations (Jie et al., 2009; Baudouin et al. 2014; Tsubota et al. 2020; Labetoulle et al., 2021). To address that problem, four different definitions of DED were used to make the results of the present study is comparable with those of previous investigations. Fifth, the multimorbidity of individuals aged 85+ years might have made the symptoms of DED and MGD seem relatively minor compared to pain or other major complaints due to medical diseases. It might have led to an underestimation of the prevalence and severity of DED and MGD in the present study population as compared to younger populations. Strengths of the present investigation are that it is the first population-based investigation on the prevalence of DED and MGD in a very old population, that is overall the first study on that topic from Russia, and that a multitude of systemic parameters was assessed and included in the statistical multivariable analysis.

In conclusion, in a population-based recruited study sample aged 85+ years, the mean prevalence of DED, defined by a dry eye score of ≥28 and a Schirmer’s test of <5 mm, was 14.5%, and the mean prevalence of MGD (grade 1 or higher) was 68.8%. The prevalences were associated with female sex, rural region of habitation, longer axial length, higher hearing loss score and lower salt consumption.

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Jost Jonas, MD

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Correspondence:
Mukharram Bikbov, MD PhD
Ufa Eye Research Institute
90 Pushkin Street
Ufa 450077
Bashkortostan
Russia
Tel: +7(347)272-37-75
Fax: +7(347)286-5303
Email: Bikbov.m@gmail.com

Jost Jonas, MD
Department of Ophthalmology
Medical Faculty Mannheim
Theodor-Kutzerufer 1
Mannheim 68167
Germany
Tel: +49-6221-3929320
Fax: +49-6221-3929309
Email: Jost.Jonas@meduni-heidelberg.de
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