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Prevalence and Associated Factors of Cataract, Cataract Surgery and Postoperative Outcome in an Old Population in Russia: The Ural Very Old Study

Mukharram M. Bikbov, MD, PhD,[1] *Gyulli M. Kazakbaeva, MD,*[1] *Songhomitra Panda-Jonas, MD,*[2,3,4] *Ellina M. Lakupova, MD,*[1] *Albina A. Fakhretdinova, MD,*[1] *Azaliia M. Tuliakova, MD,*[1] *Jost B. Jonas, MD*[3,4,5,6,7]

Purpose: To assess prevalence of cataract and cataract surgery in a very old population in Russia.

Design: Population-based study.

Participants: The Ural Very Old Study included 1526 (81.1%) participants of 1882 eligible individuals aged >85 years.

Methods: Series of ophthalmological examinations.

Main Outcome Measures: Prevalence of cataract and cataract surgery.

Results: The study included 1163 (76.3%) individuals with lens information. Cataract surgery had been performed in 469 right eyes (41.0%; 95% confidence interval [CI]: 38.1−43.9) (92.1% with posterior chamber intraocular lens [IOL]; 4.7% with multifocal IOL) and 479 left eyes (41.6%; 95% CI: 38.7−44.4) (92.7% with posterior chamber IOL; 4.2% with multifocal IOL). Cataract surgery had been performed in at least one eye for 610 (52.5%) individuals. Higher prevalence of previous cataract surgery correlated (multivariable analysis) with lower IOP (OR: 0.92; 95% CI: 0.88−0.95), glaucomatous optic nerve damage stage (OR: 1.20; 95% CI: 1.05−1.36), and better visual acuity (OR: 0.67; 95% CI: 0.51−0.89). Postoperative best corrected visual acuity was reduced to moderate-to-severe vision impairment (MSVI) in 202 eyes (44.6%; 95% CI: 40.0−49.2) and to blindness in 53 eyes (11.7%; 95% CI: 8.7−14.7). Causes of postoperative MSVI were age-related macular degeneration (AMD) (34.2%), glaucoma (13.9%), and secondary cataract (5.4%). Causes for blindness were AMD (24.5%), glaucoma (18.9%), corneal opacifications (15.8%) and myopic macular degeneration (11.3%). Yttrium Aluminum Garnet-laser capsulotomy had been performed in 6 (1.3%) of 469 right eyes and 12 (2.5%) of 479 left eyes. Prevalence of nuclear cataract and cortical cataract was 604/671 (90.0% in phakic eyes; 51.9% in the whole study population) and 97.9% eyes (48.4% in total study population). Cataract caused bilateral MSVI and blindness in 28.2% (95% CI: 25.6−30) and 2.9% (95% CI: 1.9−3.9), respectively, of all study participants.

Conclusions: Despite a relatively high prevalence of cataract surgery, this multiethnic cohort >85 years of aged from Russia showed a high prevalence of cataract-related MSVI and blindness. Main causes for postoperative MSVI (prevalence: 44.6%) and blindness (prevalence: 11.7%) were AMD, glaucoma, corneal opacifications, and myopic macular degeneration. Almost all individuals aged 85+ years need cataract surgery, despite limited chance of postoperative good vision.

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The most common causes of vision impairment and blindness worldwide are undercorrection of refractive error and blindness.[1,2] Although improvements in the socioeconomic background and refinements of the techniques of cataract surgery have markedly increased the cataract surgical rate in the last 3 decades, aging of the population has prevented a profound decrease in the number of individuals visually impaired by cataract as an age-related disorder.[1−3] Cataract has thus remained a major problem in global public health.[1,2] Numerous studies have addressed the prevalence of cataract and its associated vision impairment in various countries and world regions. Information has remained scarce however about the cataract prevalence and its associations and the prevalence of cataract surgery and its postoperative visual outcome in the very old population. It holds true in particular for Russia and Central Asia.[4,5] We, therefore, conducted this study to assess the prevalence of cataract and its associations with other ocular and general parameters, the prevalence of pseudophakia and the visual outcome after cataract surgery, and the factors influencing it in a very old group of individuals recruited in a population-based manner in Bashkortostan/Russia.

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Methods

In the Republic of Bashkortostan/Russia, we performed the Ural Very Old Study with recruitment of the study participants in a population-based manner. Inclusion criteria were an age >85 years and living in the study regions (i.e., a rural region in the Karmaskalinsky district at a distance of 65 km from the city of Ufa and in an urban region of the Kirovskii district in Ufa).[6,7] Ufa is the capital of Bashkortostan, which has a total population of about 4 million people, including Russians, Bashkirs, Tatars, and members of other ethnicities. The project was approved by the Ethics Committee of the Academic Council of the Ufa Eye Research Institute, which confirmed that the study adhered to the Declaration of Helsinki. Informed written consent was obtained from all participants. The study regions were located in the Volga district in the west of the southern Ural Mountains at a distance of 1300 km East of Moscow. Bashkortostan has a continental climate with cold, harsh, and long winters, warm to hot summers, and often cloudy skies, relatively; it is comparable to the continental climate in Northwestern Russia and Central Russia. The major occupations of the rural population are activities in agriculture and forestry with considerable exposure to cold and hot weather, whereas, in the city of Ufa and its surroundings, major industry is located including chemical processing, oil refineries, mining, oil production, and nonferrous metallurgy. During the former Soviet Union and, now, in modern Russia, the mobility of the population has been unlimited; however, immigration and emigration into and out of Bashkortostan have been relatively low. Bashkortostan as a major petroleum producing and refining region has attracted people from other regions of Russia. The density of ophthalmologists in Bashkortostan is 323 ophthalmologists per 4 065 659 inhabitants (or 1 ophthalmologist per 12 600 inhabitants), with a higher ratio in Ufa (207 ophthalmologists per 1 186 446 inhabitants or 1 ophthalmologist per 5700 inhabitants) than in the countryside (116 ophthalmologists per 2 879 213 inhabitants or 1 ophthalmologist per 24 800 inhabitants). All over Russia, the density of ophthalmologists varies between 0.4 to 1.2 ophthalmologists for 10 000 inhabitants. Health care in Bashkortostan as in any other region of Russia is free of charge for everybody, including femtosecond laser-assisted cataract surgery and intravitreal application of any approved medication. In contrast, refractive corneal surgery, including LASIK procedures, is not included in the free health care. The surgeons salary depends on the number of surgeries performed; hence, there is an incentive for carrying out cataract surgeries.

The study included 1526 participants (1136 [74.4%] women; 390 [25.6%] men) or 81% out of the entire group of 1882 eligible persons aged >85 years and living in the study regions.[6,7] The only inclusion criteria were living in the study region and an age >85 years. The participation rate did not differ markedly between the urban group (1238 [81.3%] out of 1523 individuals) and the rural group (288 [80.2%] out of 359 individuals). The distribution of sex and age did not vary markedly between the study population and the Russian population beyond an age >85 years, as examined in the recent census carried out in Russia in 2010.[8,9] Both groups showed 2 constrictions because of the consequences of World War II.[8,9] The study population of the Ural Very Old Study, as compared with the total population of Russia, had a profoundly higher proportion of Tatars (3.7% in entire Russia) and Bashkirs (1.1% in entire Russia) and, correspondingly, a lower proportion of Russians (77.7% in entire Russia). Both populations exhibited a marked preponderance of women. The inhabitants of retirement homes (i.e., 3 small private retirement homes in the urban part) were fully eligible.

The study participants were visited in their homes and were interviewed by medical doctors and trained nurses. The interview took several hours was composed of >300 questions on a panoply of topics.[6,7] The questions addressed topics on the socioeconomic background, including the self-reported ancestry, level of education, occupation, family income and family estate (ownership of a house and second house, telephone, smartphone, laptop, television, bicycle and car), and size and structure of the family; diet (number of meals per day, frequency and amount of intake of vegetables, fruits, whole grain and meat, consumption of tea and coffee, use of animal fat or cooking oil); smoking (since when or stopped, cigarettes or other types of tobacco products, symptoms of smoking cessation); alcohol consumption (since when or stopped, alcohol consumption-related wrongdoing); physical activity (frequency and intensity of daily work, leisure time activities, sitting or reclining); quality of life and quality of vision; symptoms of chronic obstructive pulmonary disease, asthma, kidney disease and orthopedic disorders; history of any type of injuries and interpersonal violence; health assessment questions; and medical history including known diagnosis and therapy of major disorders such as diabetes mellitus, arterial hypertension, cardiovascular diseases, headache, neck pain, thoracic spine and low back pain, depression, suicidal ideas, anxiety, questions on previous neurologic attacks including stroke, epilepsy, polyneuropathy and unconsciousness, and cognitive function and hearing loss. The questions had been taken from investigations like the Folstein test, Zungs self-rated depression scale, and the National Eye Institute Visual Functioning Questionnaire-25.[10,11] The study participants underwent a series of physical and ophthalmological examinations including assessment of anthropomorphic parameters, blood pressure, dynamometric assessment of the handgrip strength, biochemical analysis of blood samples taken under fasting conditions, automated refractometry, measurement of best corrected visual acuity (BCVA), static perimetry, Scheimflug camera-based and slit lamp-based imaging of the anterior ocular segment, pneumotonometry, exploration of lens pseudoexfoliation in medical mydriasis, photography of the cornea, lens, optic nerve head and macula, spectral-domain OCT (RS-3000, NIDEK Co., Ltd.) of the optic disc and macula, and sonographic determination of the axial length. The Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER statement guidelines) were applied.[12]

We assessed the presence and degree of cataract by applying the scheme of the Age-Related Eye Disease Study.[13] For the determination of nuclear cataract, we compared the lens photographs taken from the study participants, with 7 standard photographs of lenses with increasingly severe nuclear opacities. We divided the amount of nuclear cataract into 6 grades by merging standard photograph 6 and 7 into 1 grade. The presence of any nuclear cataract was defined as a nuclear cataract grade of 3+. The degrees of cortical lens opacification and posterior subcapsular lens opacification were assessed using photographs taken by retro-illumination (Topcon slit lamp and camera, Topcon Corp). Cortical and posterior subcapsular opacities appeared as darkly shaded interruptions of the reddish-orange fundus reflex in these photographs. With the help of a grid, we determined the degrees of cortical cataract and subcapsular cataract as the percentage areas of opacity. The presence of cortical cataract and subcapsular cataract was defined by the presence of any cortical or subcapsular opacity, respectively.

We defined arterial hypertension according to the guidelines published by the American College of Cardiology/American Heart Association in 2017. Criteria for the definition of diabetes mellitus were 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. We assessed depression

using the Center for Epidemiologic Studies Depression Scale Scoresheet.[6,7]

Although the interview was conducted in the homes of all study participants, the other examinations were scheduled to be undertaken in the hospital. A subgroup of persons, who were interviewed but could not go to the hospital for the other examinations, were examined in their homes by using a portable camera to take images of the anterior ocular segment and of the fundus.

We defined age-related macular degeneration (AMD) as suggested by the Beckman Initiative for Macular Research Classification Committee.[14] As recommended by the World Health Organization, we defined moderate-to-severe vision impairment (MSVI) as BCVA worse than 6/18 but equal to or better than 3/60 in the better eye or both eyes and blindness as BCVA worse than 3/60 in the better eye or both eyes.[1]

For the statistical analysis, we used a commercially available statistical software package (SPSS for Windows, version 27.0, Version 27.0). We calculated the mean values (presented as mean ± 95% confidence interval [CI]) of the main outcome parameters (i.e., the prevalence of cataract, and performed univariate binary analyses of the associations between the cataract prevalence and other ocular and systemic parameters). It was followed by a multivariable binary regression analysis, with the cataract prevalence as the dependent variable and as independent variables, all those factors which had shown relationships ($P < 0.10$) with the cataract prevalence in the univariate analyses. We then dropped those independent factors in a step-wise manner, if they showed a collinearity or if they were no longer significantly associated with the cataract prevalence. We eventually readded parameters that had been dropped from the list of independent variables, again to the model to finally test that they were indeed not significantly associated with the prevalence of cataract surgery. Odds ratio (OR) and its 95% CIs were calculated. In a similar manner, we calculated the mean and standard deviation of the degrees of the various cataract forms and examined their relationship with other parameters in linear regression analyses. It included the calculation of the standardized regression coefficient β, the nonstandardized regression coefficient B, and its 95% CIs. All P values were 2-sided and considered statistically significant if the values were <0.05.

Results

Out of 1526 individuals primarily participating in the Ural Very Old Study, the present investigation included 1163 (76.2%) individuals (856 [73.6%] women; 307 [26.4%] men) for whom the lens status was assessed. For the remaining 363 (23.8%) individuals, assessable lens photographs were not available nor was reliable information available about the status of a potentially previous cataract surgery. The study population was composed of 410 (35.3%) individuals of Russian ancestry, 512 (44.0%) Tatars, 137 (11.8%) Bashkirs, 45 (3.9%) Chuvash, 7 (0.6%) Mari, and 52 (4.5%) others. The mean age was 88.6 ± 2.7 years (median: 88.1 years; range: 85.0−100.6 years), and the mean axial length was 23.1 ± 1.1 mm (median: 23.0 mm; range: 19.37−28.89 mm). With respect to their profession, 9 (0.8%) participants had agriculture of their own, 122 (10.5%) individuals had worked as laborers in agriculture, 582 (50.0%) as laborers in other professions, 346 (29.8%) as government employees, 34 (2.9%) as nongovernment employees, 3 had a business of their own, and 67 (5.7%) participants did not clearly describe their profession. The individuals with an assessment of the lens status as compared with those without lens examination (age: 89.2 ± 3.2 years) were significantly ($P = 0.001$) younger, and both groups did not differ significantly in sex ($P = 0.07$).

Cataract Surgery

Cataract surgery had been carried out in 469 right eyes (469/1144 or 41.0%; 95% CI: 38.1−43.9) and in 479 left eyes (479/1152 or 41.6%; 95% CI: 38.7−44.4). Among the 469 right eyes with cataract surgery, 26 (5.5%) eyes were aphakic, 11(2.3%) eyes had received an anterior chamber intraocular lens (IOL), and the remaining 432 (92.1%) eyes had an implanted posterior chamber IOL, among them 22 (4.7%) eyes had a multifocal IOL. Among the 478 left eyes with cataract surgery, 31 (6.5%) eyes were aphakic, 3 (0.6%) eyes had received an anterior chamber IOL, 1 eye (0.2%) had received an iris-fixed IOL, and the remaining 444 (92.7%) eyes had got implanted a posterior chamber IOL, among them 20 (4.2%) eyes had a multifocal IOL. Among the 1163 study participants, 610 (52.5%) individuals had undergone cataract surgery in at least 1 eye.

In univariate analysis, the prevalence of cataract surgery was significantly higher in the urban region than in the rural region ($P < 0.001$) and increased with the systemic parameters of higher level of education ($P < 0.001$), higher waist−hip ratio ($P = 0.04$), higher prevalence of a history thyroid disease ($P < 0.001$), lower serum concentration of aspartate aminotransferase ($P = 0.002$), and higher serum concentrations of high-density lipoproteins ($P < 0.001$), cholesterol ($P = 0.001$), higher erythrocyte sedimentation rate ($P = 0.03$), lower international normalization ratio ($P = 0.01$) and higher prothrombin index ($P = 0.004$), higher erythrocyte count ($P = 0.02$), lower prevalence of anemia ($P = 0.03$), lower number of cups of tea taken daily ($P = 0.04$), and higher dynamometric hand grip strength ($P = 0.005$). It increased with the ocular parameters of deeper anterior chamber depth ($P < 0.001$), wider anterior chamber angle ($P < 0.001$), lower prevalence of lens pseudoexfoliation ($P = 0.001$), lower intraocular pressure (IOP) ($P < 0.001$), and better BCVA ($P = 0.006$).

The prevalence of any cataract surgery was not significantly (all $P > 0.05$) associated with the systemic parameters of age, sex, Russian versus non-Russian ancestry, the physical activity score (walking or using a bicycle for at least 10 minutes per day), family status (married versus unmarried), religion (Muslim versus non-Muslim), body height, body weight and body mass index, self-reported family income, depression score and State-Trait Anxiety Inventory score, history of angina pectoris; arthritis, cancer, cardiovascular diseases, including stroke, dementia, diarrhea, iron-deficiency anemia, episodes with low blood pressure and hospitalization, heart attack and steroid (cortisone) therapy, osteoarthritis, bone fracture and injuries other than bone fracture, prevalence of episodes of unconsciousness, backache, headache, neck pain, thoracic spine pain, skin disease and falls; serum concentrations of alanine aminotransferase, bilirubin, low-density lipoproteins, triglycerides, rheumatoid factor, glucose, creatinine, urea, residual nitrogen and hemoglobin; leukocyte count, lymphocyte count and monocyte count, prevalence of

diabetes mellitus, arterial hypertension, stage of arterial hypertension; aspects of diet (vegetarian versus mixed diet, number of days with intake of fruits or vegetables, amount of food containing whole grain, amount of self-reported salt intake, number of cups of coffee taken daily); systolic, diastolic, and mean blood pressure; ankle-brachial index, right side; current smoker; any alcohol consumed; hearing loss total score; and nor with the ocular parameters of longer axial length, refractive error, retinal nerve fiber layer thickness, prevalence of glaucomatous optic neuropathy, diabetic retinopathy, and myopic maculopathy, nor with the ocular parameters of corneal refractive power, and central corneal thickness.

In the multivariable analysis, a higher prevalence of previous cataract surgery remained to be significantly associated with lower IOP (OR: 0.92; 95% CI: 0.88−0.95; $P < 0.001$), higher stage of glaucomatous optic nerve damage (OR: 1.20; 95% CI: 1.05−1.36; $P = 0.006$) and better visual acuity (expressed in logMAR) (OR: 0.67; 95% CI: 0.51−0.89; $P = 0.005$).

The mean BCVA after cataract surgery in right eyes was 0.83 ± 1.43 logMAR (median: 0.50 [Snellen equivalent: 20/63; decimal system: 0.33]); range: light perception to −0.10 logMAR (Snellen equivalent: 20/16; decimal: 1.25). Postoperative BCVA was reduced to MSVI in 202 (44.6%; 95% CI: 40.0−49.2) eyes and to blindness in 53 (11.7%; 95% CI: 8.7−14.7) eyes. Causes of postoperative MSVI were AMD (34.2% of the eyes with MSVI), followed by glaucoma (13.9%) and secondary cataract (5.4%) (Table 1). Causes for blindness in the right eyes were AMD (24.5% of the eyes with blindness), followed by glaucoma (18.9%), corneal opacifications (15.8%), and myopic macular degeneration (11.3%) (Table 1).

The mean BCVA after cataract surgery in left eyes was 0.79 ± 1.26 logMAR (median: 0.50; Snellen equivalent: 20/63; decimal system: 0.33); range: light perception to −0.20 logMAR (Snellen equivalent: 20/12.5; decimal system: 1.6). Postoperative BCVA was reduced to values of MSVI in 199 (43.5%; 95% CI: 39.0, 48.1) eyes and to blindness in 54 (11.8%; 95% CI: 8.9, 14.8) eyes. Causes of postoperative MSVI in the left eyes were AMD (33.2% of eyes with MSVI), followed by glaucoma (12.6%) and secondary cataract (10.6 %) (Table 2). Causes for blindness in the left eyes were AMD (33.3% of eyes with blindness), followed by glaucoma (25.9%), corneal opacifications (14.8%), secondary cataract (13.0%), and myopic macular degeneration (3.7%) (Table 2).

A status after Yttrium Aluminum Garnet−laser capsulotomy was present in 6 (1.3%) out of 469 right eyes after cataract surgery and in 12 (2.5%) out of 479 left eyes after cataract surgery.

Cataract

The prevalence and degree of cataract were examined in 671 right eyes and 673 left eyes, all of which had not undergone cataract surgery and for which the clarity of the cornea allowed an assessment of the lens. In 19 right eyes and in 11 left eyes, the lens status could not validly be examined due to reasons such as corneal opacities or unclear anterior segment photographs. In the right eyes, 604 eyes (604/671 = 90.0%; or 604/1163 = 51.9% of the entire study population) had nuclear cataract, 97.9% of the eyes (or 48.4% of the total study population) had cortical cataract, and 645 eyes (96.1% or 55.5% of the total study population) had any cataract. In the left eyes, 600 eyes (600/680 = 88.2%; or 600/1163 = 51.6% of the entire study population) had nuclear cataract, 98.4% of the eyes (or 48.6% of the total study population) had cortical cataract, and 651 eyes (95.9% or 56.0 of the total study population) had any cataract.

Cataract (nuclear and cortical combined) as a cause of MSVI in the better eye or in binocular viewing was present in 321 individuals (28.2% [95% CI: 25.6−30.8] in the total study population; 48.1% [95% CI: 43.9−52.3] in the group without cataract surgery) and as a cause of blindness in the better eye or in binocular viewing in 33 individuals (2.9% [95% CI: 1.9−3.9] in the total study population; 5.0% [95% CI: 3.2−6.8] in the group without cataract surgery).

In univariate analysis, a higher cataract prevalence correlated with lower prevalence of episodes with the systemic parameters of a higher prevalence of a history of low blood pressure and hospitalization ($P < 0.001$) and previous steroid therapy ($P < 0.001$), lower serum concentration of creatinine ($P = 0.01$) and urea ($P = 0.047$), lower amount of food containing whole grain ($P = 0.001$), higher number of cups of tea taken ($P = 0.03$) and higher left ankle-brachial index ($P = 0.04$), and with the ocular parameters of a thinner central corneal thickness ($P = 0.002$). The prevalence of any cataract was not significantly (all $P > 0.05$; univariate analysis) associated with the systemic parameters of age, sex, region of habitation, Russian versus non-Russian ancestry, the physical activity score (walking or using a bicycle for at least 10 minutes per day), family status (married versus unmarried), religion (Muslim versus non-Muslim), body height, body weight and body mass index, self-reported family income, depression score and State-Trait Anxiety Inventory score, history of angina pectoris; arthritis, cancer, cardiovascular diseases, including stroke, dementia, diarrhea, iron-deficiency anemia, heart attack, osteoarthritis, bone fracture and injuries other than bone fracture, prevalence of episodes of unconsciousness, backache, headache, neck pain, thoracic spine pain, skin disease and falls; serum concentrations of alanine aminotransferase, bilirubin, low-density lipoproteins, triglycerides, rheumatoid factor, glucose, urea, residual nitrogen and hemoglobin; leukocyte count, lymphocyte count and monocyte count, prevalence of diabetes mellitus, arterial hypertension, stage of arterial hypertension; aspects of diet (vegetarian versus mixed diet, number of days with intake of fruits or vegetables, amount of self-reported salt intake, number of cups of coffee taken daily); systolic, diastolic, and mean blood pressure; ankle-brachial index, right side; current smoker; any alcohol consumed; hearing loss total score; and not with the ocular parameters of longer axial length, refractive error, retinal nerve fiber layer thickness, prevalence of glaucomatous optic neuropathy, diabetic retinopathy, AMD, and myopic maculopathy. In multivariable analysis, higher cataract prevalence remained to be significantly associated with a lower serum concentration of creatinine (OR: 0.98; 95% CI: 0.96−0.998;

Table 1. Causes for Moderate-to-Severe Vision Impairment and Blindness in Right Eyes after Cataract Surgery in the Ural Very Old Study

Primary Cause for MSVI, Right Eyes			Secondary Cause for MSVI Impairment, Right Eyes	
Parameter	*n*	*% of Eyes with MSVI*	*n*	*% of Eyes with MSVI*
Age-related macular degeneration	69	34.2%	17	8.4%
Glaucoma	28	13.9%	5	2.5%
Secondary cataract	11	5.4%	4	2.0%
Corneal opacification	5	2.5%	1	0.5%
Diabetic retinopathy	1	0.5%		
Other retinal or optic nerve diseases	8	4.0%	2	1.0%
Nonglaucomatous optic nerve damage	1	0.5%		
Myopic macular degeneration	3	1.5%		
Macular edema	1	0.5%		
Epiretinal membrane	1	0.5%		
Acute trauma	1	0.5%		
Unclear or unreliable visual acuity assessment	73	36.1%		

Primary Cause for Blindness, Right Eyes			Secondary Cause for Blindness, Right Eyes	
Parameter	*n*	*% of Eyes with Blindness*	*n*	*% of Eyes with Blindness*
Age-related macular degeneration	13	24.5%	1	1.9%
Glaucoma	10	18.9%	3	5.7%
Secondary cataract	1	1.9%		
Corneal opacification	8	15.8%	3	5.7%
Diabetic retinopathy	0	0		
Other retinal or optic nerve diseases	0	0	1	1.9%
Nonglaucomatous optic nerve damage	0	0		
Myopic macular degeneration	6	11.3%		
Macular edema	0	0		
Epiretinal membrane	0	0		
Acute trauma	0	0		
Unclear or unreliable visual acuity assessment	15	28.3%		

MSVI = moderate-to-severe vision impairment.

$P = 0.03$) and a thinner central cornea (OR: 0.98; 95% CI: 0.97−0.998; $P = 0.02$).

A higher degree of cataract correlated (univariate analysis) with the systemic parameters of rural region of habitation ($P < 0.001$), non-Russian ancestry ($P = 0.009$), lower body weight ($P = 0.01$), higher depression score ($P = 0.02$), higher prevalence of a history of dementia ($P = 0.02$) and thoracic spine pain ($P = 0.003$), lower prevalence of a history of steroid intake ($P < 0.001$), lower serum concentration of aspartate aminotransferase ($P = 0.01$), serum concentration of bilirubin ($P = 0.047$), high-density lipoproteins ($P < 0.001$), cholesterol ($P < 0.001$) and hemoglobin ($P = 0.03$), longer blood coagulation time ($P = 0.004$), lower count of erythrocytes ($P = 0.03$) and leucocytes ($P = 0.009$), higher monocyte count ($P = 0.03$), higher diastolic ($P = 0.04$) and mean arterial blood pressure ($P = 0.03$), lower number of daily meals ($P = 0.03$), and higher hearing loss score ($P < 0.001$). It was associated with the ocular parameters of thinner central cornea ($P = 0.04$), more myopic refractive error ($P = 0.02$), higher IOP ($P = 0.002$), higher prevalence ($P = 0.02$) and stage of glaucoma ($P = 0.01$). In multivariable analysis, a higher cataract degree remained to be significantly associated with higher blood coagulation time (β: 0.18; B: 0.38; 95% CI: 0.15−0.62; $P = 0.002$) and higher hearing loss score (β: 0.17; B: 0.01; 95% CI: 0.004−0.02; $P = 0.003$).

Discussion

In this multiethnic cohort aged >85 years from Russia, the prevalence of previous cataract surgery in the right eyes and left eyes was 41.0% and 41.6%, respectively, and within the group of unoperated eyes, the prevalence of nuclear cataract and cortical cataract was 90.0% and 96.1%, respectively in the right phakic eyes, and 88.2% and 98.4%, respectively in the left phakic eyes. The prevalence of cataract surgery in any eye per individual was 52.5%, and >90% of the implanted IOLs were posterior chamber IOLs, with 4.5% of the eyes having a multifocal IOL. In the operated group, the prevalence of MSVI and blindness was 44.0% and 11.7%, respectively, mainly because of AMD (34% and 28.5%, respectively) and glaucoma (13.2% and 22.4% respectively). Yttrium Aluminum Garnet−laser capsulotomy had been performed in 1.9% of the eyes with previous cataract surgery. More than 95% of all eyes without cataract surgery had cataract, causing MSVI and blindness in the better eye or in binocular viewing in 28.2% and 2.9%, respectively, of the entire study population.

The prevalence of any cataract (55.5% right eyes; 56.0% left eyes) and, correspondingly, both the prevalence of cataract-related MSVI (28.2%) and the prevalence of cataract-related blindness (2.9%) cannot directly be

Table 2. Causes for Moderate-to-Severe Vision Impairment and Blindness in Left Eyes after Cataract Surgery in the Ural Very Old Study

Primary Cause for MSVI, Left Eyes			Secondary Cause for MSVI, Left Eyes	
Parameter	*n*	*% of Eyes with MSVI*	*n*	*% of Eyes with MSVI*
Age-related macular degeneration	66	33.2%	20	10.1%
Glaucoma	25	12.6%	3	1.5%
Secondary cataract	21	10.6%	5	2.5%
Corneal opacification	4	2.0%	1	0.5%
Diabetic retinopathy	1	0.5%	0	0
Other retinal or optic nerve diseases	4	2.0%	2	1.0%
Nonglaucomatous optic nerve damage	1	0.5%		
Myopic macular degeneration	8	4.0%		
Macular edema	1	0.5%		
Epiretinal membrane	2	1.0%		
Acute trauma	0	0		
Macula hole	1	0.5%		
Amblyopia	1	0.5%		
Branch retinal vein occlusion	1	0.5%		
Unclear or unreliable visual acuity assessment	63	31.7%		
Primary Cause for Blindness, Left Eyes			**Secondary Cause for Blindness, Left Eyes**	
Parameter	*n*	*% of Eyes with Blindness*	*n*	*% of Eyes with Blindness*
Age-related macular degeneration	18	33.3%	2	3.7%
Glaucoma	14	25.9%		
Secondary cataract	7	13.0%	3	5.6%
Corneal opacification	8	14.8%		
Diabetic retinopathy	0	0		
Other retinal or optic nerve diseases	0	0	2	3.7%
Nonglaucomatous optic nerve damage	0	0		
Myopic macular degeneration	2	3.7%		
Macular edema	0	0		
Epiretinal membrane	0	0		
Acute trauma	0	0		
Unclear or unreliable visual acuity assessment	5	9.3%		

MSVI = moderate-to-severe vision impairment.

compared with data obtained in other study populations because the minimal age as inclusion criterion was markedly lower in the previous studies than in our investigation. Consequently, the figures were markedly higher in our study cohort than in cohorts examined in previous population-based studies. In a recent global meta-analysis, the age-standardized prevalence of cataract-related MSVI in the year 2020 was 4.34% (95% uncertainty interval (UI): 3.71−5.02) and of cataract-related blindness was 0.84% (95% UI: 0.7−1.0).[4] Stratified by world region, the highest rates were found for South Asia, with an age-standardized cataract-related MSVI prevalence of 9.46% (95% UI: 8.11−10.9) and an age-standardized cataract-related blindness prevalence of 2.23% (95% UI: 1.89−2.61).[4,5,15] If our study was compared with the Ural Eye and Medical Study, a population-based study performed in the same study regions on a population with a minimal age of >40 years, the cataract-related prevalence of MSVI (1.8% versus 28.2%) and blindness (0.0% versus 2.9%) were lower in the Ural Eye and Medical Study than in our very old cohort.[16]

The rate of cataract surgery in our study cohort was relatively high with 52.5% per individual. It was markedly higher than in the Ural Eye and Medical Study (6.0% in the total study population aged >40 years; and 37.6% in the individuals aged >80 years).[17] The prevalence of previous cataract surgery in our cohort was also higher than in the Central India Eye and Medical Study (conducted in rural India between 2006 and 2008; population aged >40 years: rate: 6.5%; population aged >80 years, rate: 28.8%).[5] Data on the prevalence of pseudophakia in high-income countries with a relatively large population aged >85 years are not available. Despite the high rate of cataract surgery in our study population, >90% of the study participants who had not undergone cataract surgery had significant cataract, and the rate of cataract-related MSVI and blindness was relatively high. It shows that, in such an old population, like our study cohort, almost everybody would be in need of cataract surgery. The prevalence of previous cataract surgery in our study population may be relatively high, in particular, if one considers the remoteness of the settlements in the rural study region and that the individuals were often not aware of having cataract. A factor in favor of a relatively high cataract surgery rate may have been that all inhabitants had free health care including free access to cataract surgery.

Factors associated with a higher prevalence of previous cataract surgery in our study population were lower IOP,

higher stage of glaucomatous optic nerve damage, and better visual acuity. It confirms previous studies on a reduction of IOP after cataract surgery.[17–19] In our study, cataract surgery was associated with an IOP reduction of 8% (95% CI: 5−12).

In the group of participants who had undergone cataract surgery, prevalence of MSVI and blindness was 44.0% and 11.7%, respectively, because of AMD (34% and 28.5%, respectively), glaucoma (13.2% and 22.4% respectively), secondary cataract (8.0% and 7.5%, respectively), corneal opacifications (2.2% and 15.3%, respectively), and myopic macular degeneration (2.7% and 7.5%, respectively). It reveals the age-related increase in the importance of causes of irreversible vision impairment (such as AMD and glaucoma) and underlines the necessity to screen for secondary cataract as a therapeutically modifiable cause for postoperative vision impairment. The results also show the relative importance of myopic macular degeneration which was the cause of blindness in 7.5% of the individuals after cataract surgery. Considering that the study population with a mean axial length of 23.1 ± 1.1 mm (median: 23.0 mm; range: 19.37−28.89 mm) was not markedly myopic and grew up under completely different conditions than the young myopic generation of today, one may anticipate an increase in the percentage of myopic macular degeneration-related blindness in elderly individuals after cataract surgery.[20]

When the results of our study are discussed, its weaknesses should be taken into account. First, the validity of an epidemiologic study depends on the participation rate and the representativeness of the study population. The participation rate in our investigation was relatively low with information on the lens status available for 1163 (76.3%) individuals out of the 1526 individuals primarily participating in the Ural Very Old Study. The individuals with information about their lens status were significantly younger than those without lens information. Because cataract is an age-related disorder, it may have led to an underestimation of the prevalence of cataract in the study cohort. It may be taken into account however that the high minimal age of 85 years as inclusion criteria was associated with a high degree of multimorbidity in the eligible population, preventing individuals from participating in the clinical examination. It concurs with the finding that only a few population-based studies in general epidemiology have addressed a study cohort with a minimum age of 85 years as an inclusion criterion so far. It may also be considered that in the study cohort, the prevalence of cataract was >95% in those eyes that had not yet undergone cataract surgery; hence, there was not much left for a marked underestimation of the prevalence of cataract. Second, with respect to the representativeness of the study region, it may be noted that the rural and urban study regions in the Russian Republic of Bashkortostan were typical of the entire region of South Russia and the Volga Federal District in terms of demography, geography, climate, and ethnic diversity of the population. The percentage of Russians was lower in our study region than in Northwestern Russia and Central Russia. To overcome this limitation, we examined the prevalence of cataract and cataract surgery in dependence on the ethnic background, and we did not detect significant associations between the ethnic background and the prevalence of cataract or cataract surgery. Also, our study population did not vary significantly from the population of Russia with respect to age and gender, with the inclusion criterion of an age of >85 years.[8,9] In general however, differences in the ethnic composition and in cultural, socioeconomic, and health care system parameters between the various regions of Russia as the country being globally the largest by surface area have to be taken into account, when the representativeness of the findings obtained in our study cohort for the entire of Russia are discussed. Primarily, the observations of our study refer to the Republic of Bashkortostan. In the metropolitan regions of Moscow, St. Petersburg, and Yekaterinburg, the rate of cataract surgeries will be higher than in Bashkortostan, whereas, in other regions of Russia, it will be markedly lower, so that the cataract rate found in Bashkortostan may be close to average in the country. The strengths of our study were that it is the first population-based study in ophthalmology (and 1 of the first in medicine) on a population with an age of >85 years, that the study sample size was relatively large in view of the high age of the participants, and that, besides ophthalmological factors, a large number of nonocular parameters were assessed for associations with IOP.

In conclusion, despite a relatively high prevalence of cataract surgery, this multiethnic cohort aged >85 years from Russia showed a high prevalence of cataract-related MSVI and blindness, because of the old age of the participants. After cataract surgery, the main causes of MSVI (prevalence: 44.6%) and blindness (prevalence: 11.7%) were AMD, glaucoma, corneal opacifications, and myopic macular degeneration. Almost all individuals aged >85 years will need cataract surgery to address avoidable MSVI and blindness.

Footnotes and Disclosures

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[1] Ufa Eye Research Institute, Bashkir State Medical University, Ufa, Russia.

[2] Department of Ophthalmology, University Hospital Heidelberg, Heidelberg, Germany.

[3] Rothschild Foundation Hospital, Institut Français de Myopie, Paris, France.

[4] Privatpraxis Prof Jonas und Dr Panda-Jonas, Heidelberg, Germany.

[5] Singapore Eye Research Institute, Singapore National Eye Center, Singapore.

[6] New York Eye and Ear Infirmary of Mount Sinai, Icahn School of Medicine at Mount Sinai, New York, NY, USA.

[7] Tsinghua Medicine, Tsinghua University, Beijing, China.

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Author Contributions:

Conception and design: Bikbov, Kazakbaeva, Panda-Jonas, Jonas

Data collection: Bikbov, Kazakbaeva, Panda-Jonas, Lakupova, Fakhretdinova, Tuliakova, Jonas

Analysis and interpretation: Bikbov, Kazakbaeva, Panda-Jonas, Lakupova, Fakhretdinova, Tuliakova, Jonas

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Overall responsibility: Bikbov, Kazakbaeva, Panda-Jonas, Lakupova, Fakhretdinova, Tuliakova, Jonas

Abbreviations and Acronyms:
AMD = age-related macular degeneration; **BCVA** = best corrected visual acuity; **CI** = confidence interval; **IOL** = intraocular lens; **IOP** = intraocular pressure; **MSVI** = moderate-to-severe vision impairment; **UI** = uncertainty interval.

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Correspondence:
Mukharram M. Bikbov, MD, PhD, Ufa Eye Research Institute, 90 Pushkin Street, Ufa 450077, Russia. E-mail: Bikbov.m@gmail.com; and Jost B. Jonas, Privatpraxis Prof Jonas und Dr Panda-Jonas, Adenauerplatz 2, 69115 Heidelberg, Germany. E-mail: Jost.Jonas@medma.uni-heidelberg.de.

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