OPHTHALMOLOGY

DIAGNOSTIC CAPABILITIES OF COMPUTER ACCOMMODOGRAPHY IN MIDDLE-AGED (PRESBYOPIC) INDIVIDUALS

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RESUME

Background. *Presbyopia research aims to improve the quality of life of the aging population by correcting near vision and timely addressing accommodative disorders in presbyopes, particularly when combined with hypermetropic and myopic refraction.*
The aim. *To assess the parameters of computer accommodography in individuals aged 45–59 with presbyopia combined with hypermetropic and myopic refraction.*
Methods. *A cross-sectional study was conducted on a random sample of Arkhangelsk population aged 45–59 (n = 69), including ophthalmological examination with a comprehensive accommodation assessment. Data of 127 eyes were analysed. Participants were divided into five groups: those diagnosed with myopia (mild, moderate, and high degree), those with presbyopia (with emmetropia), and those with presbyopia accompanied by hypermetropia (refraction up to 3.0 D inclusive).*
Results. *In 32.3% of cases (41 eyes), no ocular pathology was detected except for presbyopia. Myopic refraction was found in 46.5% of cases (59 eyes), with an average refraction of 3.26±0.13 D in this group. When comparing groups on quantitative accommodogram parameters, the highest microfluctuation coefficient (up to +3.0 D inclusive) was in participants with moderate myopia and in those with age-related presbyopia combined with hypermetropia, the lowest – in participants with presbyopia (with emmetropia) and in groups with mild and high myopia (p = 0.028). Microfluctuation coefficient was the most stable was in individuals without visual organ pathology, with the exception of age-related presbyopia, and among participants with mild myopia (p = 0.017).*
Conclusion. *The use of computer accommodography in ophthalmological practice can significantly expand diagnostic capabilities for identifying accommodative changes in middle-aged individuals.*

Keywords: *presbyopia, computer accommodography, healthy aging, myopia, hypermetropia*

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ДИАГНОСТИЧЕСКИЕ ВОЗМОЖНОСТИ КОМПЬЮТЕРНОЙ АККОМОДОГРАФИИ У ЛИЦ СРЕДНЕГО (ПРЕСБИОПИЧЕСКОГО) ВОЗРАСТА

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РЕЗЮМЕ

Обоснование. *Изучение пресбиопии направлено на улучшение качества жизни стареющего населения посредством коррекции зрения вблизи и своевременной коррекции аккомодационных нарушений у пресбиопов, в особенности сочетающихся с гиперметропической и миопической рефракцией.*

Цель исследования. *Оценить основные параметры компьютерной аккомодографии у лиц 45–59 лет с пресбиопией в сочетании с гиперметропической и миопической рефракцией.*

Методы. *Проведено поперечное исследование случайной выборки населения г. Архангельска 45–59 лет (n = 69), включавшее офтальмологическое обследование с комплексным исследованием аккомодации. В анализ включены данные 127 глаз. Участники были разделены на 5 групп: лица с установленным диагнозом «миопия» (слабой, средней и высокой степени), лица с пресбиопией (с эмметропией) и лица, у которых пресбиопия сопровождалась гиперметропией с величиной рефракции до 3,0 дптр включительно.*

Результаты. *В 32,3 % случаев (41 глаз) не было выявлено патологии органа зрения за исключением пресбиопии. Наличие миопической рефракции выявлено в 46,5 % случаев (59 глаз) и среднее значение рефракции в данной группе участников составило -3,26 ± 0,13 диоптрий. При сравнении групп по количественным параметрам аккомодограмм коэффициент микрофлюктуации был наиболее высок (до +3,0 дптр, включительно) в группах участников с миопией средней степени и у лиц с возрастной пресбиопией в сочетании с гиперметропией, наиболее низким – у участников пресбиопов с эмметропией, и в группах миопии слабой и высокой степеней (p = 0,028). Коэффициент микрофлюктуации был наиболее устойчив среди лиц без патологии органа зрения, за исключением возрастной пресбиопии, и у участников с миопией слабой степени (p = 0,017).*

Заключение. *Применение компьютерной аккомодографии в офтальмологической практике может значительно расширить диагностические возможности в части определения аккомодационных изменений у лиц среднего возраста.*

Ключевые слова: *пресбиопия, компьютерная аккомодография, здоровое старение, миопия, гиперметропия*

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BACKGROUND

According to the World Health Organization's first World Report on Vision [1], globally, at least 2.2 billion people are visually impaired. In the context of aging, the study of presbyopia is significant in assessing the decline of organ-specific functions. Presbyopia is a natural process of age-related vision change that occurs due to changes in the accommodative ability of the eye.

According to data published in 2020, globally, over half a billion people are visually impaired caused by uncorrected presbyopia. This number is expected to increase due to aging population [2, 3]. Despite the prevalence of this issue, research on the development of presbyopia continues to be relevant, as the underlying mechanism remains unclear. One theory that has been proposed is the Helmholtz theory of accommodation. This theory suggests that changes in lens shape occur due to alterations in the diameter of the ciliary muscle. Presbyopia is then explained by the ongoing enlargement of the equatorial region of the lens and the inability of the ciliary muscles to stretch the ligaments in that area [4].

Presbyopia is a condition characterized by a decrease in binocular interaction due to a decrease in accommodation [5]. In individuals with presbyopia, the size of the fusion field is reduced both in length and width. A more significant reduction in the field occurs as a result of losses in the area of convergence. The most significant impairment of binocular vision in individuals with presbyopia is observed in those with hyperopia [6]. In young individuals, additional accommodation takes place due to convergence when stimuli are presented at a close distance. This is less evident in older individuals as the target is typically visible at a distance of approximately half a meter and the need for convergence is lower. Increased need for convergence may also lead to further constriction of the pupil and an associated increase in depth of field [7].

Various diagnostic methods are employed to detect presbyopia. Accommodative testing is the most accurate method for evaluating accommodation, assisting to assess the magnitude of the accommodative response and microfluctuations. In presbyopic individuals, these parameters decline with age, approaching zero at about the age of 50–55 years of age [8].

In the literature, presbyopia has been described solely as a reduction in accommodative capacity [9]. The visual system is a complex functional network, the efficient operation of which depends on the proper functioning of its various components. Any impairment in one of these components should be accompanied by efforts to compensate for or adapt to it. However, the mechanisms involved in the development of presbyopia have not been thoroughly investigated. The literature lacks systematic information on the alteration of pupillary diaphragm function, and there are no data available on changes in binocular interaction levels or on the impact of the accommodative-refractive component, which are essential aspects of visual perception [10].

Ongoing research into presbyopia is aimed at improving the quality of life for the aging population and achieving full correction of near vision. Additionally, it aims to address the timely and early treatment of accommodative issues in individuals with presbyopia who have hyperopic or myopic refractive errors [11]. Therefore, it is relevant to assess the prevalence of accommodative problems among middle-aged adults who do not have ophthalmological conditions and have a history of hyperopia or myopia.

Our previous study has shown that the parameters of computer accommodography can complement traditional methods of accommodation research. We have presented these parameters in young adults and students without any ophthalmological pathologies, as well as in those with a normal accommodative response [12]. The scientific literature lacks data on these parameters for the accommodation research of middle-aged individuals.

THE AIM OF THE STUDY

To assess the main parameters of computer accommodography in individuals aged 45–59 years with presbyopia, in combination with hypermetropic and myopic refraction.

METHODS

A cross-sectional study was conducted among a random sample of Arkhangelsk residents aged 45–59 years who participated in the "Biomarkers of Individual Viability in Residents of the European North of Russia" study (hereinafter referred to as IIV). The study was conducted at the Clinical and Diagnostic Outpatient Clinic of the Northern State Medical University (Arkhangelsk) from March 1 to May 31, 2024. Participants for IIV were selected from among residents of Arkhangelsk who were previously included in a random population sample for the "Know Your Heart" study conducted in 2015–2017. The sample was formed on the basis of an anonymized database of city resident addresses provided by the regional mandatory health insurance fund [13]. Participants were contacted through telephone and mail communication with 1,014 "Know Your Heart" participants aged 45–59 years who had resided in the Arkhangelsk region for over 10 years. Exclusion criteria included the presence of mental illness, acute infection symptoms, or exacerbation of chronic conditions (hypertensive crises, fever, pain of any origin) on the day before or immediately prior to the examination. Consequently, 612 individuals underwent the IJI exam, which included an ophthalmological examination.

Inclusion criteria for the additional examination using computer accommodography included individuals aged 45–59 years who met the criteria for health groups 1 and 2 for outpatient observation by an ophthalmologist. These groups included individuals with certain disease groups

and individual nosological entities, excluding refractive errors. This means that study participants were only individuals with refractive errors, and individuals with other visual pathologies were excluded from the study. Exclusion criteria included a history of acute cerebrovascular accidents and traumatic brain injuries, as well as certain ophthalmological conditions (such as established diagnoses according to the International Classification of Diseases 10th Revision (ICD-10) codes for diseases of the eye and adnexa except for refractive and accommodative disorders (H52)). Other exclusion criteria also included a history of previous keratorefractive surgeries, the presence of partial optic nerve atrophy in both eyes, and uninformative data from computer accommodography tests. Of the total number of participants, 74 individuals were examined using a computer-based assessment. Based on the inclusion and exclusion criteria, 69 male and female participants aged 45–59 years were selected for the study.

The ophthalmological examination of the participants involved assessing uncorrected visual acuity (UCVA) ranging from 0 to 1.0 conventional units (c.u.) using the Sivtsev – Golovin charts (Golovin S.S. and Sivtsev D.A., 1928). Best-corrected visual acuity (BCVA) parameters were also assessed. Clinical refraction was performed using automatic refractometry. Based on the examination findings, an initial ophthalmologist's examination (appendix to form 025/U-07 approved by the Order of the Ministry of Health, dated August 30, 2007 No. 710) was conducted in accordance with the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10). Based on the results of a thorough study of accommodation, qualitative changes in the positive portion of the accommodative amplitude (PPAV in diopters) were evaluated, as well as the values of the main accommodative coefficients – the accommodative response coefficient (ARC), growth coefficient (GC), microfluctuation coefficient (MFC), and others. The study of the accommodative capacity of the eye was conducted using an objective computerized accommodation method employing the Acomoref-2 (Righton, Japan). In accordance with the instructions provided by the manufacturer [14], the acquired accommodograms were classified into the following categories: 1 – normal appearance; 2 – presbyopia; 3 – presbyopia accompanied by accommodative strain; 4 – phenomena related to computer vision syndrome; 5 – habitually excessive accommodative strain; and 6 – accommodative spasm. In five instances (five eyes), the data obtained from computer accommodography were not informative, and therefore, in accordance with the exclusion criteria, these instances were not incorporated into the study.

The graphical representation of the accommodogram generated using the Acomoref-2 includes a color spectrum, in which the severity of high-frequency fluctuations is indicated from green (normal) to red (indicating increased tension of the ciliary muscle) [15]. Additionally, the accommodogram demonstrates the nature of the accommodative response (AR, color columns) in relation to the presented accommodative stimulus (AS, contour columns). A typical accommodogram will display an increasing, steady curve, with AR being less than the accommodative stimulus. The color spectrum of microfluctuations will be predominantly green and yellow-green, with possible isolated instances of red towards the end of the maximum accommodative effort. An accommodogram indicating habitually excessive tension and accommodation spasm will demonstrate an unstable, increasing curve, with a red-orange color spectrum. The accommodogram in presbyopia exhibits a significantly reduced AR, a "flattened" curve resembling a plateau, and a predominance of green color spectrum. In cases of accommodative strain associated with presbyopia, the accommodative response is further diminished, with the accommodogram displaying a plateau-like curve and a yellowish-reddish color spectrum.

The study participants were divided into 5 groups: those with a confirmed diagnosis of myopia (mild, moderate, and high), those with presbyopia in combination with emmetropia (referred to hereafter as the "no pathology" group, or the comparison group), and those whose presbyopic condition was accompanied by hyperopia of up to 3.0 D inclusive. The severity of myopia was determined based on autorefractometric data and categorized as follows: mild, between -0.5 and -3.0 D; moderate, between -3.25 and -6.0 D; and high, over -6.25 D [16].

Categorical variables were presented as absolute values (abs.) and percentages (%). Comparisons of proportions in groups were performed using the Pearson's χ^2 test. The normality of the distribution of continuous variables was assessed using the Shapiro – Wilk test. Given the distribution pattern of the analyzed characteristics, results are presented as medians (Me) with values of the 25th and 75th percentiles (P25-P75). Continuous variable comparisons between men and women were performed using the Mann – Whitney U-test, and comparisons between the five groups were performed using the Kruskal – Wallis H-test. Differences were considered statistically significant at $p < 0.05$. For further pairwise comparisons between groups with and without ophthalmic pathologies, the Mann – Whitney U-test with Bonferroni correction was used, with differences considered statistically significant at $p < 0.0125$. Statistical analysis was conducted using Stata version 18.0 (StataCorp, USA, Texas, College Station).

The study was approved by the local ethics committee of the Northern State Medical University of the Ministry of Health of the Russian Federation (Arkhangelsk) (Protocol No. 03/04-23, dated April 26, 2023). All participants in the study provided voluntary informed consent.

RESULTS

A total of 69 participants aged 45–59 years were included in the study, with an average age of 51.5 years. The sample consisted of 127 eyes, 44 of which were male and 83 were female, and 64 were right eyes and 63 were left eyes. All eyes met the inclusion criteria and did not meet any exclusion criteria.

In 32.3 % of cases (41 eyes), emmetropic refraction combined with presbyopia was observed (Table 1). Myopic

refraction was present in 46.5 % of cases (59 eyes). The largest number of participants was in the group ophthalmologic pathology (32.3 %) and with a diagnosis of "mild myopia" (26.0 %), as well as in the group with hypermetropic refraction up to +3.0 D (21.3 %). The average myopic refractive error in the examined participants with myopia was -3.26 ± 0.13 diopters.

The main parameters assessed during the ophthalmological examination, including the parameters of computer accommodography (UCVA, BCVA, near visual acuity, autorefractometry, etc.), are presented in Table 2. The analyzed groups differed in UCVA ($p < 0.001$). The parameters in the groups with myopia and with presbyopia and hyperopia were lower compared to the group without pathology. After excluding participants without pathology, differences in BCVA were observed ($p < 0.001$), with individuals with myopia having reduced values for this parameter. Differences were also found in near visual acuity ($p < 0.001$), with the lowest values determined in the group with presbyopia and hyperopia. When assessing the positive part of accommodation volume, it was found to be 0 (0; 0) D in all groups of study participants.

When assessing the microfluctuation coefficient (MFC), it was observed that the highest reduction frequency was seen in the groups of participants with moderate myopia and participants with age-related presbyopia in combination with hyperopia up to +3.0 D inclusive. The lowest MFC values were found in presbyopic participants with emmetropia, as well as in groups with mild and severe myopia ($p = 0.028$) (Table 2 and Fig. 1). The stability of the σMFC was lowest in individuals with mild myopia, as well as those without visual organ pathology ($p = 0.017$) (Table 2).

In pairwise comparisons between the group without pathology and other groups, statistically significant differences were observed for the MFC parameter in comparison with the group of participants whose presbyopia was accompanied by hyperopia ($p = 0.008$) and the group of participants with moderate myopia ($p = 0.010$). Significant differences were also observed for the σMFC parameter in the group with moderate myopia ($p = 0.008$).

When analyzing the accommodogram data (Fig. 2), participants with moderate and high myopia were grouped together due to the limited number of participants in each category. The four groups under study exhibited the following types of accommodative disorders: presbyopia, presbyopia with accommodative strain, computer vision syndrome, habitually excessive accommodative strain, and accommodative spasm. The distribution of these four types of disorders among the four groups did not reach statistical significance ($p = 0.123$). It is worth noting, however, that the accommodative responses of individuals without visual impairment most frequently corresponded to presbyopic accommodative response (46.3 %) and presbyopic response with accommodative strain (29.3 %). In 5 cases (12.2 %), a normal accommodative response was observed, and among individuals with presbyopia and hyperopic refractive errors, the majority of accommodative responses demonstrated presbyopic strain (44.4 %). In the group of participants with mild myopia, the presbyopic accommodative type was most commonly observed (57.6 %). Among participants with moderate and high myopia, presbyopia with accommodative strain predominated (46.3 %).

DISCUSSION

The study revealed a decrease in visual function in the group of participants with presbyopia and hyperopia, compared to those without ophthalmopathology. This was true for all participants, except for those with presbyopia, who experienced an increase in their degree of refractive error, and as a result, a corresponding decrease in central vision.

Near visual acuity was decreased in all groups, which can be attributed to the age of the study participants. The lowest near visual acuity was observed in the presbyopic and hyperopic groups, which is explained by the presence of hyperopia in these individuals, further reducing near visual acuity. Given the reduced

TABLE 1

GENDER DISTRIBUTION OF CASES (EYES) BY SEVERITY OF REFRACTIVE DISORDERS

Groups	Sex		Total *n* = 127
	Male *n* = 44	Female *n* = 83	
	abs. (%)	abs. (%)	abs. (%)
Presbyopia and emmetropia	18 (14.2%)	23 (18.1%)	41 (32.3%)
Presbyopia and hyperopia up to +3.0 D inclusive	12 (9.4%)	15 (11.8%)	27 (21.3%)
Mild myopia	7 (5.5%)	26 (20.5%)	33 (26.0%)
Moderate myopia	4 (3.1%)	13 (10.2%)	17 (13.4%)
High myopia	3 (2.4%)	6 (4.8%)	9 (7.1%)

TABLE 2

KEY STUDY PARAMETERS, INCLUDING COMPUTER ACCOMMODOGRAPHY DATA, IN INDIVIDUALS AGED 45–59 YEARS

Characteristics	Presbyopia and emmetropia *n* = 41	Presbyopia and hyperopia *n* = 27	Myopia			*p**
			Mild myopia *n* = 33	Moderate myopia *n* = 17	High myopia *n* = 9	
	Me (25; 75)	Me (25; 75)	Me (25; 75)	Me (25; 75)	Me (25; 75)	
Indicators of visual acuity for distance and near vision, as well as accommodation						
Uncorrected visual acuity, c.u., as measured using the Sivtsev-Golovin chart	1.00 (0.90; 1.00)	0.70 (0.40; 0.80)	0.20 (0.10; 0.30)	0.05 (0.04; 0.05)	0.02 (0.01; 0.10)	<0.001
Best-corrected visual acuity, c.u., as measured using the Sivtsev-Golovin chart	–	1.0 (1.0; 1.0)	1.0 (0.9; 1.0)	1.0 (0.8; 1.0)	0.9 (0.5; 0.9)	<0.001
Near visual acuity, c.u.	0.5 (0.3; 0.5)	0.3 (0.2; 0.3)	0.7 (0.5; 0.8)	0.5 (0.2; 0.6)	0.5 (0.1; 0.9)	<0.001
Autorefractometry:						
- spherical component, D	+0.5 (+0.25; +0.75)	+1.75 (+1.5; +2.5)	-1.25 (-2.0; -0.75)	-4.25 (-4.75; -3.5)	-7.5 (-10.0; -6.5)	<0.001
- cylindrical component, D	-0.25 (-0.75; -0.25)	-0.5 (-0.75; -0.25)	-0.5 (-0.75; -0.25)	-0.5 (-0.75; -0.5)	-1.0 (-1.25; -0.75)	0.001
Intraocular pressure, mmHg	14.0 (12.0; 16.0)	14.0 (12.0; 16.0)	16.0 (14.0; 18.0)	15.0 (14.0; 17.0)	14.0 (13.0; 19.0)	0.076
Positive portion of the accommodative amplitude, D	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.0 (0.0; 0.0)	0.559
The parameters of computer accommodography						
Accommodative response coefficient (ARC), c.u.	0.04 (-0.01; 0.14)	0.12 (-0.06; 0.32)	0.03 (-0.16; 0.14)	0.09 (-0.06; 0.16)	0.02 (-0.09; 0.18)	0.509
Coefficient of stability of the accommodative response coefficient (σARC), c.u.	0.09 (0.06; 0.24)	0.19 (0.11; 0.34)	0.13 (0.08; 0.20)	0.12 (0.07; 0.19)	0.12 (0.09 0.14)	0.077
Accommodogram growth coefficient (AGC), c.u.	0.43 (0.29; 0.57)	0.57 (0.43; 0.57)	0.43 (0.43; 0.57)	0.43 (0.43; 0.57)	0.57 (0.43; 0.57)	0.448
Microfluctuation coefficient (MFC), μF/min	54.6 (51.1; 56.9)	58.5** (54.3; 61.8)	55.0 (52.8; 59.0)	59.2** (55.2; 61.1)	55.3 (54.3; 56.7)	0.028
Coefficient of stability of the microfluctuation coefficient (σMFC), c.u.	3.47 (2.79; 4.21)	3.62 (3.14; 4.41)	3.14 (2.65; 3.73)	4.97** (3.80; 5.23)	4.06 (2.57; 5.03)	0.017

Note. * Comparison of parameter values between groups using the Kruskal – Wallis test. ** Significant differences observed in the pairwise comparisons of the groups with the group without ophthalmic pathology, after applying the Bonferroni correction and considering a critical significance level of $p < 0.0125$.

near visual acuity in this age range, assessing accommodative capacity by determining accommodation reserve is not practical. Therefore, our study employed computer-based accommodation testing, which allowed us to compare the analyzed groups based on microfluctuation coefficients and their stability indices. These findings support the usefulness of this method in identifying accommodative disorders in presbyopic individuals.

When assessing the type of accommodative responses, a normal accommodative response was found in only in 5 out of 127 cases. This is consistent with literature data, which indicate that accommodation weakens significantly after the age of 45 [17]. The study of accommodative function in individuals aged 45 to 59 years allowed us to identify various types of accommodative disorders. These findings indicate that, in addition to the presbyopia that is traditionally mentioned in scientific literature, other types of abnormalities can occur at this age. Previous studies have demonstrated that in a significant number of patients, even those over the age of 60, signs

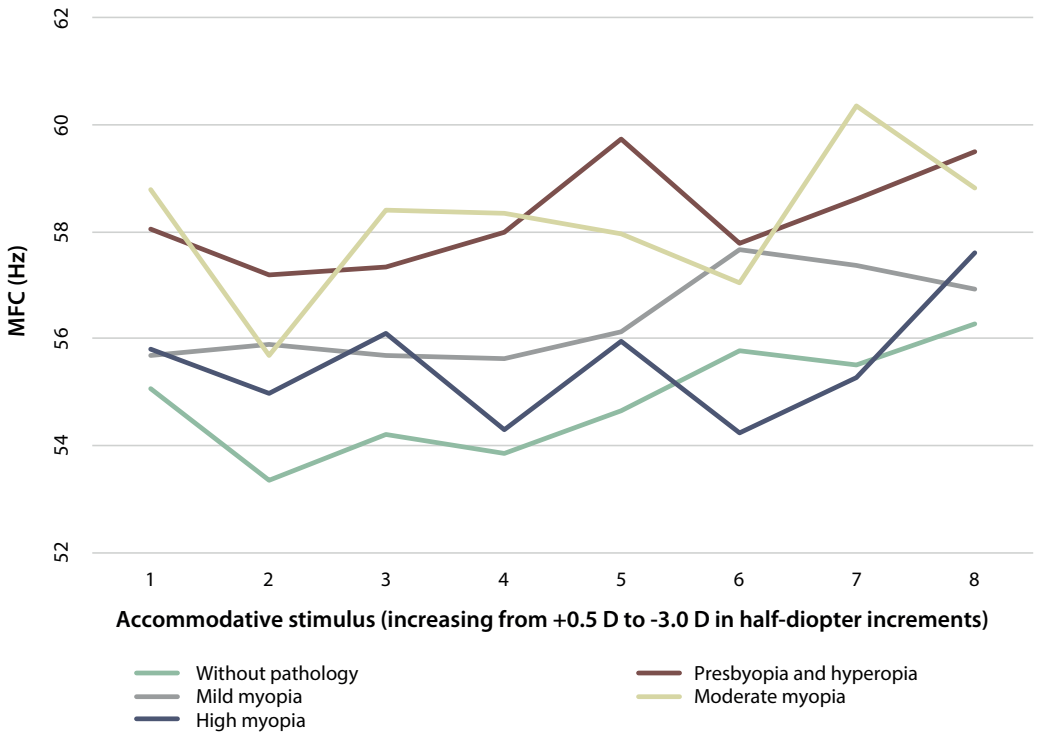

FIG. 1.
Microfluctuation changes with increasing accommodative stimulus in study participants aged 45–59 years without ophthalmopathology and in groups with different degrees of myopia

of functional accommodation are detectable. In particular, according to the findings of E.L. Shalygina, accommodative responses in the age group of 46–50 years were noted in 49 % of cases, while in the group of 51–55 years they were seen in 17 %. The presence of accommodative microfluctuations was reported in 58 % of individuals aged between 46 and 50 and 21 % of those aged 56 to 60 [18]. Additionally, I.G. Ovechkin et al. emphasized that the presence of accommodative responses and microfluctuations among individuals over the age of 55 and even 60 indicates the need for further, in-depth research into this topic [19]. Nevertheless, the prevalence of accommodative disorders among middle-aged people has not been investigated.

The accommodative capacity of the eye has been widely studied in patients who have undergone cataract phacoemulsification and implantation of various intraocular lens (IOL) types (monofocal, multifocal, accommodating) [20]. The implantation of monofocal and trifocal IOLs has been associated with a significant decrease in the MFC (by 3.8–4.4 %) and MFC stability (by 26.5–31.4 %). These changes are believed to reflect a shift in the accommodative system of the eye from a "normal" to a "habitually excessive accommodation tension" state, as reported by the authors [21]. The study identified specific features of accommodative responses in individuals after phacoemulsification, indicating the sensitivity of the MFC and MFC stability (σMFC) indices in this age group. These findings were also reflected in our own study.

The findings regarding changes in the MFC indices and MFC stability (σMFC) may be considered predictive of accommodative dysfunction in individuals aged 45–59 years and potentially in older patients. This suggests a potential avenue for further investigation of these parameters.

Therefore, the identified computer-based accommodation parameters can assist in identifying accommodative disorders in individuals with presbyopia, necessitating timely treatment. The greatest risks for the development of accommodative disorders were observed in groups of participants with presbyopia in combination with moderate to high hyperopia and myopia, warranting special attention during the examination of patients with these characteristics. The increased prevalence of accommodative disorders in these groups may be partially attributed to the presence of refractive errors.

The traditional method of assessing accommodative function through the determination of the positive component of the accommodative volume, as illustrated by the findings of this study, has been found to be insufficiently informative. A computerized accommodationography technique, which not only provides a visual representation of the accommodative process but also allows for the quantification of a range of parameters, may represent a complementary approach for the identification of accommodative disorders in this population.

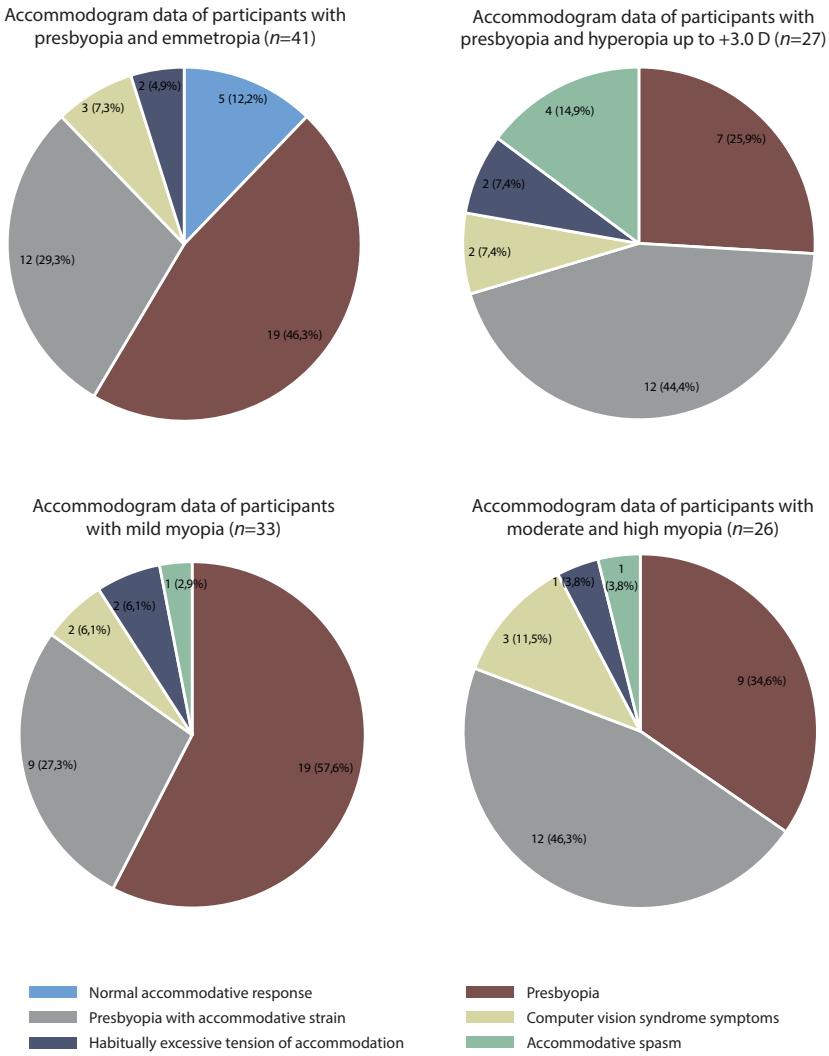

FIG. 2.
Distribution of accommodation disorders based on computer accommodography findings in participant groups (number of analyzed accommodograms, abs., %)

CONCLUSION

Computer-based accommodation parameters can significantly enhance diagnostic capabilities for detecting accommodative changes in middle-aged individuals. Our study has demonstrated that accommodative alterations in individuals aged 45–59 years encompass more than simply the traditionally described presbyopia. The coefficients of microfluctuations and stability of microfluctuations were identified as the most sensitive quantitative parameters in accommodograms. These parameters may be considered predictors of accommodative abnormalities in middle-aged patients, and potentially in older individuals as well, paving the way for further research.

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Conflicts of interest

No potential conflict of interest relevant to this article reported.

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