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Relation between Near Work and Ocular Biometric Components

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ABSTRACT

We aimed to determine the association between ocular biometric components and near work in bank employees. This study was conducted as an analytical cross-sectional study in Sari, north of Iran, 2015. A group of bank employees and a control group were randomly selected. After applying the inclusion criteria, all selected subjects had a set of examinations including refraction, uncorrected and corrected visual acuity, slit lamp biomicroscopy and ophthalmoscopy. Then ocular biometric indices were measured using a Nidek biometer (US 800). Mean spherical equivalent was -0.53 (95% CI: -0.7 to -0.36) diopter (D) in bank employees and 0.09(95% CI: -0.05 to 0.23) D in the control group (P<0.001). After adjusting for age and gender, axial length and vitreous chamber depth were significantly longer in bank employees. In a lineare regression model, near work significantly correlated with increasing axial length (Unstandardized Coefficients=0.153, P<0.001) and decreasing corneal radius of curvature (-0.049, P<0.001) after adjusting for age, gender, and refractive error. Corneal curvature and axial length correlated more strongly with axial length in bank employees compared to the control group. Ocular biometric components, especially axial length, lens thickness, and corneal radius of curvature, significantly differ between people with a history of near work and those without one.

KEYWORDS: *Ocular biometry, Near work, Refractive errors*

INTRODUCTION

Refractive errors are one of the main causes of vision impairment globally [1]. In recent years, many studies on the etiology of refractive errors have been conducted around the world [2-3]. Risk factors for refractive errors include race, genetics, environmental factors such as near work and outdoor activities, cataract, certain retinal diseases, intraocular pressure, and many other factors [3-6].

Changes in ocular biometry can cause changes in refractive errors, and any disorder in the process of eye growth affecting ocular biometric components can lead to refractive errors [7-8].

Main variables related to refractive errors are the axial length and the corneal radius of curvature, and several studies have shown a

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stronger role for their ratio than each one factor individually [9-10].

The risk factors mentioned above cause refractive errors by causing changes in ocular biometry. One of the most important risk factors mentioned above is near work, the role of which in developing refractive errors, especially myopia, has been studied in recent years [11-13]. While earlier studies found a relationship between near work and myopia, more recent ones have arrived at contradictory conclusions [11-12]. A suggested explanation is axial elongation as a result of accommodation. While several studies have looked into the relationship between refractive errors and near work, few have examined the relationship between near work and ocular biometric components. In a study by Ghosh et al. [14], changes in ocular biometry, especially axial length, have been demonstrated over 10 minutes of near work. Woodman et al. [15] have also shown transient axial elongation after near work. However, changes caused by short-term near work and accommodation is transient and soon return to baseline.

Comparing ocular biometric components between people with and without a long history of near work can help determine the effect of near work on biometric components of the eye. Here we aimed to examine the relationship between near work and ocular biometrics in a sample population of bank employees by comparing them to a control group.

MATERIALS AND METHODS

In this cross-sectional descriptive study in 2015, two groups were selected: a group of bank employees as the group with a history of near work and a control group of people who had no history of near work.

First, a number of banks were selected from all banks throughout the city of Sari, and all employees were considered in the sampling frame. Inclusion criteria were performing near work (working with a computer for at least 7 hours a day), having at least 5 years of work experience as a bank employee, and age of 40 years or less. Exclusion criteria included amblyopia, aphakia, lens opacity, diabetes, and systemic disease affecting refractive errors of the eye, history of ocular trauma, history of refractive surgery, apparent ocular deviation, and pathologic myopia.

The control group was selected from bank clients and all criteria except the history of near work were applied to them. In this group, all persons who declared more than 1 hour near work per day in the past 5 years were excluded from the study. Eventually, the two groups were invited to participate in the study, and they were enrolled after obtaining written consents.

Examinations began with vision tests. First non-cycloplegic refraction was measured using the Huvitz auto-refracto-keratometer HRK-8000A (Huvitz Co.) and checked with a Heine Streak Retinoscope (HEINE Optotechnik). Then, uncorrected visual acuity (UCVA) was tested using the Snellen chart at 6 meters. Those with UCVA worse than 20/20 also had subjective refraction, and their best-corrected visual acuity (BCVA) were recorded. Finally, far cover test at 6 meters and near cover test at 40 cm was conducted. In the next stage, all participants underwent examinations of the cornea, lens, and retina using the slit-lamp, and direct and indirect ophthalmoscopy.

For ocular biometry, the axial length, anterior chamber depth, lens thickness, and vitreous depth were measured using the Nidek (Model US 800) after instilling anesthetic drops (tetracaine 0.5%) to touch the probe against the cornea. The device was set to calculate automatically the axial length and other details after three measurements. For all participants, vision tests were conducted by the same optometrist, ophthalmic examinations were done by a single ophthalmologist, and imaging for biometry was done by a single skilled technician. Eventually, those with BCVA worse than 20/20 were excluded from the study.

Definitions: Near work was defined as working with computers for at least 7 hours a day. Refractive errors were defined based on spherical equivalent. Myopia was defined as a spherical equivalent less than -0.5 diopter (D), hyperopia as a spherical equivalent worse than 0.5 D, and astigmatism as a cylinder error of 1.0 D or worse.

Statistical analyses: All statistical analyses were done using the STATA V12 software. The data used in the analyses was collected from 796 eyes of 398 individuals. Considering the correlation between fellow eyes, results were analyzed using generalized estimating equation (GEE) to account for this correlation. First, the prevalence of refractive errors was compared between the two groups of bank employees and controls, and odds ratios were calculated using logistic regression. Then, after adjusting for age, gender and refractive errors, inter-group comparisons were made for mean ocular biometric components using multiple linear regressions.

Eventually, the relation of near work with each biometric component was examined in a multiple linear regression models. In addition to age and gender, all other biometric components were adjusted for in each model. For example, in assessing the relation between near work and axial length, the latter was entered as the dependent variable in the multiple linear regression model, and the variables of age, gender, corneal radius of curvature, lens thickness, and anterior chamber depth were considered independent along with the variable concerning type of occupation, and the regression coefficient and R-square are given.

Ethical Issues: The Ethics Committee of Mashhad University of Medical Sciences approved the study protocol, which was conducted in accord with the tenets of the Helsinki Declaration. All participants signed a written informed consent.

RESULTS

Overall, 398 people were selected; 232 bank employees and 166 persons as controls. Mean ± SD age was 33.2±5.9 yr in the group of bank employees and 33.2±6.7 years in the control group (P=0.928). Gender distribution did not differ significantly between the two groups either (P=0.104).

Mean spherical equivalent in bank employees and the control group was -0.53D (95% CI: -0.36--0.7) and 0.09D (95% CI: -0.05-0.23), respectively (P<0.001). Cylinder error significantly differed between the two groups too; cylinder error was 0.53D (95% CI: 0.45-0.60) in bank employees and 0.31D (95% CI: 0.25-0.37) in the control group (P<0.001).

Table 1 demonstrates the prevalence of myopia, hyperopia, and astigmatism in the two studied groups. After adjusting for age and gender, the prevalence of myopia (OR=4.04 95% CI: 2.34-6.96) and astigmatism (OR=2.04 95% CI: 1.29-3.23) was significantly higher in bank. Results of logistic regression are summarized in Table 1.

Table 1. Prevalence of myopia, hyperopia, and astigmatism in the group of bank employees and the control group and comparison refractive errors between two groups by logistic regression

	Control group	**Bank employees**		
	%(95%CI)	%(95%CI)	OR(95%cI)	*P*-value
Myopia	12.35 (7.56 -17.14)	36.21 (30.15 -42.26)	4.04 (2.34 -6.96)	<0.001
Hyperopia	19.58 (13.83 -25.33)	12.72 (8.63 -16.8)	0.62 (0.37 -1.06)	0.083
Astigmatism	14.16 (9.49 -18.83)	27.37 (22.1 -32.64)	2.0 4 (1.29 -3.23)	0.003

CI: Confidence Interval

Table 2 compares mean biometric components in bank employees and the control group. The two groups were compared through linear regression after adjusting for age and gender. As demonstrated in this table, axial length and vitreous chamber depth were longer in the group of bank employees.

Table 3 illustrates the relation of near work with ocular biometric components after adjusting for age, gender, and other biometrics. Axial length and corneal radius of curvature were the only indices that significantly correlated with near work, although another model indicated a significant correlation with anterior chamber depth as well.

Table 2. Comparison of ocular biometric components in the group of bank employees and the control group after adjusting for age and gender

	Control group	**Bank employees**	
	Mean (95%CI*)	Mean (95%CI)	*P*-value**
Corneal radius of curvature (mm)	7.75 (7.71 -7.79)	7.75 (7.71 -7.78)	0.239
Axial length (mm)	23.17 (23.04 -23.3)	23.65 (23.52 -23.78)	0<0.001
Anterior chamber depth (mm)	3.29 (3.24 -3.34)	3.36 (3.32 -3.41)	0.102
Vitreous chamber depth (mm)	15.88 (15.76 -16.01)	16.29 (16.16 -16.42)	0<0.001
Lens thickness (mm)	4 (3.95 -4.05)	4 (3.94 -4.06)	0.748
Axial length / Radius of curvature	2.99 (2.98 -3.01)	3.05 (3.04 -3.07)	0<0.001

*confidence interval

** The P-value was calculated by linear regression

Table 3. The association between ocular component and near work activity by multiple linear regressions (in each model the association between ocular component and near work was adjusted with age, gender and other biometric components)

	Unstandardized Coefficients	**R Square**	***P*-value**
Radius of curvature (mm)	-0.049	0.545	<0.001
Axial length (mm)	0.153	0.743	<0.001
Vitreous chamber depth (mm)	0.153	0.733	<0.001
Anterior chamber depth (mm)	-0.034	0.452	0.113
Lens thickness (mm)	0.006	0.229	0.839

The relationship between refractive errors and biometric components was examined separately in the two groups through two separate linear regression models after adjusting for age and gender (Table 4). In the control group, corneal radius of curvature directly correlated with spherical equivalent and axial length correlated inversely. In the group of bank employees, corneal radius of curvature, anterior chamber depth, and lens thickness directly correlated with spherical equivalent, and axial length correlated inversely with spherical equivalent. Nonetheless, as indicated by regression coefficients in Table 4, corneal radius of curvature and axial length had a stronger correlation with spherical equivalent in the group of bank employees than the control group.

Table 4. the association between spherical equivalent (diopter) and ocular biometry in multiple linear regressions split by control group and bank employees

	Control group		**Bank employees**	
	Coefficient (95%CI)	*P*-value	Coefficient (95%CI)	*P*-value
Age (year)	0.04 (0.01-0.07)	0.017	0.03 (0.01-0.05)	0.005
Sex (male/female)	-0.07 (-0.31-0.17)	0.551	-0.27 (-0.55-0.01)	0.061
Radius of curvature (mm)	1.39 (0.66 -2.12)	<0.001	2.97 (2.27-3.66)	<0.001
Axial length (mm)	-0.77 (-1.10--0.44)	<0.001	-1.28 (-1.51--1.06)	<0.001
Anterior chamber depth (mm)	0.20 (-0.22-0.61)	0.360	1.02 (0.61-1.44)	<0.001
Lens thickness (mm)	-0.16 (-0.56-0.23)	0.410	0.20 (0.03-0.38)	0.024

DISCUSSION

In this study, the comparisons between refractive errors and biometric components in people with a history of near work and a control group, and the relationship between biometric components and refractive errors were examined. As demonstrated, the prevalence of myopia and astigmatism was considerably higher among bank employees. In a previous study on an Iranian population, the prevalence of myopia was significantly high among carpet weavers [16]. Other previous studies with different methodologies have also demonstrated a relationship between myopia and near work [11, 17].

However, recent studies have rejected the relationship between myopia and near work, and they have demonstrated transient myopia as a result of near work [11, 12, 17-19]. Ip et al. [17] suggested that it is not the duration, but rather the distance of near work that causes myopia. Although the relationship between myopia and near work was a confirmed hypothesis for years, today, confounding factors seem to have had a role. In a study [18], the authors concluded that parents' refractive error had no effect on the myopia caused by near work; they believed primary environmental basis were more important in the myopia caused by near work. Different hypotheses have been suggested in this regard. The first concerned the role of genetics and the status of refractive errors, which has been rejected by certain studies. Another hypothesis is changes in axial length, which seems more valid than the others do, and we will discuss later. A third hypothesis states that myopes have a greater tendency to do near work. Since hyperopes develop symptoms during near work, they seemed to be less inclined to engage in near work. In confirming this hypothesis, Saw et al. [20] demonstrated that myopic people in the city and the countryside spent more time reading. As demonstrated, the prevalence of hyperopia in the group of bank employees was not significantly different from the control group. This is while a previous study found a lower rate of hyperopia in this people.

In this study, we observed higher degree astigmatism among bank employees. Other studies have also shown that astigmatism may increase in the process of near work [16, 21]. Various hypotheses seem to have been proposed in regard to the effect of near work on astigmatism. One of these hypotheses is lid pressure during near work. The relationship between near work and astigmatism can also be due to the development of astigmatism because of incyclotorsion during near work.

The present study is one of the few studies examining the relationship between near work and biometric components. According to the findings of this study, mean corneal power, vitreous chamber depth, and axial length was greater among bank employees. Also, as demonstrated, the first model with axial length revealed significantly longer axial lengths and smaller corneal radii of curvature in bank employees after adjusting for age, gender, and refractive error, and in the second model, with vitreous chamber depth, bank employees had deeper vitreous chambers and thicker lenses in addition to smaller corneal radii of curvature.

Reviewing the results of this model and their comparison can aid us in clarifying the impact of near work in changing the biometric structure of the eye. Previous studies indicated that near work can transiently increase axial length [15, 22]. We demonstrated the role of axial length in the first model, nonetheless, in the second model vitreous chamber depth and anterior chamber depth were analyzed separately. Since vitreous chamber depth constitutes a greater part of the axial length, main factors that increase axial length are related to an increase in vitreous chamber depth as well. In fact, two hypotheses can be proposed regarding increased axial length and vitreous chamber depth by near work: 1- pressure from ciliary muscle contraction and reduced sclera area (scleral stretch) and 2- choroidal thinning, which is the more important factor. As observed in the second model, by taking vitreous chamber depth into account, lens thickness was greater in bank employees as well. In fact, it must be noted that the main reason of axial elongation during accommodation and near work can be increased lens thickness [23]. This increase can be due to ciliary muscles pressing against the globe wall and globe retraction. The report by Woodman et al. [23] illustrated interesting aspects of the relationship between near work and axial length changes. They found that the reduced choroidal thickness during accommodation is associated with increased axial length, and that the reductions are greater in myopes. [23] The ciliary muscle sheath, which is attached to the anterior portion of the choroid, can affect choroidal thickness through muscle contraction. If choroidal thickness change is due to ciliary muscle pressure, then there should be a relationship between lens thickness changes during accommodation and recovery time. Nonetheless, optic factors related to accommodation can also cause changes in the choroidal thickness. Therefore, a blurred retinal image can lead to changes in choroidal thickness, and subsequently, a change in axial length occurs. Therefore, optic changes during accommodation (including increased accommodation lag or increased higher order aberrations) can lead to changes in choroidal thickness, and subsequently, changes in axial length during near work. On the other hand, to maintain a clear retinal image during near work, ciliary muscle contraction occurs along with accommodation changes as well as pressure from external ocular muscles (especially during near vision with convergence) which can affect axial length.

Reduced corneal radius of curvature with near work was another finding of our study which has been addressed in few studies. As mentioned above, the central cornea steepens due to cyclotorsion when the ciliary muscle contracts during accommodation, and the radius of curvature decreases. Pierscionek et al. [24] demonstrated certain changes that occur in the shape of the cornea during accommodation. Changes in radius of curvature have also been suggested by Ni et al.. [25].

An interesting finding of this study was the relationship between refractive errors and biometric components in separate groups of bank employees and the control group. As demonstrated, the correlation of refractive errors with corneal power and axial length was stronger in the group of bank employees. In addition, in the group of bank employees, lens thickness directly correlated with spherical equivalent. This correlation better demonstrates the role of near work in refractive errors and ocular biometrics; it indicates that refractive errors that develop in the context of near work are more susceptible to biometric changes. In the control group, a weaker correlation was observed between spherical equivalent and biometric components, and the relationship can be genetic or due to a defect in emmetropization. In addition, as demonstrated, lens thickness correlated with refractive errors in the group of bank employees. This indicates that near work and accommodation increase lens thickness.

The present study had certain limitations. A limitation of note is that socioeconomic information was not included, because certain socioeconomic indices are related to refractive errors. In addition, the working distance for near work is defined differently in different studies and computer work may not strictly count as near work. However, the purpose of this study was to examine the impact of accommodation, which is active at the working distance maintained during computer work.

CONCLUSION

In conclusion, ocular biometric components, especially axial length, lens thickness, and corneal radius of curvature, significantly differ between people with a history of near work and those without one. Also, in light of different refractive errors in these two groups, near work seems to cause refractive error by inducing changes in axial length, corneal radius of curvature, and lens thickness.

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