

ORIGINAL ARTICLE

Small Font Size Reduced Accommodation Microfluctuations Without Affecting Axial Length in Myopic Young Adults

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ABSTRACT

Introduction: Smaller fonts on near works may be environmental factors linked to myopia development. A study was carried out to explore the near-work effect on microfluctuations and axial length using two different font sizes. **Method:** Fifty young adults (age range: 21-25 years old, myopia range: -1.00D to -4.00D) were recruited using convenient sampling. WAM-550 Grand Seiko and IOLMaster 500 were used to measure accommodation microfluctuations and axial length. The visual search game, printed in N12 and N24 font size using black letters on white A4 paper, was designated near work. Both measurements were taken before and after 20 minutes of near work. The font size was randomly assigned to each subject in a cross-over design. **Results:** Paired t-test did not reveal any significant difference in axial length before and after near work of N12 font size ($p>0.05$). Similarly, there was no significant difference in axial length before and after near work of N24 font size ($p>0.05$). However, accommodation microfluctuations were significantly changed before and after near work with the N12 font size ($t=2.16$, $p=0.04$), but not N24. **Conclusion:** Font size had no effect on axial length. Both N12 and N24 font sizes had similar axial lengths. However, smaller font sizes made the near work effect on the accommodative microfluctuations more apparent. There was a significant difference in microfluctuations before and after when using the N12 but not in the N24 font size.

Malaysian Journal of Medicine and Health Sciences (2025) 21(SUPP5): 158–162. doi:10.47836/mjmh.21.s5.21

Keywords: Font Size, Accommodative Microfluctuations, Axial Length, Near Work, Myopia

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INTRODUCTION

Near work refers to any activities that are performed at a near working distance (1). Near work and inadequate outdoor exposure are crucial environmental risk factors for myopia development (2,3). The risk of myopia progression has been associated with continuous reading at very close distances (4,5). More time spent near work has been related to myopia development among university students (6,7). Huang and associates claimed that the most crucial contributor to myopia progression in university students was continuous reading of scientific literature, which was more intensive and required extended periods of near focus than doing simple calculations and reading magazines,

newspapers, or fiction literature (8). The ocular changes associated with near work that led to myopia progression remain inconclusive. Some ocular changes related to near work that have been investigated include accommodation lag, convergence and divergence issues, pupil size and depth of focus, peripheral defocus and accommodative microfluctuations (9,10). The accommodation alterations linked to near work and myopia included decreased accommodative tonus, decreased accommodative amplitude, accommodative lags, accommodative adaptation, and accommodative microfluctuations (11–14).

Understanding the temporal variations in the accommodative response is crucial in studying vision and visual comfort (15). The temporal variation in the accommodative response refers to how this response changes over time. Temporal variation in the accommodative response occurs during the fixation on a stationary target, and the constantly shifting responses

can be defined as accommodative microfluctuations (16). Accommodative microfluctuations can be influenced by age, refractive errors, and accommodative demands (17,18). The total amount of accommodative microfluctuations was higher in the first decade of life than in the third decade (19). Accommodative microfluctuations differed between refractive error groups. Myopes were reported to have higher accommodative microfluctuations than emmetropes (17,20). There was a mixed finding regarding near work effect on accommodative microfluctuations. Hynes et al. said an increase, but no change was conveyed by Iwasaki & Kurimoto (16,21).

Maintaining optimal accommodative function is crucial for comfortable and efficient reading. Majaj et al. (2002) proposed that large letters were identified by their edges while smaller letters were identified by their strokes. The detection of smaller letters was more affected by defocusing than larger letters (22). Smaller letters required greater accommodative accuracy (22). Inaccuracies in accommodation can lead to symptoms such as eye strain, fatigue, or blurred vision during prolonged reading of small text (23). With accurate accommodation, smaller letters might be easier to recognise, so the accommodation lags were less tolerated (24). The microfluctuations of accommodation were the greatest at a lower defocus level for high spatial frequency compared with low spatial frequency targets (25). Two previous studies compared the axial length changes after near work between large and small text (26,27). Schaeffel & Swiatczak reported significant axial length shortening in large text. There was a significant axial length shortening in the myope's (26). Also, no significant difference in axial length was reported with small text, while the large text elicited a significant axial length difference (27). In the present study, we aimed to investigate further the effect of near work on accommodative microfluctuations and axial length using two different font sizes.

MATERIALS AND METHODS

The present study was a cross-sectional experimental design focused on the near work effect of accommodative microfluctuations and axial length in myopes concerning font size comparison. The study adhered to the tenet of the Helsinki Declaration. The ethical approval was obtained (FERC/FSK/MR/2022/0100).

Fifty young adults, aged between 21 and 25 years old, were recruited using convenient sampling. Informed consent was obtained before participation. The inclusion criteria were best corrected near visual acuity of N12 or better, with a refractive range between -1.00 DS and -4.00DS, and no known ocular diseases or binocular disorders. The exclusion criteria: Anisometropia >2D, Astigmatism > -2.00 DC, Any known ocular problems.

The room illumination of the experimental room was calibrated and controlled at 500 lux using the illuminance spectrophotometer CL-500A (Konica Minolta, Japan). The accommodative microfluctuations and axial length were measured before and after 20 minutes of near work. The near work assigned was name-searching games. Each participant was instructed to search and circle as many names as possible on the text. The viewing distance was 25 cm (4.00D of accommodative demand). The black text was printed in N12 and N24 font sizes on A4 white paper. Each participant wore their full correction during the near work. Each participant was assigned to N12 and N24 at random. There was a wash-out period of 10 minutes between works.

The accommodation microfluctuations were measured using a binocular free-space open-field autorefractor (WAM-5500, Grand Seiko Co., Ltd., Japan). Measurements obtained during a blink and outlier were excluded. The blank portion of the measurement or a spike in measurement taken during blinking with a value greater than the mean was defined as an under-blink. The under-blink and extreme data were considered noise and removed. The axial length was measured by the optical biometer IOLMaster® 500 from ZEISS using partial coherence interferometry and a 780-nm laser diode infrared light source.

RESULTS

Demographic subjects show that the age mean was 23 ± 1.44 years old, representing young adults. All the subjects were born between 1997 and 2002. About 78% of the subjects were female. These young adults engage in higher education and universities, which shifted from schools to early stages of working environments. All the subjects were myope with a sphere equivalent of -1.68 ± 0.92 DS and the best visual acuity (VA) of 0.00 logMAR or better in both eyes. Statistical analysis was performed using SPSS software (version 28.0, International Business Machines Corp). A normality test was performed using the Shapiro-Wilk test to check whether the data were normally distributed. The data were normally distributed. Data were expressed as the mean and standard deviation. Data analysis was carried out using the parametric test and paired sample t-test. A p-value of less than 0.05 was set as the level of significance.

The paired sample t-test was used to determine whether there was a statistically significant mean difference between the accommodative microfluctuations and axial length before and after near work. The mean, standard deviation, and statistical analysis before and after near work for both N12 and N24 font sizes were summarised in Table I. There was a significant difference in accommodative microfluctuations before and after the near work with N12 font size [$t = 2.16, p < 0.05$]. There was no significant difference in accommodative

microfluctuations before and after the near work with N24 font size [$t = 0.48, p > 0.05$]. There was no statistically significant difference in the axial length before and after the 20-minute near work with N12 font size [$t = 0.62, p > 0.05$] and N24 font size [$t = 1.65, p > 0.05$].

Table 1: The paired t-test statistical analysis of accommodative microfluctuations and axial length before and after near work for N12 and N24 font sizes.

Description	Accommodative Microfluctuations in dioptres (D) (mean ± standard deviation)		Axial length in millimetres (mm) (mean ± standard deviation)	
	N12	N24	N12	N24
Font sizes of black-on-white text				
Before 20 minutes near work	0.278 ± 0.092	0.258 ± 0.084	24.612 ± 0.957	24.681 ± 0.963
After 20 minutes near work	0.223 ± 0.089	0.248 ± 0.087	24.496 ± 1.012	24.341 ± 1.254
Paired t-test	t = 2.157, p = 0.041	t = 0.481, p = 0.635	t = 0.624, p = 0.541	t = 1.654, p = 0.115

DISCUSSION

Our study revealed that smaller font sizes (N12) of black-on-white text affected accommodative microfluctuations more than larger font sizes (N24) after a 20-minute near work. Our findings agree with the study of Niwa & Tokoro (25). They reported the greatest microfluctuations of accommodation at a lower defocus level for high spatial frequency compared with low spatial frequency targets. Our finding of larger font size (N24) was also in agreement with Iwasaki & Kurimoto (21), who reported no changes in microfluctuations of accommodation. However, the finding of N12 revealed contradictory results of a reduction in microfluctuations of accommodation instead of an increase as reported by Hynes et al. (16). Our finding seemed not in agreement with previous studies where smaller letter size of reading material was reported to affect accommodation accuracy as the smallest target produced the most accurate accommodative response (24). They mentioned that the largest lags were measured for larger-sized text. Our study revealed more accommodation microfluctuations in smaller font sizes due to a 20-minute near work. One of the potential explanations would be about accommodation control mechanisms. The contradictory findings associated with smaller font sizes may be attributed to individual differences in the ciliary muscle's response to elevated accommodative demands. Specific individuals might demonstrate reduced microfluctuations as a compensatory strategy to sustain focus, while others may experience increased fluctuations due to challenges in stabilising accommodation. This adaptive variability appears insufficiently accounted for in the previous study (16).

Our axial length investigation displayed no significant changes after the near work in both font sizes. Our finding

did not agree with previous studies by Drexler et al. and Schaeffel et al. (26,28). A significant difference in axial length elongation (5 to 12 µm) was found in responding to 4 to 5D magnitude of accommodation (28). Schaeffel et al. reported significant axial length shortening in large text. There was a significant axial length shortening in the myope's (26). On the other hand, our axial length finding agreed with Swiatczak et al. (2022), who found no significant difference in axial length. However, our axial length findings partially agreed with Mallen et al., in which a significant elongation of 48 µm was reported with an accommodation stimulus of 6 Dioptre (29). That research was done with a variable of different magnitudes of accommodation stimulus. However, in this study, the magnitude of accommodation was maintained, which was 4D but with a different font size of N12 and N24. Mallen et al. found no significant elongation in the magnitude of accommodation of less than 6D. In addition, there was a difference in the methodology of the axial length measurements. Mallen et al. induced the accommodation using the Badal optometer, which could be considered a consistent accommodation value. At the same time, the participants in our study were given a text set at 25 cm to induce the accommodation. One possible explanation was the systematic instrument error. During accommodation, there would be structural changes in the eyes with an increase in the thickness of the lens and reduced thickness of the anterior chamber with a possible slight reduction in vitreous length (30). The displacement of both the anterior and posterior chambers by thickening the lens might increase the optical path length in the eye, which results in an overestimation of axial length while using IOLMaster in an accommodated eye (31).

This study objectively measured the visual structural effect of accommodation microfluctuations and axial length on spatial frequency differences near work. This study's limitation was that it may not have fully accounted for inter-individual differences in the ciliary muscle's adaptive mechanisms, which could influence microfluctuations of accommodation. The duration of the near-work task (20 minutes) may have introduced visual fatigue, potentially confounding the results. A comparison with shorter or variable durations could clarify the impact of task length on accommodative microfluctuations. Also, the study may not have considered the role of cognitive load, reading speed, or attention levels, which could modulate the accommodative response to different font sizes. The discrepancies likely result from a complex interplay of methodological and individual factors. Future studies could standardise conditions to resolve these inconsistencies. Examining the role of fatigue, cognitive demand, and task duration explicitly may illuminate the underlying mechanisms driving differences in microfluctuations and axial length effect across font sizes.

This study will create awareness of the importance of visual hygiene, especially among young adults. Public awareness of the impact of font size on visual fatigue and accommodative stability is crucial, particularly for individuals engaged in prolonged near-work activities, such as students and office workers. Evidence-based recommendations for font sizes should be incorporated into the design of educational materials, digital interfaces, and workplace settings to optimise accommodative comfort and minimise visual strain. Additionally, advancing adaptive display technologies hold promise in mitigating these effects. Such technologies could dynamically adjust the font size and contrast based on user preferences and accommodative behaviour, providing a tailored visual experience that enhances comfort and efficiency. These initiatives underscore the importance of integrating ergonomic considerations into the design of reading materials and digital devices to support long-term visual health.

CONCLUSION

The effect of font size on the axial length was negligible after 20 minutes of the visual search game. However, smaller font sizes made the near work effect on the accommodative microfluctuations more apparent. Our findings suggest that accommodation instability precedes structural changes in near work demand. Such a link to visual stress and myopia development has yet to be explored further.

COMPETING INTERESTS

The authors declare that they have no competing interests.

ACKNOWLEDGEMENT

Financial support by the Ministry of Higher Education Malaysia: Fundamental Research Grant Scheme [FRGS/1/2022/SKK06/UITM/01/1].

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