1040-5488/15/9208-0908/0 VOL. 92, NO. 8, PP. 908–915
OPTOMETRY AND VISION SCIENCE
Copyright © 2015 *American Academy of Optometry*

ORIGINAL ARTICLE

OPEN

Influence of Near Tasks on Posture in Myopic Chinese Schoolchildren

Jinhua Bao*, Björn Drobe†, Yuwen Wang‡, Ke Chen‡, Eu Jin Seow§, and Fan Lu||

ABSTRACT

Purpose. To investigate near-vision posture in Chinese myopic schoolchildren and compare near-vision posture during different near-vision tasks (i.e., playing video games, reading, and writing).

Methods. The study investigated 120 myopic children (grades 1 through 6 and aged 6 to 13 years). An electromagnetic motion-tracking system was used for continuous measurements of the working distance and head declination of the subjects while they were playing video games or reading or writing at a desk. The reading and writing documents were adjusted by grade level (i.e., grades 1 to 2, 3 to 4, and 5 to 6). For analysis, the subjects were grouped in two refractive groups according to their median spherical equivalent refractive error (−1.50D).

Results. The myopic schoolchildren used close working distances for all tasks: 21.3 ± 5.2 cm (video games), 27.2 ± 6.4 cm (reading), and 24.9 ± 5.8 cm (writing). The mean head declinations were 63.5 ± 12.2 deg (video games), 37.1 ± 12.8 deg (reading), and 44.5 ± 14.1 deg (writing). Working distance decreased significantly across time for the reading and writing tasks ($p < 0.001$). Head declination increased significantly across time only for the reading task ($p < 0.001$). Grade level significantly influenced working distance, but the difference was not significant when working distance was adjusted by the subject's size. No differences were observed within the refractive or the accommodative lag groups in terms of the posture data ($p > 0.05$). Working distance was negatively correlated with head declination ($r = -0.53$, $p < 0.001$).

Conclusions. Close working distances were observed for Chinese myopic schoolchildren. The attention dedicated to each task, the task difficulty, and the page/screen size may affect near working distance and head declination. Handheld video games were associated with the closest working distance, which may be a risk factor for myopia progression, according to previous studies.

(Optom Vis Sci 2015;92:908–915)

Key Words: myopia, working distance, head declination, video game, Chinese schoolchildren

In the past, a higher prevalence of myopia and greater progression have often been associated with tasks involving intensive schoolwork and near work. Although some studies did not find any relationship between near work and myopia,[1–3] many others have shown that near work activity is related to myopia onset or progression. A longitudinal 3-year observation study suggested that near work, such as reading or writing, might cause myopic shifts in emmetropic students.[4] In Australia, children who performed near work at a distance of less than 30 cm were 2.5 times more likely to become myopic than children who worked at a farther distance. Similarly, children who spent a longer time reading for pleasure and children who read at a distance closer than 30 cm were more likely to have higher myopic refractions.[5] Pärssinen et al.[6] showed that faster myopic progression in children was closely related to short working distances. Charman[7] suggested that the conflicting accommodation demands caused by pronounced head turns during near-vision work might cause myopic shifts. It is plausible that continuous hyperopic defocus during near work, induced by the lag of accommodation, drives the emmetropization mechanism to correct this apparent refractive error by making the eye myopic.[8–10]

In recent years, numerous epidemiological studies have used questionnaires to gather information concerning the number of near work hours per day in children, but near working posture has rarely been mentioned, particularly for schoolchildren. Few studies have described the reading posture of schoolchildren in detail.[6,11–16] In

*MSc
†PhD
‡MD
§BOptom
||MD, OD
School of Ophthalmology and Optometry, Wenzhou Medical University, Wenzhou, Zhejiang, China (JHB, YWW, KC, FL); R&D Asia, Essilor International, Singapore (BD, EJS); and Wenzhou Medical University-Essilor International Research Centre, Wenzhou, Zhejiang, China (JHB, BD, YWW, KC, FL).
This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially.

particular, a study using photography analysis found that Chinese emmetropic schoolchildren usually work at a desk at close distances (25.4 cm for a reading task and 20.6 cm for a reading/writing task).[16] Therefore, Wang et al.[16] suggested that near testing during ophthalmic examinations should be performed at 25 cm for schoolchildren and perhaps even at 20 cm for the youngest schoolchildren because these were the near distances actually used by the children when they were reading or writing. However, it is unclear to what extent this suggestion also applies to Chinese myopic schoolchildren, although white myopic children[13] have been shown to perform near tasks at closer distances compared with emmetropic children. Few ophthalmic studies have investigated the near work posture of Chinese myopic schoolchildren in detail. The aim of the present study was to compare working distance and head declination between different near-vision tasks (i.e., playing video games, reading, and writing) for myopic schoolchildren from the same primary school using continuous recording of these parameters during the entire task.

METHODS

Subjects

After regular vision screening of 642 schoolchildren from grades 1 through 6 at an elementary school in Wenzhou, Zhejiang province, China, all myopic subjects (N = 142) were recruited during a period of 3 months for posture measurements. Twenty-two children were excluded because of incomplete posture data records. The remaining 120 children consisted of 54 boys and 66 girls with an age range of 6 to 13 years and a mean age of 9.20 ± 3.62 years. Each child was myopic, with a spherical equivalent refractive error (SE) between −0.50D and −6.50D in both eyes (Fig. 1), astigmatism 1.50D or less, and anisometropia 1.25D or less, as measured by noncycloplegic subjective refraction. The monocular best-corrected distance visual acuity was 20/20 or better. All subjects were free of strabismus and had no history of ocular pathology, trauma, or surgery.

Informed consent was obtained from all subjects and their accompanying parents or guardians after the nature of the study and possible consequences had been explained. The study was approved by the ethics committee of the School of Ophthalmology and Optometry, Wenzhou Medical University, and followed the tenets of the Declaration of Helsinki.

Tasks

The three near tasks were playing a handheld video game and reading and writing at a desk. For the video game task, the subjects were instructed to play the handheld video game (Donkey Kong Country 2; Game Boy Advance SP, Nintendo) for 7 min (2 min

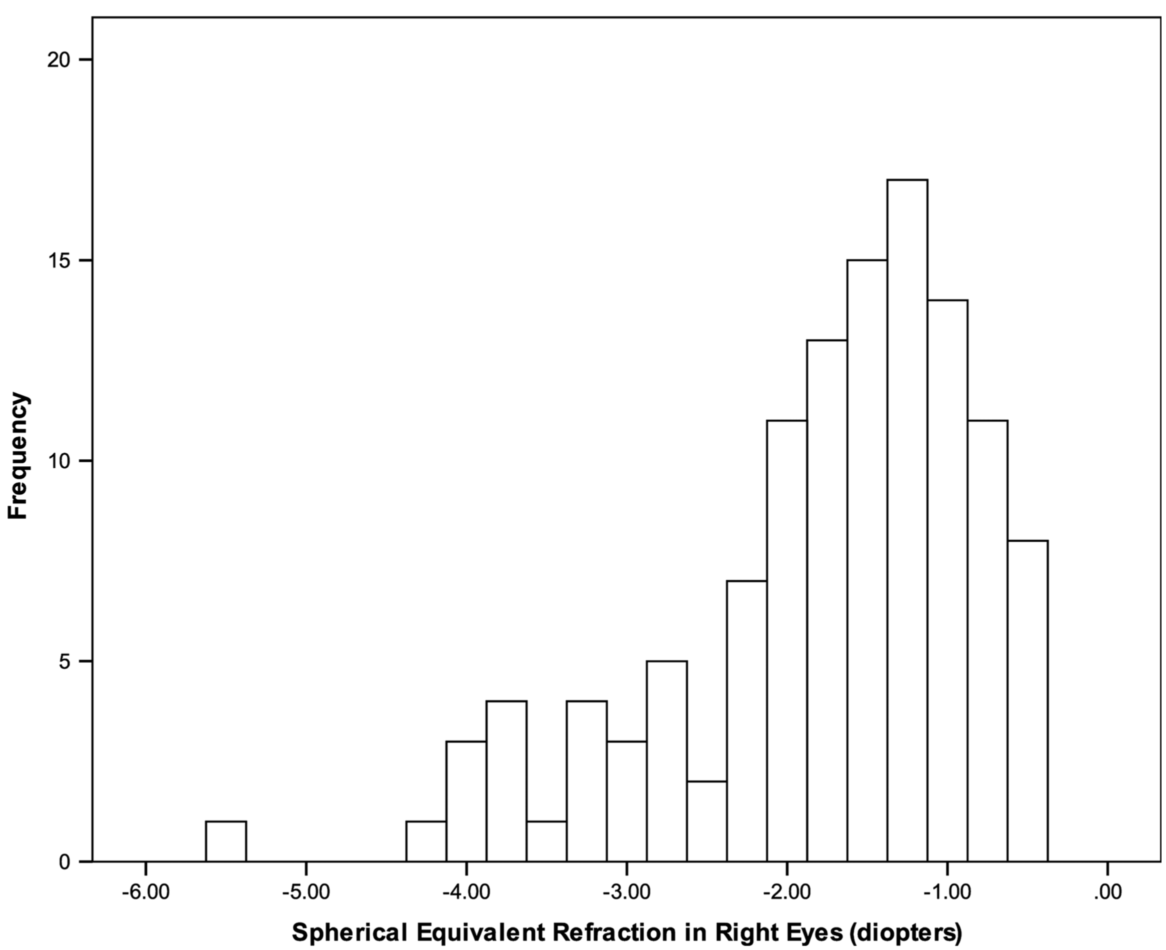

FIGURE 1.
Distribution of noncycloplegic spherical equivalent refractive error in the right eyes of 120 myopic children.

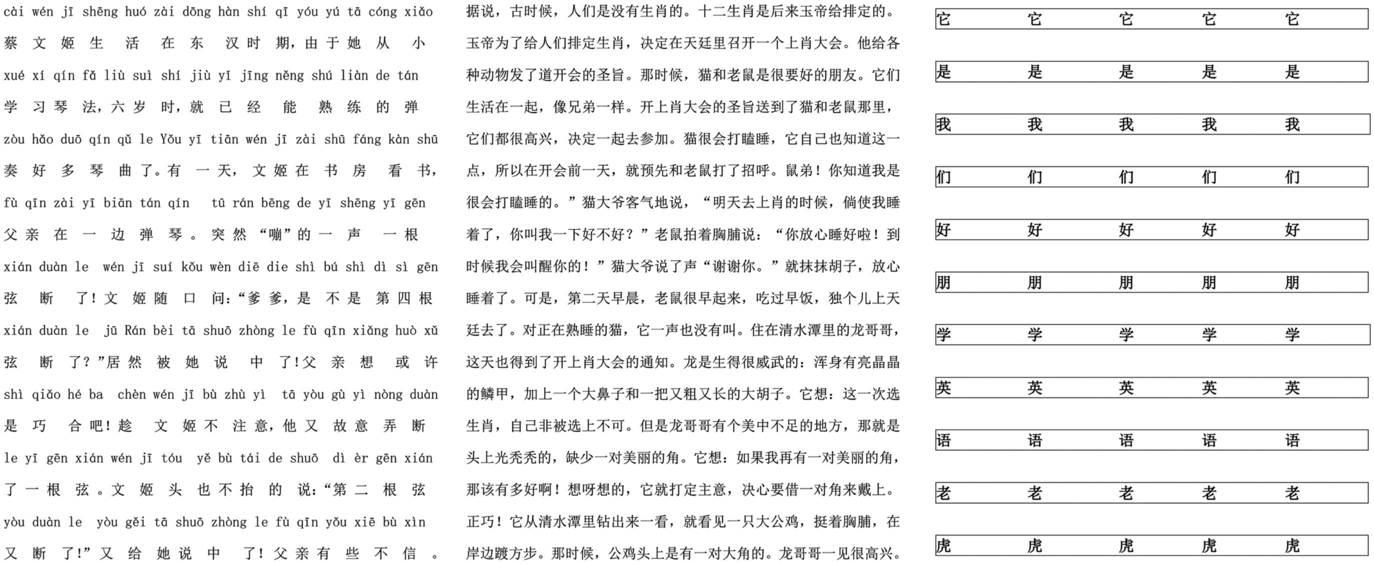

FIGURE 2.

Reading texts (left for grades 1 to 2; middle for grades 3 to 4) and writing material (right for grades 5 to 6).

for demonstration and 5 min for measurement). During the reading task measurements, the subjects were asked to read Chinese stories on a standard A5-size paper, with Chinese Song font and 1.5-line spacing (14 pt) (Fig. 2, middle). For the writing task, the subjects were asked to copy 55 Chinese characters onto a standard A5-size paper, with 11 lines and 5 same Chinese characters per line (Fig. 2, right). Each character had enough subsequent space for copying.

The reading and writing tasks had three grade-appropriate modes. For the reading task, the text for grades 1 and 2 used Chinese Hanyu Pinyin (a phonetic language that uses Western alphabet), according to their Chinese textbooks (Fig. 2, left), whereas the text for higher grade levels contained only Chinese characters (Fig. 2, middle). For the writing task, there were one to four character strokes in grades 1 and 2, four to six character strokes in grades 3 and 4, and five to nine character strokes in grades 5 and 6. All participants were divided into three grade groups that used level-appropriate reading and writing materials: grades 1 to 2, grades 3 to 4, and grades 5 to 6.

Procedures

For all subjects, two experienced optometrists performed the eye examinations, which included a case history, visual acuity, cover test, objective and subjective refraction, and slit-lamp examination, as well as accommodative response of the right eye at 33 cm, which was measured under binocular viewing conditions with a free-space autorefractor (WAM-5500; Grand Seiko Co., Ltd., Japan) fixated on a Maltese cross target. Because working distance may depend on the size of a child, we measured the height and forearm length (distance from the elbow to the wrist) of each subject.

All subjects were provided with full-correction glasses after their eye examinations. After a minimum 2-week adaptation period (for the glasses), posture measurements were performed. Posture was measured in the following order: writing, reading, and playing video games, with a 5-min break between each task. After the reading session, the subjects were asked three questions about the text passage that they had just read to confirm that they had truly read and understood the content.

Our experiment was performed in a reading laboratory where lighting conditions were carefully controlled. The average lighting intensity for the reading materials was 254 lx (248 to 260 lx). The desk and chair heights (73.2 cm and 43.7 cm, respectively) remained constant for all grade levels and were similar to those used for all subjects in grades 1 through 6 at their elementary school.

Working distance and head declination were continuously recorded at 10 Hz with a Fastrack (Polhemus, USA) electromagnetic motion-tracking system, which is commonly used for near posture measurements.[13,17,18] This electromagnetic device was composed of an emitter and several receivers. One receiver was attached to the head of the child by means of a headband, and the others were fixed to the task materials (reading and writing materials, handheld video game). This device provided complete freedom of movement during the near tasks. Before each task, calibration measurements were performed to determine the reference (vertical) head posture, location of the base of the nose and sagittal plane of the head relative to the head receiver, as well as the location of text/screen corners relative to the task material receiver.

Data from the first 3 min of each task were used for the analysis. Working distance was defined as the distance from the base of a child's nose to the center of each line (for reading or writing) or to the center of the screen (for the video game). Head declination was defined as the angle in the sagittal plane between the head and the vertical upright position measured during calibration.

One-way analysis of variance was used to compare the means of the basic biometric characteristics, such as height, forearm length, refractive error, and lag of accommodation for each grade group. A repeated-measures analysis of variance was used to analyze the mean differences for postural data, and covariates included the height and forearm length of the subjects. *Post hoc* analysis was then performed using Fisher's least significant difference test between each grade group and between each task. Pearson's correlation analysis was used to determine the strength of the relationship between the different

TABLE 1.
Relationship between the grade-level groups, sex, and biometric measurements

Grade	N	Age, yr	Height, cm	Forearm length, cm	SE (OD), D	SE (OS), D	Accommodative lag at 33 cm, D
1–2	28	7.0 ± 0.5	126.6 ± 6.5	19.6 ± 1.8	−1.76 ± 0.80	−1.58 ± 0.81	1.49 ± 0.56
Girls	14	7.1 ± 0.5	126.2 ± 6.7	19.2 ± 1.5	−1.74 ± 0.92	−1.62 ± 0.98	1.49 ± 0.45
Boys	14	7.0 ± 0.6	127.1 ± 6.5	20.0 ± 2.1	−1.78 ± 0.69	−1.55 ± 0.62	1.49 ± 0.67
3–4	44	8.5 ± 0.8	133.9 ± 7.5	20.6 ± 1.9	−1.89 ± 1.12	−1.87 ± 1.20	1.77 ± 0.43
Girls	23	8.5 ± 1.0	132.0 ± 7.0	20.1 ± 1.8	−2.15 ± 1.29	−2.07 ± 1.44	1.61 ± 0.56
Boys	21	8.6 ± 0.6	136.0 ± 7.7	21.1 ± 1.9	−1.61 ± 0.85	−1.64 ± 0.84	1.93 ± 0.61
5–6	48	11.1 ± 0.9	149.6 ± 8.7	22.7 ± 2.0	−1.69 ± 0.91	−1.72 ± 0.91	1.49 ± 0.49
Girls	29	11.0 ± 0.8	149.9 ± 7.9	22.7 ± 1.9	−1.64 ± 0.86	−1.67 ± 0.87	1.33 ± 0.47
Boys	19	11.2 ± 1.0	149.1 ± 10.1	22.5 ± 2.3	−1.77 ± 0.99	−1.80 ± 0.99	1.74 ± 0.60
Total	120	9.2 ± 1.8	138.5 ± 12.3	21.2 ± 2.3	−1.78 ± 0.97	−1.74 ± 1.00	1.59 ± 0.56

Mean ± SD data for all 120 myopic schoolchildren. There were no significant sex-based differences in age, height, forearm length, refractive error, or accommodative lag ($p > 0.05$).

SE, spherical equivalent refractive error; OD and OS, right eye and left eye, respectively.

posture measures. Statistical analysis was performed using SPSS 20.0 statistics software, and $p < 0.05$ was considered to be statistically significant.

RESULTS

Basic biometric characteristics of the subjects are described in Table 1. There were no significant sex-based differences in age, height, forearm length, refractive error, or accommodative lag ($p > 0.05$). Therefore, the sex data were combined. For the analysis, the subjects were divided into two refractive groups (SE ≥−1.50D group containing 62 subjects and SE <−1.50D group containing 58 subjects) based on the median of the refractive error (SE −1.50D).

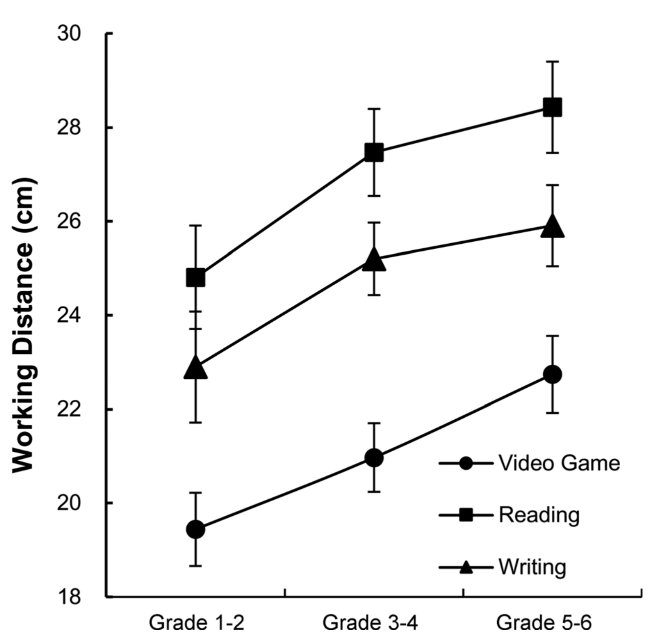

FIGURE 3.
Working distance for each grade-level group and each of the three tasks (grades 1 to 2, 28 children; grades 3 to 4, 44 children; grades 5 to 6, 48 children). The error bars indicate the standard error of the mean for each data point (video game, circles; reading, squares; writing, triangles).

Working Distance

The mean working distances of the 120 subjects were 21.3 ± 5.2 cm (video game), 27.2 ± 6.4 cm (reading), and 24.9 ± 5.8 cm (writing). The task had a significant influence on working distance ($F_{2,357} = 31.45$, $p < 0.001$), and pairwise comparisons showed that the working distances differed significantly between each task ($p < 0.005$).

Grade level influenced working distance ($F_{2,357} = 7.61$, $p = 0.001$), and working distance was shorter for grades 1 to 2 compared with grades 5 to 6 for each task (video games, $p = 0.007$; reading, $p = 0.018$; writing, $p = 0.029$). However, no difference was

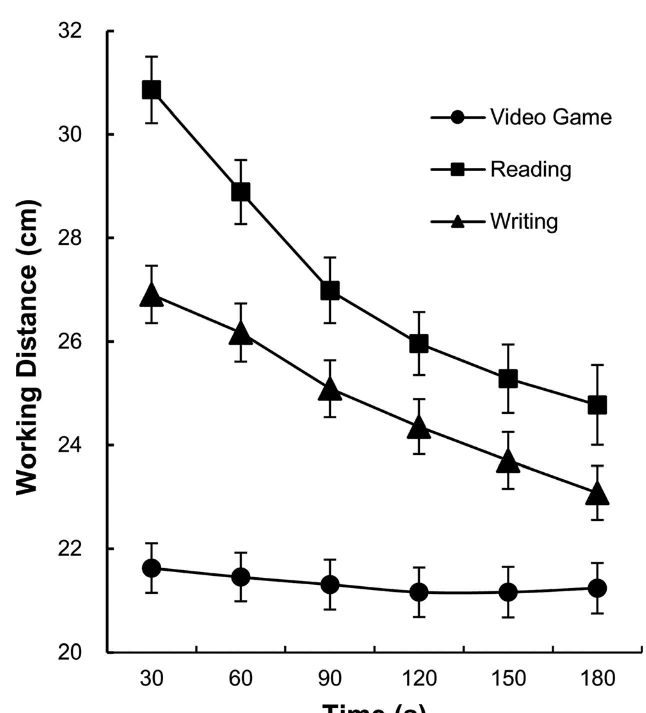

FIGURE 4.
Changes in working distance across time for each of the three tasks in 120 myopic children. The error bars indicate the standard error of the mean for each data point (video game, circles; reading, squares; writing, triangles).

found for the other pairwise comparisons ($p > 0.05$) (Fig. 3). These differences were no longer significant when the working distance was adjusted by the subject's height ($F_{2,357} = 2.23$, $p = 0.11$) or forearm length ($F_{2,357} = 1.34$, $p = 0.26$). There was no task by grade group interaction for the changes in working distance ($p = 0.96$). Moreover, no difference in working distance was found between the refractive groups (SE ≥ -1.50D group vs. SE < -1.50D group) ($p = 0.48$).

To analyze the change in working distance across time, we measured the average working distance in 30-s increments for 3 min. Working distance did not change across time for the video game task (Fig. 4; $F_{5,714} = 0.15$, $p = 0.98$). In contrast, the average working distances decreased significantly by 6.08 cm (0.80D) and 3.83 cm (0.62D) after 3 min for the reading and writing tasks, respectively (reading task, $F_{5,714} = 12.78$, $p < 0.001$; writing task, $F_{5,714} = 7.29$, $p < 0.001$).

Head Declination

The mean head declinations of 120 subjects were 63.5 ± 12.2 deg (video game), 37.1 ± 12.8 deg (reading), and 44.5 ± 14.1 deg (writing). The tasks had a significant influence on head declination ($F_{2,357} = 129.44$, $p < 0.001$), and pairwise comparisons showed that the head declinations differed highly between each task ($p < 0.001$). Grade level did not influence head declination ($F_{2,357} = 0.12$, $p = 0.88$) (Fig. 5). There was no task by grade group interaction for the changes in head declination ($p = 0.10$). Moreover, there was no difference in head declination between the refractive groups ($p = 0.46$).

We also analyzed the average head declination in steps of 30 s for 3 min. Head declination did not change across time for the video game ($F_{5,714} = 0.22$, $p = 0.95$) and writing task ($F_{5,714} = 2.03$, $p = 0.07$) during the first 3 min (Fig. 6). However, head declination increased significantly with time for the reading task (i.e., toward a more horizontal head posture) ($F_{5,714} = 6.45$, $p < 0.001$).

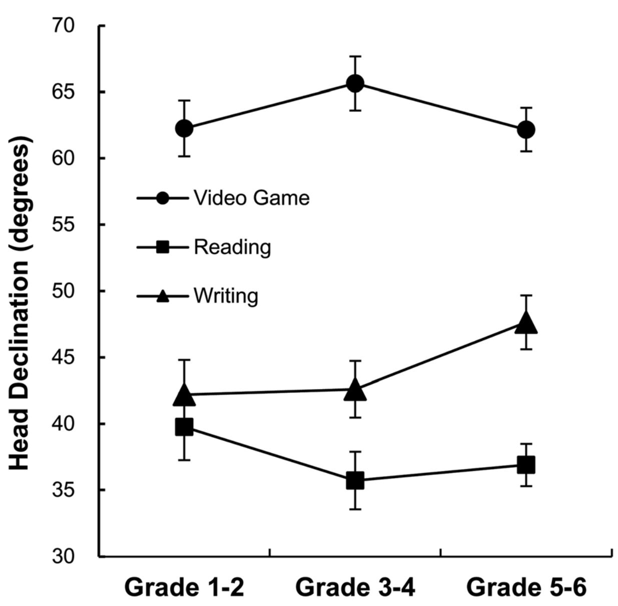

FIGURE 5.

Head declination for each grade group and each of the three tasks (grades 1 to 2, 28 children; grades 3 to 4, 44 children; grades 5 to 6, 48 children). The error bars indicate the standard error of the mean for each data point (video game, circles; reading, squares; writing, triangles).

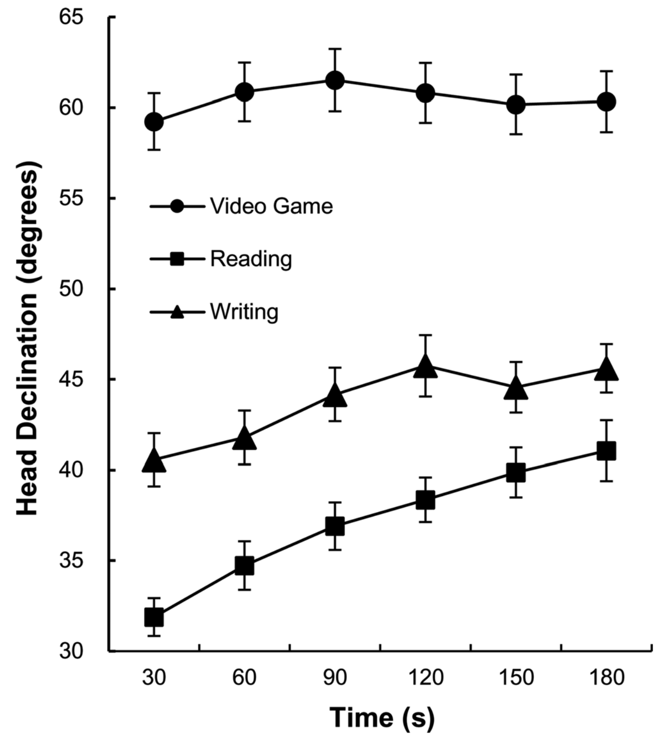

FIGURE 6.

Change of head declination across time for each of the three tasks in 120 myopic children. The error bars indicate the standard error of the mean for each data point (video game, circles; reading, squares; writing, triangles).

Correlations Between Posture Measurements

Because near tasks may induce different combinations of working distance and head declination, we performed a correlation analysis between these two measurements for each task.

Overall, working distance was negatively correlated to head declination ($r = -0.53$, $p < 0.001$). The children demonstrated a shorter working distance, with greater head declination, during the reading and writing tasks (reading, $r = -0.52$, $p < 0.001$; writing, $r = -0.52$, $p < 0.001$), but no correlation was found between these two posture measurements for the video game task ($r = -0.10$, $p = 0.29$).

Accommodative Lag

The average accommodative lag for the myopic children was 1.59 ± 0.56D at 33 cm (Table 1). For the analysis, the subjects were divided into two lag groups of 60 subjects each based on the median accommodative lag (1.60D). There was no difference in the working distance or the head declination between the two lag groups ($p > 0.05$).

DISCUSSION

A recent investigation of more than 2000 American children and teenagers aged between 8 and 18 years reported that, in an average day, more than an hour was dedicated to playing video games.[19] Similarly, all types of near distance video game devices, such as handheld video games, cell phones, and tablet PCs, have become increasingly popular among adults and even schoolchildren in China. Therefore, it may be important to understand the influence of these video games on posture in myopic schoolchildren and to investigate whether the impact of video games was any different when compared with more traditional tasks (reading/writing). We also hope that this work will help extend the prior recommendation for emmetropic Chinese schoolchildren[16] to use an appropriate near-vision testing distance for myopic Chinese schoolchildren.

In our study, the order of testing was kept constant (writing, reading, and then playing video games) instead of randomized. In a pilot study[15] on posture of Singaporean Chinese children, we did not find that the order of tasks affected the outcome within a short period. We designed the order of the tasks from hard to easy. Moreover, we designed the study to reduce interference between tasks; therefore, video games were played last, which a child may consider as a reward. In fact, in a prior pilot study, we noticed that many children did not stop playing when the proctor declared that the time had elapsed.

We performed the vision screening at the elementary school and sent them an invitation for a further eye examination at our hospital, including a free eye examination, free glasses for myopic children, and a reading posture test. Eventually, 120 myopic children were recruited to this study. The reading distances of myopic Chinese children in our study (27.2 ± 6.4 cm) were comparable to those observed in emmetropic children[16] (26.3 ± 6.0 cm) of similar ages and ethnicities for 14-pt reading ($t = -0.89$, $p = 0.38$). However, compared with the study by Wang et al.[16], the writing distances in our sample (24.9 ± 5.8 cm) were significantly farther away than those of emmetropic children (21.2 ± 6.7 cm) ($t = -3.88$, $p < 0.001$). The main difference in the research methodology between these two studies is that we used an electromagnetic motion capture device with continuous posture recording instead of a digital camera with analysis of only a few photos per task. It has been previously reported that working distances of both children and adult myopes and emmetropes do not differ significantly.[15,18,20,21] However, these results do not align with the findings of Marumoto et al.[12] and Haro et al.[13], who found that myopic children worked significantly closer during near work tasks than nonmyopic children. During their experiments, table and chair heights were adjusted according to the height of each child, and the vision correction was not specified. Moreover, we did not find that the degree of myopia had any influence on the working distances of myopic schoolchildren with full-correction glasses. Nevertheless, close working distances were measured for both myopic (this study) and emmetropic[16] Chinese children.

In our sample of myopic Chinese children, the working distance decreased significantly from the reading task to the writing task to the video game task. As previously mentioned, the working distance decreased while attentional and haptic workload and concentration increased.[13,16] Furthermore, the working distances also changed across time (Fig. 4); therefore, concentration and task difficulty might also be possible explanations for those differences. The handheld video game showed the closest and most stable working distances compared with reading or writing at a desk. Thus, the visual hazard of handheld video games could be even worse than traditional near-vision tasks (reading and writing on paper) by inducing higher levels of accommodative lag[9,22–24] and visual fatigue.[25] Using the same setting of the desk and chair, the working distance for the video game was nearest (21.3 cm). Although the reading and writing tasks were performed at slightly farther distances (27.2 cm and 24.9 cm, respectively), they were still closer than the traditional near point distance (33 cm) used for ophthalmic examinations in China. These findings were consistent with the results of Wang et al.[16] in emmetropic children, whose working distances were also significantly affected by the tasks (reading and writing) and were closer than 33 cm. Based on the previous results in emmetropic Chinese children[16] and our results in myopic children (average value for different near-vision tasks, 24.5 cm), we suggest that near testing during ophthalmic examination of 6- to 12-year-old children should be performed at 25 cm instead of 33 cm in China, independent of the child's refractive status.

In our study, myopic children showed a larger amount of accommodative lag (1.59 ± 0.56D at 33 cm) compared with the study[26] in Canadian Chinese myopic children (1.06 ± 0.43D at 33 cm), in which numbers were used as the near fixation target. The difference in accommodative lag between these two studies may be caused by different characteristics of the visual target used in each study, such as differences in visual angles, lighting, and attention factors. Based on the average reading distances for each task, the accommodative demands for the myopic children were 4.69D (video game), 3.68D (reading), and 4.02D (writing). Earlier reports have found that accommodative lag significantly increases with high accommodative demands.[9,22–24] The Chinese myopic children could therefore experience large accommodative lags, such as 1D and perhaps even 1.50D, while performing near work. An increased accommodative lag during the course of a sustained near task would induce a higher level of retinal hyperopic defocus.[22,27–29] Hyperopic defocus, induced by accommodative lag, has been identified as a potential, but challenged, factor for myopic development.[30–33]

During the first 3 min, myopic children performed the video game task with a more stable working distance and a more stable head declination compared with the other two tasks (Figs. 3 and 5). This stability may be caused by the much smaller screen size (40.8 × 61.2 mm) than those used for the reading (148 × 189 mm) and writing (148 × 192 mm) texts. Working distance decreased and head declination increased across time for reading and writing tasks (Figs. 3 and 5). We found that, during the reading or writing conditions, head tilt and working distance were negatively correlated. One plausible explanation is that the children lowered their heads to read or write the lines at the bottom of the page.

Although, in the present study, we found that grade group significantly influenced working distance, these differences were no longer significant when working distance was adjusted based on the subject's height and forearm length. These results demonstrated that working distance at the desk is closely linked to the size of a child and highlighted the importance of matching an adapted desk and chair setting with the anthropometrics of schoolchildren. Marumoto et al.[12] suggested that the recommended desk height should be equal to the sitting height/3 + leg length, after setting the chair height at 44 cm according to the standard in the School Health Law in Japan. Molenbroek et al.[34] also suggested that the design of classroom furniture should be based on students' popliteal heights. In our study, we had a similar chair height (43.7 cm), but we still chose a constant desk height for all grades, in accordance with the usual setting of our subjects' elementary school. The height of the 120 subjects in our study increased significantly in conjunction with grade level ($F_{2,117} = 51.75$, $p < 0.001$). For example, the average height of the children in grades 1 and 6 was 118.0 ± 7.1 cm and

153.0 ± 7.8 cm, respectively. The mismatch between school furniture and student size has been noted by many researchers in the field of ergonomics as a cause of neck-shoulder pain, low-back pain, stress to spinal structures and lumbar intervertebral discs, and even headaches.[35–37] Although China has a national standard for desk and chair height in high school and primary school (GB/T3976–2002), methods for describing the relationship between the height settings of the desk/chair and the size of children remain ambiguous.

In our study, head declination was affected by the tasks but not by the grade group. Head declination increased significantly from the reading task to the writing task to the video game task. Thus, head declination increased while attentional and haptic workload and concentration increased. We found that, during reading or writing tasks, the working distance became closer as a child's head tilt increased. This finding is consistent with the results from a study performed by Marumoto et al.[12] Although our subjects performed the video game task at a closer working distance and with higher head declination (i.e., more horizontal head declination, 63.5 ± 12.2 deg) than they did during reading or writing, no correlation was found between working distance and head declination for this task. One possible explanation is that most subjects held the game machine above the desk. Thus, the link between working distance and head declination was broken when the working materials were no longer placed on the desk.

The head declinations for reading (37.1 ± 12.8 deg) and writing (44.5 ± 14.1 deg) among myopes in our study were significantly higher than those of emmetropes in the study of Wang et al.[16] (reading, 26.9 ± 10.1 deg; writing, 40.3 ± 11.7 deg) (reading, $t = 5.76$, $p < 0.001$; writing, $t = 2.02$, $p = 0.045$). One possible explanation is that the lower edge of the glass frame limits the visual field of the child, forcing him or her to adopt a less vertical head posture. Another possible explanation is that myopic children bend their heads more during near-vision tasks to reduce off-axis aberrations induced by the lenses in their glasses (i.e., the myopic children preferred to look at the page or screen through the part of the lens that was close to the optical center). Similar to working distance, the degree of myopia had no significant influence on head declination.

CONCLUSIONS

Close working distances were observed for Chinese myopic schoolchildren, particularly for the handheld video game. The average value for three near-vision tasks, which are the most common near tasks at school and in everyday life, was 24.5 cm. Thus, we recommend that near testing during ophthalmic examination of all primary schoolchildren should be performed at 25 cm instead of 33 cm in China. The children experience high levels of hyperopic defocus because of a large accommodative lag during near work every day at a young age, thereby increasing the risk of greater myopia progression. Improving near posture through appropriate desk and chair settings during near work might help to slow the progression of myopia in children.

ACKNOWLEDGMENTS

We gratefully acknowledge the editors and the two anonymous reviewers for helpful comments on the earlier drafts of this manuscript.

This study was supported by the International S&T Cooperation Program of China (grant no. 2014DFA30940) and the National Natural Science Foundation of China (grant no. 81170869). Partial funding was provided by Essilor International SA.

Received November 28, 2014; accepted April 4, 2015.

REFERENCES

1. Saw SM, Nieto FJ, Katz J, Schein OD, Levy B, Chew SJ. Factors related to the progression of myopia in Singaporean children. Optom Vis Sci 2000;77:549–54.
2. Jones LA, Sinnott LT, Mutti DO, Mitchell GL, Moeschberger ML, Zadnik K. Parental history of myopia, sports and outdoor activities, and future myopia. Invest Ophthalmol Vis Sci 2007;48:3524–32.
3. Low W, Dirani M, Gazzard G, Chan YH, Zhou HJ, Selvaraj P, Au Eong KG, Young TL, Mitchell P, Wong TY, Saw SM. Family history, near work, outdoor activity, and myopia in Singapore Chinese preschool children. Br J Ophthalmol 2010;94:1012–6.
4. Hepsen IF, Evereklioglu C, Bayramlar H. The effect of reading and near-work on the development of myopia in emmetropic boys: a prospective, controlled, three-year follow-up study. Vision Res 2001;41:2511–20.
5. Ip JM, Saw SM, Rose KA, Morgan IG, Kifley A, Wang JJ, Mitchell P. Role of near work in myopia: findings in a sample of Australian school children. Invest Ophthalmol Vis Sci 2008;49:2903–10.
6. Pärssinen O, Hemminki E, Klemetti A. Effect of spectacle use and accommodation on myopic progression: final results of a three-year randomised clinical trial among schoolchildren. Br J Ophthalmol 1989;73:547–51.
7. Charman WN. Aniso-accommodation as a possible factor in myopia development. Ophthalmic Physiol Opt 2004;24:471–9.
8. Flitcroft DI. A model of the contribution of oculomotor and optical factors to emmetropization and myopia. Vision Res 1998;38:2869–79.
9. Charman WN. Near vision, lags of accommodation and myopia. Ophthalmic Physiol Opt 1999;19:126–33.
10. Wallman J, Winawer J. Homeostasis of eye growth and the question of myopia. Neuron 2004;43:447–68.
11. Chiu NN, Rosenfield M, Solan H. Habitual reading and writing distances in children. Optom Vis Sci 1994;71(Suppl.):126.
12. Marumoto T, Sotoyama M, Villanueva MBG, Jonai H, Yamada H, Kanai A, Saito S. Relationship between posture and myopia among students. In: Tokora T, ed. Myopia Updates: Proceedings of the 6th International Conference on Myopia.Tokyo, Japan: Springer-Verlag; 1998;63–6.
13. Haro C, Poulain I, Drobe B. Investigation of working distance in myopic and nonmyopic children. Optom Vis Sci 2000;77(Suppl.):189.
14. Rosenfield M, Wong NN, Solan HA. Nearwork distances in children. Ophthalmic Physiol Opt 2001;21:75–6.
15. Drobe B, Seow EJ, Koh P, Yeoh LT. Working distance in bilingual children: is Chinese text a causal factor for myopia? Invest Ophthalmol Vis Sci 2008;49 E-abstract 3585.
16. Wang Y, Bao J, Ou L, Thorn F, Lu F. Reading behavior of emmetropic schoolchildren in China. Vision Res 2013;86:43–51.
17. Drobe B, Seow EJ, Bao J, Wang Y, Lu F. Near vision posture in myopic Chinese children. Invest Ophthalmol Vis Sci 2011;52 E-abstract 2701.
18. Drobe B, Seow EJ, Tang FL. Clinical evaluation of working distance in Caucasian and Chinese adults: a comparison study in France and Singapore. Invest Ophthalmol Vis Sci 2007;48 E-abstract 962.

19. Rideout VJ, Foehr UG, Roberts DF. Generation M^2: media in the lives of 8- to 18-year-olds. A Kaiser Family Foundation Study. Menlo Park, CA; The Henry J. Kaiser Family Foundation; 2010.
20. Hartwig A, Gowen E, Charman WN, Radhakrishnan H. Analysis of head position used by myopes and emmetropes when performing a near-vision reading task. Vision Res 2011;51:1712–7.
21. Drobe B, Lombo I, Marie S. Working distance in non-presbyopes and progressive lens wearing presbyopes. Invest Ophthalmol Vis Sci 2006;47 E-abstract 5861.
22. Gwiazda J, Thorn F, Bauer J, Held R. Myopic children show insufficient accommodative response to blur. Invest Ophthalmol Vis Sci 1993;34:690–4.
23. Seidemann A, Schaeffel F. An evaluation of the lag of accommodation using photorefraction. Vision Res 2003;43:419–30.
24. Harb E, Thorn F, Troilo D. Characteristics of accommodative behavior during sustained reading in emmetropes and myopes. Vision Res 2006;46:2581–92.
25. Owens DA, Wolf-Kelly K. Near work, visual fatigue, and variations of oculomotor tonus. Invest Ophthalmol Vis Sci 1987;28:743–9.
26. Cheng D, Schmid KL, Woo GC, Drobe B. Randomized trial of effect of bifocal and prismatic bifocal spectacles on myopic progression: two-year results. Arch Ophthalmol 2010;128:12–9.
27. McBrien NA, Millodot M. The effect of refractive error on the accommodative response gradient. Ophthalmic Physiol Opt 1986;6: 145–9.
28. Rosenfield M, Gilmartin B. Disparity-induced accommodation in late-onset myopia. Ophthalmic Physiol Opt 1988;8:353–5.
29. Gwiazda J, Bauer J, Thorn F, Held R. A dynamic relationship between myopia and blur-driven accommodation in school-aged children. Vision Res 1995;35:1299–304.
30. Woodman EC, Read SA, Collins MJ, Hegarty KJ, Priddle SB, Smith JM, Perro JV. Axial elongation following prolonged near work in myopes and emmetropes. Br J Ophthalmol 2011;95:652–6.
31. Ong E, Ciuffreda KJ. Accommodation, Nearwork and Myopia. Santa Ana, CA; Optometric Extension Program Foundation; 1997.
32. Mutti DO, Mitchell GL, Hayes JR, Jones LA, Moeschberger ML, Cotter SA, Kleinstein RN, Manny RE, Twelker JD, Zadnik K. CLEERE Study Group. Accommodative lag before and after the onset of myopia. Invest Ophthalmol Vis Sci 2006;47:837–46.
33. Berntsen DA, Sinnott LT, Mutti DO, Zadnik K. A randomized trial using progressive addition lenses to evaluate theories of myopia progression in children with a high lag of accommodation. Invest Ophthalmol Vis Sci 2012;53:640–9.
34. Molenbroek JF, Kroon-Ramaekers YM, Snijders CJ. Revision of the design of a standard for the dimensions of school furniture. Ergonomics 2003;46:681–94.
35. Hakala P, Rimpelä A, Salminen JJ, Virtanen SM, Rimpelä M. Back, neck, and shoulder pain in Finnish adolescents: national cross sectional surveys. BMJ 2002;325:743.
36. Milanese S, Grimmer K. School furniture and the user population: an anthropometric perspective. Ergonomics 2004;47:416–26.
37. Saarni L, Nygard CH, Kaukiainen A, Rimpelä A. Are the desks and chairs at school appropriate? Ergonomics 2007;50:1561–70.

Fan Lu
School of Optometry and Ophthalmology
Wenzhou Medical University
270 Xueyuan Rd
Wenzhou, Zhejiang 325027
China
e-mail: lufan@mail.eye.ac.cn