Myopia induced by digital devices usage: A multicenter cross-sectional study

1. Research background

The start and development of myopia are influenced by two major factors: heredity and environment (Saw et al., 2000). Myopia is highly related to education level. One study reported that the higher the education level, the higher degree of myopia (Rosner and Belkin, 1987). Potential risks may be the reduction of outdoor activity time, the increase of near-work time, continuous reading and the increase of reading intensity. And it was reported that near-work is highly associated with axial length elongation (Ip et al., 2008). Reading distance <30cm will induce faster myopia progression. It was reported that the average reading distance of Chinese emmetropic pupils was less than 30cm (Wang et al., 2013).Jin et. al. focused on the reading posture and myopia in primary school students, and they found that closer reading distance, head tilt angle and eye tilt angle were significantly related. Eyelid pressure during near work can change the shape of cornea, and extraocular muscles can change the tension and pressure of eyeball, and then influence the development of myopia. Continuous near-work requires more accommodation to maintain the sharpness of the target, increasing hyperopic defocus. Excessive accommodation can lead to the spasm of the ciliary muscle, which can accelerate the myopia progression. The distances for reading, writing and playing PlayStation games of primary school students were significantly different, which were 27.2cm, 24.9cm and 21.3cm respectively. It seemed that playing PlayStation games was a more dangerous factor for myopia.

With social development, electronic products are widely popularized, and various learning APPs are constantly being explored. Electronic products are used not only for daily entertainment, but also as important learning tools for children and adolescents. It can be speculated that the increasing rate of teenagers myopia may be related to increasing "reading tasks" added to students by smart phones. In addition, it was reported that the cerebral cortex of children who heavily used (>7 hours) intelligent products to play video games showed signs of premature thinning, according to the preliminary research data of the National Institutes of Health (NIH). Excessive use of smart phones can also cause a series of problems such as eye acid, visual fatigue, accommodative dysfunction, and even acute concomitant strabismus (Long et al., 2017). 23% school aged children and 64-90% computer users have symptoms such as visual fatigue and visual dysfunction (Bhanderi et al., 2008). Based on the binocular examination data of Wenzhou Medical College in 2017, 72.4% college students have binocular visual dysfunction, which is far greater than that in the United States. The main reason is that Chinese children has and a longer near-work time and a higher myopia rate. Previous studies have shown that poor illumination may cause a series of eye discomfort, while appropriate illumination and screen brightness can reduce the discomfort caused by flickering during the viewing process (Benedetto et al., 2014).

"Internet plus education" is the inevitable trend of future education. Major issues that the medical and educational circles are concerned about are how the use of electronic products will affect the occurrence and development of myopia and children's eye health, and how to standardize the use of electronic products to prevent and control the development of myopia in children and adolescents.

2.Aim

We aim to clarify the conditions of electronic products usage, the occurrence and development of myopia and visual fatigue of children and adolescents through two years of research, and solve problems including whether use of electronic products influences the development of students' vision, how to choose electronic screens, brightness level, font size and other parameters to help children and adolescents prevent and control myopia. We are able to obtain basic eye health data and the new occurrence and development of myopia in the past two years of young children, and form a standardized process and feasibility report for establishing eye health archives through these studies. Simultaneously, we can obtain scientific evidence about the use of electronic products in children's and adolescents' learning and life, as well as its exact relationship with the occurrence and development of visual fatigue and myopia. What's more, the most suitable brightness and font size for teenagers were obtained, and then the brightness specifications for display panels and the standards for text font size were formulated.

3. Study design

3.1 Study type

This is a large sample, multi-center, interventional study.

3.2 Study participants

3.2.1 Inclusive criteria

School-aged children (9-11 years old) with myopia full-corrected; 2) Best corrected visual acuity of both eyes was 20/20 or better; 3) no presence of any ocular diseases or injuries or surgeries.

3.2.2 Exclusive criteria

Not meeting the above requirements.

3.2.3 Exit criteria

Participants withdraw voluntarily from the experiment, or behavioral data showed that they did not complete the task according to the task illustration.

3.3 Study design

(1) The effect of font size on reading distance and eye health in adolescents and children

The effect of font size of mobile phones on reading distance and eye health.

The effect of font size of on tablets on reading distance and eye health.

The effect of font size of personal computers on reading distance and eye health.

The effect of font size of electronic books on reading distance and eye health.

(2) The effect of viewing time on reading distance and eye health in adolescents and children

The effect of viewing time of mobile phones on reading distance and eye health.

The effect of viewing time of tablets on reading distance and eye health.

The effect of viewing time of electronic books on reading distance and eye health.

3.4 Study steps

(1) Complete the collection of visual function (uncorrected visual acuity, corrected visual acuity and refractive error) every three months in three regional schools, including rural schools, urban schools, and provincial schools. We also used electronic questionnaires (electronic product usage rating scale, visual fatigue rating scale) to understand the electronic products usage frequency and visual fatigue of children and adolescents. After the data of the scales being uploaded to the cloud platform, eye health archives of these participants are established.

(2) The screening of myopic children and basic indicators such as visual acuity, refractive error and axial length were collected with routine ophthalmic clinical examination.

A Clouclip device was used to measure the working distances when the subjects read the text and watched the video. The Clouclip device can be attached to the temple of a spectacle frame by a rubber sleeve, with its anterior panel parallel to the spectacle plane as shown in Figure 1A. The Clouclip device measured working distances every 5 s and environmental luminance every 120 s; therefore, the time-tagged perpendicular distance from the eyes of the participants to the display plane and light levels were recorded.

4. Main outcome measures

Uncorrected visual acuity, corrected visual acuity and refractive error, axial length, slit lamp examination, scores of the electronic product usage rating scale scores, viewing distance.

5. Sample size determination basis

It is estimated that 1000 pieces of data will be collected from 1000 subjects' eye health data and corresponding visual fatigue scale and electronic product usage rating scale.

During the viewing distance measurement, 360 valid data points can be collected by each measurement, and then 2520 valid data points in total of each subject.

5. Schedule of Research progress

September 2020: determine research topics and improve the experimental program

October 2020 to May 2021: Collect cases

May 2021 to June 2021: Data analysis

June 2021 to December 2021: Write and contribute papers

6. Statistical analysis

Quantitative results: parametric and nonparametric tests. The indicators that can be tested by parametric tests include uncorrected visual acuity, best-corrected visual acuity, refractive error, axial length and viewing distance. To study the correlation between various indicators, the main methods include t-test/paired t-test, repeated measurement ANOVA, correlation, regression, etc. The indicators that can be tested by nonparametric tests including the health status classification of eye surface. The main statistical methods include ANOVA, Kruskal Wallis test, chi square test Mann Whitney test.

Qualitative results: Corresponding grades will be generated according to the scores of the visual fatigue scale and the electronic product usage rating scale. Kruskal-Wallis test have been used.

7. Right protection of the subject

The results of this research may be published in medical journals, but we will keep the patient's information confidential according to the legal requirements. Unless required by relevant laws, the patient's personal information will not be disclosed. When necessary, the government management department, the hospital ethics committee and their relevant personnel can consult the patient's data according to the regulations.

8. Participating units of multi-center research

The responsible unit of the project is the School of Optometry, Peking University Health Science Center. The clinical teaching hospital of the School of Optometry of Peking University Health Science Center is composed of the People's Hospital of Peking University, the Third Hospital of Peking University and the Peking University Hospital. In this research project, 500 participants in the first part of the experiment and 25 subjects in the second part of the experiment are needed to be recruited in this research center.

The project participants are the School of Ophthalmology and Optometry, Affiliated Eye Hospital, Wenzhou Medical University. The research center has undertaken the construction of the State Key Laboratory of Ophthalmology, the National Optometry Engineering Technology Research Center, the Guo Jian Clinical Research Center and so on. In this research project, 500 participants in the first part of the experiment and 25 subjects in the second part of the experiment are needed to be recruited in this research center.

9. References

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