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Risk Factors For Visual Display Terminal Syndrome Among School-Age Children During Coronavirus Disease 2019 Home Quarantine Period

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Abstract: Background: This study aimed to determine the current status and risk factors for visual display terminal syndrome (VDTS) among school-age children during the coronavirus disease 2019 (COVID-19) home quarantine period.

Material and Methods: Using a stratified cluster sampling method, data on basic information, history of eye disease, visual display terminal (VDT)-related questions, lifestyle status, and Convergence Insufficiency Symptom Survey (CISS) scores of 720 school-age children who participated in home-based learning during the COVID-19 lockdown in Shanghai, China, from April to May 2022, were collected via an online questionnaire. Multivariate logistic regression analysis was performed to determine factors associated with VDTS.

Results: Participants were divided into VDTS positive (VDTS+; age, 9.78 ± 2.23 years) and negative (VDTS-; age, 9.46 ± 1.70 years) groups based on their CISS scores. Differences in the history of eye diseases between the two groups were statistically significant. The duration of VDT use and type differed significantly between the two groups. Daily outdoor activity time of the VDTS+ group was significantly shorter than that of the VDTS- group, but the difference in sleep duration between the two groups was not statistically significant. Refractive error, outdoor activity time, duration of VDT use, and VDT type were correlated with VDTS.

Conclusion: Upper-grade school-age children are more prone to developing symptoms of VDTS. Refractive error, outdoor activity time, duration of VDT use, and VDT type are significant influencing factors for the development of VDTS, which necessitates adopting measures to protect the eyes by targeting these aspects.

Keywords: Visual display terminal syndrome;School-age children;Home isolation

Background：

The coronavirus disease 2019 (COVID-19) pandemic has spread globally for more than 2 years and has significantly impacted the daily lives of nearly every person worldwide. To curb the spread of the virus, China has adopted a series of measures to reduce or eliminate non-essential group activities. Months ago, Shanghai was heavily impacted by an outbreak of COVID-19, which forced schools to close and caused students to switch from on-campus learning to home-based online learning. Although online classes offer greater flexibility and are often more interesting than traditional classroom-based learning, they also cause a substantial increase in the duration of visual display terminal (VDT) use, resulting in considerable eye discomfort among students. With the school years also being a critical period in visual function development, the effects of such environmental factors may easily cause damage and dysfunction to normal binocular vision, and the resultant visual abnormalities cannot be reversed.

1. Material and Methods:

1.1 Participants

A total of 720 elementary school children (grades 1–5) from Shanghai who participated in home-based learning during the COVID-19 lockdown from April to May 2022 were selected for data collection using an online questionnaire. All children had attended online classes for at least two weeks before filling out the questionnaire. Of the 720 returned questionnaires, 650 were valid (a response rate of 90.28%). This study population had an average age of 9.60 ± 1.95 years and consisted of 339 boys and 311 girls distributed across the following grade levels: 1 (119 participants); 2 (112 participants); 3 (104 participants); 4 (118 participants); and 5 (197 participants).

1.2 Questionnaire

The questionnaire comprised the following content: (1) basic demographic and clinical information: age, sex, grade level, height, and body weight; (2) history of eye diseases including hordeola or chalazia, allergic conjunctivitis, refractive error, amblyopia, keratoconus, use or non-use of eyeglasses, use or non-use of orthokeratology lenses, and use or non-use of eye drops; (3) VDT-related questions such as duration of VDT use and VDT type (computer, television, tablet, or cell phone); (4) lifestyle status, including parental smoking history, outdoor activity time, sleep duration, and absence or presence of midday napping; and (5) the 15-item version of the Convergence Insufficiency Symptom Survey (CISS). Each item was scored on a 5-point scale, where 0 = "never," 1= "infrequently," 2 = "sometimes," 3 = "fairly often," and 4 = "always," and the total CISS score was obtained by summing the scores of the 15 items. Participants with a total CISS score ≥ 16 points were classified as VDTS-positive (VDTS+), whereas those with a total CISS score < 16 points were categorized as VDTS-negative (VDTS-). Subsequently, we compared the basic information, history of eye diseases, VDT-related factors, and lifestyle status between the VDTS+ and VDTS- groups.

2. Statistical analysis

Data were statistically analyzed using Statistical Package for the Social Sciences version 20.0 (IBM, America). Quantitative data were compared between the two groups using the independent samples t-test, and qualitative data were compared using the χ^2 test. Factors influencing VDTS were analyzed using multivariate logistic regression analysis at a significance level of $\alpha = 0.05$. Multivariate logistic regression analysis was performed with the presence or absence of VDTS set as the dependent variable (0 = absent, 1 = present). The following parameters were set as independent variables: sex (0 = female, 1 = male), hordeola or chalazia (0 = absent, 1 = present), conjunctivitis (0 = absent, 1 = present), refractive error (0 = absent, 1 = present), amblyopia (0 = absent, 1 = present), eyeglasses (0 = not used, 1 = used), orthokeratology lenses (0 = not used, 1 = used), eye drops (0 = not used, 1 = used), cohabitation with smokers (0 = no, 1 = yes), duration of VDT use (1 = < 4 h, 2 = 4–6 h, or 3 = > 6 h), outdoor activity time (0 = < 2 h, 1 = ≥ 2 h), sleep duration (0 = < 9 h, 1 = ≥ 9 h), grade level (0 = grades 1–3, 1 = grades 4–5), and VDT type (1 = television, 2 = computer, 3 = tablet, or 4 = other).

3. Results:

3.1 Differences between school-age children of different sexes

The average ages of the 339 boys and 311 girls were 9.57 ± 1.68 years and 9.62 ± 2.21 years, respectively, with the difference between the two sexes being statistically insignificant (t = 1.96, P = 0.69). The distribution of grade levels also did not differ significantly between the two sexes (χ^2 = 1.66, P > 0.05). However, the body mass index (BMI) of the boys (19.10 ± 4.42 kg/m^2) was significantly higher than that of the girls (18.29 ± 4.65 kg/m^2, P = 0.023; Table 1).

Differences in the history of eye diseases between the two sexes were also not statistically significant (all P values >0.05; Table 2).

The daily duration of VDT use was similar between boys and girls, and the difference was not statistically significant (5.08 ± 3.34 h for boys vs. 4.95 ± 2.40 h for girls, P = 0.57). However, VDT type was different between the two sexes (χ^2 = 33.48, P < 0.01), with the most frequently used VDTs being tablets and cell phones for boys and girls, respectively (Table 3).

Analysis of lifestyle status revealed that 133 boys and 108 girls had parents or cohabitants who smoked, and no statistically significant differences between the two sexes were found (χ^2 = 1.41, P > 0.05). The mean amount of time spent on outdoor activities daily was 1.86 ± 1.20 h for the boys and 1.73 ± 1.10 h for the girls, and the difference was insignificant (P = 0.15). The daily sleep duration was 9.07 ± 1.39 h for the boys and 9.17±1.16 h for the girls, which also did not differ significantly (P = 0.32). Midday napping was a habit in 68 of the 339 boys and 69 of the 311 girls, with the difference between the two sexes being statistically insignificant (χ^2 = 0.44, P > 0.05). The average total CISS scores of the boys and girls were 15.01 ± 9.31 and 14.75 ± 9.03, respectively, which did not differ significantly (P = 0.72).

3.2 Relationship between basic data and VDTS

The average age of participants in the VDTS+ group was higher than that of the VDTS- group (9.78 ± 2.23 years versus 9.46 ± 1.70 years), with the difference being statistically significant (P = 0.038). Grade level constitution also significantly differed between the VDTS+ and VDTS- groups (P < 0.05). However, differences in sex constitution and BMI between the two groups were not statistically significant (BMI: 18.82 ± 4.39 for the VDTS+ group vs. 18.62 ± 4.67 for the VDTS- group, $P = 0.58$; Table 4).

3.3 Relationship between the history of eye diseases and VDTS

Eye conditions of the VDTS+ and VDTS- groups during the past two weeks were determined and compared. The results revealed significant differences between the two groups for various eye diseases (Table 5).

3.4 Relationship between VDT use and VDTS

Based on the duration of VDT use, participants in the VDTS+ and VDTS- groups were further divided into < 4 h, 4–6 h, and > 6 h groups. The differences in duration of VDT use between the VDTS+ and VDTS- groups were statistically significant ($P < 0.01$). The VDT types used significantly differed between the two groups ($P < 0.05$; Table 6).

3.5 Relationship between lifestyle status and VDTS

A total of 99 participants in the VDTS+ group and 142 in the VDTS- group had parents or cohabitants who smoked, with the difference between the two groups not being statistically significant ($\chi^2 = 0.72$, $P > 0.05$). In the VDTS+ group, the time spent on outdoor activities was significantly shorter than that of the VDTS- group ($P < 0.05$), but sleep duration did not differ significantly between the two groups (Table 7).

3.6 Multivariate logistic regression analysis of influencing factors of VDTS

Results indicated that refractive error, outdoor activity time, duration of VDT use, and VDT type were either positively or negatively correlated with VDTS (Table 8).

4. Discussion:

With rapid developments in science and technology, various electronic devices have become an integral part of our daily life. In the current information age, acquiring information through cell phones and computer networks is now the mainstay of society. This is especially true for adolescents, who are often required to spend considerable time on electronic devices with visual displays to complete their schoolwork, participate in online lessons, and send or receive school-related notifications. Therefore, electronic devices are now an indispensable part of day-to-day life and learning in adolescents. However, adolescence is also critical for rapid visual development, physical growth, and knowledge acquisition. Improper use of electronic devices during this developmental stage may easily cause damage to visual function and both physical and mental health. VDTS, also known as computer vision syndrome or digital eye strain, has been defined by the American Optometric Association as a group of eye- and vision-related problems that result from the prolonged usage of electronic devices such as computers, tablets, e-readers, and cell phones [1].

Conclusion:

Upper-grade school-age children are more prone to developing symptoms of VDTS. Refractive error, outdoor activity time, duration of VDT use, and VDT type are important influencing factors for the development of VDTS, which necessitates the adoption of eye protection measures targeted toward these risk factors.

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