

Factors Related to VDT Syndrome in Elementary School Students in Digital Learning Environments

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Abstract: *The purpose of this study was to identify factors affecting Visual Display Terminal (VDT) syndrome for elementary school students in the digital learning environment. Multiple regression analyses were performed to identify the factors affecting VDT syndrome in the digital learning environment. This was conducted with 256 elementary school students in grades 5-6 with more than a year of experience in digital learning. The regression model explained 41% of elementary school students' VDT syndrome in the digital learning environment. Variables significantly affecting VDT syndrome include game addiction, sleep time, and air quality with game addiction as the most influential. In the digital learning environment, VDT syndrome is significant because it has physical and psychological impacts on the growth of elementary school students. Therefore, it is necessary to develop guidelines for ideal computer usage habits for this age group.*

Keywords: Digital learning; VDT syndrome; Game addiction; Sleep time; Elementary student

1. Introduction

A new form of educational media has become widely available, Digital Learning, which enables learning activities through wired and wireless communication technology without time and place constraints [1]. Digital learning provides various forms of learning support, inducing students' interest and motivation and enabling customized learning anytime, anywhere without restrictions on place and time through various computer devices. In addition to these educational advantages, the negative effects that accompany them should also be examined [2].

With the rapid spread of Digital Learning, there will be many social issues if digital learning methods used in the field or at home are not uniformly introduced and if health problems among elementary school students are not investigated. For elementary school students in particular, there is extensive computer interaction in their daily lives, including using digital textbooks [3-5], so their health is important to monitor. The most important part of this is the addiction caused by the use of digital media and the dysfunctional effect on physical and psychological health. If one focus on digital media for a long time, they will not only suffer from eye fatigue and impaired vision, if many students repeatedly use digital media for a long time in a school environment, secondary health problems such as musculoskeletal symptoms can occur. Even if this problem does not occur immediately, the potential risk cannot be overlooked because elementary school students are in a period of growth [2].

VDT (Visual Display Terminal) syndrome or game addiction among elementary school students (12-13 years old), caused by excessive use of computers, is a state in which students cannot maintain their daily lives due to excessive use of computers and are mired with serious physical, psychological, and social problems [6, 7]. Game addiction defines in which cannot tolerate the desire to play and prioritizes playing games over other interests or daily life, and continues to play games without stopping games even if there are negative consequences in life. In the case of such game addiction, it negatively affects physical health, psychological health, and academic performance. Previous studies have also shown that students who have stayed up all night using computers are always sleepy, weak, and yawn frequently during the day have physical symptoms such as fatigue, dizziness, and indigestion. This is particularly closely related to game addiction, and in the case of high-risk groups of game addiction, health status deteriorates rapidly due to VDT syndrome, which negatively affects the formation of healthy lifestyles of children and adolescents in growth, so providing health care is also important part of school health [2, 5, 6].

Longer hours of computer use have led to an increasing number of teenagers complaining of physical symptoms such as neck pain and eye strain. In adults who works with computers this is known as occupational disease [8-10], which is also shown among adolescents.

VDT syndrome is any health problem that occurs in people who work with computers most of the time. Symptoms of VDT syndrome include musculoskeletal, ophthalmic, skin, and psychological symptoms [11,12].

The reason why VDT syndrome or game addiction, is serious for children and adolescents is that they can become obsessive about playing games, in which they cannot control themselves and show addictive behavior [13] Symptoms caused by VDT syndrome include eye fatigue and impaired vision, pain in the neck and back, chronic fatigue, irritation, and nervousness [11,12].

Factors affecting VDT syndrome in adolescents can be largely divided into general and environmental factors. General factors include academic background, subjective health, sleeping time, computer hours, and game addiction levels [9,10,14,15]. Environmental factors include lighting, temperature, air, and noise. Previous studies have shown that indoor factors such as lighting, temperature, air, noise, humidity, and ventilation are related to VDT syndrome, and some [8,11] have shown that these environments contribute to physical and psychological health problems such as dry eyes, migraine, and discomfort. In these era of infectious diseases, various harmful substances are exposed to the air, and if ventilation is not cared for in consideration of this environment, harmful substances that occur in daily life can cause serious problems. Indoor air quality is an important factor because it is closely related to the health of students in the school environment, but there are not many prior literature reviews related to this. Therefore, it is necessary to study the heat generated when all students use computers in the classroom and the indoor air quality [12].

The use of digital learning and the demand for it has increased in recent years out of necessity (such as responding to the global pandemic) and desire for its advantages. Digital Learning has many advantages, including portability, ease of use, and availability of vast learning resources, but it also raises the concern that health problems will increase among children as the time spent on computers increases. However, compared to the increase in computer use environments such as digital learning, there are not many studies on potential VDT syndrome influencing factors for children and adolescents. Moreover, there is little research on the computer-related environment. Therefore, it is meaningful that it considered the computer-related environmental characteristics of elementary school students living in the era of infectious diseases.

Therefore, this study sought to identify factors that affect VDT syndrome, which is the most concerning health problem among elementary school students in the Digital Learning environment. The main purpose of this study is to determine whether there are differences in VDT syndrome according to the general and digital

learning environmental characteristics of elementary school students, and to determine whether sleep time, computer usage time, and game addiction affect VDT syndrome. This study provides basic data for managing the health problems of elementary school students living in the digital age and contributes to research in this field of growing interest and importance.

2. Methods

2.1 Research materials and subjects

This is a secondary data analysis study to identify factors related to VDT syndrome in elementary school students in a digitalized environment. The subjects of the study were 256 fifth and sixth graders of the research elementary school that piloted digital learning of a research among elementary schools in Seoul.

2.2 Research variables

In this study the VDT syndrome were used as dependent variables, and game addiction, general characteristics also computer-related environmental characteristics as independent variables.

2.2.1 Dependent variables

VDT syndrome, a dependent variable in this study, was initially evaluated by the Korea Information and Culture Promotion Agency (2003) using a tool modified by Kim So-won (2005) to suit elementary school students [10]. This VDT syndrome questionnaire consists of a total of 32 questions with 9 systemic, 7 musculoskeletal, 9 eye, and 7 psychological symptoms. Questions are rated on a five-point Likert scale from zero to four. The higher the score, the worse the VDT syndrome. In Kim So-won (2003) Cronbach's α was 0.96, and in this study Cronbach's α was 0.96.

2.2.2 Independent Variables

The independent variables in this study were gender (male, female), grade (grade 5, 6), health status (unhealthy, healthy), sleep time (mean for 7 days), computer usage time (mean for 7 days).

The computer-related environmental characteristics were indoor brightness, air quality, temperature, and noise (inappropriate or appropriate).

Game addiction, the main independent variable of this study, was initially evaluated by the Korea Information Society Agency (2014) and used tools from Kim So-won (2003) for elementary school students [10]. Game addiction as an everyday life barrier was assessed with six questions, one positive expectation question, four withdrawal symptoms, three interpersonal orientation questions, two deviant behaviors, and four tolerance questions, for a total of 20 questions. The questions were rated on a four-point Likert scale from zero to four. The higher the score, the worse the game addiction. In Kim So-won (2003) Cronbach's α was 0.96, and in this study Cronbach's α was 0.95.

2.3 Data Collection Procedure

The data collection procedure for this study is as follows. In a large-scale survey "Health Status of Children and adolescents in a Digitalized Environment study (2014 KU-IRB-14-64-A-1)", 256 elementary school students suitable for the purpose of the study were selected. The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board of KUIRB-2020-0197-01 (Review type: Exempt).

Data collection was targeted at 5th and 6th graders one of the elementary schools located in Seoul. The target school was a school that piloted digital learning. Research manuals, parental consent forms, consent forms, and self-entry questionnaires were distributed to 300 students in each of the 5th and 6th grades of 6 classes. Of these, 280 questionnaires were collected, and 256 were analyzed as the final subjects, excluding 24 copies of data that were omitted or insufficient.

2.4 Analysis Method

SPSS Win 25.0 version was utilized for statistical analysis. In digital learning environments, general and environmental characteristics of elementary school students, game addiction, and VDT syndrome were characterized by frequency, %, mean, and standard deviation.

Differences in VDT syndrome according to general and environmental characteristics of elementary school students were analyzed with independent t-tests. Correlational relationships among sleep time, computer usage time, game addiction and VDT syndrome in elementary school students were analyzed by Pearson's correlational analysis. In addition, multiple regression analyses were performed to identify factors affecting VDT syndrome. We used a stepwise analysis method, and statistical significance level was set at 0.05.

3. Results

3.1 General and environmental characteristics of elementary school students.

In a digitalized learning environment, the general characteristics of elementary school students and computer-related environmental characteristics are shown in Table 1. Both general and environmental characteristics were categorical variables, so they were analyzed as N, %.

In the gender distribution 38.7% were men and 61.3% were women; 73.0% were fifth graders and 27.0% were sixth graders; 4.5% of students thought that their subjective health was unhealthy. For the computer-related environmental characteristics 9.1% reported inappropriate brightness, 14.5% uncomfortable air, 7.9% inappropriate temperature, and 21.0% inappropriate noise.

Table 1. General and environmental characteristics of elementary school students

(N=256)

Category	Classification	N	(Valid) Percent (%)
gender	male	99	38.7
	female	157	61.3
grade	5th	187	73.0
	6th	69	27.0
health status	unhealthy	11	(4.5)
	healthy	231	(95.5)
brightness	inappropriate	23	(9.1)
	appropriate	231	90.9
	inappropriate	37	(14.5)

air quality	appropriate	218	(85.5)
temperature	inappropriate	20	(7.9)
	appropriate	234	(92.1)
noise	inappropriate	53	(21.0)
	appropriate	199	(79.0)

3.2 The degree of sleep time, computer usage time, game addiction and VDT syndrome in elementary school students

Elementary school students' sleep time averaged 544.20, computer usage time averaged 113.31, game addiction averaged 1.33 out of 4, and VDT syndrome averaged 0.45 out of 4, as listed in Table 2.

Table 2. General and environmental characteristics of elementary school students Descriptive statistics for sleep time, computer usage time, game addiction and VDT syndrome among elementary school students (N=256)

Category	Mean ± SD	minimum	Maximum
sleep time (minute) (mean for 7 days)	544.20±51.21	260.00	705.00
computer usage time (minute) (mean for 7 days)	113.31±85.24	60.00	515.00
game addiction	1.33 ± 0.45	1	3.65
VDT syndrome	0.45 ± 0.52	0	2.97

3.3. Differences in VDT syndrome according to general and environmental characteristics of elementary school students

The results of difference tests with VDT syndrome according to the general and environmental characteristics of elementary school students in a digitalized environment are shown in Table 3. Grade ($p=.001$) and air quality ($p=.001$) were significant. Grade, brightness, air quality, and temperature were not assumed to be equidistant.

Table 3. Differences in VDT syndrome according to general and environmental characteristics of elementary school students. (N=256)

Category	Classification	N	Mean±SD	t(Welch)	p
gender	male	99	0.50±0.59	1.251	0.212
	female	157	0.42±0.47		
grade	5th	187	0.37±0.44	(-3.486)	0.001
	6th	69	0.66±0.63		
health status	unhealthy	11	0.52±0.63	0.398	0.691

	healthy	231	0.45±0.52		
brightness	inappropriate	23	0.58±0.66	(1.057)	0.301
	appropriate	231	0.44±0.50		
air quality	inappropriate	37	0.87±0.79	(3.704)	0.001
	appropriate	218	0.38±0.42		
temperature	inappropriate	20	0.71±0.81	(1.530)	0.141
	appropriate	234	0.43±0.48		
noise	inappropriate	53	0.49±0.52	0.686	0.493
	appropriate	199	0.43±0.51		

Welch: Equal variances not assumed

3.4 Correlations among sleep time, computer usage time, game addiction and VDT syndrome in elementary school students

The relationship between sleep time ($r=-0.215$, $p=.001$), computer usage time ($r=0.325$, $p<.001$), game addiction ($r=.554$, $p<.001$) and VDT syndrome in elementary school students was found to be significant Table 4.

Table 4. Correlational relationships between sleep time, computer usage time, game addiction and VDT syndrome in elementary school students. (N=256)

	sleep time	computer usage time	Game addiction	VDT syndrome
sleep time	1			
computer usage time	-.092	1		
game addiction	-.135*	.438**	1	
VDT syndrome	.036	.000	.554**	1
	-.215**	.325**	.000	.000
	.001	.000	.000	.000

* $p<0.5$, ** $p<0.1$

3.5 Factors affecting VDT syndrome in elementary school students

To assess factors affecting VDT syndrome in elementary school students in digitalized learning environments, grade, sleep time, computer usage time, air quality, and game addiction were included as independent variables (Table 5).

To assess multicollinearity, the tolerance and the variation Inflation were analyzed. The tolerance was 0.890-0.989, which was more than 0.1, and the coefficient of distributed expansion was 1.011-1.123, which was less than 10; therefore, there was no problem with multicollinearity. The regression model explained 41% of

VDT syndrome in elementary school students in a digitalized environment ($F=39.869$, $p<.001$). Variables significantly affecting VDT syndrome included game addiction, sleep time, and air quality, with game addiction having the greatest impact. In other words, VDT syndrome was higher as game addiction increased and sleep time during the week decreased. VDT syndrome was higher in those who felt the air condition was less appropriate compared to those who felt the air condition was appropriate.

Table 5. Factors influencing VDT syndrome in elementary school students (N=256)

	Unstandardized		Standardized		t	p	Collinearity Statistics	
	Coefficients		Coefficients				Tolerance	VIF
	B	SE	β					
(constant)	.728	.356			2.042	.043		
game addiction	.554	.069	.498		8.031	<.000	.890	1.123
air quality	.305	.089	.211		3.422	.001	.899	1.112
sleep time (minute)	-.002	.001	-.180		-3.049	.003	.989	1.011

Dummy variable: air quality (appropriate=0)

Durbin-Watson=1.853

$R^2 = 41.0\%$ (adjusted $R^2 = 0.400$), $F(p) = 39.869$ ($p<.001$)

4. Discussion

This study identified factors affecting VDT syndrome in elementary school students in digitalized environments, and multiple regression analyses showed that game addiction, sleep time, and air quality affected VDT syndrome by 41%.

Game addiction was the most influential factor on elementary school students' VDT syndrome. In fact, the biggest portion of students' computer use was related to games. Elementary school is a period of rapid physical and psychological growth, and most of the students in this period communicate with their friends by playing games. If they are immersed in the game, their diet or sleep can be irregular, and physical symptoms can occur as they continue to be nervous during the game, such as increased anxiety or weight gain due to inactivity. In addition, satisfaction with subjective health is reduced, and it can lead to psychological symptoms that cause depression [5-7][16, 17]. This can lead to adverse health functions that inevitably lead to

longer computer use from playing games, which can lead to VDT syndrome even in elementary school students. As a result, a systematic guide is needed to manage and prevent game addiction among elementary school students during their growth period. If game addiction is severe, serious symptoms such as poor self-control, loss of human relationships, and escape from reality can occur; in such cases, connections with specialized institutions in the community are needed. One of the most important parts of elementary school is to manage students who are potentially addicted to games. Depending on how they are managed, they may fall into the normal group or the game addiction group, so development of management programs are also as well as early identification of the problem important.

The second factor affecting VDT syndrome in elementary school students was sleep time. A study by Choi Jin-oh (2016) showed that fatigue, sleep problems, and eating problems are related to game addiction, and this

phenomenon affects VDT syndrome [14, 18]. Sleep time is one of the most important indicators of health among elementary school students in their growing period, and the shorter the sleep time during the week, the worse the VDT syndrome can become. As a result, school and home management systems are needed to help promote natural sleep time at home.

Environmental variables affecting VDT syndrome among elementary school students included air-related factors. Depending on the comfort students felt when using computers, less pleasant air lead to more general fatigue and headaches in VDT syndrome. Seomun GyeongAe and Lee Young-jin (2016) indicated that sufficient lighting, indoor brightness, comfort of air, noise, and desk and chair height were associated with VDT syndrome during an awareness study among male students at risk of digital addiction. Although this study showed only air as a significant variable related to VDT syndrome, environmental variables are considered important when assessing computer use, as indicated in other prior studies and in today's infectious disease era. Therefore, environmental guidelines for the health of students growing up in a digitalized environment are essential.

This can lead to emotional control problems for elementary school students in their growing period if they lack sleep or have sleep disorders, as sleep deprivation tends to cause fatigue [9, 14, 15]. And limit ability to carry out other daily activities as well as affects ability to concentrate on school work. Therefore, because computer-related devices such as smartphones and monitor screens are used until late at night, school and home interventions are needed to prevent VDT syndrome caused by short sleep time during the week, as this affects the production of melatonin, a sleep hormone.

In addition, longer computer hours during the week and weekend were related to worse VDT syndrome, and post hoc results showed more symptoms in the group that used computers for more than three hours. The longer you use a computer, the more likely physical symptoms such as musculoskeletal problems, dry eyes, and fatigue will occur, as well as psychological symptoms such as irritation and depression. Therefore, it is necessary to develop computer use guidelines for elementary school students living in a digitalized environment. To keep your eyes healthy, use the computer for an hour and rest for 10 minutes. Keep a distance of about 50cm from the computer. To maintain clean air quality, open the entire window before and after class to ventilate. Also suggest to include contribution to research field and any limitations here, such as the results could be different with a different age group.

5. Conclusions

This study has identified the factors affecting on elementary student's VDT syndrome in a digital learning environment. In a digitalized environment, VDT syndrome is important because it affects the physical and psychological well-being of elementary school students in their growing period. Previous studies have also been shown, that game addiction is serious especially for children and adolescent because excessive game use can lead to obsessive, inability to control oneself, excessive immersion and potentially to VDT syndrome. In this study, game addiction, sleep time, and air quality were shown to affect VDT syndrome. Game addiction and sleep time are interrelated variables, and this affects VDT syndrome were revealed through the results of this study. Therefore, it is necessary to develop practical guidelines on how to use computers, which would be desirable to prevent VDT syndrome among elementary school students living in the digital age. In addition, this study was significant because it looked at computer-related environmental characteristics. Schools need guidelines to maintain good air quality through proper ventilation, which can be used especially in this era of infectious diseases.

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