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Investigation of the relationship between 2D:4D finger ratios and internet and smartphone addiction in middle school children

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Abstract

In humans, prenatal testosterone exposure affects a sexually dimorphic feature called the second-to-fourth digit ratio (2D:4D). Our research sought to better understand the connections among 2D:4D, Internet addiction (IA), and smartphone addiction (SPA) among middle school students. The study included 104 students aged between 10 and 14 years (mean age for girls: 11.3, the mean age for boys: 11.6), with 48 male and 56 female participants. Measurements of 2D:4D, hand length, and hand width were taken from the participants' hands. IA was assessed using the Young Internet Addiction Scale (YIAS), and SPA was assessed using the Smartphone Addiction Scale-Short Form (SAS-SF). In male participants, a negative correlation was found between the 2D:4D ratio and IA, while no correlation was observed in female participants. Both male and female participants showed a high correlation between IA and SPA. The study concludes that 2D:4D is an easily measurable and reliable marker for gender differentiation. It was found that male participants had higher levels of IA compared to female participants and that IA and SPA are strongly correlated in both genders.

Keywords: 2D:4D ratio, internet addiction, smartphone addiction, gender, middle school children

Introduction

The 2D:4D ratio, determined during the fetal period, becomes fixed for life from the age of 2 [1]. The 2D:4D ratio has been studied in various research fields, particularly in areas where gender differences are observed (e.g., certain conditions showing males being more associated with one outcome and females with the opposite) [2]. It serves as a biological marker that provides information about prenatal testosterone exposure [3]. Prenatal sex steroids, such as testosterone, regulate brain structure, function, and finger growth during embryogenesis [4]. There is a consistent relationship between the differences in 2D:4D ratios between males and females and prenatal testosterone

concentrations [5,6]. As a result of fetal testosterone exposure, the 2D:4D ratio exhibits sexually dimorphic characteristics, with males tending to have smaller values compared to females [1]. Many psychiatric disorders are also associated with differences in 2D:4D ratios, including Attention-Deficit/Hyperactivity Disorder (ADHD) [7], Autism Spectrum Disorder (ASD) [8], schizophrenia [9], and depression [10], among others. Currently, Internet Addiction (IA) and smartphone addiction (SPA) are among those associated with these differences [11].

There are often contentious discussions on the topic because the word "addiction" itself is frequently seen as stigmatizing. Additionally, thinking of these addictions as brand-new mental

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diseases, particularly when connected to excessive non-substance use, also sparks important discussions [12].

IA and SPA, like other forms of substance addiction behaviors, have been investigated on a systemic neurobiological level involving dysfunction in the fronto-striatal-limbic loop. Dopamine, as well as serotonin and acetylcholine neurotransmitter systems, have been reported to play important roles in IA and SPA [13].

At the moment, a sizeable share of the global populace is online. As long as a smartphone/Internet connection is accessible, being online provides users with a variety of options to remain in touch with distant people, converse conveniently, and get information rapidly. Despite the benefits of the expanding digital worlds, a rising number of experts throughout the world are questioning if excessive use of digital media is a sign of addiction. IA and SPA are a global issue that are getting worse. IA and SPA present as a lack of control over internet use and social issues associated with problematic internet use, similar to other addictions [14].

There have been few studies done on middle school students, despite the fact that there have been numerous studies looking at the association between the 2D:4D ratio and IA and SPA in the literature (12-14). We assumed that we would observe lower 2D:4D ratios in children, especially in male children, who are internet and smartphone addicts. Our study aims to investigate the relationship between the 2D:4D ratio measured from the hand and IA and SPA in middle school children.

Material and Methods

A total of 104 (48 males - 56 females) students aged between 10 and 14 years (mean age for girls: 11.3, mean age for boys: 11.6) participated in the study. Sample size was calculated using G-Power 3.1.7 software with a 95% confidence interval, $\alpha=0.05$, and $1-\beta=0.80$ [15]. Each school, parent/guardian, and student were informed and provided consent, with the right to withdraw at any time. The inclusion criteria for the study were: a) being a middle school student, b) falling within the age range of 10-14, c) not having any mental problems, and d) attending the same school. Students were excluded from the study if they: a) had undergone hand surgery, b) did not fall within the required age range, c) had mental issues, or d) lost their ability to walk.

Data Collection: The study only included kids who were enrolled in the same school and were between the ages of 10 and 14. The study was started after receiving approval from the ethics committee. The student's parents or legal guardians were notified in writing before the measurements of their hands (2D:4D ratio, hand length, and hand width) were collected. The Young Internet Addiction Scale and the Smartphone Addiction Scale-Short Form (SAS-SF) were used to gauge the students' levels of smartphone and internet addiction, respectively.

The following parameters were included in the study:

Hand width (HW): With the aid of calipers, the distance between the second and fifth metacarpophalangeal joints was determined.

Hand length (HL): With the aid of a tape measure, the distance between the distal end of the styloideus and the longest fingertip will be determined.

2D and 4D finger length ratio (2D:4D): The lengths of the second and fourth fingers were measured twice with calipers and recorded in centimeters (1) (Figure 1).

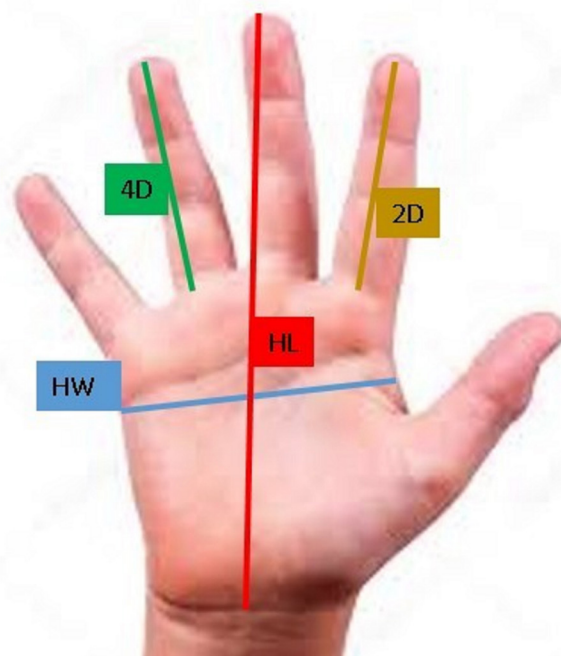


Figure 1. Demonstration of parameters

Young Internet Addiction Scale (YIAS): Dr. Young created a self-assessment scale with 20 questions on it. Participants are asked to check one of the boxes "Never," "Rarely," "Occasionally," "Often," "Most of the time," or "Always" for the questions in research on internet addiction. The scores assigned to these alternatives are 0, 1, 2, 3, 4, and 5, respectively. Internet addicts are those participants who receive a score of "80 and above." [16].

People who receive a score of between "50-79" are those who struggle with self-control and frequently encounter internet-related issues in their daily life. Risky internet users are represented by this group. Internet users that score "49 and below" are considered to be "average." Balta et al. (2008) conducted a study on the test's Turkish adaption, and it revealed that it is valid and trustworthy with a score of 0.895 [17].

Smartphone Addiction Scale-Short Form (SAS-SF): It is a self-report measurement instrument intended to examine people's "smartphone addiction." The scale's initial iteration consists of 10 items, each of which is scored on a 6-point Likert scale (1=strongly disagree, 6=strongly agree). The range of possible scores on this scale is between 10 and 60. The determined Cronbach's coefficient for reliability was found to be 0.91 after

analyzing the scale's psychometric characteristics [18]. The Turkish validity and reliability were conducted by Günüş in 2010 [19].

Ethical Aspect of the Research: From each participant, a "Voluntary Consent Form" was acquired. The tests that will be undertaken were disclosed to the participants. They were made aware that taking part in the study was completely up to them and that they might opt out at any time. The principles outlined in the Helsinki Declaration were followed while conducting the research. The Bandırma Onyedi Eylül University Health Sciences Institute Ethics Committee approved the research with decision number 2023/3, and the required authorizations were received.

Statistical analysis

The IBM SPSS package application, version 25, was used for the study's statistical analysis. The Kolmogorov-Smirnov Test was used to conduct the study's normality analysis. To check for variance homogeneity, Levene's Test was applied. The study found that the data were normally distributed, and the Pearson Correlation coefficient was used to analyze the association between the 2D:4D ratio and the YIAS and SAS-SF. The study's level of significance was set at 0.05.

Results

The study was conducted with 56 female participants with an average age of 11.3 and 48 male participants with an average age of 11.6. While females spent an average of 2.13 hours per day on the internet, males spent 1.86 hours. The average duration of internet and smartphone usage for females was 2.86 years, while for males, it was 2.39 years (Table 1).

Table 1. Demographic data of the participants

Parameters	Female (n=56)	Male (n=48)
Gender	56	48
Age (years)	11.3	11.6
Height(cm)	151	155.6
Time spent on the Internet (hours)	2.13	1.86
How many years have been using smartphone and internet?	2.86	2.39
Internet and smartphone usage reasons		
Lesson (number of individuals)	39	38
Watching movies-TV/ Listening to songs (number of individuals)	46	23
Online shopping (number of individuals)	30	25
Chatting (number of individuals)	35	31
Social media (number of individuals)	50	48

In Table 2, the relationship between the 2D:4D ratio and YIAS and SAS-SF was examined for male participants. According to the results, a negative correlation was found between the 2D:4D ratio and YIAS in male participants ($r=-0.296$, $p= 0.043$, effect size (Fisher's z)= -0.306). Additionally, a significant positive correlation was observed between YIAS and SAS-SF($r=0.593$, $p<.001$, effect size (Fisher's z)= -0.682) (Figure 2) (Table 2).

Table 2. The relationship between 2D:4D ratio of male participants and YIAS and SAS-SF

Parametreler	2D:4D	YIAS	SAS-SF
2D:4D	Pearson's	—	
	p-value	—	
	Effect size (Fisher's z)	—	
YIAS	Pearson's r	-0.296*	—
	p-value	0.043	—
	Effect size (Fisher's z)	-0.306	—
SAS-SF	Pearson's r	-0.164	0.593***
	p-value	0.270	<.001
	Effect size (Fisher's z)	-0.166	0.682

* $p<.05$, ** $p<.01$, *** $p<.001$
YIAS: young internet addiction scale, SAS-SF:smartphone addiction scale-short form

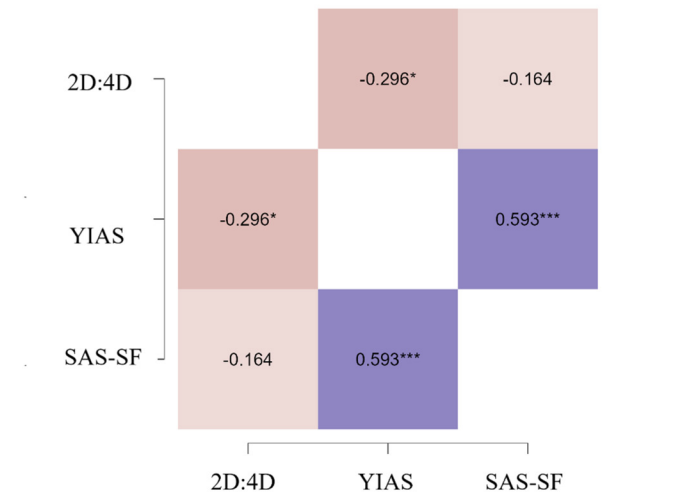


Figure 2. Pearson correlation results between 2D:4D and YIAS, and SAS-SF for male participants

In Table 3, the correlation between the 2D:4D ratio and YIAS and SAS-SF was examined for female participants. According to the results, no significant difference was found between the 2D:4D ratio and YIAS or SAS-SF. However, a significant positive correlation was observed between YIAS and SAS-SF($r=0.436$, $p<.001$, effect size (Fisher's z)= -0.467) (Figure 3) (Table 3).

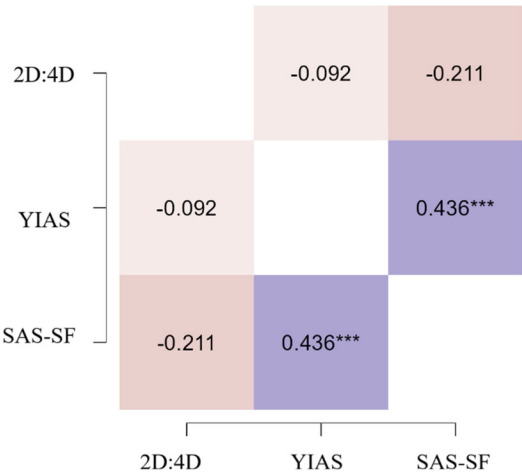


Figure 3. Pearson correlation results of 2D:4D with YIAS and SAS-SF in female participants

Table 3. The relationship between 2D:4D ratio of female participants and YIAS and SAS-SF					
Parametreler		2D:4D	YIAS	SAS-SF	
2D:4D	Pearson's	—			
	p-value	—			
	Effect size (Fisher's z)	—			
YIAS	Pearson's r	-0.092	—		
	p-value	0.499	—		
	Effect size (Fisher's z)	-0.092	—		
SAS-SF	Pearson's r	-0.211	0.436	***	—
	p-value	0.119	< .001		—
	Effect size (Fisher's z)	-0.214	0.467		—
* p<.05, ** p<.01, *** p<.001					
YIAS: young internet addiction scale, SAS-SF:smartphone addiction scale-short form					

Discussion

The two most hotly contested technological addictions at the moment are IA and SPA. According to Beranuy et al., there is a strong and favourable association between the results of the Internet Addiction Scale and the Cell Phone Addiction Scale [20]. This may be due to the fact that they share similar personalities and lifestyles.

A negative association between the 2D:4D ratio and IA was discovered in the male participants of this study, which intends to investigate the relationship between the 2D:4D ratio and IA and SPA in middle school students. No correlation was identified in the female participants. The results of Beranuy et al. are similar with the findings of both male and female participants, who demonstrated a strong association between IA and SPA [20]. This suggests that technology addiction among middle school

students goes beyond just internet addiction; they have also become addicted to their smartphones.

Male behavior is influenced by hyperandrogenization during fetal and early postnatal life, which has a long-lasting impact on brain architecture [21]. Early androgen effects are also believed to contribute to greater male phenotypic variability and increased environmental sensitivity, some of which may play a role in IA and SPA [22].

Determining potential policies aimed at IA and SPA would require an understanding of the pathways from elevated prenatal testosterone to IA. A high level of prenatal testosterone influences the mesolimbic reward system [21], potentially affecting a person's tendency to become addicted. Additionally, the different laws that govern the cyberspace versus the actual world may make up for deficits in social interaction skills brought on by high prenatal testosterone levels. According to studies, the likelihood of the first element is higher [23].

Previous studies have reported that alcohol addiction and the 2D:4D ratio are lower in males [24]. Another study examining the relationship between non-substance-related addiction (video gaming) and the 2D:4D ratio also found a lower 2D:4D ratio in males [25]. Our study is in line with the literature, as we observed that IA and SPA increased as the 2D:4D ratio decreased in male participants.

In one study, it was reported that there was no significant gender difference in ATB and IA among students. The main reason suggested was that cell phones share similar functions with the internet [26]. In another study, it was reported that males were more prone to IA and SPA than females [27]. In our study, both male and female participants showed a high correlation between ATB and IA.

Men are more interested in weather, sports, and gaming when it comes to internet activities, whereas women prefer online conversation, personal messaging, and shopping. More women are using the internet as a result of the increase in social networking services [28]. In our study, we examined the use of Watching movies-TV/Listening to songs, online shopping, chatting, and social media by gender and found that girls had a higher rate in all categories.

Studies indicating that the male gender is a risk factor for IA and SPA are rapidly increasing in the literature. They suggest that this may be because men seek more excitement than women [29-31]. Our study supports this point in the literature.

Internet user gender disparities could be a contributing reason to the rise in IA. While numerous research have been done to examine this topic, it appears that guys are more likely than females to develop SPA and online gaming addiction [32].

The 2D:4D ratio indicates sexual dimorphism. We think that determining addictions according to gender discrimination will contribute to the literature in both psychology and pediatrics.

The study investigated the internet and smartphone addiction among children aged 10 to 14 years, solely based on survey data. Not combining the results with detailed psychiatric reports of the participants represents a limitation of this study. In the future, there is a need for research with a larger sample size, along with more comprehensive psychiatric evaluations and longer follow-up periods for the participants.

Conclusion

The results of the study revealed that male participants exhibited a higher level of IA and SPA compared to female participants. In light of these findings, it is important for parents and teachers of male students to be particularly attentive to this issue. Being aware of the potential for internet and smartphone addiction can help in identifying and addressing any problematic behaviors early on, and it may also be beneficial to implement measures to promote healthy and responsible technology usage among male students. Additionally, further research and awareness campaigns on this topic can contribute to a better understanding and management of IA and SPA among children and adolescents.

Conflict of Interests

The authors declare that there is no conflict of interest in the study.

Financial Disclosure

The authors declare that they have received no financial support for the study.

Ethical Approval

The Bandırma Onyedi Eylül University Health Sciences Institute Ethics Committee approved the research with decision number 2023/3, and the required authorizations were received.

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