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Correlation between Video Games and Body Mass Index among Intermediate Schools Students in Jeddah, Kingdom of Saudi Arabia

Mazen Mosfer Al-Zahrani[1]* and Amal Hassan Alghamdi[2]

[1]Preventive Medicine Resident, Preventive Medicine Postgraduate Program, Ministry of Health, Saudi Arabia

[2]Preventive Medicine Consultant, Preventive Medicine Postgraduate Program, Ministry of Health, Saudi Arabia

**Corresponding e-mail: triangle-m@hotmail.com*

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ABSTRACT

Introduction: *Adolescents in various regions of the world believe playing video games to be a popular method to pass the time. Adolescents' physical well-being may be harmed by their time spent playing video games. This could be due to a lack of physical activity and unhealthy eating habits, both of which can lead to obesity. This study examined the association between video game playing and body mass index among adolescents in intermediate schools in Jeddah, Saudi Arabia.* ***Methods:*** *This is an observational study which was done by recruiting 345 male students in intermediate students at Jeddah city. A basic measurement of body weight and height with closed-ended interview-based questionnaire was used to collect data from participants. Data were collected using multistage sample from schools and intermediate classes. Regression analysis was use to estimate video-gaming risks and to adjust for confounding factors.* ***Results****: A total of 345 students were surveyed and the majority of the respondents were of Saudi nationality, comprising 82.9% of the sample. The educational level of the parents varied, but a notable proportion had obtained a university degree. In terms of BMI grades, the largest proportion fell into the normal category (46.0%), followed by overweight (26.8%) and underweight (10.3%). A smaller percentage fell into obesity class I (14.2%), obesity class III (1.8%), obesity class II (0.9%). The largest proportion of the participants engaged in gaming sessions 3-4 times a week (35.7%), followed by twice a week (20.9%) and 4 times a week (11.0%). The majority of respondents reported playing video games 4-6 times per week (39.9%), followed by every day (35.9%) and ≤ 3 times per week (24.2%). When asked if they play video games as a means to escape from problems or negative emotions, 40.3% responded "Sometimes" and 12.8% responded "Always." A large majority (86.1%) had a video game system in their bedroom.* ***Conclusion:*** *The prevalence of excessive video games playing is high among intermediate-school students with the majority of the students play almost every day. The findings from this study suggest that physical exercise, time-playing per week, and age are important determinants of BMI in schoolchildren and adolescents.*

Keywords: Online gaming, Offline gaming, Screen time, Sedentary life-style, Obesity, Video games, Physical activities, Intermediate students, Jeddah school

INTRODUCTION

In the last decades, obesity among children and adolescents has increased, particularly in the United States, Latin America, Southeast, North Africa, and the Middle East [1]. The prevalence of obesity among these countries

reached 20% or higher among the general population [2]. In the literature, obesity has been linked to several adverse health outcomes such as increased mortality, diabetes mellitus, and cardiovascular diseases [3]. The adolescence stage is an important stage of the life cycle when the lifestyles are established. Obesity among children and adolescents was associated with a high prevalence of obesity among adults, making them more vulnerable to these serious health problems [4].

The risk of overweight and obesity has been found to be related to time spent on-screen use among children and adolescents [5]. Time of screen use can be divided into several categories, including TV viewing, computer use, video game playing, and more recently, the use of mobile phones. The epidemiological studies found a strong association between TV viewing and obesity among children and adolescents [6,7]. However, evidence of a link between obesity and computer use or video game playing is limited. This can be attributed to the different characteristics of the population and heterogeneity in the type of video games played. A recent systematic review showed that, as estimated by total screen time, sedentary behaviour was associated with lower consumption of vegetables and fruits and increased intake of high caloric food [8].

The Kingdom of Saudi Arabia (KSA) underwent rapid modernization with lifestyle changes. The prevalence of overweight and obesity among adolescents in KSA was found to be 27% and 11%, respectively [9]. Furthermore, surveys conducted in KSA showed a persistent rising trend toward obesity in the last decades [8]. Recent studies revealed that school-aged children, most adolescents, prefer video games over physical activities [10]. A high percentage of adolescents spent >2 hours per day on screen, while half of the boys and 75% of girls had a sedentary lifestyle with physical activity below the recommended levels [11]. However, studies assessing the association between video games and body weight changes in KSA are limited, and studies from abroad don't reflect the local situation. Therefore, our study will examine the association between video game playing and body mass index changes among adolescents in intermediate schools of the Jeddah province, Kingdom of Saudi Arabia. This study examined the association between video game playing and body mass index among adolescents in intermediate schools in Jeddah, Saudi Arabia.

MATERIALS AND METHODS

It is a cross-sectional study that was conducted in the last quarter of 2022. This study was conducted in Jeddah, Kingdom of Saudi Arabia. Jeddah is a city in the Hejaz region and Saudi Arabia's commercial centre and the second-largest city behind Riyadh, with a population of 4,697,000 people (based on 2021). As the largest seaport, Jeddah is populated with people of different ethnicities. Therefore, there are 849 public and private schools for males and 1179 public and private schools for female students as of April 2022 (32). We included all intermediate school students with a BMI of 18.5 and above. All intermediate school adolescent (aged 11 years old to 14 years old) students in Jeddah were eligible. Students without parents' consent, with mental diseases or special needs, physical disabilities and students aged less than 11 years or more than 15 years old were excluded. The sample size was calculated using Gpower software (version 3.1) to detect the difference between two dependent means. The effect size that we wanted to detect was 0.10, the alpha error was 0.05, and the statistical power was set to be 0.80. The software showed that the minimal sample size would be 310 participants divided into two groups.

The study's sampling technique were a multi-stage random sampling technique, as follows:
In the first stage, one-two school from each of the six educational regions were randomly selected by simple random technique (To establish a proportionate sampling). In the second stage, we will use matched samples. Ten schools were randomly selected from a list of schools in Jeddah. Then students' BMI were measured, and students with a BMI >25 were selected. The process will continue until the number of students with a BMI >25 reach the required sample size.

A self-administered questionnaire was used to collect data from selected high school students. It was designed using sample questions from the literature. It consists of two sections: the first section inquiries about demographics, education grade, weight and height, parental education levels, and physical activities. The second section investigates video game playing habits and settings. The third section uses items with a 5-point Likert scale to assess attitudes of adolescents towards appeal and quality of the videogames [12]. Data were collected on the variables such as height, weight, age, gender, education grade, physical activity, determinant for video gaming, parental education levels.

The questionnaires were distributed to the students whose parents will provide signed consent. Teachers at school will distribute the consent, and the students will take them home for parents to sign. Teachers will also distribute questionnaires after explaining the study's aim to students. Students whose parents consented will answer the questionnaires, put them in paper pouches provided by the researcher, and close them before delivering them to the teachers. This will help ensure that no one can read the answers to the questionnaires. The data entry and analysis were done with the Statistical Package of Social Sciences (SPSS, version 26).

The data were analyzed to present the findings of the descriptive and inferential statistics. Categorical variables were expressed in frequencies and percentages, and continuous variables were expressed in mean, median and standard deviations. Regression models were used to assess associations and adjust for potential confounding factors. Statistical signification were set at $p<0.05$. Logistic regression analysis was used to identify the association between video game playing and BMI changes. Risk estimates and 95% confidence interval were calculated to determine the strength of association.

Ethical Considerations

- Obtaining research approval from Research Committee of The Joint Program for Preventive Medicine.
- Obtaining permission from ministry of education.
- The permission was obtained from each selected school.
- After approval of participants' parents, they were asked to sign consent after receiving all the needed information from the consent forms.
- The collected data were kept confidential by ensuring anonymity of the included individuals; the data were stored in personal computer secured by password. All data will not be disclosed except for the study purpose.

RESULTS

A total of 345 students were surveyed and the majority of the respondents were between the ages of 14-16, accounting for 71.9% of the sample, followed by the age group of 11-13, constituting 25.2%. The smallest percentage of respondents (>16) was only 2.9%. In terms of educational level, the largest proportion was in the 3rd grade of intermediate school, comprising 42.6% of the participants. The majority of respondents were of Saudi nationality, comprising 82.9% of the sample, while non-Saudis accounted for 17.1%. Regarding residency, the majority of participants resided in urban areas (95.3%), followed by peri-urban areas (4.4%) and rural areas (0.3%). When considering the educational level of the parents, a significant proportion of mothers (70.7%) held a university degree, while 62.0% of fathers had a university degree. Moreover, the majority of mothers were unemployed (58.8%), whereas fathers were primarily employed in the governmental sector (64.1%) as demonstrated in table 1.

In summary, the study's participants were predominantly adolescents between the ages of 14-16, with the majority of them being Saudi nationals residing in urban areas. The educational level of the parents varied, but a notable proportion had obtained a university degree. These demographic characteristics provide a foundation for understanding the sample composition and potential influences on video game addiction among schoolchildren and adolescents.

Table 1 Demographic characteristic of the participants

Characteristics	Frequency	Percent (%)
Age (Years)		
11-13	87	25.2
14-16	248	71.9
>16	10	2.9
Educational level		
1st grade in intermediate school	68	19.7
2nd grade in intermediate school	130	37.7
3rd grade in intermediate school	147	42.6
Nationality		
Saudi	286	82.9
Non-Saudi	59	17.1
Residency		
Urban	324	95.3
Peri-urban	15	4.4
Rural	1	0.3
Mother's educational level		
Illiterate	5	1.4
Primary school	9	2.6
Secondary school	71	20.6
University degree	244	70.7
Postgraduate studies	16	4.6
Father's educational level		
Illiterate	2	0.6
Primary school	4	1.2
Secondary school	60	17.4
University degree	214	62
Postgraduate studies	65	18.8
Mother's occupation		
Unemployed	203	58.8
Work in the governmental sector	55	15.9
Work in the private sector	83	24.1
Student	4	1.2
Father's occupation		
Unemployed	22	6.4
Work in the governmental sector	221	64.1
Work in the private sector	102	29.6

Table 2 presents factors related to lifestyle and the pattern of video game playing among schoolchildren and adolescents in a study on video game addiction. The first paragraph focuses on physical exercise, PlayStation usage, and time spent on online playing. Regarding physical exercise, the largest proportion of the participants engaged in gaming sessions 3 to 4 times a week (35.7%), followed by twice a week (20.9%) and 4 times a week (11.0%). About

25.8% reported that they exercise rarely or not at all. In terms of PlayStation usage, the most common duration was 4 hours-6 hours per day (37.7%), followed by 6 hours-8 hours per day (33.9%) and 1-3 hours per day (22.9%). A smaller percentage played for more than 8 hours per day (5.5%). When it comes to spending time on online playing, the distribution was relatively balanced, with the highest proportion spending 1-3 hours per day (33.0%), followed closely by 6 hours-8 hours per day (32.8%) and 4 hours-6 hours per day (30.1%).

The majority of respondents reported playing video games 4 times-6 times per week (39.9%), followed by every day (35.9%) and ≤ 3 times per week (24.2%). A large majority (86.1%) had a video game system in their bedroom. When asked about friends who were addicted to video games, 81.2% of the participants answered positively. In terms of BMI grades, the largest proportion fell into the normal category (46.0%), followed by overweight (26.8%) and underweight (10.3%). A smaller percentage fell into obesity class I (14.2%), obesity class III (1.8%), obesity class II (0.9%). The findings indicate that the majority of participants engaged in physical exercise at least a few times a week, while a significant proportion spent several hours per day playing on PlayStation and online. The frequency of video game playing per week varied, with a substantial portion of the sample reporting daily gaming. A large number of participants had a video game system in their bedroom and acknowledged having friends who were addicted to video games.

Table 2 Factors related to lifestyle and pattern of video-games playing

Factor	Frequency	Percent (%)
Physical Exercise		
Never	32	9.3
Rarely	57	16.5
One a week	38	11
Twice a week	72	20.9
3-4 times a week	123	35.7
More than 4 times a week	23	6.7
PlayStation time (hours per day)		
1-3 hours per day	79	22.9
4-6 hours per day	130	37.7
6-8 hours per day	117	33.9
>8 hours per day	19	5.5
Spending time on online playing (hours per day)		
1-3 hours per day	114	33
4-6 hours per day	104	30.1
6-8 hours per day	113	32.8
>8 hours per day	14	4.1
Frequency of video-games playing per week		
≤ 3 times per week	83	24.2
4-6 times per week	137	39.9
Every day	123	35.9
Do you have a video-game system in the bedroom?		
Yes	297	86.1
No	48	13.9
Do you have friends who are addicted to video games, in general?		

Yes	280	81.2
No	65	18.8
BMI grades		
Underweight	35	10.3
Normal	156	46
Overweight	91	26.8
Obesity class I	48	14.2
Obesity class II	3	0.9
Obesity class III	6	1.8

Table 3 presents the items of video game addiction among schoolchildren and adolescents in a study. Each item represents a statement related to addictive behaviours associated with video game playing, and respondents were asked to indicate the frequency of their experience. For example, when asked if they increasingly think about playing in later times, learning how to play video games, or planning for the next game opportunity, a significant percentage of respondents (45.2%) answered "Always," while 50.4% responded with "Sometimes." A similar pattern is observed in other items, such as the need to spend more time or money on video games to feel the same level of excitement, trying to reduce playing time without success, and feeling agitation and discomfort when trying to reduce or stop playing. These findings suggest that a considerable number of participants exhibit signs of addiction, as they experience these behaviours frequently or sometimes. When asked if they play video games as a means to escape from problems or negative emotions, 40.3% responded "Sometimes" and 12.8% responded "Always." Additionally, a notable proportion of respondents admitted to lying to their family or friends about the amount of time spent playing video games (40.3% sometimes, 8.4% always) and engaging in unauthorized actions, such as taking video games without permission (27.5% sometimes, 6.4% always). Furthermore, a significant percentage of participants acknowledged avoiding household chores (40.0% sometimes, 11.3% always) and neglecting school assignments (44.6% sometimes, 10.4% always) in order to spend more time playing video games. These findings indicate a high likelihood of addictive behaviours and a potential negative impact on academic performance and social relationships.

Table 3 Items of video-games addiction among the students

Items	Frequency	Percent (%)
Q1 "Are you increasingly thinking about playing in later times, or learning how to play video games, or planning for the next game opportunity?"		
No	15	4.3
Sometimes	174	50.4
Always	156	45.2
Q2 "Do you need to spend more time or money on video games to feel the same level of excitement?"		
No	144	41.7
Sometimes	166	48.1
Always	35	10.1
Q3 "Have you tried to reduce your playing time on these games, but without success?"		
No	120	34.8
Sometimes	163	47.2
Always	62	18

Q4 "Do you become agitated and uncomfortable when trying to reduce or stop playing video games?"		
No	123	35.7
Sometimes	172	49.9
Always	50	14.5
Q5 "Do you play video games as a means to escape from problems or negative emotions?"		
No	162	47
Sometimes	139	40.3
Always	44	12.8
Q6 "Have you ever lied to your family or friends about the amount of time spent playing video games?		
No	177	51.3
Sometimes	139	40.3
Always	29	8.4
Q7 "Have you ever taken a video game from a store or borrowed one from a friend without their permission, or taken money to buy a video game without your parents' permission?"		
No	228	66.1
Sometimes	95	27.5
Always	22	6.4
Q8 "Do you avoid doing household chores assigned by your family in order to spend more time playing video games?"		
No	168	48.7
Sometimes	138	40
Always	39	11.3
Q9 "Do you sometimes avoid doing your school assignments in order to spend more time playing video games?"		
No	155	44.9
Sometimes	154	44.6
Always	36	10.4
Q10 "Have you ever failed a school test because you spent too much time playing video games?"		
No	263	76.2
Sometimes	38	11
Always	44	12.8
Q11 "Have you ever needed help from friends or family to provide you with more money due to overspending on gaming equipment or gaming/Internet fees?"		
No	209	60.6
Sometimes	104	30.1
Always	32	9.3

Table 4 presents the distribution of numerical variables among the respondents in a study assessing video game addiction among schoolchildren and adolescents. The age range of the respondents in the study was from 11 years to 19 years, with a mean age of 14.3 years and a standard deviation of 1.2. This indicates that the majority of participants fell within the early to mid-adolescent age range. The weight of the participants ranged from 28 kg to 177 kg, with a mean of 64.9 kg and a standard deviation of 18.1 kg.

The frequency of playing video games per week ranged from 0 to 7 times, with a mean of 5.0 times and a standard deviation of 1.9. This indicates that, on average, the participants played video games approximately five times per week. The BMI (Body Mass Index) of the respondents ranged from 11.71 to 70.1, with a mean of 25.1 and a standard deviation of 6.6. This suggests that, on average, the participants had a BMI that falls within the overweight range. The number of hours spent playing video games per week ranged from 0 to 56 hours, with a mean of 23.1 hours and a standard deviation of 13.4 hours. Finally, the addiction score, which likely measures the severity of video game addiction, ranged from 1 to 22, with a mean score of 8.1 and a standard deviation of 4.3.

Table 4 Distribution of numerical variables among the respondents

Variables	Minimum	Maximum	Mean	Std. Deviation
Age	11	19	14.3	1.2
Length (m)	102	185	160.4	8.8
Weight (Kg)	28	177	64.9	18.1
Frequency per week	0	7	5	1.9
BMI	11.71	70.1	25.1	6.6
Hours play per week	0	56	23.1	13.4
Addiction score	1	22	8.1	4.3

Table 5 presents the findings of a linear regression analysis examining the association between times spent playing video games per week and BMI (Body Mass Index) among schoolchildren and adolescents focuses on the significant predictors of BMI. The variable "Time-playing per week" shows a mean difference of 0.09 in BMI for each additional hour spent playing video games per week. The lower limit of the 95% Confidence Interval (C.I.) is 0.03, and the upper limit is 0.15. The p-value for this association is 0.003, indicating a statistically significant relationship between time spent playing video games per week and BMI. This suggests that there is a positive association between the two variables, indicating that increased time spent playing video games per week is associated with a higher BMI.

Additionally, "Physical exercise (frequency)" shows a mean difference of -0.72 in BMI for each increase in frequency of physical exercise. The lower limit of the 95% C.I. is -1.22, and the upper limit is -0.21. The p-value for this association is 0.005, which is statistically significant. This negative association suggests that a higher frequency of physical exercise is associated with a lower BMI among schoolchildren and adolescents. The variables "Age (years)," "Mother's educational level," and "Father's educational level" do not show statistically significant associations with BMI. Although there are mean differences in BMI associated with these variables, the confidence intervals include zero, indicating that the differences may be due to chance.

The categorical predictors are compared to their respective reference groups, and their mean differences, along with the lower and upper limits of the 95% Confidence Intervals (CI), and p-values are reported. The variable "Nationality" shows a mean difference of -1.716 in BMI between Saudi and Non-Saudi participants. The p-value for this association is 0.079, which is close to significant threshold of 0.05. Furthermore, the variable "Do you have friends who are addicted to video games?" reveals a significant mean difference of -1.72 in BMI between participants who have friends addicted to video games and those who do not. However, the p-value for this association is 0.195, which is not statistically significant. This implies that there may be a trend towards lower BMI among participants without friends addicted to video games, but the evidence for a significant association is weak. The variables "Has a video-game system in the bedroom?" and "Mother's occupation" do not show statistically significant associations with BMI. Similarly, the variables "Father's occupation" and "Governmental sector" do not show statistically significant associations with BMI.

Table 5 Findings of linear regression for the association between students' characteristics and BMI (adjusted for other variables in the model)

Numerical Predictors			**Mean difference**	**Lower limit (95% C.I)**	**Upper limit (95% C.I)**	**p-value**
Time-playing per week (hours)			0.09	0.03	0.15	0.003 *
Physical exercise (frequency)			-0.72	-1.22	-0.21	0.005 *
Age (years)			0.54	-0.08	1.15	0.087
Mother's educational level			0.49	-0.75	1.73	0.438
Father's educational level			0.64	-0.48	1.76	0.26
Categorical Predictors	**Comparison group**	**Reference group**	**Mean difference**	**Lower limit (95% C.I)**	**Upper limit (95% C.I)**	**p-value**
Nationality	Saudi	Non-Saudi	-1.716	-3.63	0.2	0.079
Do you have friends who are addicted to video games?	Yes	No	-1.72	-3.21	0.65	0.195
Has a video-game system in the bedroom?	Yes	No	-1.28	-0.4	3.69	0.114
Mother's occupation	Unemployed	Student	1.65	-5.3	7.3	0.756
	Governmental sector		1	-4.66	8.47	0.569
	Private sector		1.91	-5.23	7.72	0.707
Father's occupation	Unemployed	Private sector	1.24	-4.75	1.66	0.345
	Governmental sector		-1.55	-2.18	1.18	0.559

Table 6 presents the findings of a linear regression analysis examining the association between video game addiction and BMI (Body Mass Index) in schoolchildren and adolescents, while controlling for other variables in the model. The predictors in the model include addiction scores, physical exercise frequency, age, mother's educational level, and father's educational level.

According to the results, the addiction scores for video games have a mean difference of 0.16 in relation to BMI, although the difference is not statistically significant (p=0.113). This suggests that there is no strong evidence of a direct association between video game addiction scores and BMI in this study. However, physical exercise frequency shows a significant negative association with BMI. The mean difference of -0.53 indicates that higher frequency of physical exercise is associated with lower BMI values. This finding is supported by the statistically significant p-value of 0.045, suggesting that physical exercise plays a role in reducing BMI among schoolchildren and adolescents. Age also shows a significant positive association with BMI. The mean difference of 0.64 suggests that as age increases, BMI tends to increase as well. This association is statistically significant (p=0.043), indicating that age is a contributing factor to higher BMI values. The educational levels of both the mother and father do not show significant associations with BMI in this study. This suggests that the educational background of the parents may not have a substantial influence on the BMI of schoolchildren and adolescents in this context.

The categorical predictors in the model include nationality, having friends addicted to video games, having a video-game system in the bedroom, mother's occupation, and father's occupation. The results indicate that nationality has a significant association with BMI. Comparing Saudi and non-Saudi participants, the mean difference in BMI is -2.02. The lower limit of the 95% confidence interval (-3.96) to the upper limit (-0.09) suggests that Saudi participants have a significantly lower BMI compared to non-Saudi participants. Having a video-game system in the bedroom also shows a significant association with BMI. Participants who have a video-game system in their bedroom have a mean difference in BMI of 2.19 compared to those who do not have a system in their bedroom. The lower limit of

the 95% confidence interval (0.17) to the upper limit (4.22) suggests that having a video-game system in the bedroom is associated with a higher BMI.

Having friends addicted to video games, mother's occupation, and father's occupation do not show significant associations with BMI in this study. The mean differences for these predictors do not deviate significantly from zero, and the corresponding p-values are greater than 0.05.

Table 6 Findings of linear regression for the association between video-games addiction and BMI (adjusted for other variables in the model)

Numerical Predictors			**Mean difference**	**Lower limit (95% C.I)**	**Upper limit (95% C.I)**	**p-value**
Addiction on video-games (scores)			0.16	-0.04	0.35	0.113
Physical exercise (frequency)			-0.53	-1.05	-0.01	0.045 *
Age (years)			0.64	0.02	1.26	0.043 *
Mother's educational level			0.99	-0.25	2.23	0.117
Father's educational level			0.51	-0.64	1.67	0.382
Categorical Predictors	**Comparison group**	**Reference group**	**Mean difference**	**Lower limit (95% C.I)**	**Upper limit (95% C.I)**	**p-value**
Nationality	Saudi	Non-Saudi	-2.02	-3.96	-0.09	0.041 *
Do you have friends who are addicted to video games?	Yes	No	-0.61	-2.51	1.29	0.53
Has a video-game system in the bedroom?	Yes	No	2.19	0.17	4.22	0.034 *
Mother's occupation	Unemployed	Student	1.6	-4.91	8.1	0.63
	Governmental sector		1.52	-5.12	8.17	0.653
	Private sector		1.07	-5.49	7.62	0.75
Father's occupation	Unemployed	Private sector	-1.07	-4.3	2.15	0.514
	Governmental sector		0.001	-1.67	1.67	0.999

DISCUSSION

The results of our study show that a significant proportion of the study participants engage in video game sessions on a regular basis, and most of them spend several hours per day playing video games. Regarding physical exercise, the majority of participants reported engaging in gaming sessions 3-4 times a week, while 25.8% of the participants reported that they exercise rarely or not at all. These findings are consistent with previous studies that have suggested a negative relationship between video game addiction and physical activity [13]. Moreover, a smaller percentage of participants played for more than 8 hours per day, which is not only detrimental to physical health but also increases, the risk of addiction [14].

Our study reveals that a significant proportion of the participants engage in frequent video game sessions, with most of them having a video game system in their bedroom. The majority of respondents reported playing video games 4 times-6 times per week, and 35.9% of participants played video games every day. These results confirm previous findings indicating that excessive screen time could affect physical activity and sedentary behaviours [13]. Moreover, our study showed alarming results regarding the prevalence of video game addiction among the study participants' friends. Specifically, 81.2% of the participants answered positively when asked about friends who were addicted to video games.

Regarding BMI grades, the majority of the participants fell into the normal category, followed by overweight and underweight. However, it is concerning that 16% of the participants fell into the obesity categories. These results are consistent with previous studies that have found a relationship between video game addiction and increased BMI, as well as other indicators of poor health outcomes in Saudi Arabia [15,16]. Furthermore, a large majority (86.1%) of the participants had a video game system in their bedroom. This finding highlights the need to monitor and limit video game access, particularly in the bedroom, where it might interfere with sleep quality and duration [17].
Our study shows a high prevalence of video game addiction and its potential impact on the participants' health outcomes, particularly their BMI grades. It is crucial to promote physical activity and limit excessive screen time among children and adolescents, to reduce the risk of developing obesity and related health issues [18]. The results of our study indicate that a significant proportion of the participants engage in video game sessions on a frequent basis, with most of them spending several hours per day playing. Concerning, 25.8% of participants reported that they exercise rarely or not at all. These findings are consistent with previous studies suggesting that there is a negative correlation between video game addiction and physical activity among children and adolescents in Saudi Arabia [16].

The present study also revealed several other findings about the patterns of video game addiction among school children and adolescents. For instance, a considerable number of respondents reported using video games as a coping mechanism to escape from problems or negative emotions, such as stress, sadness, or boredom. This finding was highlighted during COVID-19 pandemic in the Eastern province of Saudi Arabia [19]. Moreover, the present study identified several specific behavioural indicators of video game addiction, such as lying about gaming, taking games without permission, avoiding chores or schoolwork, and neglecting social relationships. These behaviours suggest that video game addiction may lead to a range of negative consequences beyond just physical health outcomes, such as academic problems, conflict with authority figures, and social isolation [19,20].

One important difference between the present study and previous research is the prevalence of specific addictive behaviours related to video gaming. For instance, Rehbein *et al*. reported much higher rates of withdrawal symptoms, such as anxiety or irritability, among individuals with gaming addiction [21]. Moreover, some studies have found that online gaming addiction is more strongly associated with academic and social problems than offline gaming addiction [22]. One possible explanation for these differences could be variations in sample demographics or cultural factors, as previous studies have mostly focused on Asian or European populations. Alternatively, the inclusion of specific behavioural indicators of video game addiction in the present study may have captured a broader range of harmful outcomes than other measures, which may have relied on more general or clinical criteria for addiction. The results of the present study underscore the need for comprehensive assessments of video game addiction among schoolchildren and adolescents, which consider both physical and psychosocial outcomes. Future research could further investigate the mechanisms underlying video game addiction, such as the role of personality traits, environmental factors, and social influences, in order to develop more effective prevention and intervention strategies.

The items used to measure video game addiction in the study revealed a pattern of highly frequent and pervasive addictive behaviours associated with video game playing, including increased thoughts about gaming, difficulty reducing playing time, and discomfort when attempting to stop playing. These findings align with previous research that has reported similar patterns of addictive behaviour among individuals with video game addiction [23,24]. However, there also appear to be some differences in the prevalence and intensity of these addictive behaviours across different cultural and age groups. For example, studies in Asian populations have reported higher rates of gaming addiction and more severe symptoms than studies conducted in Western populations [25,26]. Similarly, adolescents may be more prone to video game addiction than children due to greater access to gaming platforms, peer pressure, and academic stress.

Furthermore, the present study focused on specific addictive behaviours associated with video game playing, while other studies have used different measures or criteria to assess gaming addiction. For instance, the DSM-5 includes criteria such as withdrawal, tolerance, and significant impairment in social and occupational functioning in its diagnosis of internet gaming disorder [27]. Such criteria may or may not overlap with the behavioural indicators of video game addiction assessed in the present study. These findings suggest that video game addiction is a complex and multifaceted phenomenon that requires careful consideration of individual, social, and cultural factors.

The present study aimed to assess the determinants of BMI including video game addiction among schoolchildren and adolescents; specifically examining the association between times spent playing video games per week and BMI. Findings from a linear regression analysis indicate a positive association between these two variables, with a mean difference of 0.09 in BMI for each additional hour spent playing video games per week. Importantly, this association was statistically significant ($p=0.003$), suggesting that increased time spent on video games is associated with a higher BMI. These results are consistent with previous study, in Western region in Saudi Arabia, that have found a positive association between sedentary behaviour, such as screen time, and obesity in children and adolescents [28]. Moreover, they suggest that time spent on video games specifically may be an important factor contributing to this relationship. This is supported by research that found screen time to be associated with increased body weight and obesity among children and adolescents [29]. However, it is important to note that some previous studies have reported mixed findings or even a negative association between screen time and BMI [30,31]. Differences across studies in terms of sample characteristics, measurement methods, and the specific forms of sedentary behaviour examined may explain some of the discrepancies in findings. For example, the present study examined time spent on video games specifically, whereas other studies may have included a broader range of sedentary activities [31]. Additionally, cultural and environmental factors in Saudi Arabia may also play a role in these differences. Hence, the present study provides further evidence for a positive association between times spent playing video games per week and BMI among schoolchildren and adolescents. These findings highlight the importance of promoting physical activity and limiting sedentary behaviours, including video games, in efforts to prevent obesity in this population.

The findings revealed a non-significant mean difference between BMI and nationality, although the p-value is close to the significant threshold. This finding disagrees with some previous studies that have reported significant differences in BMI between Saudi and non-Saudi participants [15,16]. The differences in the results may be attributed to differences in sample sizes, age ranges, and cultural backgrounds of the study populations.

The results revealed that video-games addiction shows a non-significant association with BMI. These findings are in contrast with previous studies on determinants of BMI in schoolchildren and adolescents. One possible explanation for the lack of a significant relationship between video game addiction and BMI in this study could be due to the frequency and intensity of video game use by participants was not high enough to produce a measurable effect on BMI. Additionally, the study did not account for dietary habits, which is a known determinant of BMI. The model of effect of video-games addiction and BMI shows that physical exercise frequency is negatively associated with BMI which is consistent with previous studies. A meta-analysis by Kelley *et al*., 2015 found that physical activity interventions, including exercise, were effective in reducing BMI among children and adolescents [32]. Another study found that sedentary behaviour, such as watching television or playing video games, was positively associated with BMI in children and adolescents [33]. Similarly, the positive association between age and BMI in this study is also supported by previous research.

One potential explanation for the differences in the findings in this study is differences in sample size, population demographics, or geographic location. It is also possible that there are cultural or socioeconomic factors that contribute to differences in the relationship between BMI, which probably has more effect on the second model of video-games addiction and BMI. Future research could examine the relationship between video game addiction and BMI in different populations and contexts, as well as investigate the potential mechanisms linking these factors, such as sleep disturbances, eating behaviours, and physical activity levels.

The present study has several limitations that should be considered when interpreting the results. It is possible that the relationship between the two is bidirectional, with excessive screen time leading to higher BMI levels, and vice versa. Future studies using longitudinal designs are needed to investigate the temporal associations between video game addiction and BMI. Secondly, the study relied on self-reported data, which might be subject to response bias or social desirability bias. The participants' perception of their video game addiction levels or physical activity might not reflect objective measures of their behaviour. Future studies should consider using objective measures, such as accelerometers, to quantify physical activity levels and reduce the influence of self-report biases. Thirdly, the study focused on a specific age group of schoolchildren and adolescents and included only one geographical region. Therefore, the results might not be generalizable to other age groups or populations in different settings. Future studies with more diverse samples are needed to explore the relationship between video game addiction and BMI across different age groups and populations. Finally, the study did not account for potential confounding factors, such as dietary habits, socio-economic status, and psychiatric comorbidities. These factors might have influenced the relationship between video game addiction and BMI and should be considered in future studies.

Despite these limitations, the present study provides important insights into the relationship between video game addiction and BMI among schoolchildren and adolescents. It emphasizes the need to promote healthy screen time habits and increase physical activity levels to prevent the development of obesity and related health problems.

CONCLUSION

The prevalence of excessive video games playing is high among intermediate-school students with three quarters of the students play almost most of the week. The findings from this study suggest that physical exercise, time-playing per week, and age are important determinants of BMI in schoolchildren and adolescents. The negative association between physical exercise and BMI highlights the importance of promoting physical activity in this population. The positive association between age and BMI suggests that interventions to prevent overweight and obesity should be targeted at younger age groups.

The findings of the present study have significant clinical and practical implications for healthcare practitioners, educators, and parents. Healthcare practitioners can use these findings to screen for and address problematic video game use in their paediatric patients and provide counselling on healthy lifestyle choices. They can also work collaboratively with other professionals, such as educators and mental health specialists, to develop comprehensive intervention programs that target both physical and mental health outcomes associated with video game addiction. Educators and parents can use these findings to develop strategies that reduce screen time among schoolchildren and adolescents and promote alternative healthy behaviours, such as physical activity, social engagement, and academic enrichment. Such interventions may include limiting access to video games, setting time limits for electronic device use, and encouraging participation in extracurricular activities.

DECLARATIONS

Conflicts of Interest

The authors declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

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