2020

Video Games, Screen Time, and the Impact on Body Mass Index and the Cardiovascular Fitness of Adolescence

Joshua Sylvan
Wright State University - Main Campus, sylvan.2@wright.edu

Video games, screen time, and the impact on Body Mass Index and the cardiovascular fitness of adolescence.

Joshua Sylvan

Mentor: Dr. Jeannette Manger

Public Health, Population Health, and Global Health Research

Scholarship in Medicine Proposal

Abstract

Objective: To determine the effect of screen time/video gameplay has on the BMI and cardiovascular fitness of adolescence between the ages of 12 and 15 years old.

Methods: All data were collected and analyzed based on the CDC's NHANES National Youth Fitness Survey (NNYFS).

Results: Analysis showed that there was no significant difference between body mass index and time spent using a computer as well as no significant difference between estimate maximal O2 uptake (primary endpoint for cardiovascular fitness) and time spent using a computer.

Keywords: BMI, Cardiovascular Fitness, Video Games, Screen Time

Introduction

For decades, the prevalence of childhood obesity in The United States has been on the rise.[1] As of October 2017, the prevalence of obesity for those between the ages of 2 to 19 years old is 18.5% (13.7 million).[2] This number is comparable to the prevalence of childhood obesity in the world which sits at just over 18% for those between the ages of 5 to 19 years old.[3] The reason for this obesity is multifactorial. One such factor could be the amount of physical activity in which a child participates and to what extent they live a sedentary life. According to the CDC, about 30% of adolescence participate in daily physical activity.[4] So what factors could be leading to this sedentary lifestyle?

One aspect of a sedentary lifestyle that has been under scrutiny for some time is video games and screen time. In 2017, the US spent close to $30 billion on video games, with approximately60% of American's playing video games on a daily basis.[5,6] With the increase in technological advances in entertainment since the early 1970s, there has been a plethora of options for Americans, especially children, to stay on the couch and live an increasingly sedentary lifestyle. In one study by Chaput et al, a single session of video gameplay in a healthy male teenager was associated with an increase in the amount of caloric intake.[7] Moreover, a study conducted by Stettler et al. out of Switzerland showed a significant association between video games and obesity [OR = 2.03 per hour per day, $p < 0.001$].[8] However, meta-analyses conducted in 2004 and 2008 showed mixed reviews in that some studies showed a higher weight status with an increase in video game usage whereas others showed a positive association only when video games were combined with TV usage.[9,10]

The importance of maintaining or improving one's cardiovascular fitness in their teenage years is crucial for leading a healthier life in adulthood and beyond. However, little research has been conducted on the association between screen-time and cardiovascular/cardiorespiratory fitness. An initial assumption that could be made between these variables would be that with increased sedentary behavior, less physical activity would be carried out resulting in a decline in cardiovascular fitness. Mitchell et al concluded, through exercise testing, that more screen time was associated with lower cardiorespiratory fitness.[11]

Due to increasing public health concern, researchers and developers have been working on what is called "Active Video Games" (AVG). AVG are games that take the user out of their seat and involve them more actively in the games they play. One of the most popular and most commonly recognized version of AVG consoles is the Nintendo Wii. Multiple meta-analyses performed show that, although small, AVG has some positive effect on the Body Mass Index (BMI) of children and adolescences.[12,13] Furthermore there is promise in the improvement of the health status of certain populations (children with disabilities, the elderly, etc.) and further research is being performed on how to incorporate this into further healthcare strategies.[14] With further technological improvement of gaming, one can be hopeful that, for example, creating health platforms using virtual reality, would help improve the health outcomes of the youth today. Due to the relative infancy of this research, further investigation is necessary to understand the true relation between video games, screen time, and the health of our youth. Once a fuller picture can be established, overcoming the negative consequences of screen time and video games on fitness and BMI can be reduced.

Hypothesis

Adolescents who spend more time in front of the screen and more time playing video games have a higher BMI and lower cardiovascular fitness.

Research Questions

RQ1. What differences exist in BMI among different groups of youth categorized by the amount of time spent playing video games??

RQ2. What differences exist in overall cardiovascular fitness among different groups of youth categorized by the amount of time spent playing video games?

RQ3. How does cardiovascular fitness compare among children with low/normal, overweight, and obese BMIs?

RQ4. How does BMI compare among those of different physical activity readiness scores?

Methods

All data used is public data and was collected by the Centers for Disease Control and Prevention (CDC) in the NHANES National Youth Fitness Survey (NNYFS). This study was conducted in 2012 by the National Center for Health Statistics (part of the CDC) and included a questionnaire and data collection on physical activity and fitness levels of non-institutionalized children in the U.S. aged between three and 15 years old. This appears to be the only inclusion criteria. There was no oversampling of any race-ethnicity subgroups. The 1,640 youth that were interviewed were found through random sampling.

Data collection

Data specific to this study included those aged between 12 years and 15 years old with a sample size of $n = 510$. Variables utilized included age, gender, race, BMI, hours of computer usage in the past 30 days, cardiovascular fitness level, and physical activity readiness. Hours of computer usage was defined as the average amount of hours per day the participant used a computer or played computer games outside of work or school in the past 30 days. Cardiovascular fitness level was determined based on gender-age specific cut-points of estimated VO_2 max. Cardiovascular fitness was assessed through the NNYFS treadmill protocol with VO_2 max being the primary outcome.[15] VO_2 max is defined as maximal oxygen consumption. Participants were assigned to one of five treadmill test protocols that varied by grade and speed based on gender, age, BMI, and self-reported physical activity. The test consisted of a two-minute warm-up, two three-minute exercise periods, and a two-minute recovery period. The purpose of this was to achieve a heart rate that is approximately 75% of the predicted maximum heart by the end of the test (220 minus age). Heart rate was continuously monitored and VO_2 max was estimated using the heart rate at the end of each exercise period. Cardiovascular fitness was then categorized into three categories, Healthy Fitness Zone, Needs improvement – some risk, and Needs improvement – high risk.

Physical activity readiness was determined through a series of questions to describe the participant's typical physical activity level. These were categorized as:

- Little or no regular exercise and avoids walking or exertion
- Little or no regular exercise but walks for pleasure and occasionally exercises
- Modest exercise (10-60 mins per week)
- Modest exercise (>60 mins per week)
- Heavy physical activity (< 30 mins per week)
- Heavy physical activity (30-60 mins per week)
- Heavy physical activity (1-3 hours per week)
- Heavy physical activity (> 3 hours per week)

Specific variables include: Respondent sequence number, Gender, Age in years at screening, Race / Hispanic origin, Body Mass Index (kg/m**2), BMI category – Children/Adolescents, Cardiovascular fitness level, Physical activity readiness code, and Hours use computer past 30 days. There was no recategorization of this data. The data was prepared by maintaining the above-mentioned variables by how they are already categorized.

Data Analysis Plan

Data analysis will include descriptive statistics on demographics, crosstabulation, and one-way ANOVA comparing trends between the variables shown below. Data analysis was conducted using IBM SPSS Statistics software.

- SEQN – Respondent sequence number
- RIAGENDR – Gender
- RIDAGEYR – Age in years at screening
- RIDRETH1 – Race / Hispanic origin
- BMXBMI – Body Mass Index (kg/m**2)
- BMDBMIC – BMI category – Children/Adolescents
- CVDFITL2 – Cardiovascular fitness level
- CVXPARC – Physical activity readiness code
- PAQ715 – Hours use computer past 30 days
- CVDESVO2 – Estimated maximal O2 uptake (ml/kg/min)

Results

Using the data obtained from the CDC's NHANES National Youth Fitness Survey, 510 youth were analyzed. Descriptive statistics of the population can be found in *Table 1* and *Table 2*, show BMI vs. Gender and BMI Category vs. Gender respectively. Using a Two-Sample t-Test, there was no significant difference found in the mean BMI between the two genders (Male = 22.71 vs Female = 22.90; p = 0.78). When analyzing the difference between gender and computer usage, *Figure 1* shows that predominantly male youth spend one or more hours on a computer over the past 30 days.

Table 3 provides descriptive characteristics for BMI within different groups of computer usage (n = 485). There was no statistically significant difference between groups as determined by one-way ANOVA ($F_{6,478} = 0.205, p = .975$) (**RQ1**). There were no statistically significant differences between groups found in the ANOVA post hoc test. Furthermore, using the primary output of the fitness test, there was no statistically significant difference between estimated maximal O2 uptake and hours of computer usage as determined by one-way ANOVA ($F_{6,443} = 0.145, p = 0.990$) (Table 4) (**RQ2**).

When analyzing data concerning cardiovascular fitness, only those between the ages of 12 and 15 were analyzed (n = 451) due to NNYFS protocols. Figure 2 illustrates the hours spent using a computer vs cardiovascular fitness (Healthy Fitness Zone, Some Risk, and High Risk). When analyzing further, Figure 3 compares the cardiovascular fitness level and BMI category (Underweight, Normal Weight, Overweight, and Obese). **(RQ3)**.

Physical Activity readiness was determined through a questionnaire to discern the level of activity of each participant as reported by the participant. Physical Activity readiness was compared to BMI and can be found in Table 5. There was a statistically significant difference between groups as determined by one-way ANOVA ($F_{7,455} = 2.624, p = 0.012$) (**RQ4)**. Post hoc testing revealed a statistically significant difference in BMI between the youth in the "Heavy Physical Activity (>3 Hours per week)" group and those in the "Modest exercise (10-60 mins per week) group (p = 0.016).

Discussion

Many youths of today (including myself at some point) have been told in some form or another to "stop playing those video games and go play outside" for the fear of our health. But how does this match up to the data? Contrary to my hypothesis, there is no statistically significant difference in either body mass index or estimate maximal O2 uptake between different hours of computer usage ($p = 0.975$, $p = 0.990$, respectively). What could account for this? Well, that is difficult to say as there are plenty of factors that play into the health of our youth.[4] From diet to school activities, to perhaps misremembering information when answering a questionnaire, all these factors need to be taken into account to obtain a holistic view of the health profile of a child.[7] Furthermore, with the increase in virtual reality video games and other "active video games", the data does not specify the type of gaming console which is being used, rather the way the data was collected lumps all these systems into "hours of computer usage, including video games".

There is perhaps less of a surprise when looking into how body mass index compares to physical activity and physical fitness.[8,10] Figure 3 show that with an increase in body mass index there is an increase in the proportion of those who are at high risk and require some improvement in their physical fitness. This makes sense as generally, those who are more physically active and fit, will be utilizing more energy for physical activities and less for storage as adipose tissue. Table 5 further exemplifies this point as those who demonstrate more physical activity have a statistically significant decrease in BMI ($p = 0.012$).

Limitations

Future studies should be less general and study design should be specific for video game usage and its impact on physical fitness and health. Studying a larger cohort across multiple centers (across other countries) could provide stronger evidence for or against the negative health impact video games have on our lives. Lastly, a portion of the data collected was done so through a questionnaire. This form of data collection can lead to some recall bias and thus provide a less accurate picture of the data.

Conclusion

It is clear and has been proven over the years that any physical activity shows improvement in both body mass index and physical fitness, and thus being sedentary for long periods can be of some detriment. However, video games may not warrant the negative complex that it has been given. Although some forms of video games do lead to some sedentary activity, developers along with scientists have worked together to tackle this issue by creating what is known as active video games. Active video games (e.g. Nintendo Wii, Oculus Rift Virtual Reality, etc.) provide an active form of entertainment that may promote a more active lifestyle. Dare I say that soon, along with other health factors like eating a healthy diet and being involved in sports, active video games could also be recommended to improve the health and wellbeing of the youth.

Tables and Figures

Table 1. Descriptive Statistics for Body Mass Index and Gender

Gender	n	Mean	SD
Male	250	22.7108	5.30700
Female	239	22.9008	5.61216
Total	489	22.8037	5.45350

Abbreviation: SD, Standard Deviation
No statistical difference found (p = 0.78)

Table 2. Body Mass Index Category vs. Gender

		Male	Female	Total
BMI Category - Children/Adolescents	Underweight	11	6	17
	Normal Weight	135	145	280
	Overweight	40	47	87
	Obese	64	41	105
Total		250	239	489

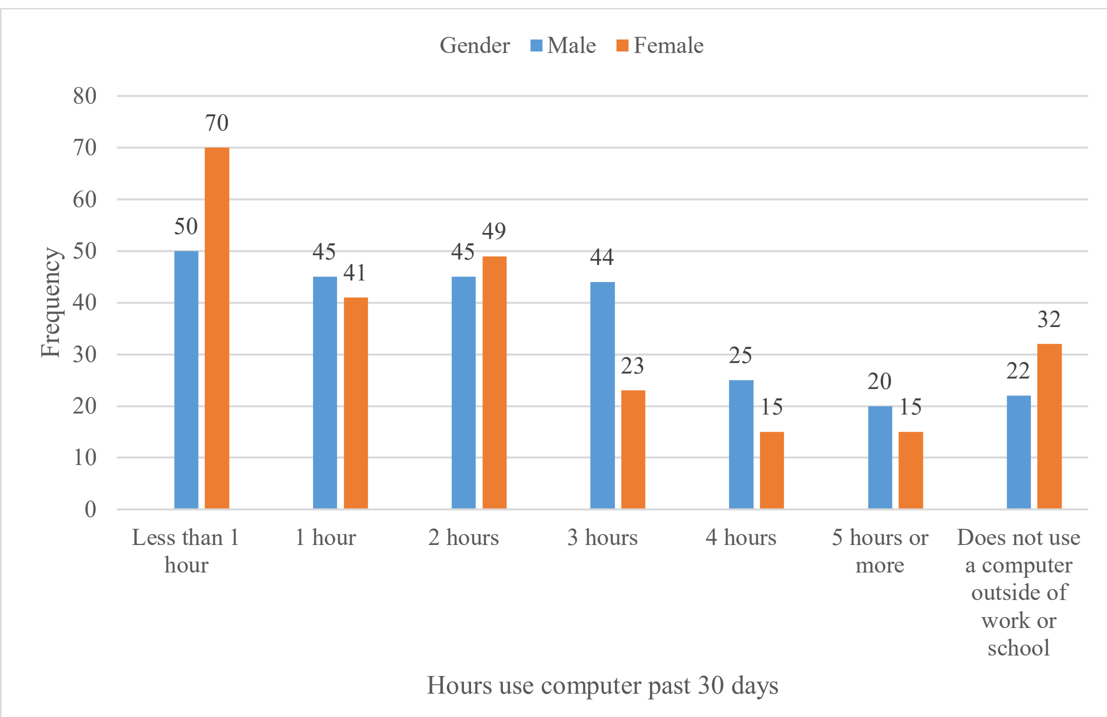

Figure 1. Bar Chart Comparing Hours of Computer Usage over the Past 30 days Sorted by Gender

Table 3. Descriptive Statistics showing Body Mass Index vs. Hours Spent Using a Computer Outside of Work or School

	n	Mean	SD
Less than 1 hour	119	22.8790	5.85611
1 hour	84	22.8750	5.88997
2 hours	91	22.5978	4.87344
3 hours	67	22.8597	5.76521
4 hours	40	23.1550	4.21937
5 hours or more	34	21.9206	4.68820
Does not use a computer outside of work or school	50	22.9040	5.77433
Total	485	22.7810	5.44462

Abbreviation: SD, Standard Deviation

Table 4. Descriptive Statistics showing Estimated Maximal O2 Uptake vs. Hours Spent Using a Computer Outside of Work or School

	n	Mean	SD
Less than 1 hour	110	40.9805	8.83923
1 hour	79	41.6161	9.04047
2 hours	84	41.5279	10.23560
3 hours	66	41.6762	9.70888
4 hours	40	40.7398	11.20946
5 hours or more	28	41.4732	8.66405
Does not use a computer outside of work or school	43	40.3784	10.77289
Total	450	41.2480	9.62517

Abbreviation: SD, Standard Deviation

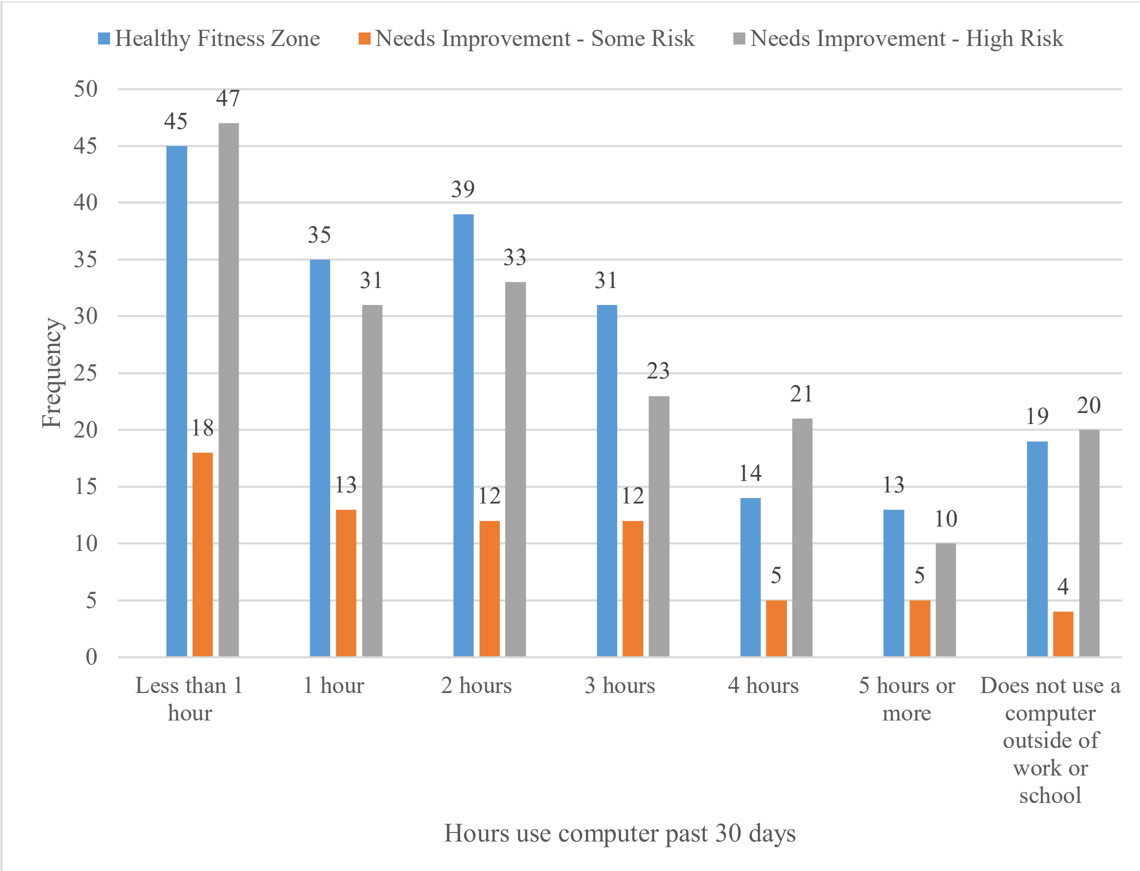

Figure 2. Bar Chart of Hours Spent Using a Computer over the Past 30 Days vs. Cardiovascular Fitness

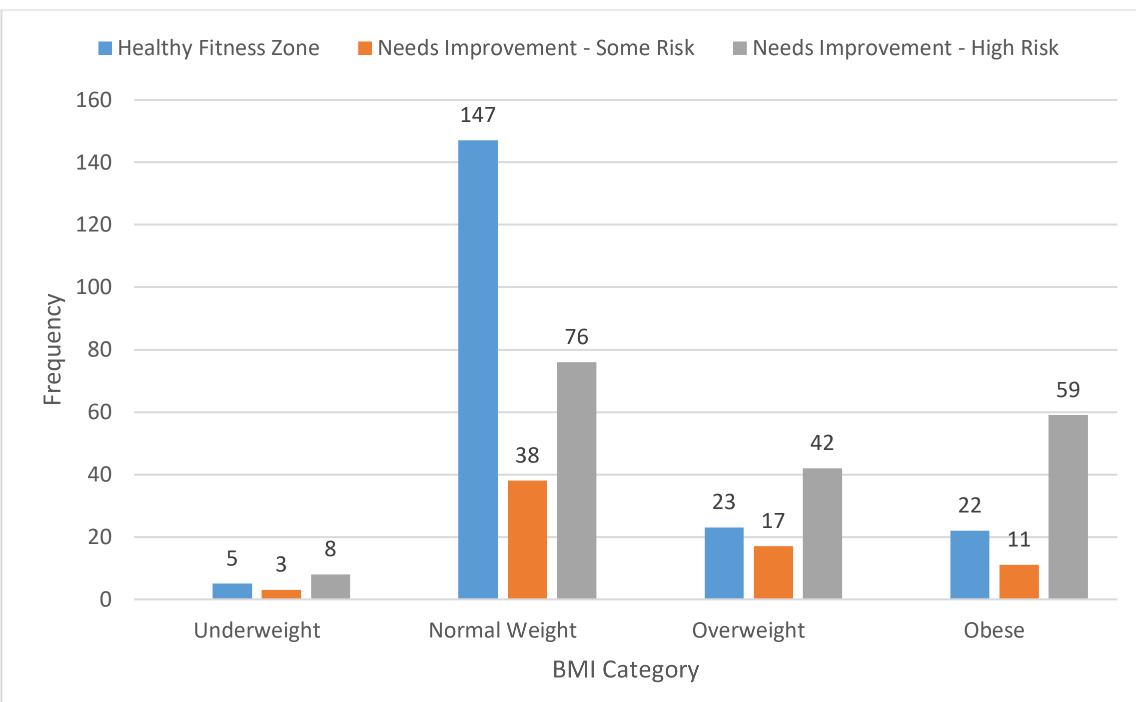

Figure 3. Bar Graph Representation of Table 6. Showing BMI Category and Cardiovascular Fitness

Table 5. Descriptive Statistics between Body Mass Index and Physical Activity Readiness Scores

	n	Mean	SD
Little or no regular exercise and avoids walking or exertion	6	25.8333	5.98153
Little or no regular exercise but walks for pleasure and occasionally exercises	27	24.3296	5.9806
Modest exercise (10-60 mins per week)	90	24.2578	5.16849
Modest exercise (> 60 mins per week)	102	23.0392	6.18264
Heavy Physical activity (< 30 mins per week)	7	21.3429	9.86692
Heavy Physical activity (30 - 60 mins per week)	37	21.8622	6.52578
Heavy Physical activity (1 - 3 hours per week)	68	22.3765	4.22311
Heavy Physical Activity (> 3 hours per week)	126	21.6849	4.48577
Total	463	22.8019	5.44675

Abbreviation: SD, Standard Deviation

References

1. Products - Health E Stats - Prevalence of Overweight and Obesity Among Children and Adolescents Aged 2–19 Years: United States, 1963–1965 Through 2013–2014. Published June 4, 2019. Accessed April 1, 2020. https://www.cdc.gov/nchs/data/hestat/obesity_child_15_16/obesity_child_15_16.htm

2. Childhood Obesity Facts | Overweight & Obesity | CDC. Published June 24, 2019. Accessed April 1, 2020. https://www.cdc.gov/obesity/data/childhood.html

3. Obesity and overweight. Accessed April 1, 2020. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

4. Nutrition, Physical Activity, and Obesity: Data, Trends and Maps | DNPAO | CDC. Published November 6, 2019. Accessed April 1, 2020. https://www.cdc.gov/nccdphp/dnpao/data-trends-maps/index.html

5. Kracht CL, Joseph ED, Staiano AE. Video Games, Obesity, and Children. *Curr Obes Rep*. 2020;9(1):1-14. doi:10.1007/s13679-020-00368-z

6. 2018 Essential Facts About the Computer and Video Game Industry. Entertainment Software Association. Published October 9, 2018. Accessed April 1, 2020. https://www.theesa.com/esa-research/2018-essential-facts-about-the-computer-and-video-game-industry/

7. Chaput J-P, Visby T, Nyby S, et al. Video game playing increases food intake in adolescents: a randomized crossover study. *Am J Clin Nutr*. 2011;93(6):1196-1203. doi:10.3945/ajcn.110.008680

8. Stettler N, Signer TM, Suter PM. Electronic games and environmental factors associated with childhood obesity in Switzerland. *Obes Res*. 2004;12(6):896-903. doi:10.1038/oby.2004.109

9. Marshall SJ, Biddle SJH, Gorely T, Cameron N, Murdey I. Relationships between media use, body fatness and physical activity in children and youth: a meta-analysis. *Int J Obes Relat Metab Disord J Int Assoc Study Obes*. 2004;28(10):1238-1246. doi:10.1038/sj.ijo.0802706

10. Rey-López JP, Vicente-Rodríguez G, Biosca M, Moreno LA. Sedentary behaviour and obesity development in children and adolescents. *Nutr Metab Cardiovasc Dis NMCD*. 2008;18(3):242-251. doi:10.1016/j.numecd.2007.07.008

11. Mitchell JA, Pate RR, Blair SN. Screen-Based Sedentary Behavior and Cardiorespiratory Fitness from Age 11 To 13. *Med Sci Sports Exerc*. 2012;44(7):1302-1309. doi:10.1249/MSS.0b013e318247cd73

12. Hernández-Jiménez C, Sarabia R, Paz-Zulueta M, et al. Impact of Active Video Games on Body Mass Index in Children and Adolescents: Systematic Review and Meta-Analysis Evaluating the Quality of Primary Studies. *Int J Environ Res Public Health*. 2019;16(13). doi:10.3390/ijerph16132424

13. Oliveira CB, Pinto RZ, Saraiva BTC, et al. Effects of active video games on children and adolescents: A systematic review with meta-analysis. *Scand J Med Sci Sports*. 2020;30(1):4-12. doi:10.1111/sms.13539

14. Tripette J, Murakami H, Ryan KR, Ohta Y, Miyachi M. The contribution of Nintendo Wii Fit series in the field of health: a systematic review and meta-analysis. *PeerJ*. 2017;5. doi:10.7717/peerj.3600

15. National Youth Fitness Survey (NYFS)- Treadmill Examination Manual 2012. :152.