



# The Effect of Using Virtual Reality Games on Health and Fitness

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## Abstract

During the coronavirus pandemic, physical activity levels significantly decreased due to quarantine measures. Even after restrictions were lifted, many people remained largely inactive. Nearly two billion people worldwide are overweight, meaning that over 30% of the global population is either obese or overweight. In this study, we proposed a solution for fitness and weight loss at home. Two groups participated in the study, with the first group consisting of 20 people following a traditional fitness program and the second group comprising 20 people using virtual reality. All participants were undergraduate students who took part in the study for four weeks, attending three sessions per week, and none of them had prior experience with virtual reality. The results show that the BMI value has increased from 27.41 to 25.36, as well as the average WtHR from 0.93 to 0.89 in men and from 0.86 to 0.83 in women. WC value from 86.9 to 73.9 in men and from 71.2 to 67.3 in women, which shows the impact of virtual reality games on health. Motivation to continue the study was higher among participants in the virtual reality group compared to those in the traditional group.

*Key word:* Virtual reality, Fitness, Interaction, Exercise

## 1. Introduction

With the industrialization of societies and the growth of technology, people's physical activities have decreased. Decreased activity leads to obesity, which in turn can cause various types of diseases. Cardiovascular diseases are among these illnesses that can be fatal. Fitness is something that young people in big cities pay special attention to, but various factors may prevent them from going to sports clubs. Virtual reality technology is a tool that can eliminate distances and attract the attention of children and young people, indirectly causing them to be active through games. On the other hand, with the advancement of technology, new methods in sports and rehabilitation have replaced traditional methods. The use of virtual reality in various applications such as medical training [1], rehabilitation [2], treatment [3], sports [4], and reduction of various phobias [5] has been able to prove its useful performance.

The body mass index (BMI) is currently introduced as the metric for defining anthropometric

height/weight characteristics and classifying adults into groups. BMI is commonly interpreted as an individual's fatness. However, it should be noted that BMI is a poor indicator of body fat percentage. BMI performs weakly in recording information about fat density in various physical sites [6]. Waist circumference (WC) is an indicator of intra-abdominal fat tissue, with high levels indicating an increased risk of cardiometabolic disease. Population data on WC should be more instructive than data on BMI, which is considered a general indicator of body size. One study evaluated the significance of WC relative to BMI in cross-sectional relationships with blood pressure, glucose, and total cholesterol in the adult population of Vietnam [7].

The waist-to-height ratio (WtHR) has been considered an effective and practical measure of central obesity in children. Recent studies suggest that a WtHR higher than 0.5 could be a significant metabolic risk indicator for children and adults [8]. It has also been noted that the WtHR (waist circumference divided by height, both measured in centimeters) is a practical and convenient

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measurement of central obesity that could be superior to BMI in determining cardiometabolic risk [4]. One study examined the use of WtHR in the properties of cardiometabolic risk in children already classified by BMI. The WtHR determined the cardiometabolic risk assessment of overweight and obese children. A significant proportion of obese subjects with a high WtHR had abnormal cardiometabolic risk factors and met the criteria for metabolic syndrome. Overweight and obese children with a low WtHR appeared to have a cardiometabolic risk that approached that of children with normal BMI [9].

A Multi-User Virtual Reality (MUVR) system was applied for therapeutic use for participants at high risk of developing eating disorders. The study demonstrated the positive effect of using MUVR remote psychotherapy to improve traditional therapeutic exercises. Overall System Usability Scores for participants (78.93%) and therapists (84.96%) showed high rates of system usability, with an average score of 81.5% [10]. Another study investigated the numerous effects of online high-intensity interval training in abdominally obese women experiencing health problems due to COVID-19. Significant changes in body fat mass, BMI, and reduced abdominal subcutaneous fat thickness were observed. HIIT technology using a smart device was helpful for improving abdominal obesity and increasing muscle strength, leading to reduced stress in sedentary women during the COVID-19 era [11].

Virtual reality (VR) as a modern technology has the potential to expand opportunities within behavioral treatment to exercise desired weight control behaviors at the frequency and magnitude necessary to create lasting habits. Some participants with overweight or obesity were randomly assigned to a Standard Behavioral Weight Loss Plus Non-Weight-Related VR app. VR has the capacity to enhance standard behavioral weight loss treatment, as it could be useful by offering more common conditions for patients to practice behavioral modification skills [12].

### **3. Materials and Methods**

#### **2.1 Participants**

In this study, two groups participated, and the number of people was selected using G\*power software with a power of 0.95 and an alpha value of 0.05. The output was 17. To account for unpredicted events during the experiment, 20 people were selected for each group. The first group consisted of 12 men and 8 women with an average age of 21.8 years and an average BMI of 27.9. They played table tennis in a traditional way under the guidance of a coach. The second group included 13 men and 7 women with an average age of 22.1 years and an average BMI of 27.8, who underwent training and exercise through VR.

#### **2.2 Experimental Group**

To play the game, the first group engaged in table tennis with a sports coach for four weeks, three times a week, and 30 minutes per session. After each session, Cooper's test was administered to participants. The second group was also evaluated during the same period. For this purpose, the game "Eleven" was used. Examples of game scenes are shown in Figure 1. The second group was examined at the same time as the first group. The table tennis game features different environments that create variety for the player, and the game environment changes every session. The height of the game table can be adjusted according to each player's height, but during the test, the international standard table height was taken into account. The player can choose their racket according to whether they are right-handed or left-handed. On the opposite side, there is an avatar with artificial intelligence, which is shown in Figure 1. The Oculus 2 registration tool is a game with two joysticks, one held with the racket handle and the other used to hit the ball up to serve. An example of equipment placement is shown in Figure 2.



Fig.1. Table tennis game environment in VR



Fig.2. Oculus2 (Head Mounted Display and Joystick)

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## 2.3. Evaluation Criteria

### 2.3.1. BMI

Height and weight are two important factors to determine the ideal weight for each person. BMI is a person's weight in kilograms divided by the square of their height in meters [13]. This index is an inexpensive and easy screening method. BMI can be a screening tool, but it does not determine a person's body fat percentage or health. In order to more accurately measure the percentage of fat and other factors that indicate obesity, factors such as measuring skin thickness, diet, physical activity, and family history should also be evaluated. After calculating BMI, it is time to interpret it, which is as follows:

- \*Below 18.5 indicates underweight
- \*Between 18.5 and 24.9 represents the normal range or normal weight
- \*Between 25 and 29.9 is overweight
- \*30 and above indicates obesity

BMI of children and adolescents aged 2 to 20 is determined using a BMI table that compares their weight and height along with growth charts. Growth charts use the child's BMI, age, and gender to generate a BMI percentile. A child or teenager who is between the 85th and 95th percentile on the growth chart is overweight, and a child or teenager who is in the 95th percentile and above is considered obese.

### 2.3.2 WC Index

The WC measurement index helps you to be aware of some weight-related health conditions[14]. Waist measurement alone cannot indicate your health status, but it can help you to know your body fat. If the amount of accumulated fat in the waist is more than the amount in the hips, the possibility of diseases such as heart diseases and type 2 diabetes increases. Use a non-elastic tape to measure your waist. Determine the upper limit of the pelvic bone in the area of the sides and measure exactly above this limit (almost level with the navel). The meter should be completely attached to the surface of the skin, but you should not press the two ends together because it will cause you to get a smaller than the actual measurement. Perform the measurement several times to make sure you get the correct amount. The value of WC is declared in Table 1.

Table 1 :  
the value of WC

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Normal value	Women—>64 to 80 cm Men——> 78 to 94 cm
Overweight	Women——>80 to 88 cm Men——>94 to 102 cm
obesity	Women——>above 88 cm Men——> above 102 cm

### 2.3.3 WtHR

WtHR is considered a valid index to check people's health level. It is one of the criteria that doctors can use to diagnose excess weight[15]. It is a very easy and inexpensive method that can predict the risk of heart diseases and diabetes. To implement this method, use a tape measure that does not have elasticity. Measure your waist circumference and measure the widest part of your hips to calculate your hip circumference. To measure, be in a standing position and put your feet together. Perform this measurement several times to make sure that the obtained numbers are correct. According to the World Health Organization, the normal range of the WHR index is as follows:

0.9 or less in men  
0.85 or less in women

In both men and women, a waist-to-hip ratio greater than 1 increases the risk of heart disease and other diseases associated with being overweight. Also,

keep in mind that women with a waist-to-hip ratio greater than 0.8 are at risk of infertility.

### 2.3.4 Cooper's Test

The maximum amount of oxygen consumed is one of the most important influencing factors in endurance sports. There are different methods to evaluate this factor, the most famous of which is Cooper's test. The Cooper test is a physical fitness test used to estimate a person's aerobic fitness [16]. This test was designed by Kenneth H. Cooper in 1968 for the United States Army and has since been used by various coaches in various sports. An athlete's maximal oxygen consumption is a key factor in athletic performance and cardiorespiratory endurance. The ability to continuously supply the muscles with adequate levels of oxygen is sometimes referred to as aerobic capacity. Measuring the endurance fitness of athletes here allows for an accurate measurement of this component by forcing the participant to push their body to its limits. Cooper's 12-minute walk/run test is a popular maximal test of aerobic fitness in which participants attempt to cover as much distance as they can in 12 minutes.

## 3.Results

WC, BMI, and weight criteria in this study were extracted for each participant during 12 sessions, and the information was manually transferred to MATLAB 2018B software for analysis. After the tests, the average results of the participants during 12 training sessions are reported in Figures 3 and 4. The results show that the evaluated criteria of BMI, WC, and weight have improved. No participant in this study was obese, and the participants were in the overweight category. The average BMI of people at the beginning of the study was 27.41, which, after being exposed to the VR game, reached 25.36. Due to the ease of use of VR, every participant was able to do their own exercise and record the results. The average values of WtHR at the beginning of the test were 0.93 for male participants and 0.86 for female participants. It reached 0.89 and 0.83 for women. Also, the value of WC at the beginning of the test was 86.9 for men and 71.2 for women, which has decreased to 73.9 and 67.3. As mentioned before, the results show that the improvement of high levels causes the reduction of diabetes and heart disease. The accuracy of the numbers reported in this study was 0.1.

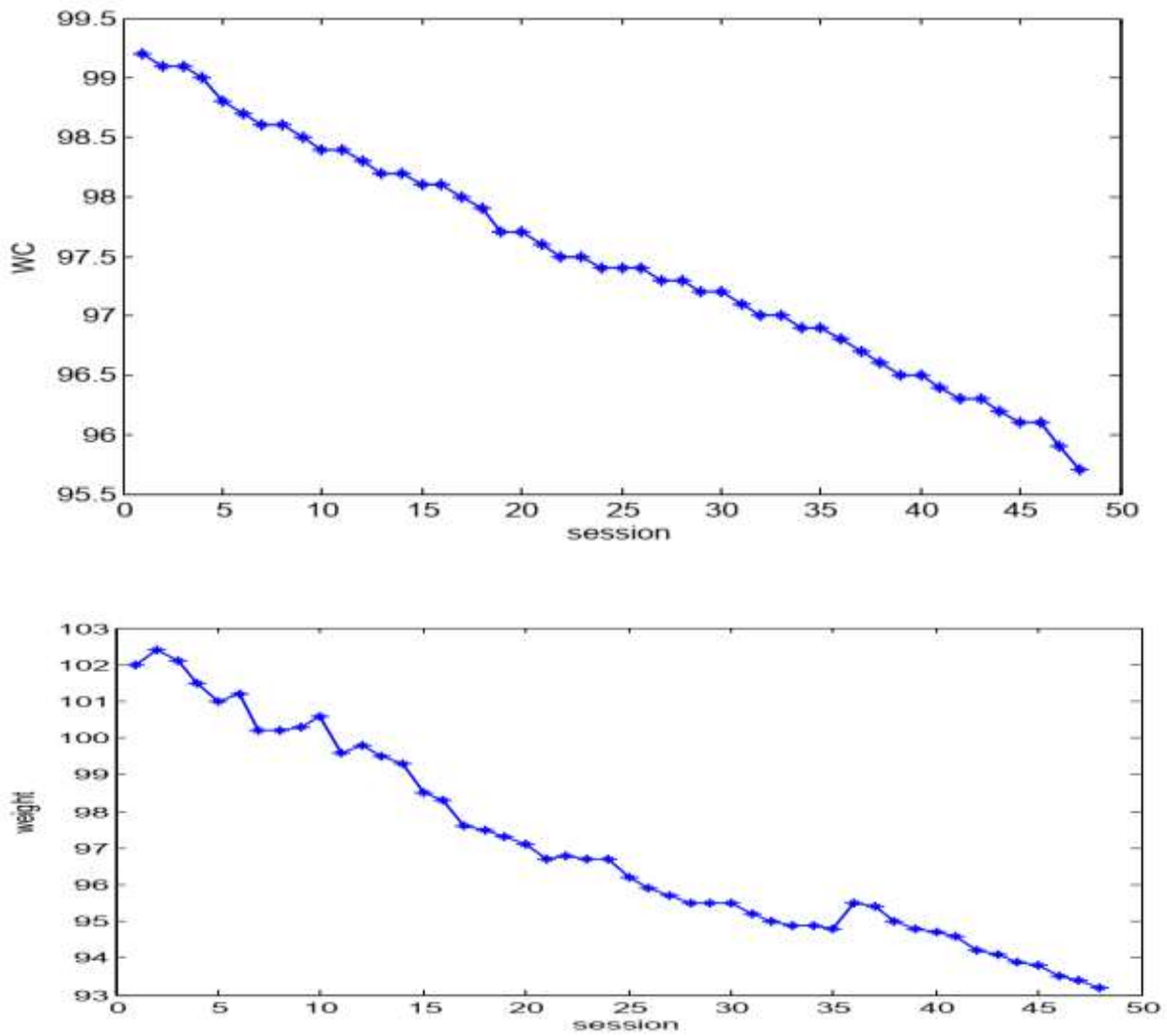


Fig 3 : above(Waist Circumference Index result ), below weight)

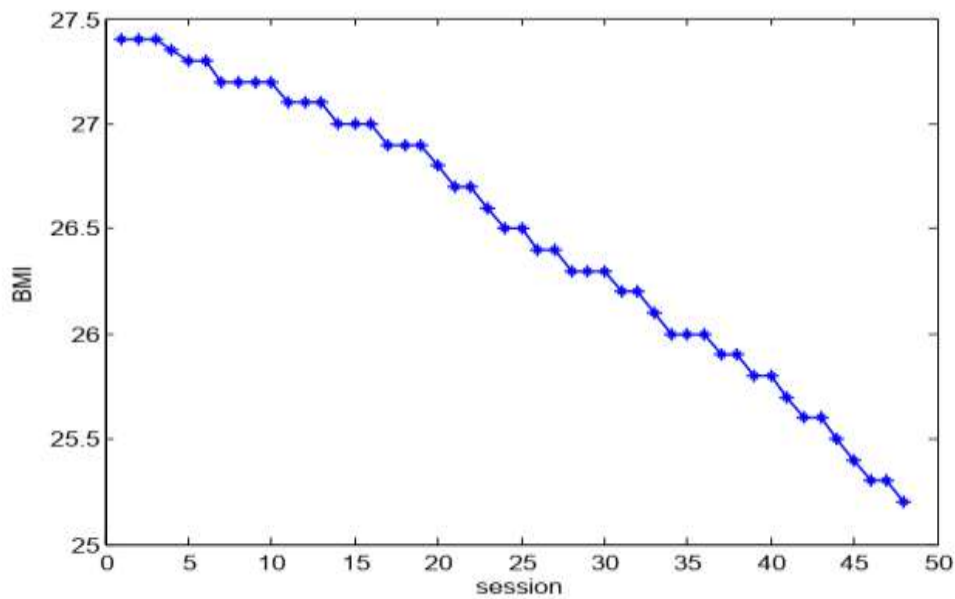


Fig.4 .body mass index result

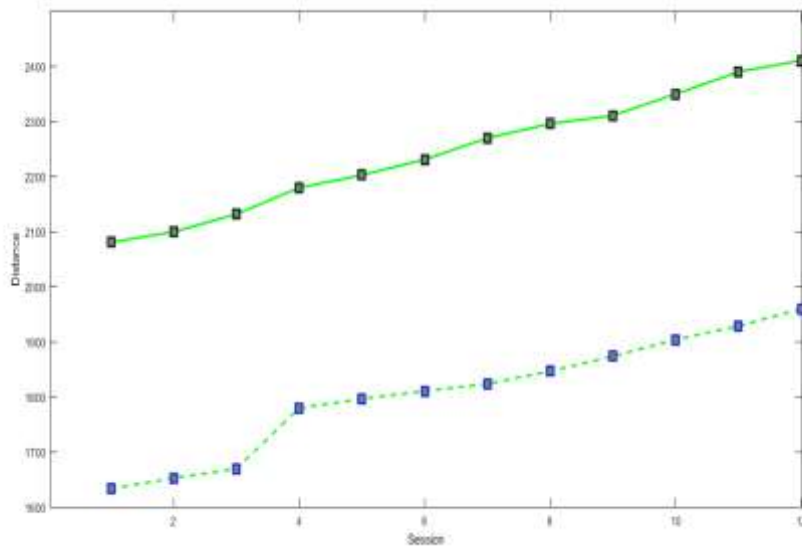


Fig.5. up figure related to man and down figure related to women(Distance-session)

#### 4. Conclusion

In the last 5 years, the spread of the coronavirus disease worldwide has caused serious problems, especially overweight issues due to insufficient movement. The use of technology in daily work has grown tremendously, and the development of tools that meet people's needs remotely has increased. In this article, we have examined the potential of VR in sports and fitness. VR is a useful tool for exercising

and rehabilitation at home. In the future, using the Metaverse, which is launched under VR, group activities and educational work can be implemented remotely under the supervision of an expert trainer. In this article, two groups were investigated: one group played table tennis in the traditional way, and the second group played table tennis in their own home using VR. The values of four parameters—WC, BMI, weight, and Cooper's test—were recorded in each session. With repeated follow-up in each session, the average value of WC for people using

VR decreased from 99.24 to 95.71 at the end of the test sessions, which, when compared to the first group and the t-test, showed no significant difference. The average BMI of the group using VR decreased from 27.41 to 25.36. In comparison with the first group and the t-test, no significant difference was observed. Also, the average distances covered in the Cooper test for women increased from an average of 1623 meters to 1959, and for men, it increased from 2080 to 2410, which, compared to the first group and the t-test, showed a significant difference. In general, the second group exhibited more motivation to continue due to the variety and novelty of VR scenes. Additionally, with the use of VR, people could perform the test more easily and at their own home, which reduces commuting, transportation costs, risks outside the home, and air pollution. It is recommended to use VR applications for fitness.

#### Limitations.

In this study, we recorded the comments of participants and experimenters after each session. The participants stated that the heaviness of the headset sometimes bothered them and then caused pain in their necks. On the other hand, before each session of the experiment, the experimenters called them and informed them of the start time of the training sessions, which some participants did not attend regularly due to their daily busyness, and they were asked to adhere to the exercises. It is necessary to have a headset and two joysticks for this test, which costs 399 dollars and 19.9 dollars to purchase the game. Also, a proper diet and avoiding high-calorie foods such as fast food is very effective in the testing and fitness process for individuals and should be controlled. After the tests, ten natural fruit juice coupons were given to the participants.

Conflict of Interest:  
"The authors have no conflict of interest to report."

Reference:

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