



The virtual reality aerobic exercise on the anthropometric and psychological indices of overweight female students

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| Article Info | Abstract |
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| <p>Original Article</p> <p>Article history:</p> <p>Received: 18 August 2021</p> <p>Revised: 28 August 2021</p> <p>Accepted: 10 September 2021</p> <p>Published online: 11 November 2021</p> <p>Keywords: anthropometric index, psychological index, virtual reality.</p> | <p>Background: Virtual reality (VR) as a digital technology may affect the physical and mental performance of students.</p> <p>Aim: The aim of the present study is to examine the effects of VR aerobic exercise on the physiological and psychological indicators of overweight female students.</p> <p>Materials and Methods: In the present study, a number of 30 overweight (body mass index (BMI) of 27 ± 2) female students (aged 10-13 years), have been classified into three groups of aerobic exercise with VR glasses, aerobic exercise without VR glasses and control. The workout groups performed 8 weeks of aerobic exercise with and without VR glasses at home, during which time the control group did not exercise. Prior to and after the course, the students participated in pre-and post-test, which included body composition tests, waist to hip circumference to measure the anthropometric indices, and Harvard step test to measure aerobic capacity. The sport motivation and physical activity enjoyment scale were employed in order to measure the psychological indices.</p> <p>Results: The present results have indicated that eight weeks of aerobic exercising with and without VR glasses significantly reduces BMI ($P= 0.0001$ and $P= 0.005$, respectively) and Heart Rate Recovery (step test) ($P= 0.0001$ and $P= 0.003$, respectively). However, the indices of enjoyment of sports activity ($P= 0.0001$ and $P= 0.004$, respectively) and sports motivation ($P= 0.0001$ and $P= 0.001$, respectively) were found to meet a sharp increase in both exercise groups.</p> <p>Conclusion: The present achievements showed that both exercise methods lead to reduced anthropometric and improved psychological indices.</p> |

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1. Introduction

Diseases in the industrial world today are moving towards those rooted in inactivity [1]. The physical inactivity in the international community and also in Iran can be attributed to a change in lifestyle, including turning to motionless activities such as watching TV and playing computer games [2]. Due to the studying conditions and sitting behind the desk for a long time, students are considered to be sedentary people of the society; this lack of mobility and low physical activity is introduced as an overweight-related factor [3, 4]. Since overweight children are at risk for a variety of non-communicable diseases and are overweight in adulthood, paying attention to weight loss strategies in primary school students is of high importance [5].

Childhood inactivity and overweight are serious public health challenges. More than 42 million children under the age of 5 in the world are overweight, and according to the current trends, this number is expected to reach about 70 million by 2025. The physical and mental health of overweight children is often at risk. In the short term, these effects can be associated with poor self-esteem, negative body image, and reduced self-confidence [5]. On the other hand, the social conditions for girls' physical activity and the belief in the need for their sports activities in our society are less than those of the boys [6]. Research has reported this inactivity to be higher among the girls than the boys [7].

In the recent epidemic, staying at home has been considered a key safety step preventing the spread of the disease. On the other hand, staying at home for long time periods may lead to an increasingly sedentary lifestyle, such as spending too much time sitting or lying down for activities such as watching TV and using

mobile devices [2]. There are indications that interventions to control the Covid-19 epidemic are exacerbating the worldwide crisis of overweight and obesity in children. Limited use of public and game spaces provides fewer opportunities for the physical activity of children than before the epidemic. School closures have also complicated the situation. Studies have shown that children gain more weight during the holidays when they are out of school. This weight gain might be due to the loss of positive effect of the school attendance on key risk factors such as eating time, physical activity, and poor sleep schedule. Compared to pre-epidemic conditions, children are now more dependent on family members for making dietary decisions. Therefore, a decrease in regular physical activity, followed by an energy consumption reduction, leads to an increased risk of health-related conditions such as overweight, obesity and decreased aerobic capacity [8]. Maintaining regular physical activity and daily exercise in a safe home environment is an important strategy for a healthy life during the coronavirus crisis [5].

On the other hand, living in small apartments has limited the possibility of exercising in an appropriate space. Being absent from gyms and public spaces for exercising discourages children who tend to enjoy sensory experiences during physical activities, including visual, auditory, tactile, and olfactory stimuli. Hence, one should think of measures in order to take advantage of this limited space [5].

As an artificial medium through sensory stimuli (such as scenes and sounds) provided by a computer, VR provides the ability to recreate real and fantasy environments and many experiences [9]. In this technology, the three factors of

interaction, imagination, and immersion are effective in simulating the environment for human perception. Among these factors, interaction refers to the two-way relationship between human beings and the virtual world. Interaction has been also focused on optimizing user control. The interaction-based VR system responds to the user's input data quickly and accurately and allows users to communicate with the computer in a two-way manner. Based on this interaction, the students' cognitive learning can be improved. The perception factor also indicates how much the users feel like they are really present in a virtual environment, even though they are physically in another one. Immersion as one of the important factors in the use of VR technology demonstrates the experience level of user presence as "being in that place" or "losing yourself" (drowning) in the virtual environment and disconnecting from the elements of the physical world [10].

VR can be employed in a variety of contexts because it makes it easier to perceive problems and provides a platform for modeling things. This technology brings novel and unknown scenarios by entering many fields, such as education, military training, sports and medicine. However, this is just the beginning, and researchers believe that VR has great potential to provide positive results in these areas. Analysts in the field of educational innovation have been constantly looking for better educational media to help with education; VR is one of them. VR presents abstract concepts to students in a three-dimensional environment which leads to better understanding and learning. In addition, it seems to be a promising and motivating tool for advancing learning outcomes [11].

VR can be helpful for overweight

people. One of the reasons that overweight children stop exercising is that their attitudes toward exercise become negative due to their perception of the body's unpleasant feelings. Thus, pleasure and attention seem to be important factors in practice, because they both work together as a mind-boggling process, which can also help eliminate motions that create a lack of motivation to exercise. VR is effective in improving exercise performance in sedentary people and can help change focus and attention and improve students' distraction. VR increases enjoyment during exercise and children prefer to use virtual environments while doing exercise [12].

Davoodeh et al. (2020) examined the effect of VR games on the mental health of girls with normal BMI and above 30. They concluded that the VR games affect the mental health of girls with a BMI above 30, but they have no effect on that of girls with a normal index [13].

Roshanpour and Nikroo (2020) investigated the effects of VR and games on improving physical activity in school. They arrived at the fact that VR technology and gaming in sports activity environments have a positive effect on the motivation of elementary students. VR and gaming with increasing motivation lead students to achieve higher levels of engagement in sports activities [14].

Qian et al. (2020) found that VR sports activity has a positive effect on the physiological, psychological, and rehabilitation parameters compared to traditional sports activity [15].

Considering the high level of concern about students' inactivity in recent years due to conditions, the need to provide appropriate strategies for doing exercise at home is highly felt. The need to improve the quality of life through exercise, which is

related to prevention and improvement, has increased. Technologies appear to be used to help with overweight care as well as to monitor exercising. The present case study, conducted during the epidemic period, aims to assess whether aerobic VR sports activity can affect the anthropometric indices which included body composition, waist to hip circumference, aerobic capacity, and psychological factors (sport motivation and physical activity enjoyment scale) in female students.

2. Materials and Methods

The current research was a cross-sectional study. It is an applied and pseudo-experimental study in terms of purpose and nature, with pre and post-test, conducted with the aim of examining the VR aerobic exercise on the anthropometric and psychological indices of the overweight female students. The research was carried out during the time frame of Jun 23, 2021, to August 24, 2021, in Tehran, Iran. The statistical population of the study consisted of 30 overweight primary school girls in District 9 of Tehran province within the age group of 10-13 years.

The inclusion criteria were as follows: Girls are in the second grade of elementary school (aged 10-13 years) and overweight, their mobile device has a gyroscope sensor, do not participate in a regular exercise program, do not have a specific disease (physical and mental), do not have any specific diet, are ready to participate in sports activities and have parental consent to participate in research.

The students were selected after completing the consent form by parents and medical health questionnaire, and randomly categorized into three groups aerobic exercise with VR glasses, aerobic exercise without VR glasses, and control.

The data were collected in two stages

pre-and post-test. In both pre-and post-test stages, 48 hours prior to and after the implementation of training protocols, all the examinees were measured for height, weight, BMI, waist to hip ratio, and step test to monitor cardiorespiratory endurance. Also, the questionnaires of sports motivation and enjoyment of physical activity were completed by the examinees. The sport motivation scale-6 questionnaire has six subscales (apathy, internal motivation, external adjustors, mixed adjustment, self-adjustment, built-in adjustment) and 24 seven-Likert items. The reliability of the questionnaire is estimated using Cronbach's alpha. Coefficient alpha ranges from 0 (unreliability), to +1 (complete reliability), and the closer the value obtained to +1, the greater the reliability of the questionnaire. Cronbach's alpha for the sport motivation questionnaire is equal to 0.85. The results of the Pearson correlation showed that there is a significant correlation between all subscales. In fact, the correlations between subscales of apathy, external adjustors, built-in adjustment, self-adjustment, mixed adjustment, and internal motivation were estimated as 0.83, 0.84, 0.85, 0.89, 0.89, and 0.91, respectively. According to these results, the present questionnaire meets a good validity and reliability [16].

The physical activity enjoyment scale (PACES) in children meets a good fit of the Persian version of the physical activity enjoyment scale model. The Ramsey, CFI, and NNFI fitness indices were obtained as 0.05, 0.92, and 0.9, respectively. Also, Cronbach's alpha coefficient with an estimated amount of 0.83 and intra-class correlation coefficient of 0.80 indicated acceptable values. The findings also support the single-factor and 16-point structure of the main scale. Therefore, the

Persian version of the physical activity pleasure scale meets structural validity and acceptable internal and temporal reliability among children aged 10-13 years and can be used as a valid and reliable tool to assess the physical activity pleasure of Iranian children [17].

Both exercise groups engaged in aerobic exercising at home for eight weeks and three sessions per week. The exercise consisted of 15-30 minutes of aerobic activity with and without VR glasses. In order to determine the intensity of activity, the tempo change (multiplication per minute), which is directly related to the Heart Rate, was used. The intensity of activity varied from 85 to 200 tempo. The activity duration was increased by two minutes per week and its intensity was increased to the amount of 5 tempos per session [18].

The exercise group with VR glasses did the same activity while wearing the glasses. They installed the corresponding application on their mobile phones having a built-in gyroscope sensor and placed them inside the device, and at the same time as performing the desired activity, they put VR glasses on their eyes and entered the VR space. The students in the VR exercise group practiced in the VR Cliffy Farm Run environment and walked at the same time as the tempo sound. Cliffy Farm Run VR is a VR game set in an alternating dimension. It is an endless running program, in which the goal is to collect more coins, while the obstacles that appear in front of the player must be avoided. In the alternating dimension of the game, gravity acts in a very different way and the person will be able to run completely upside down and horizontally to avoid hitting obstacles, during which time the control group continued to live without changing

conditions. Finally, the students in both exercise groups reported their activity by submitting their workout videos. The present statistical method used to analyze the data and test the research hypotheses was MANOVA. In order to study the intra-group changes of research variables in the pre-and post-test stages, the paired sample t-test was employed.

3. Results

The present results have indicated that eight weeks of aerobic exercising with and without VR glasses significantly reduces BMI ($P= 0.0001$ and $P= 0.005$, respectively) and Heart Rate Recovery (step test) ($P= 0.0001$ and $P= 0.003$, respectively). The waist to hip ratio of the groups in the post-test did not significantly change compared to the pre-test ($P= 0.367$ and $P= 0.210$, respectively). Furthermore, the enjoyment scale of sports activity ($P= 0.0001$ and $P= 0.004$, respectively) and sports motivation ($P= 0.0001$ and $P= 0.001$, respectively) underwent a significant increase in both exercise groups (Table 1).

4. Discussion

The idea of VR and exercise has been less investigated in the literature. However, the results so far are promising and positively predict the future of technology. It seems that the use of VR headsets improves physical and mental health. The use of such VR systems might improve the way many daily tasks are performed by humans and, if performed correctly, can have positive effects on health [19]. The experiment described in this article has indicated that using the VR system during exercise has a positive effect on the body composition and Heart Rate Recovery (step test). These findings are consistent with those reported in the study of McClure and Schofield (2020) [19].

Table 1. The paired Sample t-test results for the in-group comparison of variables in pre-and post-test stages

| Variables | Groups | Training process | | T | Sig. |
|---------------------------------------|---------------------|------------------|---------------|---------|--------|
| | | Pre-test | Post-test | | |
| BMI | Control | 25.157±0.579 | 25.871±1.009 | -0.376 | 0.697 |
| | VR aerobic exercise | 27.560±2.936 | 25.143±2.225 | 9.826 | 0.000* |
| | Aerobic exercise | 26.380±2.212 | 24.940±2.347 | 6.2999 | 0.005* |
| WHR | Control | 0.874±0.020 | 0.874±0.023 | -0.068 | 0.528 |
| | VR aerobic exercise | 0.843±0.034 | 0.832±0.109 | 1.387 | 0.367 |
| | Aerobic exercise | 0.870±0.122 | 0.884±0.131 | -1.016 | 0.210 |
| HRR (Step Test) | Control | 131.90±14.994 | 132.30±14.893 | 0.376 | 0.384 |
| | VR aerobic exercise | 125.80±15.143 | 121.40±16.673 | -16.845 | 0.000* |
| | Aerobic exercise | 126.80±16.697 | 124.20±18.727 | -7.730 | 0.003* |
| Physical Activity Enjoyment Scale | Control | 54.14±2.911 | 53.71±1.604 | 0.742 | 0.278 |
| | VR aerobic exercise | 51.00±2.739 | 57.60±2.702 | -13.93 | 0.000* |
| | Aerobic exercise | 51.40±1.817 | 56.80±3.271 | -12.287 | 0.001* |
| Physical Activity Motivation Scale | Control | 94.0±14.364 | 91.5±12.765 | 0.276 | 0.569 |
| | VR aerobic exercise | 84.4±26.463 | 109.2±16.362 | -35.276 | 0.000* |
| | Aerobic exercise | 75.0±19.853 | 97.2±23.690 | -18.754 | 0.001* |

* Significance ($P \leq 0.05$)

According to the data collected in this research, it can be concluded that working while using a VR headset leads to a higher Heart Rate, which consequently yield higher calories burning during exercise. The current study also showed that participants who used a VR headset could keep themselves farther from physical emotions and this allows them to practice longer. Here, the limitation reported by the researchers was that given the longer time it took to conduct the study, health levels could be compared over a period of time with or without the use of a VR headset. This could be a more accurate determination of whether a VR headset can be helpful or not during the workout [19].

On the other hand, eight weeks of aerobic workout with and without VR glasses significantly has been found to reduce the BMI and Heart Rate Recovery (step test). These indices did not change under the influence of VR compared to exercising without VR glasses, being consistent with the results obtained by Banos et al. (2016). They examined the

impact of VR sports activity on body composition and Heart Rate of overweight children aged 10-15 years and found no difference between workout groups with and without VR glasses [12].

In a study conducted by Guixeres et al. (2013) on the effect of VR on body composition and Heart Rate in 9-13-year-old children, similar results have been achieved and no significant difference was observed between the exercise groups. The use of VR glasses during sports activities seems to prevent the proper performance of workouts and reduce its positive effects, due to impacts on balance during usage [20].

The waist to hip ratio index did not significantly decrease in both exercise groups, which can be attributed to the short duration of sports activity in this study. van Biljon et al. (2018) arrived at the fact that long-term exercise interventions affect the waist to hip ratio index in children more than short-term ones [21].

Da Silva et al. (2017) examined the effect of performing six months of VR

exercise on the waist to hip ratio. Their achievements showed the positive effects of exercise with VR glasses on the body composition and waist to hip ratio. The sports activity in this study was performed with 65 to 70 Reserve Heart Rate [22], being equivalent to 120 to 140 tempos [23] which were less than the intensity of the present study. However, the workout duration in the study was longer than the present one. Hence, the discrepancy between the results can probably be attributed to the longer duration of aerobic exercise and its greater impact on the body composition and waist to hip ratio.

In another study, Barsasella et al. (2021) investigated the effects of VR sessions on functional fitness, including waist to hip ratio, in which the group received experimental VR sessions intervention for 15 minutes twice a week for a total period of six weeks. In line with the present findings, the results of this study did not show a significant effect on the waist to hip ratio in the case of a short workout duration [24].

Different results have been observed in various studies on the effects of sports activities with VR glasses on the psychological indices. In the present study, the two scales of enjoyment of sports activity and sports motivation in both training groups have been found to increase significantly ($P \geq 0.05$). The results reported by Ulas et al. (2020) [25] and Li (2021) [26] were inconsistent with the present achievements.

Ulas et al. (2020) examined the biological and motivational effects of aerobic exercise with VR glasses and traditional exercise methods and concluded that practice with VR glasses have greater motivational effects than the latter ones [25].

Li (2021) conducted a study on the effect of using VR equipment on people's motivation to practice and indicated that people who use these facilities have a higher motivation to do sports and dedicate more time to the workout [26].

VR games can engage users in sports activities with high levels of pleasure. Understanding the motivation of users while being engaged in and enjoy the VR exercising platforms is different. The VR exercising platforms can be in two forms of user interface (UI) and world-open environment. Among the participants, more pleasure was reported in the case of world-open environment compared to a static UI. Moreover, pleasure in both static and world-open environments is positively correlated with psychological needs and user experience. It seems that the discrepancy between the results of studies dealing with the effect of sports activities with VR glasses on the motivation and enjoyment depends on the incentive of users to participate in VR sports activities and enjoy different platforms of VR exercising [27].

Concerning the influence of sports activities with VR glasses on the participants' pleasure, the results are different. In another study by Farrow et al. (2019), which was consistent with the present investigation, the researcher showed that the VR game is not considered as an effective intervention to increase pleasure during a period of intense periodic exercise and, like the present results, no difference was observed between the effects of exercising with and without VR glasses on this psychological factor. It seems that this discrepancy between the results can be attributed to the volume and type of sports activities and that the use of VR glasses in exercises with higher intensity and volume

and periodic activities that are not uniform, negatively affects the enjoyment of workout [28].

Due to the current situation in the world and pandemic-related restrictions imposed, performing sports in public and school spaces poses problems for the students. Practicing in the safe home space seems to be an appropriate way to compensate for the sedentary. However, it is only possible to perform certain activities in the limited space of homes that can be boring for the students. Therefore, if the sports activity is in the form of computer games, it can deal with the inactivity and overweight of students and increase their motivation and enjoyment of sports activities. VR is a digital technology that is experienced artificially through sensory stimuli (visual, auditory, etc.) provided by a computer. It is an environment for the expansion of the body and mind, which is able to recreate real environments, fantasies and many sensory experiences, and provides the opportunity to discover many social and psychological phenomena that occur in the real world. To use this technology, the students must have mobile phones with built-in gyroscope sensor, and the homes must have a limited space that make it possible to do certain sports activities. However, many students do not have the space or equipment to do sports activities. Therefore, in future studies, one can use sports activities such as stationary bikes and treadmills in a safe sports environment in order to perform exercise protocols.

5. Conclusion

The present results showed that the VR technology has a positive effect on the BMI, Heart Rate Recovery (step test), and several indices such as enjoyment of sports activity and sports motivation in elementary school

students. Although it seems that these indices are more effective under the influence of sports activities with VR glasses than those without them, no significant difference was observed between VR and traditional sports activities. Therefore, it can be concluded that although VR sports activities have optimal effects on the body and mind of students, the stress caused by VR glasses on the students' faces and the type of sports activities performed by them might reduce these effects.

Conflict of interest

The authors declared no conflicts of interest.

Authors' contributions

All authors contributed to the original idea, study design.

Ethical considerations

The author has completely considered ethical issues, including informed consent, plagiarism, data fabrication, misconduct, and/or falsification, double publication and/or redundancy, submission, etc.

This research was approved under the ethics code UMIN000045787.

Data availability

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

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