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Virtual reality-based tabata training: a professional method for changing levels physical fitness and psychological well-being on student-athletes

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Abstract

Background and Study Aim Physical fitness and psychological well-being of student-athletes had decreased significantly and became the main problem in this study. This study aims to investigate the effect of virtual reality-based Tabata training to increase the level of physical fitness and psychological well-being through a mixed method.

Material and Methods This study used a mixed method. The participants involved in this study were student-athletes (n=40) at Singaperbangsa Karawang University (Indonesia). Quantitative instruments used to measure physical fitness include 20 m shuttle run, 30 m sprint run, horizontal jump and leg dynamometer. While the qualitative instrument used to measure student-athlete perceptions through in-depth interviews for 30 minutes. Quantitative statistical analysis through IBM SPSS was used to find the mean and standard deviation. Independent samples t-test was used to test the difference in values between the experimental and control groups before and after the experiment. Meanwhile, the Paired samples t-test was used to investigate the effect of this training, both in the experimental and control groups. Qualitative statistical analysis was carried out qualitatively thematically, namely the results of in-depth interviews were coded and categorized into three themes.

Results There were several findings in quantitative research. First, there was no difference in physical fitness or psychological well-being between the experimental and control groups before the experiment ($p>0.05$). Second, there were differences in the values of physical fitness and psychological well-being between the experimental and control groups after the experimental program ($p<0.05$). Third, there was a significant effect in the experimental group on the level of physical fitness and psychological well-being ($p<0.05$) and the control group also showed an effect on changes in physical fitness and psychological well-being but smaller than the experimental group ($p<0.05$). In Qualitative research, student-athletes provided positive perceptions about virtual reality-based Tabata training which was easy, efficient and effective, fun and encouraged them to be more active. Negative perceptions were not all student-athletes and universities were equipped with virtual reality facilities. It must carried out in a location or place that was completely safe or far from vehicles.

Conclusions Our mixed study confirms that virtual reality-based Tabata training had positive effect to change the level of physical fitness and psychological well-being among student-athletes.

Keywords: virtual reality, tabata training, physical fitness, psychological well-being, mixed method

Introduction

Entering 2023, all types of professional sports had been competed normally at national and international levels [1, 2], many students-athletes came back active in sports [3, 4, 5] and improved their performance which had decreased during the COVID-19 pandemic crisis. Student-athletes who were involved in swimming was one of the many aspects that affected by COVID-19 [6], so the data recorded that the performance of student-athletes related to physical fitness [7] had decreased significantly. Data showed that the level of physical fitness of people in several countries including Indonesia had decreased and the causative factor was the lack of physical activity and sports during the COVID-19 pandemic crisis [8, 9, 10]. In addition, another factor that were negatively impacted in student-athletes was psychological well-being [11].

Physical fitness included as a crucial and supportive aspect for student-athletes to achieve success in all types of sports [12, 13, 14). According to Gani et al. [6] in swimming a student-athlete was required to have good physical fitness, for

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example with good physical fitness, they can swim in high speed and was not easily felt tired when exercising. A recent study reported that physical fitness was a determining factor in the good or bad performance of student-athletes [15, 16, 17]. In addition, excellent physical fitness has the potential to improve the technique and tactics of student athletes [18]. Whereas if physical fitness was low, student-athletes would experience injuries [19] and difficult to achieve the best performance [20].

Psychological well-being was the second aspect that should be improved after the COVID-19 pandemic crisis [21]. Psychological well-being has a concept as a condition of psychological well-being which was characterized with a feeling of happiness [22], satisfaction and life goals [23] and without the risk of mental disorders [24, 25]. According to Jovanovic, Smrdu, Holnthaner & Kajtna [26], low psychological well-being could trigger anger, depression, anxiety and stress, resulting in poor performance. Meanwhile, a high psychological well-being can trigger positive behaviors such as having good relationships with other people, self-efficacy and goal setting, independence [11]. In addition, previous studies reported that someone who has high psychological well-being was more successful in terms of education, career, socializing and better level of physical health [27]. Considering the importance of physical fitness and psychological well-being for student-athletes to support their success in sports activities, it is needed training system that has the potential to improve these two aspects. Tabata training based on virtual reality was estimated to be a sports method that can change the level of physical fitness and psychological well-being among student athletes.

Tabata is a training method that combines high-intensity and interval training [28, 29]. In Tabata training there are several types of movements, such as jogging, squat jumps, jumping jacks, plank, high knee, climber, where each movement is performed for 20 seconds and rests for 10 seconds [6, 30]. After it was created by Izumi Tabata, the popularity of Tabata training courses has increased and has been widely studied in several countries. For example, Domaradzki, Cichy, Rokita & Popowczak [31], applied Tabata training to male and female aged 16 who came from Poland and it was proven that this training could provide benefits for reducing their weight. In addition, previous studies reported that Tabata training was also effective for increasing the strength of soccer players [32], muscle power in athletes in swimming [6] heart rate and blood lactate [33]. In fact, this training has been noted to increase physical fitness effectively [34]. Unfortunately, research on Tabata training was limited to traditional methods and there was no research on technology-based Tabata training that involved virtual reality. Virtual reality-based Tabata training is a training that uses technological media, so the experience can be similar with the real based [35, 36]. Through Tabata virtual reality training, student-athletes observed pictures or animations that were doing physical activity and student-athletes must follow all the movements (Fig.1). According to Bedir & Erhan [37], the popularity of virtual reality technology has increased in sports, because through virtual reality people can experience events, times and environments that were not real but as if it really happened.

Figure 1. Virtual Reality-Based Tabata Training

The benefits of using virtual reality technology could help student-athletes to have a better understand about the exercises or movements that will be learned in sports [38, 39]. Even though, virtual reality technology provided many benefits in sports and facilitated coaches and student-athletes [40], unfortunately no one has implemented virtual reality in Tabata training. In addition, this study was the first work that tried to implement virtual reality-based Tabata training to change the level of physical fitness and psychological well-being among student athletes. In addition, this study presented novelty in terms of analyzing the effects of virtual reality-based Tabata training through quantitative and qualitative analysis (mixed method), so this research was different from previous studies on Tabata training. It is expected that this research will contribute to the development of the Tabata training method which involve virtual reality technology, so that coaches and student-athletes can use it in the future. Therefore, this study aims to investigate the effect of virtual reality-based Tabata training as an effort to change the level of physical fitness and psychological well-being through a mixed method.

Materials and Methods

Participants

The participants involved in this study were male student-athletes who were active in swimming sports from Singaperbangsa Karawang University, which is one of the universities in Indonesia. Participants were selected through a random technique, by sending invitations via WhatsApp. There was 40 out of 50 student-athletes who were invited, showed a positive response and interested in participating in this study. Before the experimental research was carried out, all participants were required to sign a letter of intent to become participants. After forty participants were selected, the next step was to allocate them to the experimental group who received the virtual reality-based Tabata training program (n=20, mean ± SD= age: 21.05±2.5, weight: 55.68±6.4 kg, height: 1.63±0.5 cm) and to the control group who carried out their daily training activities (n=20, mean ± SD= age: 20.47±0.9, body weight: 51.65±7.8 kg, height: 1.59 ± 0.4 cm). Participation inclusion criteria include; history of participating in Tabata training, participants are physically active, healthy and must be free from injury within the past year. Before the research started, all participants were given information about the rules in conducting this research. Then they are required to make and sign a statement about their willingness to become participants in this research

Research Design

This study used mixed types or a combination of quantitative and qualitative research. Quantitative research was carried out experimentally using a pretest-posttest control group design. While qualitative research through in-depth interviews with participants for 30 minutes.

This research was conducted in November-December 2022 in the University of Singaperbangsa Karawang (Indonesia) with number: 273/SP2H/UN64.10/LL/2022. This research was conducted based on the guidelines of the World Medical Association Code of Ethics (Helsinki Declaration for Humans). In quantitative research, at the first meeting, all participants carried out initial test activities, namely physical fitness tests and filling out the psychological well-being scale (22 November 2022) from 08.00 am until finished. In the second meeting (24 November 2022), the experimental group carried out a virtual reality-based Tabata training program and the control group carried out their daily training such as jumping jacks, side leg raises and running until the twelfth meeting (17 December 2022). At the 13th meeting (20 December 2022) all participants carried out physical fitness tests and filled out the psychological well-being scale. Detail of virtual reality-based Tabata training program is presented in Table 1.

Whereas for qualitative research through in-depth interviews it was carried out on 21-22 December 2022. In-depth interviews were carried out using Bahasa inside the room for 30 minutes per person. In this study, the interview was conducted for experimental group who received the virtual reality-based Tabata training program which was in accordance with the objectives of this study. After the interview was completed, the data from interview was analyzed by 3 people who were experts in sports training methodology and Dr. degree holders. The mixed research design is presented in Figure 2.

Research Instruments

Quantitative Instruments

Physical Fitness. Quantitative instrument was used to measure the level of physical fitness of athletes which had been adopted from previous studies [41], with the following test items:

20 m Shuttle Run (ml/kg/min). This instrument has a function to measure the level of VO2max endurance. This test was carried out by running continuously with a distance of 20 meters following the "bleep" audio. The participant was standing in cone A after the audio bleep sounded, the participant run towards cone B. Repeat this running motion until the participant was no longer able or unable to adjust with the speed set in the audio recording. Assessment was conducted by calculating

Table 1. Virtual Reality-Based Tabata Training Program

Training Unit Components	Activities	Duration
Warm-up	Warm-up	2 min
Virtual Reality-Based Tabata Training	Squat jump. Kick sideways. Kick back. Jumping Jack. Side Lunges. Single movement was performed with a duration of 20 seconds and 10 seconds rest.	5 min
Cool-down	Cardiorespiratory cool down and the poststretch.	2 min

the number of levels and feedback obtained then converted into Vo2max. This instrument had been tested previously, with a validity value of 0.89 and a reliability of 0.84.

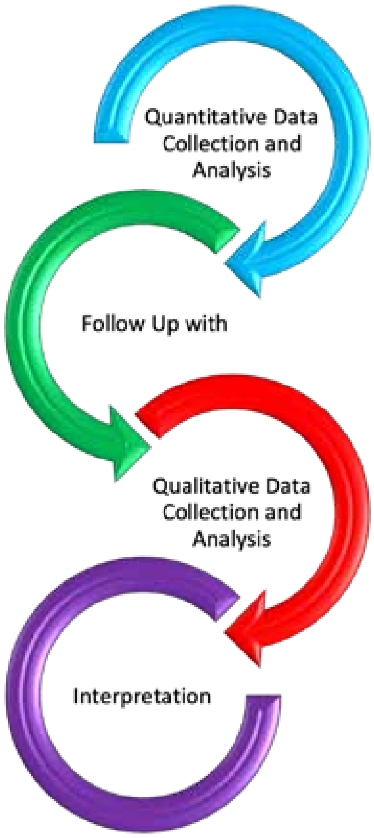

Figure 2. Mixed Method Research Design

30 m Sprint Run (s). This instrument used to measure the level of speed. This test was carried out by standing at the start line and after the whistle sounded, the participant run as fast as possible for 30 meters to the finish line. The assessment was carried out by calculated the score which was based on the fastest time. This instrument was tested beforehand in this study with a validity value of 0.80 and a reliability of 0.83.

Horizontal Jump (cm). This instrument was used to measure the level of power. This test was carried out by conducting horizontal jumps for twice times and the best value was used for statistical analysis. This instrument was tested beforehand in this study with a validity value of 0.87 and a reliability of 0.80.

Leg dynamometer (kg). This instrument aims to measure muscle strength of lower leg [42]. This test was conducted by standing on the leg dynamometer, hands holding the handle, body upright and legs bent. Then the participant pulled the handle as hard as possible and straightened the knee until it stands straight. The leg muscle strength score can be seen on the leg dynamometer measurement tool. This instrument has a validity level of 0.87 and a reliability of 0.75 in this study.

Psychological Well-Being Scale (points). The instrument for measuring the level of psychological well-being was psychological well-being scale, adopted from Simons & Bird's [11]. The instrument had 14 question items which were divided into three subscales. The first subscale related to subjective well-being has 3 item questions (for example "during the last week, how often did you feel happy when participating in sports"). The second subscale related to social well-being has 5 item questions (for example "during the last week, how often did you feel you had something to contribute to a sports team/community). The third subscale related to psychological well-being has 6 item questions (for example "during the last week, how often have you felt purposeful in sports). This questionnaire was answered by using a Likert scale from a value of 0 (never) to a value of 5 (every day). This instrument based on previous studies has high internal consistency reliability for all subscales (subjective well-being, α = 0.85; social well-being, α = 0.83; psychological well-being, α = 0.87) and Cronbach's α coefficients of 0.88, 0.88 and 0.90 [11].

Qualitative Instruments

A qualitative instrument was used to measure the effect of implementing virtual reality-based Tabata training towards changes in physical fitness and psychological well-being levels through in-depth interviews of 30 minutes per person. This test aims to investigate participants' perceptions about the convenience and difficulty when participating in virtual reality-based Tabata training. In addition, this test aims to reveal the impact of this training towards changes in the level of physical fitness and psychological well-being. The results of interviews with participants were recorded both in audio and text and then analyzed by researchers and 3 experts [6].

Statistical Analysis.

Quantitative analysis

Data on test results and measurements of physical fitness and psychological well-being were analyzed through IBM SPSS version 25.0 (Armonk, NY: IBM Corp). The measurement test was conducted in several stages. First, conducting the normality test of data through Shapiro-Wilk analysis ($p>0.05$). Second, statistical descriptive testing, by calculating the mean ($\overline{X}$)±standard deviation (S). Third, Independent samples t-test to analyze the difference in values between the experimental and control groups before and after the experiment ($p<0.05$). Fourth, the Paired samples t-test which aims to test whether there was an effect from the experimental and control groups ($p<0.05$).

Qualitative analysis

Data from in-depth interviews were analyzed qualitatively thematically, the results were coded and categorized into three themes [6], namely theme 1: the advantages of virtual reality-based Tabata training, theme 2: difficulties from using virtual reality-based Tabata training and theme 3: impact of using virtual reality-based Tabata training on physical fitness and psychological well-being.

Results

Quantitative results

Table 2 shows that data in the experimental and control groups was normally distributed. Table 3 shows the mean and standard deviation values of the experimental and control groups have increased from pretest to posttest. Table 4 shows that there was no difference in the value of physical fitness and psychological well-being between the experimental and control groups before the experiment (p> 0.05). Tables 5, 6 shows that there were differences in the values of physical fitness and psychological well-being between the experimental and control groups after the experimental program (p<0.05).

Meanwhile, the Paired samples t-test showed that there was a significant effect from the experimental group on changes in the level of physical fitness and psychological well-being (p<0.05) and the control

Table 2. Normality test calculation

Dependent Variable	Experimental Group	n	p	Control Group	n	p	Description
Physical Fitness							
20 m Shuttle Run (ml/kg/min)	Pretest	20	0.070	Pretest	20	0.240	Normal
	Posttest	20	0.167	Posttest	20	0.149	Normal
30 m Sprint Run (s)	Pretest	20	0.234	Pretest	20	0.207	Normal
	Posttest	20	0.087	Posttest	20	0.366	Normal
Horizontal Jump (cm)	Pretest	20	0.275	Pretest	20	0.204	Normal
	Posttest	20	0.188	Posttest	20	0.156	Normal
Leg Dynamometer (kg)	Pretest	20	0.261	Pretest	20	0.200	Normal
	Posttest	20	0.356	Posttest	20	0.344	Normal
Psychological Well-Being							
Subjective Well-Being (points)	Pretest	20	0.200	Pretest	20	0.383	Normal
	Posttest	20	0.090	Posttest	20	0.068	Normal
Social Well-Being (points)	Pretest	20	0.182	Pretest	20	0.179	Normal
	Posttest	20	0.322	Posttest	20	0.308	Normal
Psychological Well-Being (points)	Pretest	20	0.395	Pretest	20	0.299	Normal
	Posttest	20	0.337	Posttest	20	0.095	Normal

Table 3. Descriptive Statistics

Dependent Variable	Experimental Group (n=20)		Control Group (n=20)	
	Pretest	Posttest	Pretest	Posttest
	X̄ ±S	X̄ ±S	X̄ ±S	X̄ ±S
Physical Fitness				
20 m Shuttle Run (ml/kg/min)	27.85±1.49	41.60±5.61	27.15±1.18	37.75±3.21
30 m Sprint Run (s)	5.10±0.64	3.40±0.50	5.40±0.59	3.80±0.52
Horizontal Jump (cm)	1.45±0.51	2.70±2.70	1.35±0.48	2.25±0.55
Leg Dynamometer (kg)	18.40±3.20	40.85±3.45	19.60±3.16	38.30±2.83
Psychological Well-Being				
Subjective Well-Being (points)	5.75±1.25	11.55±2.13	5.35±0.98	10.00±1.52
Social Well-Being (points)	10.95±10.95	20.85±3.42	10.10±2.12	18.00±2.86
Psychological Well-Being (points)	12.65±2.94	22.65±2.99	11.35±1.69	19.65±2.41

Table 4. The results of differences physical fitness and psychological well-being on the experimental (n=20) and control (n=20) groups before the experiment

Dependent Variable	Group	Statistical Indicators		
		X±S	**t**	**p**
Physical Fitness				
20 m Shuttle Run (ml/kg/min)	Experimental	27.85±1.49	1.642	0.109
	Control	27.15±1.18		
30 m Sprint Run (s)	Experimental	5.10±0.64	-1.531	0.134
	Control	5.40±0.59		
Horizontal Jump (cm)	Experimental	1.45±0.51	0.632	0.531
	Control	1.35±0.48		
Leg Dynamometer (kg)	Experimental	18.40±3.20	-1.191	0.241
	Control	19.60±3.16		
Psychological Well-Being				
Subjective Well-Being (points)	Experimental	5.75±1.25	1.122	0.269
	Control	5.35±0.98		
Social Well-Being (points)	Experimental	10.95±2.41	1.181	0.245
	Control	10.10±2.12		
Psychological Well-Being (points)÷	Experimental	12.65±2.94	1.712	0.095
	Control	11.35±1.69		

Table 5. The results of differences physical fitness and psychological well-being on the experimental (n=20) and control (n=20) groups after the experiment

Dependent Variable	Group	Statistical Indicators		
		X±S	**t**	**p**
Physical Fitness				
20 m Shuttle Run (ml/kg/min)	Experimental	41.60 ±5.61	2.663	0.011
	Control	37.75±3.21		
30 m Sprint Run (s)	Experimental	3.40±0.50	2.466	0.018
	Control	3.80±0.52		
Horizontal Jump (cm)	Experimental	2.70±0.47	2.781	0.008
	Control	2.25±0.55		
Leg Dynamometer (kg)	Experimental	40.85±3.45	2.554	0.015
	Control	38.30±2.83		
Psychological Well-Being				
Subjective Well-Being (points)	Experimental	11.55±2.13	2.640	0.012
	Control	10.00±1.52		
Social Well-Being (points)	Experimental	20.85±3.42	2.855	0.007
	Control	18.00±2.86		
Psychological Well-Being (points)	Experimental	22.65±2.99	3.488	0.001
	Control	19.65±2.41		

Table 6. The results of the Paired Samples t-test

Dependent Variable	Experimental Group (n=20)			Control Group (n=20)		
	Pre-Post X±S	t	p	Pre-Post X±S	t	p
Physical Fitness						
20 m Shuttle Run (ml/kg/min)	13.75±5.81	10.581	0.000	10.60±3.53	13.428	0.004
30 m Sprint Run (s)	1.70±0.86	8.794	0.004	1.60±0.68	10.514	0.006
Horizontal Jump (cm)	1.25±0.63	8.753	0.002	0.90±0.78	5.107	0.007
Leg Dynamometer (kg)	22.45±3.98	25.227	0.000	18.70±4.54	18.407	0.000
Psychological Well-Being						
Subjective Well-Being (points)	5.80±2.09	12.395	0.001	4.65±1.66	12.504	0.000
Social Well-Being (points)	9.90±4.03	10.964	0.000	7.90±3.86	9.141	0.003
Psychological Well-Being (points)	10.01±3.21	13.924	0.000	8.30±3.10	11.213	0.000

group also showed that there was an effect on changes in physical fitness and psychological well-being ($p < 0.05$) but not as big as the experimental group.

Qualitative Results

In-depth interviews with participants obtained the following results:

Theme 1: Advantages of virtual reality-based Tabata training

This first theme relates to the perceptions of the participants (student-athletes) about the advantages of the virtual reality-based Tabata training program. In this case the participants argued that:

> "In our opinion, this program has several advantages, such as we felt happy and enthusiastic in carrying out the training, because we were guided by an animation that was in virtual reality" (Results of interviewed with Participants 1, 2, 3, 4, 6, 7).

> "The Tabata training program based on virtual reality is amazing!!..We can actively move in this training program even without a trainer or lecturer who guided us, because in virtual reality there was an animation that replaced the role of trainer or lecturer" (Results of interviewed with Participants 8, 9, 11, 12, 13, 14).

> "The advantages of this training program are it is more efficient, effective and fun, because there was an animation who guided us exercises in virtual reality" (Results of interviewed with Participants 16, 18, 19, 20).

Another advantage of the virtual reality-based Tabata training program is it can be carried out anywhere and at any time, without the presence of a trainer or lecturer (Results of interviews with Participants 5, 10, 15, 17).

Theme 2: Difficulties in implementing virtual reality-based Tabata training

The second theme related to difficulties in carrying out virtual reality-based Tabata training which must be explained clearly, so that later it can be minimized. In this case the participants argued that:

> "According to us, there are several difficulties in carrying out the virtual reality-based Tabata training program, namely: (i) we could not conduct this exercise without cellphones and virtual reality glasses (ii) For student-athletes who have eye disorders, it will be harm for their eye health if they use it in long term" (Results of interviews with Participants 2, 5, 7, 9, 11, 13, 15, 17).

> "Not all student-athletes and universities own virtual reality facilities, so we think this will be a difficulty in implementing this program. Thus, this program is limited only to student-athletes and universities with proper facilities" (Results of interviews with Participants 1, 3, 4, 6, 8, 10, 12, 14).

Virtual reality-based Tabata training must be carried out in a location or place that is truly safe, because if it is carried out in a place with vehicles going back and forth it will have the potential to cause an accident (Results of interviews with Participants 16, 18, 19, 20).

Theme 3: Impact of implementing virtual reality-based Tabata training

The last theme related to the impact of implementing virtual reality-based Tabata training on changing levels of physical fitness and psychological well-being. In this case the participants argued that:

> "Obviously the implementation of virtual reality-based Tabata training program has really helped us to change our level of physical fitness and psychological well-being for the better

results, for example, previously we were easily got tired, and after joining this program, we were able to do physical activity for a long time without fatigue. Apart from that, this program allowed us to release our stress" (Results of interviewed with Participants 3, 6, 8, 9, 12, 14, 16, 19).

The Tabata training program based on virtual reality with high intensity and intervals triggered us to be more active, so that was the main factor that causes our physical fitness increase gradually (Results of interviewed with Participants 1, 4, 5, 7, 10, 11, 13). In addition, virtual reality-based Tabata training accompanied by energetic music which helped us felt comfortable, calm, happy and it was the main factor to reduce all problems that exist in our mind (depression, anxiety and stress), thus encouraged us willing to involve and set our goals to exercise (Results of interviewed with Participants 2, 15, 17, 18, 20).

Discussion

This study aims to investigate the effect of virtual reality-based Tabata training to change the level of physical fitness and psychological well-being through a mixed method.

This study obtained several results related to the effect of virtual reality-based Tabata training First, there was no difference in the value of physical fitness or psychological well-being between the experimental and control groups before the experiment. Second, there were differences in the values of physical fitness and psychological well-being between the experimental and control groups after the experimental program. Third, there was a significant effect of the changes in physical fitness and psychological well-being level in experimental groups. Likewise, the control group also showed a significant effect on changes in physical fitness and psychological well-being. However, the experimental group showed a greater increase than the control group.

The increase in physical fitness components (e.g., VO2max endurance, speed, power, strength) in the experimental group was happened because researchers tried to present an innovation and novelty in Tabata training that was different from previous studies, namely virtual reality-based Tabata training. This training presented exercises which rich in movement for student-athletes, to guided them became more active in the training process. In addition, high intensity Tabata training with intervals involving virtual reality technology was much more effective and attractive for student athletes, which can accelerate the results of achieving physical fitness. It was inline with Sohail, Firdos, Ikram & Talha [38], agreed that virtual reality technology had the potential to encourgate student athletes more easily carry out and achieve sports goals. The results of these findings were in line with previous studies which show that Tabata training has proven effective in improving components of physical fitness such as power and speed [43] and strength ([6]. Similarly, Ambrozy et al [44], reported that there was an increase in the level of physical fitness in men between the ages of 35 and 40 due to the effect of applying Tabata training. Other studies reported that high-intensity Tabata can increase the aerobic capacity of men [31]. According to Tabata [28], high-intensity interval training was a key factor for increasing maximum aerobic power. Reinforced by the study of Murawska-Cialowicz et al. [45], Tabata protocol training is characterized by high intensity and punctuated by short rest, this can promote the development of oxygen capacity and increase in VO2max. Similar results were reported by Scoubeau, Bonnechère, Cnop, Faoro & Klass [46], that the importance of using Tabata training turns a low level of physical fitness into a high one. Thus, the uniqueness and novelty of this study was virtual reality-based Tabata training had an effect on changes in the quality of physical fitness based on quantitative and qualitative (mixed) research.

On the other hand, psychological well-being among student-athletes was also change, because virtual reality-based Tabata training was a fun training, student-athletes can do exercises by following the animations presented in virtual reality. Borrega-Mouquinho, Sánchez-Gómez, Fuentes-García, Collado-Mateo and Villafaina [47], described that Tabata/high-intensity interval training had been shown to be effective in reducing levels of anxiety, stress and depression simultaneously. The strength of virtual reality-based Tabata training can trigger student-athletes felt happy, thereby significantly reducing psychological disorders [48]. Other research confirms that Tabata training can reduce risk symptoms for psychological disorders such as anxiety and depression [49]. Similar results were reported by Terada et al. [50] conducted Tabata/high-intensity interval training for twelve weeks had a positive, sustained effect on reducing depressive symptoms. Alves et al. [51] reported that Tabata/high-intensity interval training has a strong effect on improving psychological well-being. Thus, the uniqueness and novelty of this study was the virtual reality-based Tabata training had an effect on changing the quality of psychological well-being based on quantitative and qualitative (mixed) research.

While the qualitative findings in this study showed that participants (student-athletes) gave positive perceptions that the virtual reality-based Tabata training program was easy, efficient and effective, fun and could help them more active. In addition, participants also gave negative perceptions such as not all student-athletes and universities were equipped with virtual reality facilities and it must be carried out in a location or place that was completely safe or far from vehicles. Then they also agreed that overall the virtual reality-based Tabata training program was effective in changing the level of physical fitness and psychological well-being to be better than previous.

Conclusions

This mixed research confirms that virtual reality-based Tabata training has positive effect to change the level of physical fitness and psychological well-being of student-athletes to a better direction. In addition, this research contributes to the development of technology-based training methods which can increase student-athletes achievement. Similar with other studies, this research also has limitations in terms of the limited number of participants who came from one university in Indonesia. Future studies are needed to cover a large quantity of participants from several universities in Indonesia.

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Conflict of interest

We hereby declare that there is no conflict of interest in this research.

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