Using virtual reality-based physical activity to change the mental health and cognitive function of karate athletes

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Authors’ Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Abstract

\textbf{Background and purpose}

\textbf{Purpose}. The use of virtual reality technology in the field of sports is increasing, but there is a lack of evidence reporting the effects of virtual reality to change the level of mental health and cognitive function in Karate athletes through mixed research methods. This study to determine how virtual reality-based physical activity affected athletes’ levels of mental health and cognitive function.

\textbf{Material and methods}

This study involved male Karate athletes from Cendikia Leadership School in Indonesia (n=30). The athletes were allocated to the experimental group (n=15) and control group (n=15).

\textbf{Results}

First finding of the quantitative study showed that before the experiment there was no difference in the scores of mental health and cognitive function in the two groups. The second finding showed that there was a difference after the experiment. In qualitative study, athletes revealed their perception that the advantages of virtual reality-based physical activity were fun, easy to implement, and can be carried out without the supervision of a coach. Moreover, they also mentioned the weakness of this tool, namely not all athletes have virtual reality tools, the impact to their eye health, exercise must be carried out in a safe place.

\textbf{Conclusions}

Thus, this study concluded that physical activity based on virtual reality was proven to be effective in changing of mental health and cognitive function of Karate athletes.

\textbf{Keywords}: virtual reality, psychological health, cognitive function, combat sport
Анотація

Феррі Фендріан, Амунг Мамун, Юді Гендраяна, Хаміді Рональд Даніель Рей, Армандо Монтерроса-Кінтеро, Еді Сетіаван. Використання фізичної активності на основі віртуальної реальності для зміни психічного здоров'я та когнітивних функцій караїстів

Мета. Використання технології віртуальної реальності у сфері спорту зростає, але бракує доказів впливу віртуальної реальності на зміну рівня психічного здоров'я та когнітивних функцій спортсменів-каратистів за допомогою змішаних методів дослідження. Це дослідження, щоб визначити, як фізична активність на основі віртуальної реальності вплинула на рівень психічного здоров'я та когнітивні функції спортсменів.

Матеріал і методи

У цьому дослідженні брали участь спортсмени-чоловіки караїті зі школи лідерства Cendikia в Індонезії (n=30). Спортсмени були виділені в експериментальну групу (n=15) та контрольну групу (n=15).

Результати

Перші результати кількісного дослідження показали, що до експерименту не було різниці в показниках психічного здоров'я та когнітивних функцій у двох групах. Друге відкриття показало, що різниця була після експерименту. У якісному дослідженні спортсмени показали, що вони вважають переваги фізичної активності на основі віртуальної реальності веселою, простою у впровадженні та її можна виконувати без нагляду тренера. Крім того, вони також відзначили слабкість цього інструмента, а саме: не всі спортсмени мають інструменти віртуальної реальності, що впливає на здоров'я їхніх очей, впрацю виконуватися в безпечному місці.

Висновки

Таким чином, це дослідження прийшло до висновку, що фізична активність, заснована на віртуальній реальності, була докладна як ефективна для зміни психічного здоров'я та когнітивних функцій караїстів.

Ключові слова: віртуальна реальність, психологічне здоров'я, когнітивні функції, єдиноборства

Аннотация

Ферри Фендриан, Амунг Мамун, Юди Хендраяна, Хамиди Рональд Дэниел Рэй, Армандо Монтерроса-Кинтеро, Эди Сетиаван. Использование физической активности на основе виртуальной реальности для изменения психического здоровья и когнитивных функций караэтисов

Цель. Использование технологии виртуальной реальности в спорте расширяется, но недостаточно доказательств, сообщающих о влиянии виртуальной реальности на изменение уровня психического здоровья и когнитивных функций у спортсменов-карате с помощью смешанных методов исследования. Целью этого исследования было определить, как физическая активность, основанная на виртуальной реальности, влияет на уровень психического здоровья и когнитивных функций спортсменов.

Материал и методы

В этом исследовании приняли участие спортсмены-карате из школы лидерства Сендикия в Индонезии (n = 30). Спортсмены были разделены на экспериментальную группу (n=15) и контрольную группу (n=15).

Полученные результаты

Первый результат количественного исследования показал, что до эксперимента не было никакой разницы в оценках психического здоровья и когнитивных функций в двух группах. Второе открытие показало, что после эксперимента была разница. В качественном исследовании спортсмены выявили своё мнение о том, что преимущество физической активности на основе виртуальной реальности заключается в развлечении, простоте реализации и возможности выполнять её без присмотра тренера. Кроме того, они также упомянули слабость этого инструмента, а именно, не у всех спортсменов есть инструменты виртуальной реальности, влияние на их здоровье глаз, упражнения должны выполняться в безопасном месте.

Выводы

Таким образом, это исследование пришло к выводу, что физическая активность, основанная на виртуальной реальности, доказала свою эффективность в изменении психического здоровья и когнитивных функций спортсменов-карате.

Ключевые слова: виртуальная реальность, психологическое здоровье, когнитивная функция, единоборства
Introduction

Karate is a competitive combat sport [1], every athlete is required to have excellent performance. Data showed that mental health [2], and cognitive function [3], were not properly built and developed in the current era [4], even though these factors greatly affect the performance of athletes in competition [5]. One of the key elements that helps athletes succeed at practicing karate is mental wellness. Mental health can be interpreted as a condition of an athlete who has never experienced depression, anxiety or high stress [6, 7]. Previous studies reported that during and after the COVID-19 pandemic crisis, many athletes had issues with their mental health [8, 9]. For example, a recent study reported that several professional athletes for the Olympics in Tokyo had issues with their mental health, so that it had an impact on their sports performance which decreased drastically [10, 11]. In addition, athletes who participated in competitive sports, especially in combat sports were more likely to suffer from mental health issues [12]. According to Purcell, Gwyther & Rice [13], there were many factors that triggered mental health disorders among athletes, for example overtraining [14], high injury rates, boredom with the training process, problems with the coach [15], teammates/friends, family until low performance [16].

Cognitive function was an aspect that supported all types of exercise including sports [17, 18], and in recent years, this element has drawn a lot of attention [19, 20, 21]. Data showed that 47.5 million people had dementia, which was characterized by a decline in cognitive function, and it was estimated that by 2030, 75.6 million people will be affected globally [22], and 135.5 million in 2050 [23]. Cognitive function is the ability to participate, recognize and plan for internal and external stimuli [24, 25]. In addition, according to Büchel, Gokeler, Heuvelmans & Baumeister [26], cognitive function involved several aspects namely, short-term or long-term memory, attention, planning and reasoning in thinking. In sport exercise, cognitive function could express the ability to process and make decisions quickly during competition, while impaired cognitive function had an impact on low tactical and technical performance [27]. According to previous studies, it was reported that extraordinary or outstanding athletes had fostered and developed their cognitive functions, so that they could make well-informed decisions and extrapolate [28]. Several factors that cause a decrease in cognitive function, for example consuming excessive alcohol, did not carry out physical exercise and sports were the biggest factors that happened globally [29].

Physical activity is an exercise which has claimed contains many benefits for humans [30], including among athletes. Physical activity is part of sports exercise, but some literature defines physical exercise as exercise that involve skeletal muscles movement (body movements) [31]. Data globally has documented that physical activity can improve health status [4, 32], and performance of athlete [33]. Meanwhile, people who inactive in physical activity can get various kinds of chronic diseases and psychological disorders [34]. Although physical activity has proven to have great benefits, it was recorded that people [35], including athletes has rarely carried out physical activity [36]. This condition was due to several factors which was influenced by the environment, socio-culture or the boring process of training exercise [37]. Therefore, this study presented physical activity with new experiences, namely through virtual reality. Virtual reality-based means a physical activity carried out in cyberspace [38, 39]. According to Asadzadeh, Samad-Soltani, Salahzadeh & Rezaei-Hachesu [40], using virtual reality technology cause athletes apparently carried out physical activity like actual situations. In addition, the process of physical activity through virtual reality could display simulations and an immersive and interactive environment [41], which cause it much more enjoyable [5]. Previous studies had reported the benefits of using virtual reality, for example athletes can more understand a new skill in sports [42], improve physical [43], and mental health status [44].

Although research on virtual reality has been widely researched and well-documented internationally [9], but previous research only focused on systematic reviews [45, 46], scoping review [37], exploratory [47], cross-sectional [48], and experimental [49, 50, 51]. According to our knowledge, there has been no previous study that reported the effects of virtual reality-based physical activity on increasing levels of mental health and cognitive function in Karate sports athletes. In addition, our research presented a novelty in terms of investigating the effects of virtual reality-based physical activity through a mixed research method. This research contributed to the development of
virtual reality based physical activity, therefore, it is expected that this study can provide important information to coaches and athletes about the importance of using virtual reality-based physical activity. Therefore, this study to determine how virtual reality-based physical activity affected athletes' levels of mental health and cognitive function.

Materials and Methods

The participants involved in this study were Karate athletes with male gender from Cendikia Leadership School in Indonesia (n=30). The inclusion criteria of participants include; physically active and healthy condition. Participants who involved in this study were given a reward of 10 USD. Participants were recruited randomly, in the first stage the researchers sent invitation letters to athletes and got positive response from all athletes, in the second stage they were required to create and sign a letter of willingness to participate in this study. Researchers used G Power analysis to calculate the required sample size in this study and the result was a of 15 athletes in each group [52]. After fulfilled the sample size criteria, the athletes were allocated to the experimental group which received a virtual reality-based physical exercise program (n=15, mean±SD: age = 14.13±0.6 years, weight = 44.60±3.3 kg, height= 1.34±0.8 cm) and the control group (n=15, mean±SD: age= 13.80±0.8 years, weight= 43.60±2.7 kg, height= 1.32±0.9 cm). In order to keep the confidentiality of athlete's identity, the researcher provided symbols with A, B, C and so on to replace the name of participants.

This research has been provided in according to ethical principles embodied in the Helsinki Declaration.

Instruments

Quantitative Instruments

Mental health. In this study, we employed the Depression Anxiety Stress Scale-21 to assess the level of mental health among athletes. This instrument consists of three subscales, namely: depression, anxiety and stress. According to Ghani, Zainuddin, Ibrahim, Hashim & Van [53], the depression subscale has 7 question items. Depression with normal (0-9), mild (10-12), moderate (13-20), severe (21-27) and very severe (28-42) levels. The anxiety subscale has 7 question items. Anxiety with normal (0-6), mild (7-9), moderate (10-14), severe (15-19), and very severe (20-42) levels. Meanwhile, the stress subscale has 7 questions. Stress with normal (0-10), mild (11-18), moderate (19-26), severe (27-34) and very severe (35-42) levels. In our study, Cronbach’s alpha for reliability was 0.85-0.89, indicating good reliability and content validity. This instrument was filled using a Likert scale with a value of 0 = never, 1 = almost never, 2 = sometimes, 3 = quite often and 4 = very often.

Cognitive function. To measure cognitive function of athletes, we used the Stroop test which was adopted from previous studies [25]. This Stroop test was used to measure cognitive function related to the focus of attention. This test was conducted by quickly mentioning the color of word which was located in two columns (20 words per column). The participant should mention the color of word, and not the written word (Fig. 1). Assessment was conducted by counting the duration in mentioning 20 words.

Qualitative Instruments

The qualitative instrument used 30-minute in-depth interviews with participants in the experimental group about the strengths, weaknesses and impacts of virtual reality-based physical activity programs. Based on previous studies, this instrument has proven effective in revealing a problem [54].

Procedure

This study applied a quantitative and qualitative approaches (mixed research method). This study was carried out through two stages.
First, collecting quantitative data (numbers) through experimental. Second, collecting qualitative data (verbal) through in-depth interviews.

Research was conducted from December 2022 until January 2023 at Cendikia Leadership School in Indonesia. In addition, this research has obtained permission from the Scholars Leadership School Committee and the Indonesian University of Education with approval number: 0152/UN40.SP. DI/TA.00.03/2022. The World Medical Association Code of Ethics was followed for all of the study's activity. Quantitative research through experiments was started on December 1, 2022, all participants carried out pre-test, namely filling out mental health questionnaires and stroop tests from 08.00 am until finish. The second meeting was held on December 3, 2022, participants in the experimental group carried out a virtual reality-based physical activity program and the control group only carried out the regular physical activity that they usually did until the 12th meeting (December 28, 2022). The last meeting on December 30, 2022, all participants carried out post-test, namely filling out a mental health questionnaire and a stroop test from 09.00 am until finished.

At Cendikia Leadership School, qualitative research using in-depth interviews was carried out on the weekend of January 6 and 7, 2023. The researchers interviewed participants in the experimental group, because it was in accordance with the purpose of this study, which was to reveal the effects of using virtual reality-based physical activity. Interviews were conducted using Bahasa language and the researchers were able to interview 7-8 participants in one day. The results of the recorded interviews were analyzed by the research team.

Virtual reality group protocol

The virtual reality-based physical activity program was carried out in the morning from 08.00 until finished and the training was located at Cendikia Leadership School gymnasium field. The first exercise was warming-up for 5 minutes and then continued with physical exercise in the form of brain jogging, neurotracker and aerobic circuit (e.g., squats, plank, jumping jack), contained in virtual reality. Each of these physical activity was carried out for 15 minutes with 2 minutes rest. Finally, the athletes carried out a cool-down exercise for 4 minutes. This program was carried out for 3 days, namely Wednesday, Friday and Saturday in a week.

Control group Protocol

In comparison, the control group carried out regular daily physical activity as usual, such as push-ups and running, each training was carried out for 20 minutes and rested for 10 minutes. Participants in the control group were monitored, so that could not influence the results of this study. This program was carried out for 3 days, namely Wednesday, Friday and Saturday in a week.

Statistical analysis

Quantitative analysis

In quantitative research, IBM SPSS v.25 was used to analyze all of the data. First, normality testing (Shapiro-Wilk). Second, descriptive statistical value testing which included mean and standard deviation. Third, Independent samples t-test to analyze the difference in values on mental health and cognitive function between the experimental and control groups before and after the experiment (p<0.05). Statistical significance was determined to be p<0.05. Cohen's test (d) was used to calculate the effect on mental health and cognitive function from before and after. The effects were interpreted using maximum values of 0.20 (small effect), 0.50 (medium effect) and 0.80 (large effect) [55].

Qualitative analysis

In qualitative research, data from interviews were analyzed through qualitative thematic which includes: recording interview results, coding and categorized into three major themes, namely: theme 1: The advantage, theme 2: The weakness and theme 3: Impact.

Results

Quantitative results

The normality test showed that the results were normally distributed (p>0.05). Table 1 shows the mean and standard deviation values of the experimental and control groups. Table 2 shows that there was no difference in the value of mental health and cognitive function between the virtual reality and control groups before the experiment (p=0.05). Table 3 shows that there were differences in the values of the virtual reality group proved to have a significant effect on mental health and cognitive function after the experiment (p<0.05).
### Table 1

Result of dependent variable (mean± standard deviation)

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Virtual Reality Group (n=15)</th>
<th>Control Group (n=15)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>Mental Health</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression (points)</td>
<td>24.07±1.79</td>
<td>17.93±1.90</td>
</tr>
<tr>
<td>Anxiety (points)</td>
<td>16.80±1.37</td>
<td>13.00±1.00</td>
</tr>
<tr>
<td>Stress (points)</td>
<td>21.20±1.89</td>
<td>16.73±1.10</td>
</tr>
<tr>
<td>Cognitive Function</td>
<td></td>
<td></td>
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<tr>
<td>Attention (min)</td>
<td>2.27±0.45</td>
<td>1.20±0.41</td>
</tr>
</tbody>
</table>

### Table 2

The results of differences mental health and cognitive function on the virtual reality groups and control groups before experiment

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Group</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>t</th>
<th>p</th>
<th>Cohen (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental Health</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression (points)</td>
<td>Virtual Reality</td>
<td>24.07</td>
<td>1.79</td>
<td>-1.738</td>
<td>0.093</td>
<td>0.00</td>
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<td>1.78</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Anxiety (points)</td>
<td>Virtual Reality</td>
<td>16.80</td>
<td>1.37</td>
<td>-1.488</td>
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<td>0.00</td>
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<tr>
<td>Stress (points)</td>
<td>Virtual Reality</td>
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<td>1.89</td>
<td>-1.643</td>
<td>0.112</td>
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<td>22.40</td>
<td>2.09</td>
<td></td>
<td></td>
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<tr>
<td>Cognitive Function</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Attention (min)</td>
<td>Virtual Reality</td>
<td>2.27</td>
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<td>0.456</td>
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<td>Control</td>
<td>2.40</td>
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</tbody>
</table>

Notes: Significance level was set at p < 0.05

### Table 3

The results of differences mental health and cognitive function on the virtual reality groups and control groups after experiment

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Group</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>t</th>
<th>p</th>
<th>Cohen (d)</th>
</tr>
</thead>
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<td></td>
</tr>
<tr>
<td>Depression (points)</td>
<td>Virtual Reality</td>
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<td>1.11</td>
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<tr>
<td>Anxiety (points)</td>
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<td>0.53</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stress (points)</td>
<td>Virtual Reality</td>
<td>16.73</td>
<td>1.10</td>
<td>-2.646</td>
<td>0.013</td>
<td>0.65</td>
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<td></td>
<td>Control</td>
<td>17.60</td>
<td>0.63</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cognitive Function</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention (min)</td>
<td>Virtual Reality</td>
<td>1.20</td>
<td>0.41</td>
<td>-4.111</td>
<td>0.000</td>
<td>0.82</td>
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<td></td>
<td>Control</td>
<td>2.07</td>
<td>0.70</td>
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</tbody>
</table>

Notes: Significance level was set at p < 0.05
Qualitative Results

In-depth interviews with participants obtained the following findings:

**Theme 1: The advantages**

The first theme that was revealed through interviews with participants was the advantages of virtual reality-based physical activity programs. In this case the participants argued that:

"In our opinion, the main advantages of a virtual reality-based physical activity program are: (i) fun and challenging, (ii) easy to do anywhere and anytime, but must be in a safe place, (iii) can do exercises without supervision from a coach" (Results of interviews with participants A, B, C, D, E).

The most prominent advantage of this program was feeling more motivated in carrying out this activity. In addition, we can study brain jogging, neurotracker and aerobic circuit activities in detail with virtual reality (Results of interviews with participants F, G, J, K, L).

"This program is very easy to use, for example by simply following the animations in the virtual reality tool, we can do physical activity that are fun and make us sweat" (Results of interviews with participants H, O).

In our opinion, the advantage of this virtual reality-based physical activity program was efficient, for example being able to do exercises at home independently. In addition, through virtual reality we can carry out physical activity even though it has short duration (Results of interviews with participants I, M, N).

**Theme 2: The weakness**

The second theme related to the weakness of virtual reality-based physical activity programs. Participants argued that:

“This virtual reality-based physical activity program has several weakness, such as this method needs tool but not all athletes have this tool and not all coaches and athletes understand how to use it. Thus, in our opinion, it is needed to socializing virtual reality-based physical activity to coaches and athletes in Karate” (Interview results with participants A, B, D, F).

“We assume that the weakness of this program was the impact to eye health if using it in a long duration (e.g., 1 or 2 hours) and continuously. So, it is better to use this virtual reality tool in a short duration (Results of interviews with participants C, G, I, K).

We thin, the weakness of this program was it could not be used in crowded places, for example places that have the potential to cause injury to athletes and must be carried out in a location which far from vehicles and has wide place (Interview result with participants E, H, J, N). In addition, another weakness was it could not be used on a large number of athletes, due to limited virtual reality tools” (Interview result with participants L, M, O).

**Theme 3: Impact of virtual reality-based physical activity on mental health and cognitive function**

Some participants argued that:

“Participating in this virtual reality-based physical activity program, help us feel happy and enjoy all the physical exercise presented in virtual reality, so that all the problems that cause us depressed, anxious and stressed slowly decrease. In addition, we feel that carried out virtual reality-based physical activity can improve our cognitive functions better than before” (Results of interviews with participants A, C, G, K, L, M, O).

“We really enjoy this program!!!. Our mental health related to depression, anxiety and stress are gradually being improved. Using images or animations in virtual reality tools indirectly trains our focus of attention to remember movements in brain jogging, neurotracker and aerobic circuit exercise (interview results with participants B, D, E, F, H, I, J, N).

**Discussion**

Through a mixed research methodology, our study intends to examine the impact of virtual reality on karate athletes' levels of mental health and cognitive function.

The first finding in a quantitative research showed that virtual reality-based physical activity had a better effect than the control group [56, 57]. This was because virtual reality-based physical activity programs promote fun, interesting exercise experiences [37, 39], the physical activity looks and feels like conducting activities in real life [40, 47].
In line with Mcclure & Schofield [58], with virtual reality, athletes can see and hear an environment that seems real. The results of this study are in line with previous research which revealed that virtual reality was proven to reduce levels of anxiety [38], and depression [46], because virtual reality-based physical activity was a strategy to provide pleasure to their users [4]. In addition, other studies had shown similar results, the effects of virtual reality-based physical activity were effective in reducing symptoms of high stress in adults [59]. Basically the main factor that can reduce symptoms of depression [44], and stress, to increase mental health was virtual reality technology creating an immersive and interactive environment [9, 60]. Harrison et al [61], involved thirteen female soccer players and the results showed that virtual reality technology interventions can reduce cognitive and somatic anxiety.

On the other hand, the second finding in this quantitative study showed that cognitive function of Karate athletes had changed, because virtual reality-based physical activity was an activity that presented a stimulus which can improve cognitive performance [62]. This was in line with other study from Zhu et al [3], that physical activity with virtual reality technology interventions was a powerful method to improve cognitive function. Basically, physical activity such as brain jogging, neurotracker and aerobic circuit were immersive stimuli that required athletes to see, hear and remember all their movement patterns, which could improve cognitive function [63], related to focus attention [64]. Other research also confirmed that virtual reality physical activity had a positive effect on cognitive function in adults [39]. Krommidas et al [52], reported similar results, virtual reality-based physical activity had a higher score than the control group in developing cognitive function in children. In addition, according to Bauer & Andringa [65], virtual reality was an effective form of cognitive training for providing an immersive and interactive environment with real simulations which was suggested as a tool in improving cognitive function.

Meanwhile, qualitative research showed that the participants (athletes) provided various perceptions such as this virtual reality-based physical activity program has advantages in terms of fun, easy to implement and the exercises can be carried out without supervision from a coach. Apart from that, according to them this method had several weakness, namely this method could be assessed by limited athletes because not all athletes have virtual reality tools, it can impact to eye health if carried out for a long term and continuous duration, it must be carried out in a place far from vehicles and quite spacious and safe. In addition, another weakness was that it cannot be used on a large number of athletes, due to limited virtual reality tools. Participants argued that by participating in this virtual reality-based physical activity program, they felt happy and help to decrease depression, anxiety and stress and accelerate their cognitive function.

Thus, the uniqueness and novelty of this study was virtual reality-based physical activity was proven to have an effect on changes in the quality of mental health and cognitive function of Karate athletes with adolescents based on mixed research methods, while the differences in findings from previous studies were only proven in quantitative research.

**Conclusion**

Based on the results, it can be concluded that physical activity based on virtual reality was an effective way to change the level of mental health and cognitive function of Karate athletes. However, this study has limitations in terms of only involved participants from Karate. It is recommended that future research needs to be carried out by involving participants from other sports such as Pencak Silat or Muay Thai. This research contributes to the development of physical activity involving virtual reality, so that athletes can carry out this method continuously to foster their mental health and cognitive function to maintain and develop their competence in the future.

**Conflict of Interest**

Authors do not have any conflicts of interest to declare.
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