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Investigation on the Effect of Virtual Reality Training on Reaction Time in Football Goalkeepers

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Abstract

This study aims to investigate the effects of virtual reality (VR) training on the reaction times of football goalkeepers. A total of 12 male goalkeepers, who were officially licensed by the Turkish Football Federation (TFF), participated in the research. Among the 12 goalkeepers, 6 were assigned to the control group and 6 to the performance group. The performance group underwent a total of 12 training sessions over 6 weeks, training 2 days a week, using the Rezzil Player® virtual reality application. The control group continued with their regular team training sessions. Before and after the training period, a Go/No-Go test was conducted as a pre-test and post-test. According to the analysis results, a statistically significant difference was found in the reaction times of the application group ($p<0.05$). No significant change was detected in the reaction times of the control group ($p>0.05$). When comparing the performance group to the control group, a statistically significant positive difference in reaction times was observed in favor of the performance group ($p<0.05$). This study indicates that VR technology can be an effective method in reaction training for football goalkeepers. VR can be utilized as a beneficial tool for enhancing athletes' skills.

Keywords: Football, Virtual Reality, Training, Football Goalkeepers, Reaction.

Özet

Futbol Kalecilerinde Sanal Gerçeklik Antrenmanının Reaksiyon Süresine Etkisinin İncelenmesi

Bu çalışmanın amacı, sanal gerçeklik (SG) antrenmanlarının futbol kalecilerinin reaksiyon süreleri üzerindeki etkisini incelemektir. Araştırmaya, Türkiye Futbol Federasyonu (TFF) tarafından resmi lisans verilmiş 12 erkek futbol kalecisi katılmıştır. Araştırmamıza katılan 12 futbol kalecisi 6'sı kontrol grubu, 6'sı performans grubu olarak belirlenmiştir. Performans grubu 6 hafta boyunca haftada 2 gün olmak üzere Rezzil Player® sanal gerçeklik uygulaması ile toplamda 12 birim antrenman gerçekleştirmiştir. Kontrol grubu ise kendi takım antrenmanlarına devam etmiştir.

Araştırmanın başında ve sonunda ön-test ve son test olarak Go/No-Go testi uygulanmıştır. Analiz sonuçlarına göre, uygulama grubunun reaksiyon sürelerinde istatistiksel olarak anlamlı farklılık tespit edilmiştir ($p<0.05$). Kontrol grubunun reaksiyon sürelerinde anlamlı bir değişiklik saptanmamıştır ($p>0.05$). Analiz sonuçlarına göre performans grubu kontrol grubuyla karşılaştırıldığında reaksiyon sürelerinde istatistiksel olarak pozitif yönde anlamlı farklılık tespit edilmiştir ($p<0.05$). Bu çalışma, futbol kalecilerine yönelik reaksiyon antrenmanlarında SG teknolojisinin etkili bir yöntem olabileceğini göstermektedir. SG, sporcuların becerilerini geliştirmek için faydalı bir araç olarak kullanılabilir.

Anahtar Kelimeler: Futbol, Sanal Gerçeklik, Antrenman, Futbol Kalecileri, Reaksiyon.

INTRODUCTION

Football is one of the most popular sports globally, captivating millions of fans and athletes alike. During a match, players must rely not only on their physical prowess but also on their cognitive abilities to make rapid decisions and respond effectively to dynamic situations on the field (20). This is especially true for goalkeepers, who are required to make split-second choices during critical moments when the outcome of the game can hinge on their actions. The goalkeeper's position is vital in football, as improvements in their skills can have a profound impact on the overall performance of the team (14,22).

In recent years, advancements in sports science and training technologies have opened new avenues to enhance athlete performance. Within this context, virtual reality (VR) technology emerges as a groundbreaking tool that offers significant advantages for athletes during their training processes (10). By leveraging VR applications, athletes can develop their cognitive and motor skills through simulated training environments that closely replicate real-match conditions, allowing them to experience the pressures and nuances of gameplay in a controlled setting (4,7,22). Moreover, one of the remarkable features of virtual reality is its accessibility; athletes can utilize this technology without the necessity of an actual football field. This means they can engage in focused training, refining their skills in a safe environment where they feel secure and free from the physical wear and tear of traditional training. This flexibility not only enhances their training effectiveness but also encourages consistent practice, ultimately leading to improved performance on the field(5,22).

Virtual reality technology provides a unique platform for creating highly specialized training scenarios that cater specifically to the goalkeeper position in football (2,8). These meticulously designed scenarios enable goalkeepers to engage in simulations that target essential skills such as rapid response, strategic decision-making, precise positioning, and the execution of saves (2,16). One of the most significant advantages of VR applications is their ability to construct controlled environments that closely mimic the dynamics of real match conditions. This realism allows goalkeepers to pre-simulate a wide variety of challenging game situations they are likely to encounter, assisting them in acclimating to the pressures of live gameplay (8,17). By immersing themselves in these virtual scenarios, goalkeepers can substantially enhance their reaction times and fine-tune their decision-making skills, which are critical for delivering optimal performance during crucial match moments. For instance, within the VR environment, goalkeepers can practice against a range of shots from opposing players, coming from various angles and at different velocities (9). This practice not only improves their reflexes but also allows them to learn to anticipate the trajectory of the ball based on the attackers' movements, thereby improving their overall saving success rates. Additionally, the versatility of VR training extends to incorporating diverse elements that mirror real-life match situations. Goalkeepers can experience different weather conditions, such as rain or snow, and variations in field characteristics, such as turf or gravel, as well as simulate the unpredictable behaviors of various player types. By exposing themselves to these multifaceted scenarios, goalkeepers are better equipped to adapt and respond effectively to an array of challenges they may face during actual games (5, 7, 9, 18). This comprehensive and immersive training approach not only enhances their skill set but also instills a greater sense of confidence and preparedness, enabling them to perform at their best when it matters most.

Virtual reality technology offers not only a dynamic training environment for football goalkeepers but also serves as a valuable tool for accurately measuring their reaction times and monitoring their development over time (6,24). The comprehensive performance data generated during training sessions provides crucial insights that goalkeepers can analyze to gain a better understanding of their strengths and areas for improvement. This ability to track their progress enables athletes to make informed adjustments to their training approaches. Additionally, this wealth of information can significantly aid coaches in designing more targeted and effective training programs tailored to the specific needs of each goalkeeper (5,10, 12, 19). ultimately enhancing overall team performance. By leveraging these advanced metrics, both players and coaches can work collaboratively to optimize skill acquisition and performance outcomes.

The purpose of the study was to assess the effectiveness of VR applications in simulating real match conditions, grounded in theoretical foundations. This approach addresses the gap in existing literature regarding the impact of virtual reality on the development of cognitive and motor skills. Ultimately, the findings suggest that goalkeepers who engage in VR training can make quicker and more accurate decisions during critical moments of a game, providing significant advantages to their teams.

METHOD

The present study utilized experimental research models commonly employed in the field of sports science, employing a pretest-posttest control group design. The experimental design is a research domain in which data is generated to elucidate the causal relationships between variables under the researcher's control (13).

Data Collection Tools

In the present study, Reaction Wall and Rezzil Goalkeeper applications within the Rezzil Player® software, developed by Rezzil, were used as data collection instruments to measure the pre-test and post-test values. The Rezzil Player® application is a virtual reality platform that provides users the opportunity to work with virtual reality-specific three-dimensional glasses. This application offers users an effective means to train and develop the skills specific to football goalkeepers in any environment (football pitch, home, performance laboratories, etc.).

Population and Sample of the Research

The study included 12 licensed male goalkeepers (mean age: 21.87±1.15 years; height: 191.08±10.99 cm; weight: 80.28±11.50 kg) actively competing in Turkish Football Federation leagues, divided equally into control and performance groups. This sample size aligns with precedent VR-training studies in elite athletes, demonstrating significant effects with similar participant numbers, n=10 (19). All participants had ≥5 years of professional experience (consistent with talent development thresholds for goalkeepers (16). Exclusion criteria covered visual/neurological impairments, following standard protocols for motor learning studies (20). The Declaration of Helsinki guidelines obtained ethical approval (Protocol: 20.478.486 / 2581) and written informed consent. In line with their annual training and competition programs, all the football goalkeepers in the performance group trained with the Rezzil virtual reality application for 2 days a week for 6 weeks in the fitness center, before their regular team training. In the main training phase, which will take place with virtual reality:

1. Week: Rezzil Reaction Wall (Level 1)

2.ve 3. Weeks: Rezzil Reaction Wall (Level 2-3)

4.ve 5. Weeks: Rezzil G.K Drills

6. Week: Rezzil Reaction Wall and Rezzil G.K Drills

The training was conducted using the applications. At the beginning of the training, there was a 10-minute dynamic warm-up, a 30-minute main phase of the training carried out with virtual reality technology, with 1:1 rest given between sets, and a total of 1:3 rest time given during the exercise transition phases. In the last 5 minutes of the training, static stretching exercises were performed for recovery.

All applications lasted a total of 45 minutes. Conversely, the control group continued their team training in line with their annual training and competition programs for 6 weeks.

Performance Measurement Test

In the study, the Go/No-Go test was performed to measure the participants' reaction times. This test aims to measure the participants' ability to quickly and accurately respond to visual stimuli. After the practice trials, the participants performed 50 test trials. Each trial involves the display of "Go" or "No-Go" stimuli on the screen, with the duration randomly varying between 500-2000 milliseconds. Participants were instructed to press a key as quickly as possible when they saw the "Go" stimulus and to refrain from responding when they saw the "No-Go" stimulus. During the test trials, the participants' reaction times and accuracy rates were recorded in real-time (15).

Data Analysis

In the statistical analysis of the data from our study, the SPSS 25.0 software package was used. The normality of the data distribution was checked using the Shapiro-Wilks test. The within-group pretest-posttest differences were analyzed using the dependent samples t-test. The between-group differences were analyzed using the independent samples t-test. The significance level was set at $p<0.05$.

Ethical approval and institutional permission

To examine the scientific and ethical suitability of the research, an application was made to Manisa Celal Bayar University, Faculty of Medicine, Health Sciences Ethics Committee and an ethics committee permit was obtained (Document number: 20.478.486 / 2581).

RESULTS

Demographic information of participants: mean age, height, and weight of control and performance groups. The information related to this is provided below.

The control group has a mean age of 22,91±0,92 years, a mean height of 191,50±10,99 cm, and a mean weight of 80,28±11,50 kg. The performance group has a mean age of 20,82±0,75 years, a mean height of 190,65±11,34 cm, and a mean weight of 80,28±11,50 kg.

Table 1. Pre-test and post-test values Go/No-Go of the performance and control groups

Groups	Tests	N	Mean±SD (ms)	t	p
Control	Pre-test	6	334,0±90,1	0,194	0,239
	Post-test	6	364,0±88,1		
Performance	Pre-test	6	372,2±84,4	3,434	**0,003***
	Post-test	6	263,6±87,8		

*p<0.05

When Table 1 is examined, no statistically significant difference was detected in the control group's Go/No-Go pre-test and post-test mean scores ($p>0.05$). However, a statistically significant difference was detected in the performance group's Go/No-Go pre-test and post-test scores ($p<0.05$).

Table 2. Comparison of Go/No-Go test results between the performance and the control groups

Groups	Tests	N	Mean±SD (ms)	t	df	p
Performance	Pre-test	6	381,2,0±84,4	3,434	10	**0,015***
	Post-test	6	259,2,0±74,4			
Control	Pre-test	6	364,0±90,1	0,231	10	0,826
	Post-test	6	374,0±87,1			

*p<0.05

When Table 2 is examined, the results of the pre-tests show that there was no statistically significant difference in the Go/No-Go score averages between the performance and control groups ($p>0.05$). However, following the post-tests, a statistically significant difference was observed in the performance group's Go/No-Go scores compared to the control group ($p<0.05$). Specifically, the reaction time scores of the performance group decreased, indicating improved performance compared to the control group.

DISCUSSION AND CONCLUSION

This study aimed to investigate the effect of virtual reality training on reaction time in football goalkeepers, focusing on how immersive VR experiences can enhance the cognitive and motor skills necessary for goalkeeping. By simulating real match scenarios, the research sought to determine whether virtual reality could provide a competitive edge in improving the decision-making speed and accuracy of goalkeepers during critical moments in a game. Ultimately, the study aimed to contribute valuable insights into the integration of innovative training techniques within sports performance enhancement.

As a result of the study, it was determined that the performance group, which participated in the 6-week training, exhibited a statistically significant improvement in reaction times compared to the control group, according to the statistical tests conducted (19,20). This increase can be attributed to the immersive nature of virtual reality training, which has been shown in previous research to enhance cognitive processing and perceptual skills. By engaging in realistic scenarios that challenge their decision-making abilities, goalkeepers in the performance group were able to develop faster neural responses and improve their overall reaction times. These findings align with existing literature that supports the effectiveness of VR technology in facilitating skill acquisition and performance enhancement in various sports contexts Barbosa et al. (1) in their study, they found that the exercises using virtual reality technology improved the reaction times of child athletes. Goyal et al. (5) in their study specific to the tennis branch, they found significant differences in reaction time and coordination times in the group that trained with VR. This study is parallel to the results of the performance group working with the Rezzil Player® application in our study. Theofilou et al. (20) in their study on young football players, they performed Fitlight, VR and cognitive function training for 6 months contributed to the reaction time of the football players. As a result of this study, they found that virtual reality technology improved the reaction time of young football players. Witte et al. (23) in their study on karate athletes, they found that VR exercises not only improved their motor skills, but also effectively developed their reaction times. Wood et al. (24) in their study, they found significant differences in football-specific technical skills and decision-making skills of football players using the Rezzil virtual reality application. Shimi et al. (19) In their study aimed at improving attention skills in football, the participants were given the goalkeeper task using VR technology and were asked to respond to the perceived skills. As a result of this study, they found that the participants' perception improved, and their attention skills developed. Bideau et al. (3) in their study on handball goalkeepers, they created virtual opponents guided by a kinematic animation model using virtual reality technology to examine their reaction times as in real match performance. As a result of this analysis, they found significant differences in the reaction times of handball goalkeepers. This study is parallel to the results of the performance group working with the Rezzil Player® application in our study. Krupitzer et al. (14) in their study on football players using the CortexVR application, they found significant differences in the reaction times of football players, which affected their cognitive fatigue levels. Tomic et al. (21) In their study on football players, they simulated a real-world football match in the virtual world. In this study, they asked the athletes to react as quickly as possible to the simulated images and take action accordingly. As a result of the examinations, it was determined that there were significant differences in the reaction times of the football players during the simulated football match in virtual reality. This study is paralell to the results of the performance group working with the Rezzil Player® application in our study. When the literature was reviewed, it was determined that the training carried out with virtual reality technology allows the participants to develop their skills by enjoying them more, and these skill acquisitions have increased positively (11).

The studies on the use of virtual reality technology in improving sports performance are not yet sufficient. However, existing studies show that virtual reality applications can provide a more effective training method for transferring skills learned in the real world, due to their comprehensive nature as simulators.

In conclusion, according to this study, it was concluded that the training carried out with virtual reality technology was effective in reducing the reaction times of football goalkeepers. Based on this, we can say that the opportunities provided by virtual reality technology can be used as an effective training model in reaction training specific to football goalkeepers.

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