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The Effect of Virtual Reality Training on Heading Skills in 12-13 Years Old Child Footballers*

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Abstract

This study aims to evaluate the effectiveness of the heading skills of virtual reality training in 12–13 years old child football players. 24 child football players between the ages of 12-13, licensed by the Turkish Football Federation as amateur athletes, participated in this study. 24 volunteer participants participated in the 8-week training process in 3 groups. Each group has 8 players. These groups are as follows; first, the VR group which performs football heading shoot skill only with virtual technology method, second, VR and traditional method group which uses virtual reality and traditional methods in a mixed way, third, the control group which uses only traditional methods. The instructional design model carried out in the research is five-stage instructional design model developed by Kalkan and Çamlıyer (2020). The performance test of the research was carried out as a pre-test, mid-test, and post-test. As a result, it was concluded that virtual reality technology can be used as an effective training method in the development of heading skills in football.
Keywords: Football, Training, Virtual Reality, Technique, Skill

12-13 Yaş Çocuk Futbolcularda Sanal Gerçeklik Antrenmanının Kafa Vuruşu Becerisine Etkisi

Öz

Bu çalışmanın amacı, 12-13 yaş arası çocuk futbolcularda sanal gerçeklik antrenmanının kafa vuruşu becerisinin etkisinin değerlendirilmesidir. Araştırmaya 12-13 yaş arasında, Türkiye Futbol Federasyonu tarafından amatör sporcu lisansına sahip 24 çocuk futbolcu katılmıştır. 24 gönüllü katılımcı, sadece sanal gerçeklik teknolojisi yöntemi ile futbol kafa vuruşu becerisini uygulayan SG grubu, sanal gerçeklik ve geleneksel yöntemlerin karma bir şekilde kullanıldığı SG ve geleneksel yöntem grubu ve sadece geleneksel yöntemlerle antrenman yapan kontrol grubu olarak, 3 ayrı gruba 8'er kişi olarak ayrılarak 8 haftalık antrenman sürecine katılmışlardır. Araştırmada, Kalkan ve Çamlıyer (2020) tarafından geliştirilen beş aşamalı öğretim tasarım modeli kullanılmıştır. Araştırmanın performans testi ön-test, ara-test ve son test olmak üzere gerçekleştirilmiştir. Araştırmanın sonucu olarak elde edilen bulgular sanal gerçeklik teknolojisinin futbolda kafa vuruşu becerilerinin geliştirilmesinde etkili bir antrenman yöntemi olarak kullanılabileceği sonucuna varılmıştır.
Anahtar kelimeler: Futbol, Antrenman, Sanal Gerçeklik, Teknik, Beceri

* This study was produced from an MSc thesis (No: 693422) conducted by the 1st Author under the consultancy of the 2' Author.

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INTRODUCTION

Virtual reality technology is a system that enables individuals to perceive a virtual environment in a real-like way by using their senses or to experience events as if they are reliving them (Emmelkamp & Meyerbröker, 2021; Thatcher et al., 2020). Virtual reality technology is used in many fields such as physical therapy and rehabilitation, military field education, examination of space sciences, and design (Gasco et al., 2014; Jorgensen et al., 2022; Jotwani et al., 2021; Neroni et al., 2021). In addition, the use of virtual reality technology has increased significantly in recent years, including many team sports or individual sports. It has been proven by studies that virtual reality technology, which has been adopted by sports clubs and trainers in different branches in recent years, will also be beneficial in terms of sportive performance (Li et al., 2022; Romeas et al., 2022; Zhao & Guo, 2022).

Many skills form the basis of performance in the game of football, but the most decisive element is considered to be decision-making. Coaches' athletes have limited opportunities to develop decision-making in training and competitions. When this situation is evaluated, it is generally used to improve decision-making and technical skills after the exercises to be performed with virtual reality technology in training (Dowsett et al., 2022; Kittel et al., 2019; Neroni et al., 2021; Thatcher et al., 2020). When the use of virtual reality technology is examined in the field of football and especially in the long-term development of athletes in child football players, the child football players between the ages of 12-13 in our study are in the age range of training for training (Balyi et al., 2013; García-Angulo et al., 2020). During this period, skill training should be increased in parallel with the training intensity. Thus, mental, and spiritual endurance and improvements in concentration occur. This situation plays an important role in directing the technical skill teaching method to be applied in training and increases the awareness of the players in terms of the tactics carried out in the game (Balyi et al., 2013; García-Angulo et al., 2020; Jayanthi et al., 2022; Till et al., 2021; Varghese et al., 2022). Compared to other branches, football draws attention in terms of double struggles and the resulting concussion injuries. Recent studies in football show that traumas caused by heading have increased. In particular, concussions constitute 9.6% of injuries in all young American football players (Milef et al., 2022). In football, the definition of concussions has changed over time. Also, situations that were not considered injuries 20-25 years are defined as injuries now. A statistic that has been reasonably stable over time has found that any head or neck injury (crush, tear, concussion, eye, etc.) accounts for 15% of all injuries (Kirkendall & Sayers, 2020; Milef et al., 2022; Patton et al., 2021). However, clinical and research studies have focused on concussions, which are very rare injuries. There were 3 documented concussions in 64 games at the 2014 FIFA Brazil World Cup at a rate of 0.14/1,000 match hours. In other words, the injury frequency per match is 0.05 (Kirkendall & Sayers, 2020; Milef et al., 2022; Patton et al., 2021; Tomblin et al., 2020). Based on these cases, virtual reality training may be used in child football players to improve their heading skills without a ball being impacted on the head (Wood et al., 2021).

In addition, virtual reality training can be defined as a training method that uses the materials of virtual reality technology in an environment where they feel safe, without being in a training area, to improve their physiological development, technical and tactical development. It might

improve people in the rehabilitation phase and especially increase the decision-making process to the maximum limits (Nambi et al., 2021; Oagaz et al., 2021; Wood et al., 2021). The effects on technical skills have been proven in the studies specific to the table tennis branch carried out thanks to virtual reality technology (Kalkan & Çamlıyer, 2020; Nambi et al., 2021; Oagaz et al., 2021). Therefore, the study aims to improve the heading technical skills of child football players by using virtual reality technology without experiencing any injuries due to heading at a young age in the future.

METHODS

Research Model

In this study, the research design consists of the pre-test, mid-test, and post-test experimental designs, and they are matched paired control group design. Experimental design is the research area in which the data to be observed are produced to discover the cause-effect relationships between the variables under the researcher's control (Karasar, 2005).

Sampling

A total of 24 male football players between the ages of 12 and 13 participated in the research. Those players were also licensed by the Turkish Football Players. The subject of the research was explained to the athletes and their parents before the start of the study. Consent and voluntary consent forms were signed by the parents who accepted them. There are 24 participants in total, 3 separate groups, each group consisting of 8 players. The control group includes 2 defenders, 2 wing and fullback players, 2 midfielders, and 2 forward players. The VR group includes 2 defenders, 2 wing and fullback players, 2 midfielders, and 2 forward players. The VR and traditional method group includes 2 defenders, 2 wing and fullback players, 2 midfielders, and 2 forward players.

Virtual reality technical skill learning opportunities, five-stage instructional design model and the mixed application of these two methods were combined with traditional methods and the effect on learning was tested (Figure 1). According to the opinions and suggestions of the experts, the training period of this study is 8 weeks, and the evaluation of the learning criteria consists of measuring the head skills by testing.

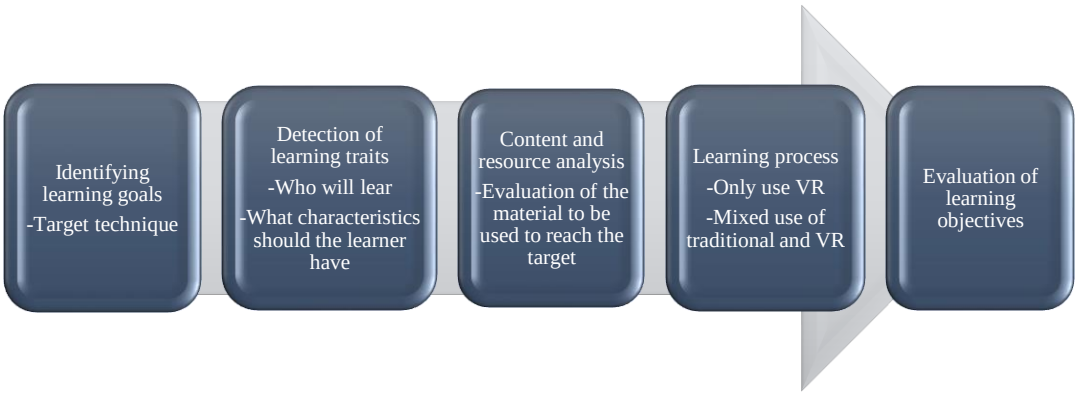

Figure 1. Instructional Design Model Executed in the Study (Kalkan & Çamlıyer, 2020).

The control group participated in training with classical methods for 8 weeks, 2 days a week. The control group participated in stretching exercises for 15 minutes of warm-up, 5 minutes of rest, 30 minutes of main training, and 10 minutes of recovery. VR group, 8 weeks, 2 days a week, participated in the studies to improve the heading technique in football with the Head Smart VR application developed by Rezzil, they participated in 15 minutes of warm-up, 5 minutes of rest, 30 minutes of main training, and 10 minutes of stretching for recovery purposes. VR and the traditional group participated for 8 weeks, 2 days a week, with 15 minutes of warm-up, 5 minutes of rest, 30 minutes of main training and traditional heading training, and the Head Smart VR application developed by Rezzil to improve the heading technique in football. In the last phase of the training, they applied stretching exercises for 10 minutes for recovery.

The training program performed by the participants included,

- 5 minutes warm-up with a soccer-specific ball
- 5 minutes of joint mobility and dynamic stretching
- 5 minutes of warm-up with soccer-specific
- Main training phase: 30 minutes
- Cool-up: 10 minutes of stretching exercises

During the training and studies, two trainers, who are experts in their fields, have the coaching certificate of the relevant federation, and graduated from the faculty of sports sciences, took charge.

Research Ethics

Approval was obtained with the "Informed Voluntary Consent Form". The ethics committee decision was taken from Manisa Celal Bayar University, The Health Sciences Ethics Committee and Ethics Committee Permission was obtained (Document date and number: 22.07.2020 / 20.478.486 /467).

Data Collection

Head Smart VR application, which was developed by Rezzil as a data collection tool in our research, was used to measure pre-test, mid-test, and post-test. Rezzil Head Smart application is an application designed to allow working with specific virtual reality technology. This application provides an opportunity for users to take care of any area (home, performance laboratory, football field, etc.) where they can effectively train and improve themselves for this skill. It is designed to improve soccer-specific heading at 5 different levels such as Level 1, Level 2, Level 3, Level 4, and Level 5, making the right decision under pressure, and improving heading skills by making the right decision in the moving game.

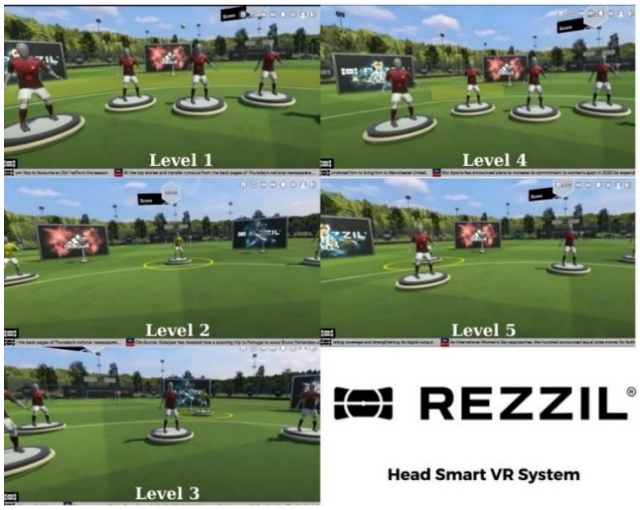

Photo 1. Rezzil head smart VR system.

Rezzil Head Smart application has been founded suitable by the experts to be used to improve football heading skills. It has been stated that the application's work with ball-throwing machine simulation can meet the performance measurement method and the purposes of our study.

The performance test of the practitioners participating in the research was carried out with the Court Mate Shooter ball throwing machine by taking the pre-test, mid-test, and post-test values.

Photo 2. Court mate shooter ball throwing machine

The data collection tool used in our groups was determined during the performance test in line with the functionality of the Rezzil Head Smart application. Subjects were asked to heading coming from the ball throwing machine, which was placed at distance intervals according to the regular football measurements, with a heading to the colored area in the same direction.

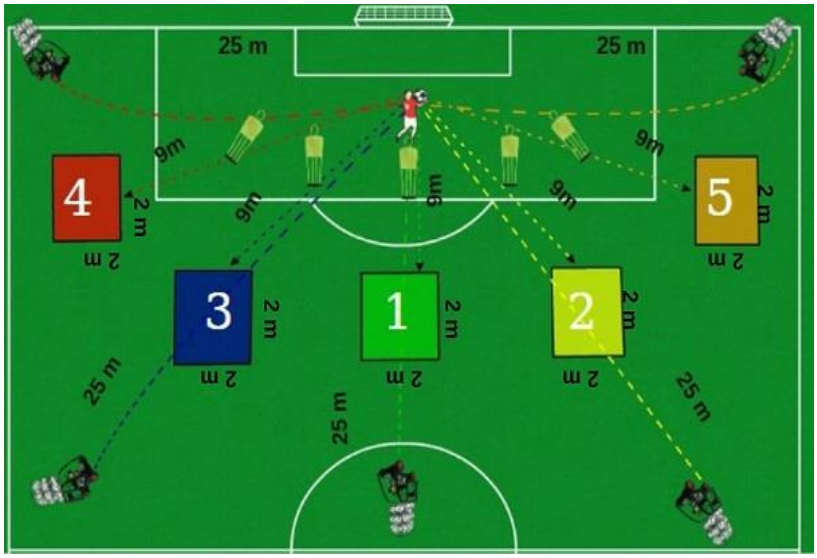

Photo 3. Performance test evaluation pattern

Data Analysis

According to the results of the pre-test applied in the environment where the application will be made, three groups that did not differ significantly between them were randomly assigned the control group, VR group, VR, and traditional method groups. As a result of the pre-test being made to form the groups, even if all the congruences are met, if the pre-test equality could not be achieved, a one-way analysis of variance was applied. Heading skill assessment track achievement test results related to skill learning between control and practice groups. If the results showed normal distribution, Independent Sample T-Test was applied to evaluate the differences from parametric tests, and Related-Sample T-Test was applied to look at the test success within the groups. If the results did not show normal distribution, and if the repeated analysis of variance yielded significant results, T-tests paired with Bonferroni correction were performed.

FINDINGS

Findings on Pre-Test Averages of Experimental Groups

One-way analysis of variance was performed to determine whether there was a significant difference between the pre-tests of the experimental groups in terms of heading. The results of the analysis showed that there was no significant difference between the control group, VR group, and VR traditional method groups in terms of heading ($F_{(2.23)}$ =,639, p=,538).

Table 1. Pre-test averages of experimental groups

Groups	*n*	$\bar{X}$	*S*	*f*	p
Control Group	8	3,42	1,20		
VR Group	8	3,27	,90	,639	,538
VR& Traditional	8	2,92	,45		

***p<0.05**

Three repeated measures analysis of variance was performed to examine the effect of the experimental intervention in the control group, VR group, and VR and traditional groups. With the aforementioned analysis, the pre-test, mid-test, and post-test headings were compared within each group. If the sphericity assumption was violated while reporting the results of the repeated measurements analysis of variance, the degree of freedom was corrected with the Greenhouse-Geisser method. T-tests paired with Bonferroni correction were performed if repeated analysis of variance yielded significant results. Accordingly, the standard confidence interval was accepted as 0,05. Repeated measures analysis of variance was performed to examine the difference in heading rates in the control group in pre-, intermediate and post-test. The results showed no significant difference between the pre-, intermediate, and post-test in terms of the dependent variable ($F_{(2,14)}$ =,905, p=.427, η2 =,11).

Table 2. Pre-, mid and post-test results of the control group

Control Group	*n*	$\bar{X}$	*S*	*f*	p
Pre-Test	8	3,42	1,20		
Mid Test	8	3,27	,90	,905	,427
Post Test	8	2,92	,45		

***p<0.05**

Findings on The Virtual Reality Group

The results of repeated measures analysis of variance in the VR group indicated that there was a significant difference between the pre-, intermediate and post-test in terms of the dependent variable in the VR group ($F_{(2,14)}$ = 8,5, p=.004, η2=,55). After repeated measures analysis of variance yielded significant results, three paired T-tests were performed with Bonferroni correction to determine the source of the difference. The results showed that the heading increased significantly from the pre-test to the mid-test in the VR group (T(7) =15,34, p=,001). In addition, the heading accuracy increased significantly from the pre-test to the post-test. (T(7)= - 6,89, p=,001). However, no significant difference was found between the mid-test and the post-test in the heading (T(7)=1,34, p=22).

Table 3. Pre-, mid and post-test results of the virtual reality group

VR Group	*n*	$\bar{X}$	*S*	*f*	p
Pre-Test	8	3,27	,90		
Mid Test	8	4,30	,74	8,52	,004*
Post Test	8	4,25	,92		

***p<0.05**

Findings on Virtual Reality and Traditional Method Group

The results of repeated measures analysis of variance in the VR and traditional groups indicated that the heading in the VR and traditional groups showed a significant difference between the pre-, intermediate and post-test ($F_{(618, 826)}$ = 46,06, p=,001, η2=86). Repeated measurements were matched with the Bonferroni correction to determine the source of the difference after the analysis of variance yielded significant results. Triple-paired T-tests were performed and, the results indicated that heading accuracy increased significantly from pre-test to mid-test in the VR and traditional groups (T(7)=-15,34, p=,001). The heading accuracy increased significantly

from the pre-test to the post-test (T(7) = - 6,89, p=,001). On the other hand, no significant difference was found between the mid-term and post-test in terms of heading in the VR and traditional groups (T(7) = -1,34, p=,221).

Table 4. Pre-, mid and post-test results of virtual reality and traditional group

VR& Traditional Group	*n*	X̄	*S*	*f*	p
Pre-Test	8	2,92	,45		
Mid Test	8	5,07	,31	46,06	,000*
Post Test	8	5,47	,77		

***p<0.05**

Findings of Percentage Change between Experimental Groups

The percentage change between the dependent variable pre-test and post-test was calculated to examine the difference in development between the groups in the heading of the training method used. The post-test was divided by the pre-test and multiplied by 100. One-way analysis of variance was performed to examine the difference in percentage changes between the groups. After the results were obtained, Post Hoc analysis Tukey test was applied to measure the significance of the difference ($F_{(2,23)}$ =F11,23, P=,001). According to Tukey's results, the percentage change of the VR and the traditional group has a significantly higher change than the control group. Likewise, it was determined that the percentage change of the VR group had a higher change than the control group. In addition, VR and traditional groups differed more significantly from the control and VR groups.

Table 5. Experimental groups' percentage change findings

Experimental Groups	*n*	X̄	*S*	*f*	p
Control Group	8	95,82	38,82		
VR Group	8	133,71	30,39	11,23	,001*
VR& Traditional Group	8	193,60	52,64		

***p<0.05**

DISCUSSION

The total number of participants participating in our study is 24. Considering the age, height, and weight distributions of the participants, the mean height (157,50±10,99) of the control group, where all participants were between the ages of 12-13, was the mean weight (48,28±7,50) of the VR group (150,62±7,42) mean weight (43,41±8,19) was found to be (39,12± 5,80) in the VR and traditional group (145,750±7,16).

After 8 weeks of training, it was determined that the participants of the 3 groups differed from each other in their heading. In the performance tests to determine which training method provides more improvement in the participants, the change in heading rates over time in univariate analysis, it was determined that the training design in the VR group and the VR and the traditional group affected the change in heading rates over time. Farley et al., (2020) stated

in their research that the exercises performed for skill training with VR in sports provide advantages compared to the branch.

Michalski et al., (2019) found in their study accompanied by an expert trainer with VR technology that teaching technical skills in table tennis aim to train forehand and backhand techniques, specific to table tennis with VR technology. In this study, they applied both VR and reality-based exercises to one group of practitioners and the second group of practitioners with VR support. In line with the results of the study, improvement in forehand and backhand techniques was determined in the group that performed both VR technology and reality-based training together, compared to the other group.

Kalkan and Çamlıyer, (2020) found that participants who use virtual reality applications in learning VR-assisted table tennis skills improved their forehand skills compared to participants who learned with the traditional method. When this study is compared with our study, the results show the parallelism between the VR group and the VR and traditional group. Using virtual reality technology, thanks to Rezzil Head Smart, points are given for the heading of the practitioners to hit the specified areas. We can say that the practitioners who provide training increase their performance by increasing their motivation during the work. When the literature is examined, we can say that virtual reality contains motivating elements that affect technical skills (Oagaz et al., 2021; Pastel et al., 2022; Romeas et al., 2022; Thatcher et al., 2020; Zhao & Guo, 2022).

Nambi et al., (2021) found that balancing training with virtual reality technology had a neurological effect on individuals. Pastel et al., (2022) found that VR technology was effective in learning these movements in the training they performed using VR technology in learning complex sports movements. DiCesare et al., (2020) stated that VR can be a promising element for transferring sportive skills.

Balkó et al., (2018) examined virtual reality studies in sports and healthy environments and found that in most studies, the authors did not differentiate between immersive and non-immersive virtual reality. In his review, he said that the virtual reality environment can be useful for improvements in sports performance and motor skill control. Based on the post-test results for the heading skill, it was determined that the training made using virtual reality technology was superior to the control group. We can say that the development of the VR group and the VR and traditional method group of the groups that train with virtual reality technology in heading skill show parallelism. However, we can also say that the development of the group that applies VR and traditional methods in a mixed way, referring to the VR group, is at a higher level. In a study by Neumann et al., (2018) they examined about 20 articles covering the evaluations of VR applications used in the exercise. In the study, they found results that people who exercise with VR applications have improved in physiological and psychological performance stages. At this stage, it can be said that the VR group and the VR and traditional group training with virtual reality technology have an advantage over the control group and contribute to the heading skill. When the effects of the pieces of training on the general performance levels are compared, it has been observed that a mixed method such as "Virtual Reality and Traditional Method" contributes to a higher level of performance than the control

group, which only works with traditional method training. However, no significant difference was found between the VR group and the VR and traditional methods group.

Arndt et al., (2018) investigated whether VR could improve the technical skills of the athletes during rowing exercises by including an athlete in a virtual environment who performs the action of rowing with a stationary rowing machine. In the study, they said that virtual reality technology increases training performance, increases skill development, and can provide an enhanced experience in the VR environment for athletes as a result. Sato et al., (2015) indicated that no attempt was made on the control group, and exercise movements were performed on the VR group using "Kinect". Practitioners exercised a total of 24 times with the X-Box Kinect. As a result of this study, it was determined that balance, walking, and muscle strength were improved. Croft et al., (2011) found that carried out on the athletes in the Rugy Unions branch, the athletes training with VR technology compared to the control group continuing the classical training in the passing technique, elbow joint angles (5.8%), the angle of the forefoot (94.5mm), trunk flexion and pass. They found that the angle (17° wider) improved more. Mousavi et al., (2019) examined the effect of virtual reality on dart-throwing performance and kinematics in their study. In this study, they said that virtual reality can be used as an effective tool in learning motor skills. Nambi et al., (2020) examined they compared virtual reality training and isokinetic strength training in football players with chronic low back pain. In this study, they found that strength training with virtual reality technology is more effective than isokinetic strength training. We can say that these studies show parallelism with the results we reached in our study at the level of effect on the heading skill.

When we evaluate the experimental process of the research, we can say that the combination of HTC Vive and Rezzil Head Smart application can be evaluated as an effective method in improving the heading skills of practitioners. When the results were examined, it was determined that the use of VR and traditional method in a mixed manner was the most effective method. We can say that supporting a sports branch that is performed physically in the real world, thanks to advancing technological developments, will help users in real life in terms of performance, learning, and transferring these technological developments to today's world. Scientific research since this developing technology can be applied in the performance increase, different technical tactic learning, rehabilitation phase as a result of injury, regardless of amateur or elite athletes, and the effectiveness of the use of these technological developments as an advanced training method in the performance levels of athletes are becoming more and more important day by day. When the literature is examined, studies are carried out in this sense around the world, but their number is still small. In addition, the fact that virtual reality applications for sports are simulators will allow it to be a more effective training method within the scope of physical performance transfer to the real world.

When different game applications, libraries, or websites are examined, there are virtual reality games for many different sports branches such as football, tennis, table tennis, basketball, and boxing, but it has been observed that many of these games are not sufficient in this context. Therefore, we advocate that the studies should be evaluated and tested within the scope of expert opinion, as well as by experiencing different games and applications.

Studies that will provide performance development with virtual reality technology specific to sports branches are limited in the world literature. We can say that provide few studies provide the transfer of performance and skill to today's world made with the fully immersive system HTC Vive and its equivalents that we used in our study. In general, it has been observed that these studies are not fully immersive and are designed mostly for "Kinect" and rehabilitation studies.

Balkó et al., (2018) found that immersive virtual reality technology can be used to affect reaction times and decision-making in sports, in their review of virtual reality research in health and sports environments. In this study, they also stated that it is useful in teaching the movement given to the practitioner during rehabilitation. We can say that these results show that full immersive systems are more suitable for training, exercise, and sports. We can say that HTC Vive, the fully immersive system we used in our study, is suitable and supportive.

DiCesare et al., (2020) examined the reactions against the risks of injury in a simulated sports field and a real sports field using virtual reality technology. In this study, a VR environment that includes heading in football corner kick scenarios was provided to the participants working with traditional methods and working in a VR environment designed specifically for sports. As a result of the study, it was concluded that the participants working with VR performed more mindful behaviour against sports injuries than the participants working with traditional methods.

CONCLUSION

Given these results, the use of fully immersive virtual reality systems together with the Rezzil Head Smart VR application can be used as an alternative training method for performance improvement in football-specific heading skills. In addition, the use of virtual reality systems through games or applications with a head-mounted headset, thanks to game consoles and computer environments, can provide practitioners with different environments effectively and practically. Immersive virtual reality systems, which maximize the dimension of reality by providing full immersion privilege, apart from other technological systems without time and space limits, provide a fully interactive environment for practitioners. In this study, we examined only the heading skills of 12-13 years old child football players. In future research may be researched different football-specific technical skills. In addition, studies can be carried out using virtual reality technology in different branches and different gender and age ranges.

Conflicts of Interest: There is no personal or financial conflict of interest within the scope of the study.

Authors' Contribution: This Study was Produced from an MSc Thesis (No: 693422) Conducted by the 1st Author under the Consultancy of the 2 'Author.

Research Ethic Informations
Ethics Committee: Manisa Celal Bayar University Faculty of Medicine Health Sciences Ethics Committee
Date: 22/07/2020
Protocol number: 20.478.486

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