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ORIGINAL SCIENTIFIC PAPER

Effects of Integrating 3-D Virtual Reality Prior to Small-Sided Games on Intention to Continue Exercising, Teamwork, and Technical Performance in Young Soccer Athletes

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Abstract

In soccer, the use of small-sided game (SSG) is still a trend among professional coaches, but previous studies combining 3-DVR before SSG are still very limited. Our current study aims to analyze the effects of 3-DVR before SSG on intention to continue exercising (ItCE), teamwork (TW) and technical performance (TP) among young soccer athletes. Fifty young soccer athletes were involved as voluntary participants in a true experimental study with a randomized design and they were allocated into 3-DVR before SSG (n=25) and training control group (TCG, n=25). Measurements of ItCE, TW, and TP were conducted at pretest (T1), midtest (T2), and posttest (T3). The results of the mixed repeated measures ANOVA analysis showed that there was an interaction effect of training conditions × time, there was an effect of training conditions, and there was an effect of time for the variable parameters of ItCE ($p<0.05$ [large effect]), TW (all, $p<0.05$ [large effect]) and TP (all, $p<0.05$ [large effect]). Meanwhile, the results of the post hoc pairwise comparisons analysis showed that both the 3-DVR before SSG and TCG (only SSG) groups experienced an increase in ItCE, TW and TP scores at stages T1, T2 and T3. However, we observed that the increase was higher in the 3-DVR before SSG group than in the TCG (only SSG) group. Thus, our study adds to the literature proving the positive effects of 3-DVR before SSG on increasing ItCE, TW and TP among young soccer athletes.

Keywords: *soccer performance, virtual-based teaching, modified game, youth athletes*

Introduction

Modern soccer today demands high physical, tactical, psychological and technical demands (Guneralp et al., 2025; Ridwan et al., 2025). These factors are known to significantly affect the performance of young athletes and can determine the outcome of a match (Pancar et al., 2025). Of these many factors, the aspects of intention to continue exercising (ItCE), teamwork (TW), and technical performance (TP) are the most central and are currently the focus for young athletes.

Contextually, the ItCE aspect describes athletes' ability to maintain their intention to continue their exercise activities at present or in the future (Yang et al., 2025). ItCE is essentially based on the theory of planned behavior (TPB), which explains how a person's intention to act can influence behavioral practices to achieve a goal (Sas-Nowosielski & Nowicka, 2018). In Asian countries such as Korea, research on ItCE is still limited (Park et al., 2023), including in Indonesia. Most studies on young athletes still focus on factors that can influence competition performance rather than ItCE. Previous literature reveals that ItCE has the potential to provide important benefits for young athletes, such as athlete enjoyment (Teixeira et al., 2022). In addition, ItCE is known to predict a person's behavior in performing an activity. For example, high ItCE will result in positive behavior related to an increase in the level of regular participation in sports exercise (Kim, 2022). Meanwhile, low ItCE is associated with negative behaviors such as the potential to quit exercise and in the worst case, to stop being an athlete (Rodrigues et al., 2019). Apart from ItCE, another aspect that is no less important to pay attention to is the TW of young athletes. Conceptually, TW can be interpreted as the ability of young athletes to perform well in cooperation (Ball et al., 2025). Basically, TW is closely related to the cooperation between athletes in organizing an attack or when defending (Práxedes et al., 2018). In addition, high TW makes it possible to produce an effective attack and ultimately score goals (Gesbert et al., 2017). Furthermore, TW can produce a team with a strong defense, making it difficult for opponents to penetrate. Thus, it is crucial to encourage young athletes to improve their TW quality.

Professional coaches today have recommended that in soccer, young athletes should master basic techniques such as dribbling, passing, and shooting (Guneralp et al., 2025; Pop et al., 2022). In the field of soccer, it has been shown that TP has been considered an important factor for decades because it can significantly influence the outcome of a match (Ridwan et al., 2025). In addition, high technical performance can be a major predictor of young athletes achieving peak performance, while low technical performance can worsen the future careers of young athletes (Sørensen et al., 2024)

In recent years, the application of modern technology has brought about significant changes in various fields, including: medicine, business, tourism, and competitive sports such as soccer. The integration of 3-D virtual reality (3-DVR) is one type of modern technology that is beginning to be considered by some professional coaches for competitive sports training (Günar & Bavlı, 2025; Lachowicz et al., 2025) and has become a global phenomenon that is changing the paradigm of traditional training towards a more innovative, interactive, and immersive simulation-based approach (Lewellen et al., 2025). Data shows rapid growth in the use of 3-DVR and it has now gained recognition for its potential to revolutionize training methodologies in various sports fields (Ma et al., 2024). Essentially, 3-DVR technology now functions not only as a visual aid, but has evolved into a training platform capable of creating a fully virtual immersive simulation world (Richlan et al., 2023) and providing a much more enjoyable training experience that can be tailored to the individual needs of young athletes. The application of 3-DVR technology allows young athletes to observe and analyze various technical performances in specific sports and ultimately have the opportunity to learn technical performance optimally (Günar & Bavlı, 2025). Additionally, current phenomena based on previous studies have shown that 3-DVR technology has been proven to have positive impacts, such as offering an effective approach to enhance muscle activation in athletes (Bedir et al., 2025).

Applying 3-DVR technology before training, including small-sided games (SSG), is a strategy that is expected to be more effective. In recent years, SSG has remained a trend among coaches in the world of soccer training (Pancar et al., 2025). Essentially, SSG is a training methodology that focuses on presenting a modified form of soccer (Custódio et al., 2022). In addition, based on previous literature, modifications can be made to the rules of soccer, such as the number of players, time, or field size (Bekris et al., 2022). SSG allows novice athletes to focus on practicing soccer technical skills similar to those in actual matches but on a field smaller than the FIFA standard size (Castillo et al., 2020). Furthermore, SSG presents games with fewer players, for example, involving the use of a 4 vs. 4 and 5 vs. 5. Several recent studies report that SSG remains consistent and has a significant positive impact on changing the physical tactical, and psychological performance of soccer athletes (Ridwan et al., 2025).

By combining 3-DVR before SSG, this can offer a new training climate that is far different from traditional SSG training, because the training session will begin with beginner athletes observing every technical performance movement through 3-DVR before carrying out SSG. However, to the best of our knowledge, there are still limited researchers who directly report the effects of incorporating 3-DVR before SSG and its influence on ITCE, TW and TP aspects is not clear. Thus, our study aims to analyze the effects of applying 3-DVR before SSG on ItCE, TW and TP among young soccer athletes. In this case, we hypothesize that the 3-DVR program before SSG training can significantly affect the aspects of ItCE, TW and TP higher than the training control group (TCG).

Materials and methods

Sample size and randomization

In this study, the minimum sample size was calculated in advance using G-Power software version 3.1.9.7 (University of Dusseldorf, Dusseldorf, Germany) by entering the following statistical parameters: effect size f=0.25, α=0.05, statistical power 1-β=0.95. Thus, the calculation results showed that a minimum sample size of 44 participants was required to achieve adequate statistical power. Considering the potential

dropout rate (approximately 5%) among young athletes, we recruited a total of 50 participants consisting of male young soccer athletes who voluntarily participated in this study. The random assignment of participants into the 3-DVR group before SSG and TGC training involved the use of Random Allocation Software with the assistance of a computer expert.

Participants and design

In this study, we recruited participants based on the following inclusion criteria: (i) male athletes at the beginner level (aged 17-19), (ii) not currently ill, injured, or suffering from chronic diseases such as heart disease or asthma that could interfere with the intervention program, (iii) obtained parental consent. Participants were randomly assigned to either the 3-DVR group before SSG training (n=25) or TGC (n=25). Voluntary consent forms were signed by the parents of the beginner athletes, and they were given information about the tests and training program. In addition, they were informed that this research was voluntary and that beginner athletes could withdraw from our research activities at any time. This research protocol was approved by the State University of Yogyakarta Ethics Committee (Approval Number: 789/UNY/10-08-2025), and our research was conducted based on the principles and rules of the Declaration of Helsinki. Information about our participants is presented in Table 1.

Table 1. Characteristics of Participants

Characteristic Parameters	Groups	Mean±SD	p
Age	3-DVR before SSG (n=25)	17.60±0.76	0.23
(years)	TCG (Only SSG) (n=25)	18.00±0.86	
Height	3-DVR before SSG (n=25)	161.00±4.25	0.25
(cm)	TCG (Only SSG) (n=25)	163.00±4.49	
Weight	3-DVR before SSG (n=25)	56.10±2.39	0.30
(kg)	TCG (Only SSG) (n=25)	57.60±2.89	
Body mass index	3-DVR before SSG (n=25)	21.80±0.98	0.07
(kg/m²)	TCG (Only SSG) (n=25)	22.00±1.06	
Soccer training experience	3-DVR before SSG (n=25)	1.88±0.53	0.45
(years)	TCG (Only SSG) (n=25)	1.68±0.56	
SSG training experience	3-DVR before SSG (n=25)	1.52±0.59	0.06
(years)	TCG (Only SSG) (n=25)	1.40±0.50	
Experience using 3-DVR	3-DVR before SSG (n=25)	1.42±0.50	0.29
(years)	TCG (Only SSG) (n=25)	1.35±0.49	

Note. 3-DVR: 3-D virtual reality; TCG: training control group; SSG: small-sided game; S.D: standard deviation; n: participants; p: significance.

In this study, we determined to use a true experimental pretest (T1), midtest (T2)-posttest (T3) with a randomized design from August to September 2025. During this period, participants (young athletes) engaged in a 3-DVR training routine before SSG and TCG, which only underwent SSG. The experimental program routine is carried out every 3 sessions/week, especially on Wednesday, Friday and Sunday. In the first week, participants performed T1, which was the measurement of ItCE, TW, and TP. Then, in the second to fifth weeks following, the participants performed the experimental condition. In the sixth week, the participants carried out T2, which was a measurement of the same aspects as in the T1 stage. Then, in weeks eight and nine, the experimental condition was reapplied to the two groups. In the tenth week, participants carried out T3, namely re-measurement activities related to ItCE, TW and TP with the same time and rules as T1 and T2 (see Figure 1).

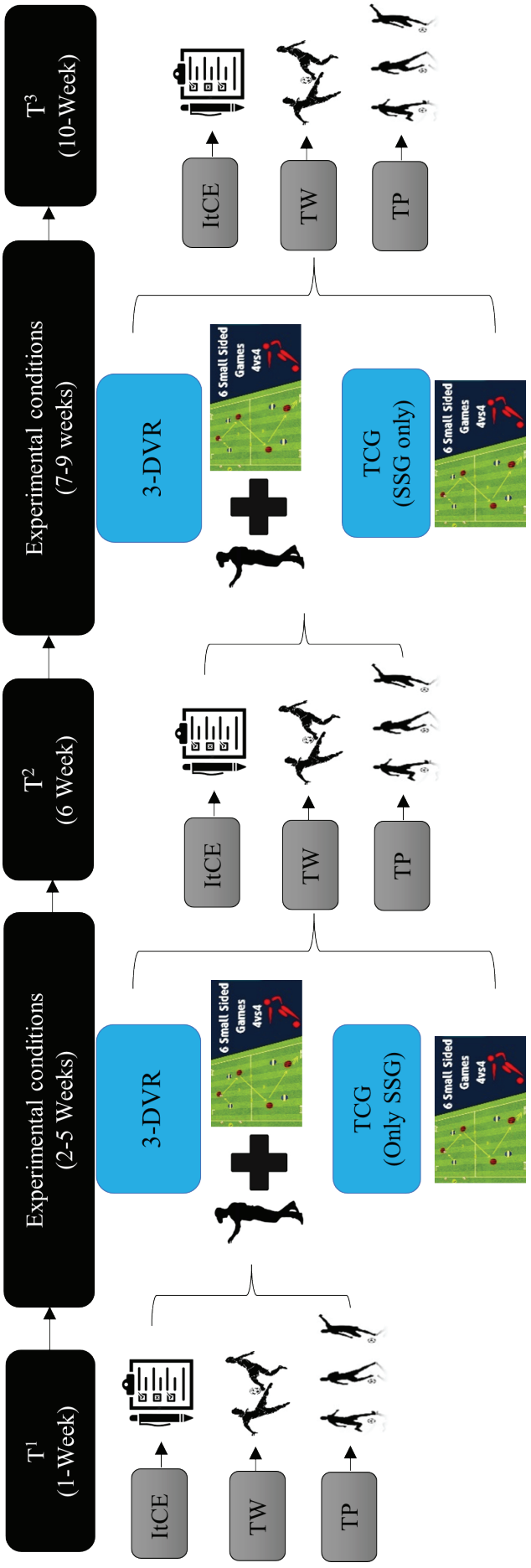

Figure 1. Experimental design settings. Note. ItCE: intention to continue exercise; TW: teamwork; TP: technical performance; 3-DVR: 3-D virtual reality; TCG: training control group; SSG: small-sided game; T1: pretest; T2: midtest; T3: posttest.

Measures

Anthropometric measurements

Before the intervention program was carried out, the research team first collected information on age, soccer training experience, SSG training experience, and experience using 3-DVR. In addition, anthropometric measurements included height with an accuracy of 0.1 cm (Seca 769, Hamburg, Germany) and weight with an accuracy of 0.1 kg (Tanita TBF 300, Tokyo, Japan). BMI was calculated by dividing body weight (kg) by height squared (m^2) (BMI=kg/m^2) (Guneralp et al., 2025).

Intention to continue exercise (ItCE)

A previous study recommended the Intention to Continue Exercise Scale to measure the extent to which athletes intend to train at present or in the future and based on a previous study that three items were used to assess the intention to continue exercising (Teixeira et al., 2022). Example of a question item: "I will continue to practice soccer as I do now or in a very similar way with the same type, frequency, duration, and intensity," and "I will continue to practice soccer in the next 6 months as I do now. Participants answered each item using a 7-point Likert scale ranging from 1 (“Not at all”) to 7 (“Very much so”). Scores were calculated by summing all questionnaire items, with the highest score indicating a high level of ItCE in young athletes. In the context of this study, the reliability test-retest value obtained was 0.91 while validity was 0.88.

Teamwork (TW)

In this study, to measure the teamwork level of young soccer athletes, we adopted the Soccer Teamwork Skills Scale (STSS) from a previous study (Liu et al., 2022). However, based on the needs of this study, we revised the questionnaire and translated it into Indonesian. The STSS consists of fourteen items from three dimensions: (i) Team Support-Offensive Capacities (the athlete's ability to provide important passes to teammates in offensive), (ii) Team Support-Defensive Capacities (the athlete's ability to provide assistance and cover teammates in defense), and (iii) Team Support-Communication Capacities (the athlete's ability to understand signals or communication from teammates). All questions were answered using a Likert scale from 1 ("I never do it!") to 5 ("I always do it during matches!"). The test-retest reliability value of STSS was 0.80 and Cronbach α was 0.96 which has been reported in previous studies (Liu et al., 2022).

Technical performance (TP)

In this study, to measure TP among young soccer athletes, we used several test items, such as: (i) the Loughborough Soccer Passing Test (LSPT) (Bian et al., 2022) and the Loughborough Soccer Shooting Test (LSST) (Liu et al., 2025), which have been widely validated in previous literature. The LSPT evaluates the accuracy of passes directed at a moving target, and the LSST measures the accuracy of shots from various distances directed at a target zone. Meanwhile, to measure the level of speed in dribbling, we used the Short Dribbling Test (SDT), which has been used in a previous study (Gidu et al., 2022). Each test was conducted three times. Additionally, scoring for the LSPT and LSST was done by summing the points obtained from the three attempts. Meanwhile, the SDT assessment is carried out by recording the speed of dribbling the ball in seconds from start to finish with a distance of 15 meters. In the context of this study, the reliabilitas test-retest value obtained was 0.94 (LSPT), 0.90 (LSST) and 0.88 (SDT), while validity was 0.88 (LSPT), 0.96 (LSST) and 0.91 (SDT).

3-DVR before SSG program

The 3-DVR program before SSG was conducted on a soccer field at a university in Indonesia. The 3-DVR program before SSG started at 9:00 to 10:00 a.m. This program is divided into several activities:

First activity. First, the application used is VRFS-Football (Soccer Simulator) and the headset is from the Meta Quest 2 product. Furthermore, a controller is used to select features and move soccer training activities. In VR, all participants are presented with various shooting, passing, and dribbling exercises in a virtual environment. This VR also includes a feature explaining the various tactical patterns that can be used in soccer games. VR content has been standardized across all sessions for participants. Meanwhile, the virtual avatar feature can represent both the team and the opponent during soccer matches. Second activity. After the analysis activity using 3-DVR was completed, it was followed by a warm-up activity (5 min). All participants performed full body stretching (Proprioceptive Neuromuscular Facilitation Stretching). Third activity. The SSG activity was conducted for 20 minutes (round 1) in a 4-on-4 format without a goalkeeper and with a modified field size (length = 10 x width = 15). After finishing, participants were instructed to rest (2 min) and then enter round 2, where participants performed SSG activities again for 20 minutes in a 5-on-5 format and field size (length=25 x width=20). Fourth activity. The activity ended with an evaluation and cool-down (3 min).

Statistical analysis

Descriptive statistics in the form of mean, S.D and percentage change (%Δ) were reported for all dependent variables (ItCE, TW, TP) separately for the 3-DVR before SSG and TCG (only SSG) groups at each measurement point (T1, T2, T3). Preliminary analysis was conducted to test statistical assumptions, including distribution normality (Shapiro-Wilk test), and the results showed that all data were confirmed to be normally distributed (all, $p>0.05$). The analysis used mixed repeated measures ANOVA, focusing on the effect of significant interactions (training condition vs. measurement time). In addition, the main effects of the between-subjects factor were training conditions (3-DVR before SSG vs. TCG [only SSG]) and the within-subjects factor was measurement time (T1, T2, T3). Post-hoc pairwise comparisons were performed using Bonferroni correction. Effect sizes were reported using partial eta squared (ηp^2), where 0.01 indicates a small effect,

0.06 indicates a moderate effect, and 0.14 indicates a large effect. All statistical analyses were performed using Jamovi software version 2.3.28 (Jamovi Project, Sydney, Australia) with a significance level set at $p<0.05$ for all hypothesis tests.

As shown in Table 2, the results of testing the mean and standard deviation in all variable parameters in T1, T2 and T3 were found. The data showed that there was a significant percentage change in the ItCE, TW and TP scores in both groups (3-DVR before SSG vs. TCG (only SSG).

Results

Table 2. Mean and S.D are reported for all variables

Variable parameters	Groups	T1 M±SD	T2 M±SD	T3 M±SD
Intention to Continue Exercise (ItCE)				
Exercise	3-DVR before SSG	15.24±2.87	17.42±2.64	19.35±2.18
(score)	TCG (SSG only)	15.08±2.95	16.21±2.81	17.19±2.73
Teamwork (TW)				
Offensive Capacities	3-DVR before SSG	2.84±0.67	3.62±0.61	4.18±0.58
(score)	TCG (SSG only)	2.81±0.69	3.08±0.67	3.34±0.65
Defensive Capacities	3-DVR before SSG	2.93±0.71	3.76±0.64	4.32±0.60
(score)	TCG (only SSG)	2.89±0.73	3.15±0.71	3.47±0.68
Communication Capacities	3-DVR before SSG	2.76±0.74	3.54±0.67	4.08±0.62
(score)	TCG (only SSG)	2.73±0.76	2.98±0.74	3.26±0.71
Technical Performance (TP)				
Passing Accuracy	3-DVR before SSG	68.40±8.20	77.80±7.40	84.7±6.90
(score)	TCG (SSG only)	67.90±8.50	71.60±8.10	76.3±7.80
Shooting Accuracy	3-DVR before SSG	5.72±1.24	6.94±1.15	7.96±1.08
(score)	TCG (SSG only)	5.68±1.31	6.14±1.27	6.89±1.19
Dribbling Speed	3-DVR before SSG	8.94±0.86	8.12±0.78	7.43±0.72
(s)	TCG (SSG only)	8.98±0.89	8.56±0.85	8.08±0.81

Note. 3-DVR: 3-D virtual reality; TCG: training control group; SSG: small-sided game; T1: pretest; T2: midtest; T3: posttest; M: mean; S.D: standard deviation; %Δ: percentage change

Effects of exercise on intention to continue training (ItCE)

As shown in Table 3, the analysis proved that there was an interaction effect of training conditions × time ($F=15.83$; $p<0.001$; $\eta p^2=0.152$) and there was an effect of training conditions ($F=52.47$; $p<0.001$; $\eta p^2=0.374$). In addition, we observed a time effect ($F=96.32$; $p<0.001$; $\eta p^2=0.523$) for the ItCE variable on the exercise parameter.

Effects of exercise on team work (TW)

The analysis in Table 3 also proved that there was an interaction effect of training conditions × time ($F=13.47$; $p<0.001$; $\eta p^2=0.133$) and there was an effect of training conditions ($F=48.91$; $p<0.001$; $\eta p^2=0.357$). In addition, we observed a time effect ($F=89.76$; $p<0.001$; $\eta p^2=0.505$) for the TW variable on the offensive capacities parameter. Furthermore, there was an interaction effect of training conditions × time ($F=15.23$; $p<0.001$; $\eta p^2=0.145$) and there was an effect of training conditions ($F=49.77$; $p<0.001$; $\eta p^2=0.362$). Furthermore, we observed a time effect ($F=84.55$; $p<0.001$; $\eta p^2=0.434$) for the defensive capacities parameter.

We observed the same findings in the communication capacities parameter, which showed that there was an interaction effect between training conditions × time ($F=11.47$; $p=0.002$; $\eta p^2=0.126$) and a training conditions effect ($F=32.71$; $p<0.001$; $\eta p^2=0.243$). In addition, we observed a time effect ($F=75.12$; $p<0.001$; $\eta p^2=0.320$).

Effects of exercise on technical performance (TP)

The analysis proved that there was an interaction effect of training conditions × time ($F=11.29$; $p=0.003$; $\eta p^2=0.114$) and there was an effect of training conditions ($F=44.68$; $p<0.001$;

ηp^2=0.337). In addition, we observed a time effect (F=84.52; p<0.001; ηp^2=0.490) for the TP variable on the passing accuracy parameter. Furthermore, there was an interaction effect of training conditions × time (F=10.74; p<0.001; ηp^2=0.109) and there was an effect of training conditions (F=41.83; p<0.001; ηp^2=0.322). Furthermore, we observed an effect of time (F=78.96; p<0.001; ηp^2=0.473) for the shooting accuracy parameter. Finally, we observed that the dribbling speed parameter showed an interaction effect between training conditions and time (F=9.86; p=0.007; ηp^2=0.101) and a training conditions effect (F=38.47; p<0.001; ηp^2=0.304). In addition, we observed a time effect (F=73.28; p<0.001; ηp^2=0.454), as shown in Table 3.

Table 3. Effects of hypothesis testing interactions and main effects

Variable parameters	Effects	F	p	ηp^2
Intention to Continue Exercise (ItCE)				
Exercise (score)	Training conditions × Time	15.83	<0.001	0.15
	Training conditions	52.47	<0.001	0.37
	Time	96.32	<0.001	0.52
Teamwork (TW)				
Offensive Capacities (score)	Training conditions × Time	13.47	<0.001	0.13
	Training conditions	48.91	<0.001	0.35
	Time	89.76	<0.001	0.50
Defensive Capacities (score)	Training conditions × Time	15.23	<0.001	0.14
	Training conditions	49.77	<0.001	0.36
	Time	84.55	<0.001	0.43
Communication Capacities (score)	Training conditions × Time	11.47	0.002	0.13
	Training conditions	32.71	<0.001	0.24
	Time	75.12	<0.001	0.32
Technical Performance (TP)				
Passing Accuracy (score)	Training conditions × Time	11.29	0.003	0.11
	Training conditions	44.68	<0.001	0.34
	Time	84.52	<0.001	0.49
Shooting Accuracy (score)	Training conditions × Time	10.74	<0.001	0.11
	Training conditions	41.83	<0.001	0.32
	Time	78.96	<0.001	0.47
Dribbling Speed (s)	Training conditions × Time	9.86	0.007	0.10
	Training conditions	38.47	<0.001	0.30
	Time	73.28	<0.001	0.45

Based on the results of the post hoc pairwise comparisons analysis, it shows that both groups between 3-DVR before SSG and TCG (only SSG) experienced an increase in ItCE (see Figure 2), TW and TP scores (see Figure 3) at stages T1, T2, T3. However, we observed that the improvement based on the percentage change was higher in participants in the 3-DVR group before SSG compared to the TCG group (SSG only).

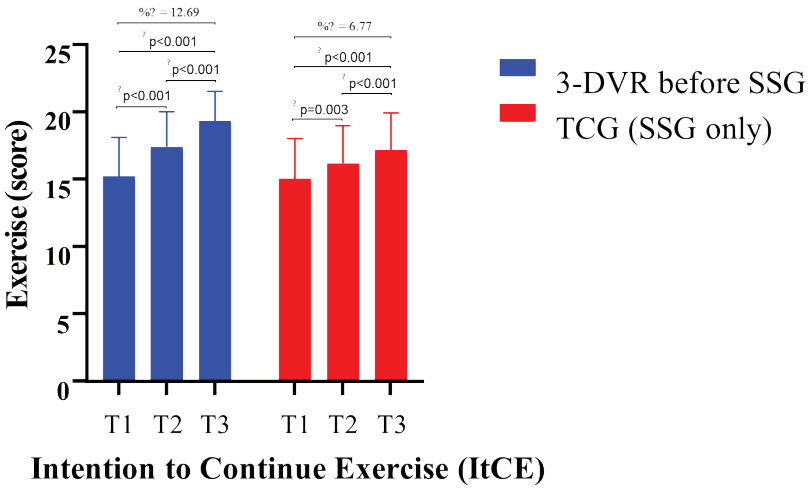

Figure 2. Post-hoc pairwise comparisons: Intention to Continue Exercise (ItCE) each training. *Indicates a significant difference between PT1, P2 to PT3.

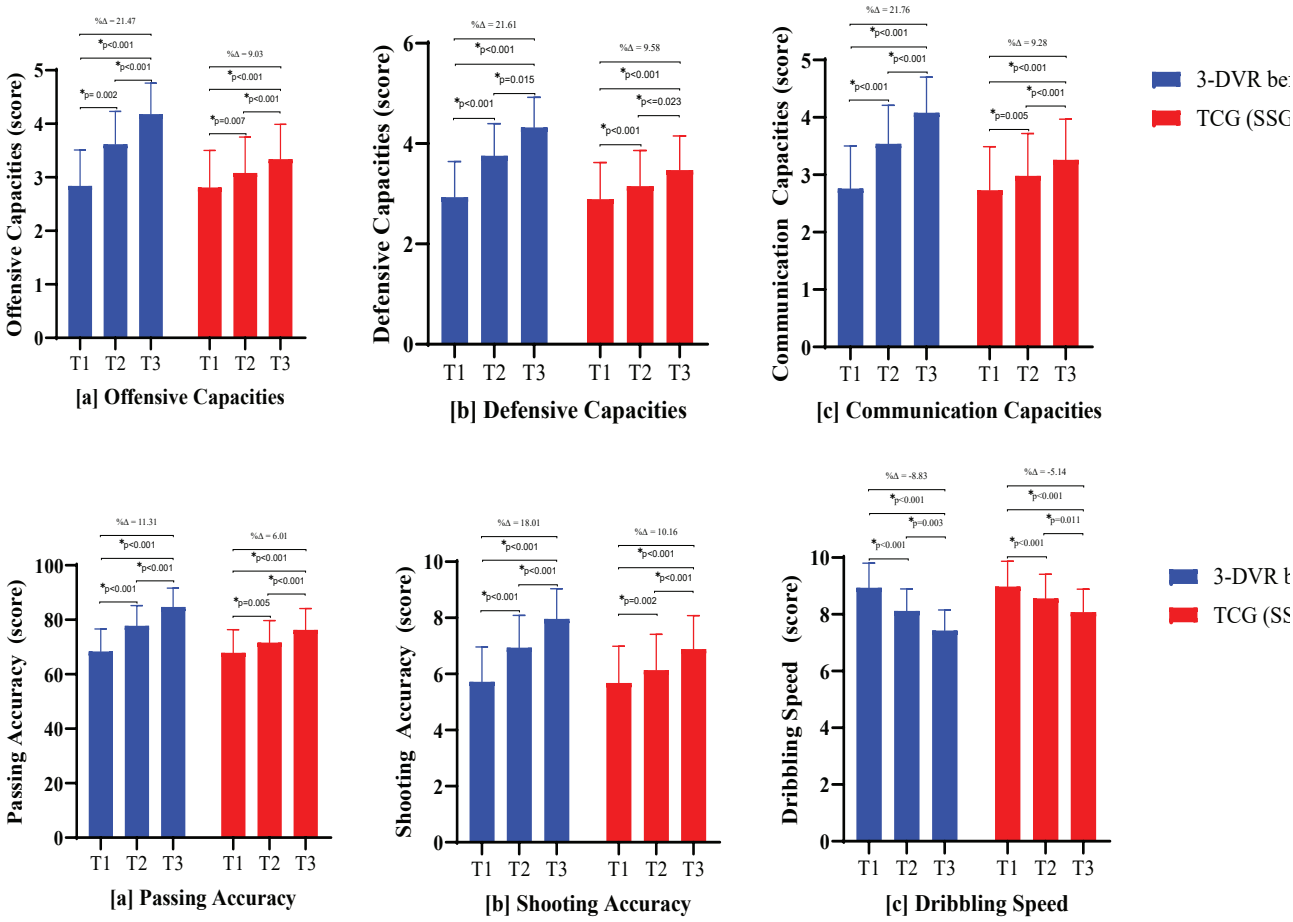

Figure 3. Post-hoc pairwise comparisons. Teamwork (TW): [a] offensive capacities, [b] defensive capacities, [c] communication capacities and technical performance (TP): [a] passing accuracy, [b] shooting accuracy, [c] dribbling speed between training. *Indicates a significant difference between PT1, P2 to PT3.

Discussion

Our current study aims to analyze how 3-DVR before SSG affects ItCE, TW and TP among young soccer athletes. We emphasize that this is the first finding and is in line with the prediction of our hypothesis that 3-DVR before SSG has a higher effect than TCG (only SSG) on the ItCE parameter. This is because the 3-DVR before SSG has several advantages over the TCG (SSG only). First, the 3-DVR before SSG program is designed to provide detailed feedback to young athletes. In addition, in 3-DVR, young athletes are presented with the experience of practicing soccer in a fully virtual environment, which triggers participants to feel more interested and motivated to continue participating. These findings are confirmed and supported by recent studies that show that implementing modern technological tools such as virtual reality can be a positive sports methodology approach to changing several important aspects of athletes, including those related to psychology (Xian, 2025).

Basically, the use of 3-DVR technology offers interesting features such as training videos demonstrated by professional coaches. In addition, another feature provided is the demonstration of each type of exercise by a virtual avatar, which is impossible for young athletes to obtain in the real world (Egiziano et al., 2025). These features are important tools to help young athletes analyze each type of exercise or movement optimally before carrying out the actual training. A report by Harrison et al. (2021) shows that all the modern features presented in 3-DVR have been proven to reduce cognitive anxiety levels. Meanwhile, findings from a previous study show that 3-DVR training can significantly improve athletes' cognitive abilities (Lachowicz et al., 2025). In addition to the effects of 3-DVR, we also found that the implementation of the SSG program has proven to be a key tool in developing young athletes' intention to continue training. Basically, SSG is a training methodology that presents soccer games in a modified way in terms of number of players (4 vs. 4 and 5 vs. 5), and field size (15 m wide and 25 m long), making it more interesting than actual soccer games. This was also stated by Pancar et al. (2025) that SSG, with its modified game characteristics, is the main asset for optimizing the results of soccer training. Our current research findings show that the application of 3-DVR before SSG has a positive impact on improving both TW and TP among young soccer athletes. Although our findings are the first of their kind, to address these findings, we cite previous findings that are almost similar. For example, Shields et al. (2025) show that 3-DVR soccer training has the potential to be a flexible methodology that can improve athletes' performance on the field. Meanwhile, in the context of basketball training, the integration of 3-DVR technology specifically has the positive effects expected by coaches, where there has been an increase in every indicator of psychophysiological performance and mental health of athletes (Wang, 2024). On the other hand, another report revealed that the application of 3-DVR during an 8-week training program yielded satisfactory results in improving the TP aspect in basketball (Günar & Bavlı, 2025). Finally, the findings of Richlan et al. (2023) serve as evidence that 3-DVR interventions have significant potential to produce tangible effects in improving athletic performance, as the use of virtual reality devices facilitates motor skill training when athletes demonstrate what they see in the virtual reality device (demonstrations by virtual avatars). Thus, the findings from previous studies indicate that the findings in our current research align with and add to the literature on the effectiveness of using 3-DVR during training sessions in specific sports, including soccer.

Strengths, limitations and future suggestions

Thus, we emphasize that the main strength of this study is the design of a new training methodology program, namely the application of 3-DVR before SSG to improve ItCE, TW and TP among young soccer athletes. However, we found that there are still limitations to this study, for example, (i) the participants we involved were only young male soccer athletes, without involving female athletes. Additionally, the participants came from only one sports department at a university in Indonesia, so the results cannot be generalized to other populations. (ii) another limitation is that we only designed the 3-DVR before SSG program specifically for soccer. (iii) potential novelty/placebo/attention effects (VR group may be more motivated simply due to new technology), (iv) lack of blinding; Possible differences in total time-on-task between conditions (v) and lack of follow-up. Therefore, we suggest that future research include participants from several universities in Indonesia or other countries. In addition, we suggest designing programs for other sports such as futsal, basketball, or handball. In addition, future research is expected to address some of the other limitations in our current study.

Conclusions

We emphasize that our current research has been successful, as the application of the 3-DVR before SSG program has been proven effective in improving ItCE, TW and TP among young soccer athletes. Our research contributes to the scientific knowledge of soccer coaches, enabling them to change the paradigm in the use of traditional training methodologies by incorporating modern technological tools, including 3-DVR, during SSG training sessions. Furthermore, the results of this study are expected to be used by soccer coaches in Indonesia and other countries to improve and enhance the quality of ItCE, TW and TP performance, ultimately leading to higher achievements by young soccer athletes.

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Conflicts of Interest
No conflict of interest.

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