Asia-Pacific Journal of Science and Technology: Volume: 27. Issue: 03. Article ID.: APST-27-03-03. Research Article

APST

Asia-Pacific Journal of Science and Technology

https://www.tci-thaijo.org/index.php/APST/index

Published by the Research and Technology Transfer Affairs Division,
Khon Kaen University, Thailand

Esports may improve cognitive skills in soccer players: A systematic review

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Received 11 November 2021
Revised 16 December 2021
Accepted 18 December 2021

Abstract

Electronic sports, or esports, are a quickly becoming a worldwide athletic trend and may benefit traditional sport players. Because soccer is a popular sport that requires high-skilled performances, the aim of the present study was to determine whether the practice of esports was associated with improved cognitive soccer skills. This meta-analysis evaluated esports in relation to the memory, decision-making ability, reaction times, and executive functions of soccer players. The inclusion criteria were studies conducted for soccer players that compared esports with any other sport or control; the study types included randomized controlled trials and quasi-experimental studies selected from 276 records in five databases. Three studies were included in this analysis; two of these were randomized controlled trials in which soccer players between 14–20 years of age with 3–5 years of experience were enrolled. A total of 150 soccer players participated in these three studies, and the largest sample size was 75 players. Since these three studies did not share common interventions or outcomes, the results thereof were reported as descriptive outcomes; all three studies yielded significant outcomes. This study concludes that the practice of esports has the potential to improve the cognitive skills of young soccer players, and that additional larger randomized controlled trials are required.

Keywords: Randomized controlled trial, Quasi-experimental, Memory, Decision making, Reaction time, Executive function

1. Introduction

Electronic sports (henceforth “esports”) are a growing sporting trend in which billions of players participate worldwide; most of these participants are part of the emerging adulthood demographic between 18–25 years of age [1]. There is currently only limited data on the health aspects of esports and esports guidelines related to physical activity, healthy diet, and proper sleep hygiene [2]. Even though the winners of esports competitions earn money prizes that are equal to the financial compensations of elite athletes, there are some concerns about

health issues, particularly those associated with sedentary behaviors [2,3]. Moreover, 37.1% of electronic football players have reported depression, and 45.2% have reported sleep disturbances [4].

Esports may benefit traditional sport players. A previous study found that esport players had significantly better accuracy than traditional soccer players (69.80% vs. 79.24%; $p < 0.01$) [5]. These results seem to indicate that esports can improve perceptual–cognitive skills in soccer. Young soccer players required specific skills to improve their performance, and high-division players display better cognitive flexibility than low-division players ($p < 0.001$) [6]. These results highlight the possibility of translating esports skills to traditional athletes. Because soccer is a popular sport that requires high performance skill, the aim of this study is to determine whether esports is associated with improved cognitive-related soccer skills [7,8].

2. Materials and methods

This meta-analysis assessed esports in relation to the memory, decision-making, reaction times, and executive functions of soccer players. The inclusion criteria were studies conducted on soccer players that compared esports to any other sports or control. The study types included randomized controlled trials or quasi-experimental studies; observations, case reports, case series, commentaries, books, and reviews were all excluded, as well studies for which there were no comparisons between the two groups.

The following five databases were utilized for this systematic search: Pubmed, Central Database, Scopus, CINAHL Plus, and Web of Science. Search terms included “esports,” “cognitive training,” “memory,” “decision making,” “reaction time,” and “executive function” (Appendices 1–5); our search concluded on October 26, 2021. Eligible articles were reviewed after duplicates were removed, and a full-text review of the articles that met the inclusion criteria was then independently performed (i.e., TB and SK); this resulted in a study flow chart (PRISMA) (Figure 1). Qualitative and quantitative analyses were both performed and the findings thereof were reported.

The outcomes of the study were related to cognitive training, memory, decision making, reaction times, and executive function. The outcomes of esports participants and athletes in other groups were then compared and reported as mean differences with 95% confidence interval (CI) for numerical factors. For the categorical outcomes, an odds ratio with a 95% CI of categorical factors between both groups was executed, and a forest plot of each factor was created to illustrate the differences between both groups. The analyses were performed if there were at least two studies with similar interventions and outcomes. The biases of eligible studies were then independently evaluated by two authors (TB and CN). These biases included selection bias (i.e., random sequence generation and allocation concealment), performance bias (i.e., blinding of participants and personnel), detection bias (i.e., blinding of outcomes assessment), and attrition bias (i.e., incomplete outcome data); and the biases for each item were classified as low-risk, unclear, and high-risk. Disagreements between two authors related to review results and biases were resolved by a third person (i.e., KS), and calculations were performed by RevMan Version 5.4.1 (Copenhagen, Denmark).

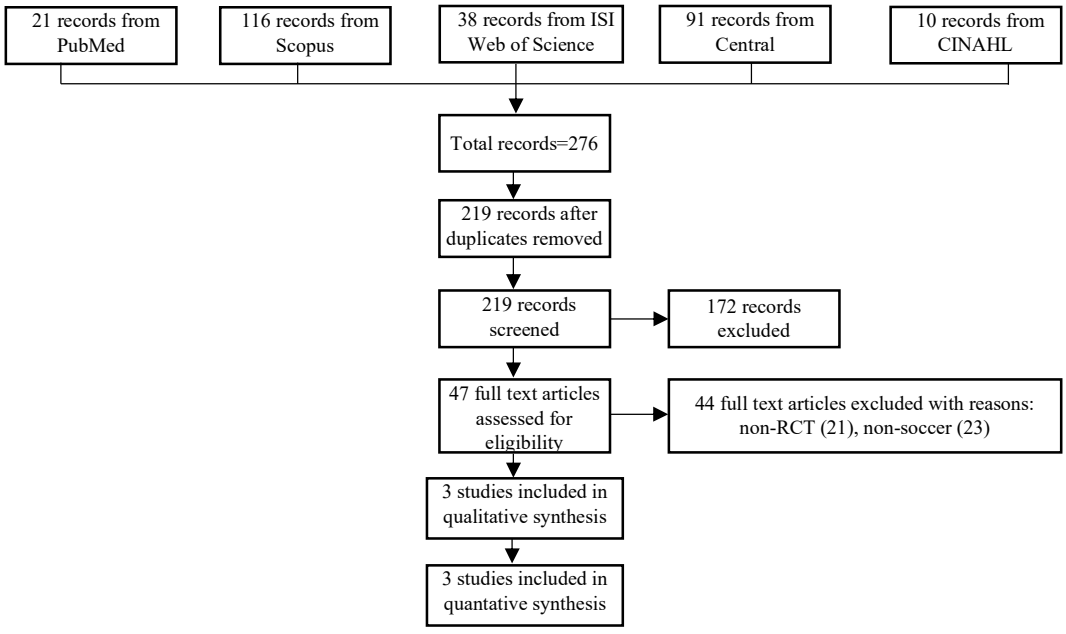

Figure 1 Searching for esports and cognitive skills in soccer players in five databases.

3. Results

There were initially 276 records from five databases; after duplicates were removed, 219 records remained. Of these, 47 records were eligible for a full-text evaluation: 44 records were excluded due to non-randomized controlled trial (RCT) (21 records) and non-soccer (23 records), resulting in the inclusion of three studies in this analysis (Figure 1) that were published between 2019–2021, the countries of origin of which were Brazil, Spain, and Turkey [9-11]. Two of these studies were randomized controlled trials of soccer players between 14–20 years of age with 3–5 years of experience, and one study included players from a national team [9]. The esports characteristics in all three studies were virtual reality, computerized attention training, and gamed-based training with a training duration that ranged from one day to nine weeks (Table 1).

Table 1 Characteristics of eligible studies on esports and cognitive skills in soccer players.

Study	Year	Country	Study design	Study population: age, setting	Type of training
Emirzeoğlu	2021	Turkey	Randomized controlled trial	Male soccer players 15–20 years old, three years' experience	Cognitive and game-based trainings and cognitive-based neuromuscular training, 1 h training
Fortes	2021	Brazil	Randomized trial	Young soccer players 15-16 years old, five years' experience, national team	Physical, technical, and tactical skills, 6 weeks, 30 sessions
Reigal	2019	Spain	Quasi-experimental	Young soccer players 14 -18 years old, five years' experience	Computerized attention training, 3 days/week, 9 weeks

Since none of these studies shared common interventions or outcomes, the results thereof were reported as descriptive outcomes. A total of 150 soccer players participated in these studies, and the largest sample size was 75 players. Two of the studies included two comparison groups; the third study included the following groups: cognitive-based neuromuscular training, game-based training, and a control group. Regarding the outcomes of each, all three studies yielded significant outcomes (Table 2). Three outcomes in the Fortes study—decision-making, visual search behavior, and inhibitory control performance—were noticeably improved after the intervention (i.e., pre-post), as well as improvements in the virtual reality and video-screen training; the only area without improvements was that of inhibitory control performance [9]. While the Reigal study found that compared with control group, the computerized-attention program yielded better attention test results [11]; the Emirzeoğlu study found more improvements in the dynamic balance and speed performance of the cognitive and game-based trainings than in cognitive-based neuromuscular training and the control groups [10].

Table 2 Training and outcomes of eligible study on esports and cognitive skills in soccer players.

Study	Device	Training program	Total cases, group (n)	Outcome	Results
Emirzeoğlu, 2021	Xbox One console, Kinect sensor, and Kinect Sports Rivals games	1. Cognitive and game-based trainings (GBT) 2. Cognitive-based neuromuscular training (CBNT)	49, GBT (17)/ CBNT (16)/ Control (16)	1. Dynamic balance (DB): Star Excursion Balance Test 2. Speed performance (SP): Speed Dribbling Test	1. DB significantly improved in all directions and in all groups ($p < 0.05$). 2. SP improved by the CBNT ($p = 0.001$) and GBT groups ($p = 0.003$)
Fortes, 2021	Custom-made videos training, Smartphone, iMac 14.1	Physical, technical, and tactical skills training	26, VR (13)/ VID(13)	1. Decision-making (passing decision-making accuracy) 2. Visual search behavior 2.1 Number of fixations 2.2duration of the fixation 3. Inhibitory control (Stroop Task accuracy)	1. Improvement of passing decision-making performance ($p < 0.05$) 2. Both groups had 2.1 Increasing fixations ($p < 0.05$) 2.2 Increasing fixation duration ($p < 0.05$) 3. Improvement of response time ($p < 0.05$)
Reigal, 2019	Rejilla 1.0 software	Selective attention program	75, control (38)/ experimental (37)	D2 attention test -cancellation of numbers	Experimental group had differences among initial, midterm, and final evaluation significantly ($p < 0.05$).

Note. VR: virtual reality; VID: video-screen training.

Regarding biases, the Fortes study had a low risk of performance, detection, and attrition biases; the Emirzeoğlu study had a low risk of selection and attrition biases; and the Reigal study had high risk selection, performance, and detection biases (Figure 2).

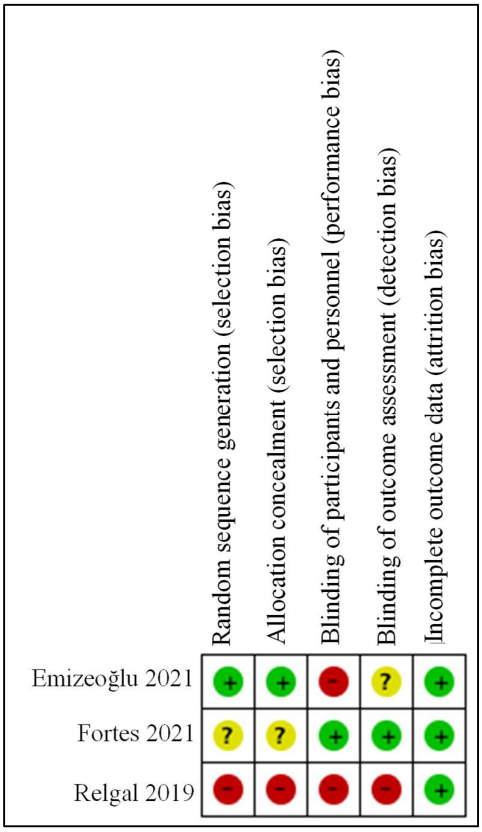

Figure 2 Risk of bias summary: review authors' judgements about each risk of bias item for each included study.
Note. + indicated low risk; ? indicated unclear risk; - indicated high risk.

4. Discussion

Even though we were unable to perform a classic meta-analysis calculation due to the incompatibility of the studies under consideration, there was some evidence of the benefits of practicing esports on the cognitive functions of young traditional soccer players.

As was previously explained, young high-division Italian soccer players had better inhibitory control than low-division players and a positive correlation was found between their performance and their inhibitory responses ($r = 0.55$; $p = 0.0001$) [6]. The Fortes study also concluded that esports that included virtual reality or video-screen training resulted in significantly improved inhibitory control in relation to accuracy and response times ($p < 0.05$) [9]. An improvement of attention by computerized attention training was reported by Reigal et al.; this was supported by a previous systematic review of 28 studies that investigated different computerized cognitive training programs for various acquired brain injuries [12]. Similar to this systematic review, a trend of benefits from computerized training and attention was detected; notably, however, classical calculations that were performed for this study were not performed for the other meta-analysis. Finally, a study on the gaming experience in action and real-time strategies supported the findings of this systematic review [13]; this study found higher accuracy rates of single-target condition in experts than in non-experts (96% vs. 90%; $p < 0.05$); the experts also displayed higher amplitude in P3 electroencephalogram than non-experts, which indicates that they processed information faster and had better visual-selective attention.

There were some limitations in this study. Only young soccer players were studied, there no classical meta-analysis calculations were conducted due to an insufficient number of eligible studies, the types of esports examined were diverse, and the sample size in each study was small. While there were statistically significant declarations in all three studies, the study by Reigal et al. resulted in a high risk of three kinds of biases (Figure 2). Further randomized controlled trials are required.

5. Conclusion

Practice of esports had a trend to improve cognitive skills in young soccer players. Further and larger randomized controlled trials are required.

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Appendix 1 Searching strategy for PubMed on 26 October 2021.

Search number	Search terms
1	Esport*[Title/Abstract] OR Sports[MeSH Terms]
2	cognitive train*[Title/Abstract]
3	(memory) OR (decision making) OR (reaction time) OR (executive function)
4	randomized controlled trial[MeSH Terms] OR clinical trial[Publication Type] OR randomiz*[Title/Abstract] OR randomis*[Title/Abstract] OR Quasi*[Title/Abstract]
5	(#1 AND #2) AND #3
6	#4 AND #5

Appendix 2 Searching strategy for Scopus on 26 October 2021.

((((TITLE-ABS-KEY (esport*)) OR (TITLE-ABS-KEY (sport*))) AND (TITLE-ABS-KEY (cognitive AND train*))) AND ((ALL (memory) OR ALL (decision AND making) OR ALL (reaction AND time) OR ALL (executive AND function)))) AND ((TITLE-ABS-KEY (randomized AND controlled AND trial)OR TITLE-ABS-KEY (clinical AND trial) OR TITLE-ABS-KEY (randomiz*) OR TITLE-ABS-KEY (randomis*) OR TITLE-ABS-KEY (quasi*))) AND (LIMIT-TO (DOCTYPE ,"ar"))

Appendix 3 Searching strategy for ISI Web of science on 26 October 2021.

Search number	Search terms
1	TI=Esport* OR AB=Esport* OR AK=Esport*
2	TI=sport* OR AB= sport* OR AK=sport*
3	TI=(cognitive train*) OR AB= (cognitive train*) OR AK=(cognitive train*)
4	ALL=(memory) OR ALL=(decision making) OR ALL=(reaction time) OR ALL=(executive function)
5	TI=randomiz* OR AB= randomiz* OR AK=randomiz* OR TI=randomis* OR AB= randomis* OR AK=randomis* OR TI=Quasi* OR AB= rQuasi* OR AK=Quasi*
6	(#1 OR #2) AND #3
7	(#6 AND #4) AND #5

Appendix 4 Searching strategy for Central on 26 October 2021.

Search number	Search terms
1	(Esport*):ti,ab,kw
2	MeSH descriptor: [Sports] explode all trees
3	cognitive train*):ti,ab,kw
4	((memory) OR (decision making) OR (reaction time) OR (executive function))
5	MeSH descriptor: [Randomized Controlled Trial] explode all trees
6	(clinical trial) : ti,ab,kw OR (randomiz*) : ti,ab,kw OR (randomis*) : ti,ab,kw OR (Quasi*):ti,ab,kw
7	(#1 OR #2) AND #3
8	#7 AND #4
9	#8 AND (#5 OR #6)

Appendix 5 Searching strategy for CINAHL 26 October 2021.

Search ID	Search Terms	Search Options
S1	TI esports OR AB e-sports OR TI sports OR AB sports	Expanders - Apply equivalent subjects Search modes - Find all my search terms
S2	TI cognitive train* OR AB cognitive train*	Expanders - Apply equivalent subjects Search modes - Find all my search terms
S3	TX memory OR TX decision making OR TX (reaction time or response time) OR TX executive function*	Expanders - Apply equivalent subjects Search modes - Find all my search terms
S4	TI randomized controlled trial* OR AB randomized controlled trial* OR TI randomised control trial OR AB randomised control trial OR TI quasi-experimental OR AB quasi-experimental	Expanders - Apply equivalent subjects Search modes - Find all my search terms
S5	(S1 AND S2) AND S3	Expanders - Apply equivalent subjects Search modes - Find all my search terms
S6	S5 AND S4	Expanders - Apply equivalent subjects Search modes - Find all my search terms