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Review Article

INFLUENCE THE NUMBER OF TOUCHES ON PHYSICAL AND PHYSIOLOGICAL RESPONSES DURING SMALL-SIDED SOCCER GAMES

INFLUÊNCIA DO NÚMERO DE TOQUES NA BOLA NAS RESPOSTAS FÍSICAS E FISIOLÓGICAS DURANTE PEQUENOS JOGOS DE FUTEBOL

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RESUMO
O objetivo da presente revisão foi analisar os efeitos do número de toques na bola, nas respostas físicas e fisiológicas de durante pequenos jogos de futebol. Foram realizadas buscas eletrônicas nas bases de dados: "*Web of Science", "Scopus"* e *"PubMed*", utilizando os descritores "*Small-sided games"; "Intensity"; "Touches"; "Soccer"; "Soccer players"; "Modified rules*". A estratégia PICO foi utilizada e o grupo de palavras foi combinado em duplas ou trios, utilizando os conectores OR e AND. Foram considerados apenas os artigos publicados entre 2010 e 2022. Foram excluídos: (a) anais e suplementos de eventos científicos, (b) revisões, artigos editoriais e de validação de instrumentos, e (c) estudos com mulheres. De 578 estudos, 9 foram selecionados e analisados. De um modo geral, a adoção da regra de limite de toques na bola aumentou as respostas fisiológicas, embora tenham sido observadas discrepâncias entre os estudos quanto as respostas físicas, devemos considerar as diferenças metodológicas entre os estudos. Concluímos que manipular o número de toques de bola permitidos por posse de bola influencia as respostas fisiológicas dos jogadores. Especificamente, maior intensidade é esperada em SSGs com menos toques de bola permitidos. Por outro lado, as respostas físicas não são influenciadas por esta regra.
Palavras-chave: Futebol. Revisão sistemática. Desempenho atlético.

ABSTRACT
The objective of the present review was to analyze the effects of the number of touches on the ball, in the physical and physiological responses during small soccer games. Electronic searches were carried out in the databases: "Web of Science", "Scopus" and "PubMed", using the descriptors "Small-sided games"; "Intensity"; "Touches"; "Soccer"; "Soccer players"; "Modified rules". The PICO strategy was used and the group of words was combined in pairs or trios, using the OR and AND connectors. Only articles published between 2010 and 2022 were considered. The following were excluded: (a) annals and supplements of scientific events, (b) reviews, editorial and instrument validation articles, and (c) studies with women. Of 578 studies, 9 were selected and analyzed. In general, the adoption of the limit rule for touching the ball increased the physiological responses, although discrepancies were observed between the studies regarding the physical responses, we must consider the methodological differences between the studies. We conclude that manipulating the number of touches allowed per ball possession influences players' physiological responses. Specifically, higher intensity is expected in SSGs with fewer ball touches allowed. On the other hand, physical responses are not influenced by this rule.
Keywords: Soccer. Systematic Review. Athletic Performance.

Introduction

Small-sided games (SSG) are modified tasks played in reduced pitch areas, including adapted rules and involving fewer players than the official match. SSGs are employed as training means in different team sports, including soccer[1]. Also, SSGs can be adopted for improving soccer players' physical skills [2,3] as previous studies confirmed the positive effects of their practice on physical-related performance indicators [4-6].

The training prescription using SSGs requires adjusting constraints, such as the number of players[2,7] and the pitch size [8,9]. These manipulations can be simultaneously employed considering the development of technical-tactical and physical skills, eliciting specific responses from the players [10]. Changing game rules[11], for example, limiting the number of ball toches allowed [12], is another commonly adopted rule change during the training using SSGs. Therefore, coaches have a large amount of possibility when designing SSGs, requiring researchers to try to summarize findings, for example, through systematic reviews.

The influence of limiting the number of allowed touches per possession on soccer players' responses during SSGs has been previously investigated[12-14]. For example, Casamichana et al.[13] showed that reducing the number of ball touches increased the physical demands of the SSG. Similarly, Giménez et al.[14] verified that limiting the number of ball touches increased the frequency of accelerations. Souza et al.[12] suggested that these results are explained by the need of the off-the-ball players to offer more support to the restricted on-the-ball player, increasing the total amount of movement performed. For this reason, the authors affirmed that changing the rules can impact the players' behaviours, which indicates that this subject is worth investigating. Considering this, understanding the impact of manipulating the ball touches allowed per possession on players' responses can improve the quality of the training prescription by improving the link between the SSG design and the training goals[1,13-17].

Systematic reviews about SSGs were previously published[16-18]. However, no studies have addressed the impact of manipulating the number of touches on players' responses. Organizing the knowledge on this topic, which is possible through a systematic review, can provide coaches with practical information on how to use SSGs in soccer training. The systematic review is a procedure that allows scientific evidence to be organized and synthesized, providing support for practical interventions and future research[19]. Therefore, this study aimed to review the effects of ball touches limitations on soccer players' physical and physiological responses during SSGs.

Methods

Study search

The study search followed the PRISMA guidelines[20]. Searches were conducted in Web of Science, Scopus and Pubmed, using the advanced search between Aug 15 and 22nd, 2022. The search strategy included the combination of the following words: "*Small-sided games"; "Intensity"; "Touches"; "Soccer"; "Soccer players"; "Modified rules*" using the Booleans OR and AND. Only articles published between 2010 and 2022 were considered.

Inclusion and exclusion criteria

Studies were included if they were published in peer-reviewed journals, in English, and presented original data (reviews excluded). Besides the article-type screening, the PICO strategy was adopted to check for inclusion and exclusion criteria. Chart 1 below shows the summary of the criteria adopted.

PICO strategy	Inclusion criteria	Exclusion criteria
Population	Professional and semiprofessional male soccer athletes.	Athletes from other sports, injured athletes, women athletes.
Intervention	Studies transversal and involving SSGs.	Case studies, systematic reviews.
Comparison	Comparisons involving two or more SSGs conditions but with similar number of ball touches allowed per possession between them.	Comparisons involving other variables, such as technical or tactical ones, or studies involving formal games.
Outcome	Physical responses (total distance covered and distance travelled at different speed zones) and	Responses related to tactical or technical variables.

PICO strategy	Inclusion criteria	Exclusion criteria
	physiological responses (heart rate, lactate concentration, and rate of perceived exertion).	

Chart 1: Inclusion and exclusion criteria adopted in the review
Notes: SSG: small-sided games
Source: The authors

Study selection

The flow diagram (figure 1), based on the PRISMA guidelines[20], shows the steps carried out for study selection. Two researchers conducted the whole selection process, and a third one was consulted when divergencies were observed.

The initial screening found 578 articles. Among them, 21 were excluded because they were duplicates. After reading the titles and abstracts, following the exclusion criteria, 537 articles were excluded, these being: review studies (98); with athletes from other sports (112); that analyzed technical and tactical variables (192); and that they weren't about SSGs (135). After initial screening, 20 records were selected for full-text screening.

During the eligibility analysis, five articles were included from the references of the selected articles. After analyzing the 25 full texts, 16 were excluded due to due to evaluation of other physical and physiological parameters (five) and outcome incompatible with the inclusion criteria (11). Finally, nine articles were selected for the systematic review.

The selected articles were organized according to the publication year. Also, they were characterized considering: a) players' level of competition; b) The SSG format; c) instruments adopted for investigating physical and physiological responses; and d) characteristics of the study participants.

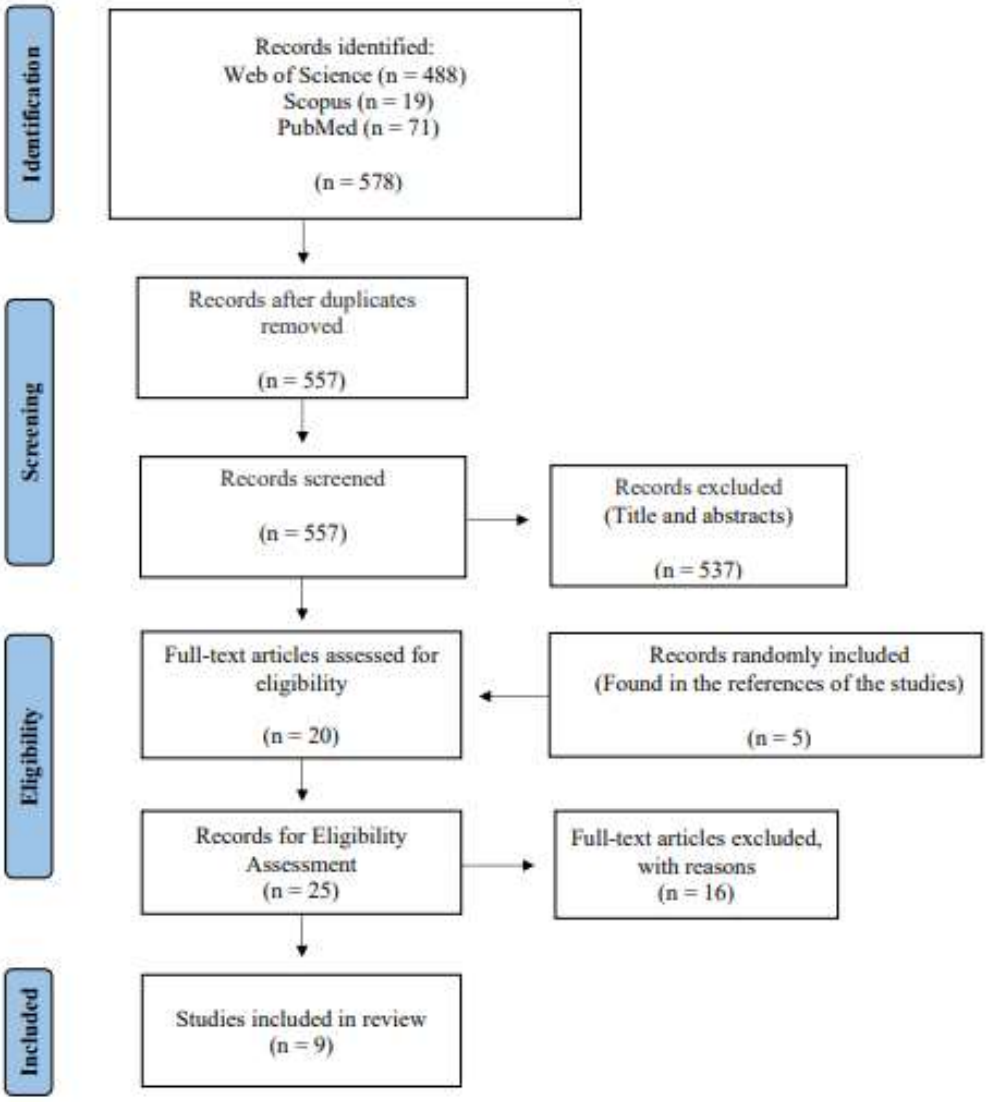

Figure 1. Procedures for the exclusion/inclusion of the articles in the review.
Source: The authors

Methodological Quality Assessment

The modified Quality Index Scale[21] was adopted to analyze the methodological quality of the selected studies. This version of the instrument has been adopted in previous systematic reviews in sport[5] and consists of 14 from the original 24 items proposed by the authors. For quantitative studies, the 14 items are related to the study's design, the sampling, the methods, the data analysis, the results, and the conclusion. Articles are evaluated as 1 (satisfactory), 0 (unsatisfactory), o U (unable to determine) for each item. This procedure, previously adopted in the literature, reduces the risk of bias when interpreting the results[21]. Two researchers (AAL and CCFB) analyzed the studies, verifying the agreement using Cohen's Kappa (k = 0.968). When discrepancies in the assessment were observed, a third researcher (LCES) analyzed the article to provide a different opinion. Table 2 shows the scores obtained by the studies.

Results

Table 2 shows the methodological quality of the selected studies. The average Quality Index was 79,4%, higher than the minimum recommended in the literature[5]. The highest score was 90,9%, and the lowest was 63,6%.

Table 2. Qualitative analysis of the selected studies.

Studies	1	2	3	6	7	10	12	15	16	18	20	22	23	25	Final score
Dellal et al., 2011[24]	1	1	1	1	1	1	0	U	1	1	1	U	U	0	81,8%
Dellal et al., 2011[25]	1	1	1	1	1	1	0	U	1	1	1	U	U	0	81,8%
Dellal et al., 2011[22]	1	1	1	1	1	1	0	U	1	1	0	U	U	U	80,0%
Casamichana et al., 2013[13]	1	1	1	1	1	1	0	U	1	1	1	U	U	1	90,9%
Román-Quintana et al., 2013[26]	1	1	1	1	1	1	0	U	1	1	1	U	U	0	81,8%
Casamichana et al., 2014[23]	1	1	1	1	0	0	0	U	1	0	1	U	U	1	63,6%
Giménez et al., 2018[14]	1	1	1	1	1	1	0	U	1	0	1	U	U	0	72,7%
Younesi et al., 2021[27]	1	1	1	1	1	1	0	U	1	0	1	U	U	1	81,8%
Younesi et al., 2021[28]	1	1	1	1	1	0	0	U	1	U	1	U	U	1	80,0%

Note: U = Unable to determine
Source: The authors

Participants in the selected studies were between 23 and 27 years old, between 1.76 and 1.81 meters tall, and weighed between 72 and 79 kg. Four studies included semiprofessional players and five professional players. The studies were conducted on three different continents: Europe (three), Africa (one), and Asia (one). Two studies did not mention the nationality of the participants. Also, one study was conducted in a pitch with natural grass while two were conducted in synthetic grass pitche. The other studies did not report the characteristics of the pitch surface.

SGGs' formats

Different SSG formats were adopted in the selected studies. The protocol without limitations in the ball touches was adopted as control and compared with the protocol with the rule. The number of ball touches allowed per possession in the experimental conditions with this rule was one (six studies), two (seven studies), or three (two studies). The number of players in the SSGs varied from 2-a-side to 7-a-side, and the relative area per player ranged from 75m² to 245m². In one study, the ball limitation rule was analyzed together with the influence of the presence of goalkeepers.

Physiological responses

Seven studies used the heart rate (HR) to analyze the activity intensity [13,22-27]. The other three studies also adopted the blood lactate concentration and the rate of perceived exertion (RPE) to measure the intensity/exertion[22,24,25]. Table 3 summarizes the physiological responses considering the format of SSG adopted in the studies.

In 2vs2 SSGs, two studies analyzed the physiological responses. Only Dellal et al. [24] showed higher RPE and blood lactate with the 1-touch rule than the 2-touches and the free-play SSGs. In another study, Dellal et al. [22] did not show differences between the protocols with and without the ball touches limitation. While the first study was conducted with professional players, the second included semiprofessional ones.

In three studies, the blood lactate concentration values were higher in the formats with fewer players (2vs2 and 3vs3) than in the larger formats (4vs4, 6vs6, and 7vs7). It is noteworthy

that in the 2vs2 and 3vs3 formats, the intensity of effort was greater in the one touch rule condition, when compared to the game with free touch, with two touches or three touches.

Concerning the HR values, in four studies that adopted the same constraints (free-play, 1-touch, and 2-touches), the results indicated values higher than 80% in 7vs7[26], 6vs6[23], 4vs4[25], 3vs3 or 2vs2[22,24] formats.

Table 3. SSGs characteristics and results regarding the physiological responses

Studies	Format	Duration (min)	App (m^2)	Results			
	SSG 2vs2			LAC	RPE	HR	Differences
Dellal et al. (2011)[24]	1T	2	75	3.9*	8.2**	182	*>2T e FP
	2T			3.5	7.7	182	**>FP
	FP			3.4	7.6	182	
Dellal et al. (2011)[22]	1T	2	75	3.9	8.1**	90.3%	-
	2T			3.5	7.9	90.1%	
	TL			3.5	7.5	90%	
	SSG 3vs3			LAC	RPE	HR	Differences
Dellal et al. (2011)[24]	1T	3	75	3.8*	8.1**	181	*>2T e FP **>FP
	2T			3.3	7.9	180	
	FP			3.0	7.5	181	
Dellal et al. (2011)[22]	1T	3	75	3.6	8.2	90%	-
	2T			3.4	7.9	89.4%	
	FP			3.1	7.5	89.6%	
Younesi et al. (2021)[27]	3T	3	90	ni	ni	156	-
	TL			ni	ni	157	
	3T+G			ni	ni	158	
	TL+G			ni	ni	159	
	SSG 4vs4			LAC	RPE	HR	Differences
Dellal et al. (2011)[24]	1T	4	75	2.9	8.0*	177*	*>FP
	2T			2.8	7.9*	173	
	FP			2.9	7.2	171	
Dellal et al. (2011)[25]	1T(M1)	4	75	2.5	6.8	85%	-
	2T(M1)			2.5	6.9	83.4%	
	FP(M1)			2.4	6.3	82.7%	
	1T(M2)			2.8*	7.8*	86.7%	
	2T(M2)			2.7	7.7*	84.7%	
	TL(M2)			3.1*	7.1*	84.1%	
	1T(M3)			3.1*	7.9*	88.2%	
	2T(M3)			3.0*	8.1*	86.1%	
	FP(M3)			3.3*	7.3*	85.1%	
	1T(M4)			3.5*	8.9*	90.4%*	
	2T(M4)			3.2*	8.9*	89.7%*	
	FP(M4)			4.5*	8.2*	86.8%*	
Dellal et al. (2011)[22]	1T	4	75	3.0	8.0	87.6%	-
	2T			2.9	7.9	85.6%	
	FP			2.8	7.3	84.7	
	3T	4	90	ni	ni	158	-

Studies	Format	Duration (min)	App (m^2)	Results			
Younesi et al. (2021)[27]	FP			ni	ni	157	
	3T+G			ni	ni	161	
	FP+G			ni	ni	160	
	SSG 6vs6			LAC	RPE	HR	Differences
Casamichana et al. (2014)[23]	2T	6	245	ni	ni	90.4%*	*>FP
	FP			ni	ni	83.8%	
Casamichana et al. (2013)[13]	1T	12	80	ni	ni	82.9%	*>FP
	2T			ni	ni	83.5%*	
	FP			ni	ni	80.8%	
	SSG 7vs7			LAC	RPE	HR	Differences
Román-Quintana et al. (2013)[26]	1T	12	210	ni	ni	145.5	*>1T e 2T
	2T			ni	ni	146.9	
	FP			ni	ni	159.5*	

Notes: min: minutes; App: area per player; LAC: Blood lactate concentration; RPE: Rate of perceived exertion HR: Heart rate; PRO: professional; Semi: semiprofessional; T: toques; G: Goalkeeper, ni: non investigated; 1T: 1-touch; 2T: 2-touches; FP: free-play; M: match.
Source: The authors

Physical responses

From the nine selected studies, eight reported players' physical responses using the total distance covered [13,14,22-26,28]. Analyzing the distances covered in different speed zones was impossible because the studies presented little and heterogeneous data. However, methodological differences between the studies were observed concerning the SSG duration, pitch size, relative area per player and format. For example, the pitch size ranged from 20x25m to 60x49m, with a relative area per player ranging from 75m² (three studies) to 245m² (one study). Table 4 summarizes the results and the characteristics regarding the physical responses.

Table 4. SSGs characteristics and results regarding the physical responses

Studies	Format	Duration (min)	App (m^2)	Results	
	SSG 2vs2			Distance covered (m)	Differences
Dellal et al. (2011)[24]	1T	2	75	1305.5*	*>2T e FP
	2T			1211.8	
	FP			1157.7	
Dellal et al. (2011)[22]	1T	2	75	1305.6	-
	2T			1211.8	
	FP			1157.7	
	SSG 3vs3			Distance covered (m)	Differences
Dellal et al. (2011)[24]	1T	3	75	2247.6*	*>2T e FP **>FP
	2T			2124.7**	
	FP			2013.9	
Dellal et al. (2011)[22]	1T	3	75	2247.6	-
	2T			2124.7	
	FP			2014.0	

Studies	Format	Duration (min)	App (m^2)	Results	
Younesi et al. (2021)[28]	3T FP	3	90	310.8 386.7	-
	SSG 4vs4			Distance covered (m)	Differences
Dellal et al. (2011)[24]	1T 2T FP	4	75	3057.3* 2814.6** 2663.6	*>2T e FP **>FP
Dellal et al. (2011)[25]	1T(M1) 2T(M1) FP(M1) 1T(M2) 2T(M2) FP(M2) 1T(M3) 2T(M3) FP(M3) 1T(M4) 2T(M4) FP(M4)	4	75	835.7 711.9 726.3 793.6 689.2 679.4 759.6* 667.8* 659.5* 668.7* 604.9* 597.6*	*<J1
Dellal et al. (2011)[22]	1T 2T FP	4	75	3057.4 2814.7 2663.7	-
Younesi et al. (2021)[28]	FP 3T+G	4	90	506.0 667.2	-
Giménez et al. (2018)[14]	1T 2T	4	90	1576 1644	-
	SSG 6vs6			Distance covered (m)	Differences
Casamichana et al. (2013)[13]	1T 2T FP	12	80	1409.7 1295.2 1393.9	-
Casamichana et al. (2014)[23]	2T FP	12	245	683.0* 642.2	*>2T
Younesi et al. (2021)[28]	3T FP	4	90	470.4 432.0	-
	SSG 7vs7			Distance covered (m)	Differences
Román-Quintana et al. (2013)[26]	1T 2T FP	12	210	1226.8 1224.9 1345.2	-

Nota: min: minutes; App: area per player G: Goalkeeper. 1T: 1-touch; 2T: 2-touches; FP: free-play; M: match.
Source: The authors

Discussion

This systematic review investigated the impact of manipulating the number of ball touches allowed per possession on players' physical and physiological responses. Overall, the adoption of the ball-touch limitation rule increased physiological responses. On the other hand, discrepancies were observed among studies regarding the physical responses, which did not

allow for identifying a clear trend of the rule's influence on the distance covered by athletes during small-sided games.

Regarding physiological responses, the values of LAC (lactate) and RPE (rate of perceived exertion) were significantly higher in the 1T small-sided games (SSGs) compared to free-play (FP), and this pattern was observed in the 2vs2, 3vs3, and 4vs4 formats.[22,24,25,27]. Reducing the number of ball touches may lead athletes to perform a higher number of sprints and high-intensity running activities to create passing lanes[29,30], which would justify such a result. In the present review, studies with larger SSG formats (6vs6 and 7vs7) [13,23,26] did not assess the variables discussed here. Discussing the rule's impact (number of ball touches) in 6x6 and 7x7 small-sided games still represents a gap to be investigated in the literature concerning this training method.

Regarding the physiological responses, the heart rate (HR) did not differ between protocols with and without ball-touch limits in the 2vs2 and 3vs3 SSG formats. It is worth noting that the stimulus (series) duration in the SSGs was 2 and 3 minutes, which may have been insufficient to generate a significant increase in HR[31]. Thus, PJ protocols with reduced durations may not allow for the emergence of significant differences between conditions with and without ball-touch limits, which explains this finding. Out of the four studies that examined HR response in the 4vs4 format[22,25,27], three studies did not find differences in results between protocols. Only one study[24] reported significant differences in HR, with the 1T condition showing higher intensity than the FP and 2T conditions. This finding can also be explained by the fact that the 1T SSG included a higher proportion of high-intensity activities than FP[25].

In the 6vs6 condition, both studies [13, 23] showed higher relative values of HR (%HR) in the 2T condition compared to FP, also justified by a higher proportion of high-intensity activities compared to FP [25]. In the 7vs7 format, evaluated by only one study [26], HR values were significantly higher in FP compared to the 1T and 2T conditions in semi-professional athletes. One possible explanation for this finding, which contradicts the findings of previous studies, is that a ball-touch limit may affect players in different ways depending on their competitive level. Thus, players with higher technical-tactical skills could move more effectively to offer passing lanes, resulting in a longer sequence of passes and increased game demands due to the maintenance of this sequence for a longer period. For players with lower technical-tactical skills, the maintenance of a passing sequence may be shorter, resulting in a reduced demand when a restriction such as the number of ball touches is imposed. Therefore, more skilled athletes may need to run less to achieve a specific objective.

Regarding the physical responses, the current systematic review relied only on the results of total distance covered as it was the only variable reported by all studies. Overall, adopting the ball-touch limitation rule did not induce different responses in terms of total distance covered, which was reported in six out of the eight studies evaluated. In line with our findings, Souza et al. [12] investigated the influence of limiting the number of ball touches on players' tactical behavior during SSGs and found no impact on the total distance covered as an outcome. It is worth noting that despite no differences in total distance covered, differences could appear in high-intensity actions, a parameter not explored by all studies in this review. Typically, sprint activities account for 1.8% to 2.6% of the total distance covered during a match [32], with variations in sprint efforts between professional and amateur athletes.

On the other hand, in one study [24], the total distance covered was significantly higher in the 1T condition compared to the 2T and FP conditions. This response was reported in the 2vs2, 3vs3, and 4vs4 formats, with differences also observed between the 2T and FP conditions in the 3vs3 and 4vs4 formats. Another study [23] reported greater distances covered in SSGs with 2T compared to FP in the 3vs3, 4vs4, and 6vs6 formats. Specifically, the 2T SSGs allow for contact with the ball before passing or shooting, which could result in better passing accuracy and improved ball possession[33], explaining the greater distances covered. Contrary to these

findings, Coutinho et al.[34] found that playing with limited ball touches resulted in an overall decrease in the distance covered. The one-touch rule improved the number of passing actions (including unsuccessful ones) while reducing physical responses.

Regarding the physical responses, it is worth noting that in one study[24], there was a higher physical demand in the game with a ball-touch limit compared to the game without a limit in professional players. The authors attribute this to the SSG formats (<3vs3), the type of technology used to capture external load measurements (GPS vs. video motion tracking), and the level of experience of the participants (amateur vs. professional). In contrast, Dellal[22] and Younesi[28] did not find differences between protocols with and without ball-touch limits in the same formats. The authors attribute this absence of differences to the lower level of experience of the players (semi-professionals), which may result in a higher number of technical errors, potentially increasing the number of interruptions and leading to a reduction in the distance covered in SSGs with formats involving fewer players (<3vs3). Thus, there seem to be different results in the physical demands when different populations are investigated. However, due to methodological differences between studies, further research is recommended to identify the actual impact of ball-touch limits on the physical demands in games with different formats, player areas, and athlete levels.

Practical Applications

In terms of practical application, to increase intensity, it is recommended to limit the number of ball touches. This strategy can be effective in SSGs with 2vs2, 3vs3, and 4vs4 formats. On the other hand, in formats with more players (6vs6 and 7vs7), such manipulation seems to have no effects on intensity. Additionally, implementing a ball-touch limit in athletes with less experience in the sport may result in a game with a higher frequency of errors, which will reduce the physical and physiological responses. It is also recommended to conduct further studies analyzing the number of ball touches in different small-sided game formats (e.g., 5vs5 and 8vs8) and how these different formats may influence athletes' physiological and physical responses.

Limitations

Despite the qualitative assessment of the studies, ensuring all the required controls were adopted in the selected studies is impossible. At this point, some information is missing, compromising the analysis and requiring attention. For example, information regarding the time of the day when the data were collected, the environmental conditions, and the players' fatigue status can influence the players' responses and were not mentioned by the studies. Finally, future reviews are recommended to broaden the knowledge on physical and physiological responses to different SSG manipulations, improving the possibility of using this training tool adequately in practice.

Conclusion

This systematic review revealed that altering the number of ball touches permitted per possession impacts the physiological responses of players. Notably, SSGs with fewer ball touches tended to elicit higher intensity. However, it was observed that this rule does not significantly affect physical responses. Further research is warranted to deepen comprehension of the physiological and physical responses to different SSGs. Additionally, exploring the potential manipulation of factors such as player number, field size, and goalkeeper involvement could enhance football players' performance.

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