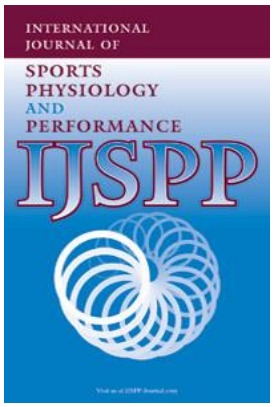

In press

Title: ***Locomotor and heart rate responses of floaters during small-sided games in elite soccer players: effect of pitch size and inclusion of goal keepers***

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1. Abstract:

Purpose: To (1) compare the locomotor and heart rate responses between floaters and regular players during both small and large small sided games (SSGs) and (2) examine whether the type of game (i.e., game simulation vs possession game) affects the magnitude of the difference between floaters and regular players.

Methods: Data were collected in 41 players belonging to an elite French football team during three consecutive seasons (2014-2017). 5-Hz GPS were used to collect all training data, with the Athletic Data Innovation analyser (v5.4.1.514, Sydney, Australia) used to derive total distance (m), high-speed distance (> 14.4 $km \cdot h^{-1}$, m) and external mechanical load (MechL, a.u). All SSGs included exclusively one floater, and were divided into two main categories, according to the participation of goal-keepers (GK) (game simulation, GS) or not (possession games, PO) and then further divided into small and large (>100 m2/player) SSGs based on the area per player ratio.

Results: Locomotor activity and mechanical load performed were likely-to-most likely lower (moderate to large magnitude) in floaters compared with regular players, while differences in HR responses were unclear to possibly higher (small) in floaters. The magnitude of the difference in locomotor activity and MechL between floaters and regular players was substantially greater during GS compared with PO.

Conclusions: Compared with regular players, floaters present decreased external load (both locomotor and MechL) despite unclear to possibly slightly higher HR responses during SSGs. Moreover, the responses of floaters compared with regular players are not consistent across different sizes of SSGs, with greater differences during GS than PO.

Keywords: Small-sided games, soccer, floaters, locomotor activity, mechanical load.

2. Introduction

During recent years, soccer training has evolved towards a more integrated type of physical training with coaching staff generally aiming to maximise training time with the ball. In addition to the tailoring of between-players relationships and overall team tactical principles, it is now clear that small sided games (SSGs) can be used to improve football-specific fitness and match winning-related factors.[1-3]

The key programming elements of SSGs are now well understood: a range of variables can be modulated to affect intensity, and in turn, the metabolic and locomotor responses (i.e,[4]). Nevertheless, while the management of the group training load is of primary importance, most of the time, "one size does not fit all" when it comes to regulating individual player load (e.g., players unable to tolerate the overall training load or returning from injury). One option offered to coaches to individualise the SSGs demands for some players is to use them as 'floaters'.[4] A Floater transitions between the two teams and always remains with the team in possession, however is unable to score. This approach is believed to place specific metabolic and locomotor demands on players used as floaters. However, research related to the use of floaters in soccer is scarce. In the only paper where floaters are mentioned, they were reported to cover greater total distance than their teammates during 3-4 sided SSGs , probably due to frequent changes in ball possession between teams that may require the floater to travel greater distances.[5] Caution is however needed when interpreting those results as they were obtained with a small sample size (n = 12) representative of a very specific population (i.e., U16 Australian youth soccer players). As technical and tactical level has a likely impact on the response to SSGs6, generalizing the results of this specific group to other populations (e.g., senior professional players, where manipulation in load prescription is of greatest importance) may be uncertain. Additionally, restricting time motion analyses to the distance ran in different speed zones is limited during SSGs and may not draw an accurate picture of the actual locomotor demands imposed on floaters. Indeed, in the particular case of SSGs where the pitch is reduced, players are not able to reach large distances at high speed and thus most of the actions are rather characterized by a high mechanical load (acceleration/deceleration/change of direction) at low speed than distance covered at high speed.

Therefore, the purpose of this study was to (1) compare the locomotor (high-speed running and external mechanical load) and heart rate responses between floaters and regular players during both small and large SSGs and (2) examine whether the type of game (i.e., game simulations including goal keepers vs. possession games) affects the magnitude of the difference between floaters and regular players.

3. Methods

Participants:

Data were collected in 41 players (24.9±5.4 yr, 180±6 cm, 76.1±6.8 kg) belonging to an elite French football team (qualified for the last stage of the Champion's league competition) during three consecutive seasons (2014-2017). These data arose from the daily player monitoring in which players' activities are routinely measured over the course of the season. Therefore, ethics committee clearance was not required. The study conformed nevertheless to the recommendations of the Declaration of Helsinki.

Study overview:

All training data were collected in-season on a hybrid turf (DESSO GrassMaster, Tarkett, Nanterre, France) during typical training sessions. While changes in environmental conditions throughout the year could impact responses to SSGs, floaters' responses were always compared with those of the regular players involved in the same drill on the same day, which likely levels off the impact of environment. Players' activity was recorded using 5-Hz GPS (Spi-Pro, Team AMS R1 2016.8; GPSports, Canberra, Australia). The reliability and validity of this system to measure distance and accelerations has been reported elsewhere.[7] GPS data were further analysed using Athletic Data Innovation (ADI) analyser (v5.4.1.514, Sydney, Australia) to derive total distance (TD, m), high-speed distance (HS, distance above 14.4 $km \cdot h^{-1}$, m) and external mechanical load (MechL, a.u). MechL is an overall measure of velocity changes and is calculated using >2$m.s^{-2}$ accelerations, decelerations and changes of direction events. Heart rate was monitored using Polar H1 units (Polar, Kempele, Finland) and further analysed using the ADI analyser to derive mean heart rate (HR) expressed as a percentage of maximal heart rate (HR%max, %). Data were then normalised relative to the drill duration to allow comparisons. No HR data were collected during large game simulations as these games are generally planned the day before matches.

Small-Sided Games:

All the SSGs examined (n = 68) in the present study included exclusively one floater (floaters: n = 68, 1.5 ± 2.5 'floater' session per player; regular players: n = 815, 22.7 ± 14.9 session per player), and were divided into two main categories, according to the participation of goal-keepers (GK) (game simulation, GS) or not (possession games, PO) and then further divided into small and large SSGs based on the area per player ratio (Table 1). Pitch dimensions were similar to those commonly used in elite football.[4] SSGs were analysed from the first to the end of the last repetition, including resting periods.[8]

Statistical analyses:

Data in the text, tables and figures are presented as means with standard deviations (SD) and 90% confidence limits/intervals (CL/CI). All data were first log-transformed to reduce bias arising from non-uniformity error. Between-player roles (for each SSG: one individual floaters vs. group of regular players involved in the SSG of interest) differences and between-SSG relative differences in the differences between player roles were examined using standardized differences, based on Cohen's *d* effect size principle. Probabilities were used to make a qualitative probabilistic mechanistic inference about the true changes/differences in the changes, which were assessed in comparison to the smallest worthwhile change (0.2 x session SDs). The scale was as follows: 25−75%, possible; 75−95%, likely; 95−99%, very likely; >99%, almost certain. Threshold values for standardized differences were >0.2 (small), >0.6 (moderate), >1.2 (large) and very large (>2).[9]

4. Results:

Table 2 presents the locomotor demands and HR responses of floaters and regular players during typical SSGs. Standardised differences between floaters and regular players are presented in Figure 1. Overall, locomotor activity and MechL demands were likely-to-most likely lower (moderate to large magnitude) in floaters compared with regular players, while differences in HR responses were unclear to possibly higher (small) in floaters. Floaters showed likely lower activity during GS (moderate) but not during PO (unclear to possibly small).

The effect of pitch dimension on the differences between floaters and regular players in locomotor activity, mechanical load demands and HR responses are presented in Figure 1. The difference in TD between floaters and regular players was likely-to-most likely greater during GS than PO (small to moderate respectively) and during large PO than small PO (likely small). The difference in MechL and HR responses between floaters and regular players was likely lower during small PO than other SSGs (small), while no between-SSGs difference was reported for HS.

5. Discussion:

To our knowledge this study is the first to compare the activity of floaters and regular players during different types of SSGs. The main findings of this study were (1) overall, locomotor activity and MechL demands were likely-to-almost certainly lower in floaters compared with regular players, while differences in HR responses were unclear to possibly higher in floaters and (2) the magnitude of the difference in locomotor and MechL load between floaters and regular players is substantially greater during GS compared with PO.

Locomotor activity (TD and HS) and MechL were likely lower in floaters compared with regular players during SSGs, both large and small (Table 2 and Figure 1). These results contrast with those of Hill-Hass et al.[5] who reported increased TD and HS in floaters. However, the playing standards of the team (elite vs sub-elite), age grade (senior vs U16s) as well as the specific rules used may explain the differences observed. Nonetheless, our results confirm the general interests for coaching staff to use floaters when it comes to modulating an individual players' responses. Floaters can be used to substantially decrease locomotor activity as well as MechL in individual players without compromising the overall team dynamic and is more 'game-specific' than using relay players outside the playing area. Moreover, our results reported that HR%max responses of floaters during the SSGs were not substantially different than those of regular players. While caution is needed when using HR to infer on metabolic demands of SSGs due to the likely dissociation between HR and VO_2,[10] the floater role may be used to decrease overall external load (both locomotor and mechanical) while maintaining internal loading and thus aerobic stimulus. It is noteworthy that some players returning to play as floaters after injury were also included in this study, which might have inflated HR responses possibly due to lower fitness following the recovery period[11]; further investigation required.

The second important finding is that the difference in responses between floaters and regular players was affected by SSG type (GS vs PO and pitch size). In fact, the effect of floaters to unload both locomotor and MechL was substantially higher in GS compared with PO games (Figure 1). This may be related to the fact that during both types of SSGs, floaters are only in possession of the ball and thus, their role is more likely comparable to that of regular players during PO than during GS. It is noteworthy that field size also influenced the relative activity of the floaters in the PO games. Indeed, the difference in both TD and MechL between floaters and regular players was lower during small compared with large PO, possibly resulting in an increased HR response. These results have direct implications for individualising training load or when programming progressive return-to-play with injured players. Following injury, players may start as floaters during small GS (lower TD, lower HS), then small PO (lower HS) to finally be involved in large GS and large PO (higher TD, higher HS) before returning to full training.

6. Practical applications:

- Using a player as a floater is a simple means to decrease both their locomotor (TD and HS) and MechL load during SSGs, while preserving the specificity of team dynamics.
- The magnitude of the difference in locomotor and MechL load between floaters and regular players is substantially greater during game simulations (including goal keepers) than possession games (without goal keepers).

7. Conclusions:

Compared with regular players, floaters present decreased external load (both locomotor and MechL) despite almost unchanged HR responses during SSGs. Moreover, the decreased external load of floaters compared with regular players are not consistent across different sizes of SSGs, with a greater decrease in activity for floaters vs. regular players during game simulations than possession games.

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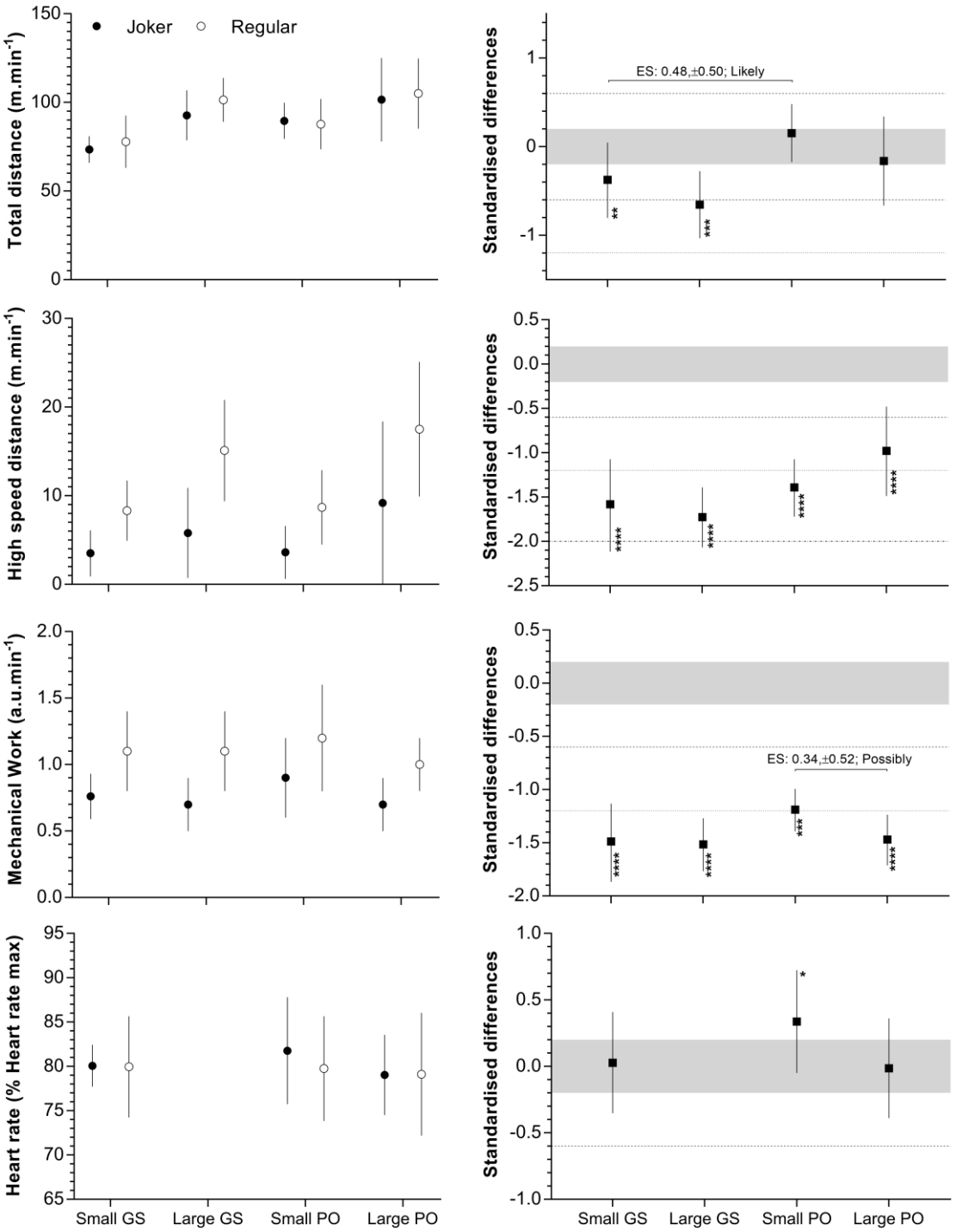

Figure 1: Standardised differences between floaters and regular players during typical SSGs. SWC: smallest worthwhile change; *: possibly; **: likely; ***: most likely; ****: almost certainly difference.

228 Table 1: Field dimension, playing area and number of players of the different small-sided games.
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		Mean field dimension	Area (m2)	Players (n)	Area / player (m2)
Game Simulations (GS)	Small	30x25	781±200	12±2	65±16
	Large	50x55	2497±387	20±2	124±14
Possession Games (PO)	Small	25x30	793±213	13±2	61±10
	Large	40x55	2147±617	18±3	118±16

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232 Table 2 - Locomotor demands and heart rate responses of floaters and regular players during typical
233 small-sided games.

		Game Simulations		Possession Games	
		Large pitch (n=21)	Small pitch (n=10)	Large pitch (n=15)	Small pitch (n=22)
Total distance (m.min-1)	Floaters	93.6±14.5	73.4±7.5	101.5±23.6	89.6±10.2
	Regular	101.1±6.1	81.1±11.5	103.4±14.4	87.2±8.6
	Differences (%)	-7.8,±4.8%	-8.3,±2.8%	-2.5,±5.6%	+3.4,±4.6%
	Magnitude & Likelihood	Moderate; 97/3/0	very large; 100/0/0	unclear; 58/32/10	small; 3/25/71
High-speed (m.min-1)	Floaters	6.5±5	3.5±2.6	9.2±9.2	3.6±3
	Regular	15±2.4	8.6±1.9	16.4±4.7	8.6±1.9
	Differences (%)	-57.5,±11.1%	-60.7,±14.2%	-50.2,±16.1%	-56.5,±14.5%
	Magnitude & Likelihood	very large; 100/0/0	very large; 100/0/0	large; 100/0/0	large; 100/0/0
Mechanical Load (au.min-1)	Floaters	0.68±0.20	0.76±0.17	0.67±0.24	0.91±0.33
	Regular	1.04±0.10	1.13±0.21	1.02±0.10	1.18±0.18
	Differences (%)	-34.7,±6.6%	-31.8,±9.3%	-33.3,±11.7%	-22.9,±9.1%
	Magnitude & Likelihood	very large; 100/0/0	very large; 100/0/0	large; 100/0/0	large; 100/0/0
Heart rate (%Hrmax)	Floaters	-	80.1±2.4	78.6±4.5	81.8±6
	Regular	-	80.6±3	79.3±3.1	79.8±2.2
	Differences (%)		-0.6,±2.8%	-0.7,±2.3%	+2.0,±2.2%
	Magnitude & Likelihood		unclear; 50/27/22	unclear; 53/31/16	small; 2/17/81

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235 Likelihood are expressed as percentage of chances of having -ve/trivial/+ve differences.

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