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Research article

Higher Heart Rate Intensity Can Negatively Impact Tactical Decision-Making and Technical Accuracy in Small-Sided Games: A Study on The Effects of Field Size and Scoring Method Manipulation

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Abstract

This study investigated how varying task constraints - pitch size and the presence of a goal - affect psychophysiological intensity, technical execution, and tactical decision-making in small-sided games (SSGs). The study also examined correlations between intensities and technical and tactical performance. Thirty-six regional-level male youth soccer players (aged 16.5 ± 0.5 years) participated in a four-week intervention using a non-controlled, repeated-measures design within a single cohort. Players completed 3v3 SSGs under six conditions combining three pitch sizes (75, 100, and 125 m² per player) and two task goals (ball possession vs. small goals). Each session included standardized warm-ups and three 4-minute bouts per condition. Psychophysiological responses were measured via Rating of Perceived Exertion (RPE) and heart rate monitoring (HRmean, % time in Zone 5). Technical actions (passes, receptions, dribbles, shots) and tactical decision-making (Passing Decision-Making index) were assessed through video-based analysis. Significant interactions ($p < 0.001$) between field size and scoring method were found for HR measures and passing. Ball possession games showed higher HRmean and HR Zone 5 across all field sizes compared to small-goal games ($p < 0.001$). However, even in small-goal games, HRmean and HR Zone 5 significantly increased with larger field sizes ($p < 0.001$). Small-goal games resulted in more successful dribbles ($p < 0.001$), with fewer successful passes on the smallest field. A moderate negative correlation was observed between HRmean and successful shots ($r = -0.346$, $p = 0.039$), and between time in HR Zone 5 and the passing decision-making index ($r = -0.363$, $p = 0.029$). The study suggests that both field size and scoring method significantly influence players' physiological responses, technical performance, and decision-making. Ball possession games and larger fields increase physical intensity and passing success, while smaller fields and small-goal games promote dribbling. However, higher physiological strain appears to negatively impact shooting effectiveness and decision-making quality, although these correlations are moderate and no definitive conclusions can be drawn or generalized.

Key words: Football, soccer, intensity, drills, performance, fatigue.

Introduction

Small-sided games (SSGs) are highly relevant in soccer training due to their ability to replicate the physical, technical, tactical, and psychological demands of match play in a controlled and adaptable environment (Fernández-Espínola et al., 2020; Ferreira-Ruiz et al., 2022). Grounded in the ecological dynamics framework, these games promote representativeness, support perception–action coupling, and align well with a constraints-led approach to training (Silva et al., 2016). Scientific evidence shows that SSGs enhance aerobic fitness, with reviews reporting significant improvements in maximal oxygen uptake comparable to traditional endurance training (Clemente et al., 2024b). Additionally, SSGs promote technical skill development and decision-making under pressure by increasing the frequency of ball contacts, passes, and tactical interactions (Clemente et al., 2021). The manipulation of variables such as pitch dimensions (Casamichana and Castellano, 2010), number of players (Clemente et al., 2025), and rules allows coaches to target specific training outcomes, such as intensity regulation (Hill-Haas et al., 2011) or tactical awareness (Ometto et al., 2018).

During SSGs, soccer players typically experience high psychophysiological intensities, characterized by elevated heart rates, oxygen consumption, and lactate concentrations, coupled with accumulated fatigue (Hidalgo-de Mora et al., 2025). Studies consistently show that heart rates during SSGs range between 80 - 95% of maximum heart rate (Bujalance-Moreno et al., 2019), reflecting substantial cardiovascular load. Additionally, lactate concentrations increase, particularly in smaller formats, suggesting the activation of anaerobic pathways (Koklu and Alemdaroglu, 2016). The physiological demands are accompanied by subjective fatigue, which can manifest as muscle soreness, and impaired neuromuscular function after successive repetitions of SSGs (Papanikolaou et al., 2021). However, such intensities can vary depending on the task constraints applied, which can be used to either increase or reduce training intensity. The intensity and fatigue are influenced by factors such as the number of players, the duration of the game, and the size of the playing area, with smaller pitches and fewer players resulting in higher intensities and faster fatigue onset (Papanikolaou et al., 2021). Similarly, changes in task constraints also affect technical actions and accuracy, reflected in both the number of specific technical events performed by each player and the proportion of those executed correctly. The evidence suggests that smaller formats of play lead to greater

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individual involvement in technical execution - such as passing, shooting, and dribbling (Clemente and Sarmento, 2020). Additionally, modifications in pitch dimensions can influence players' tactical behavior, notably by encouraging greater use of wide areas (Silva et al., 2014a).

High intensities experienced during SSGs may impair technical execution - reflected in both the frequency of technical actions performed by each player and their accuracy - as well as tactical decision-making, which involves the number and quality of context-specific behaviors influenced by interactions with teammates and opponents (Clemente, 2024a). The physiological demands of SSGs often lead to fatigue, which may negatively impact motor skills and decision-making (Skala and Zemková, 2022). Fatigue may cause a reduction in motor control, leading to less accurate passes, poor ball control, and diminished shooting accuracy (Dambroz et al., 2022). Additionally, rapid increases in intensity and intermittent recovery periods during SSGs can impair cognitive function, reducing the players' ability to make optimal tactical decisions (Teoldo et al., 2024). The combination of physical fatigue and cognitive overload in high-intensity scenarios in SSGs can limit both technical performance and the capacity to execute well-thought-out tactical movements (Skala and Zemková, 2022).

Despite the widespread use of SSGs in soccer training, there is limited understanding of how specific task constraints - such as pitch size (i.e., playing in larger or smaller areas) and the presence or absence of a goalkeeper (i.e., scoring in goals versus maintaining possession to earn points) - influence psychophysiological demands and affect players' technical execution and tactical behavior during these games (Skala and Zemková, 2022). While it is well established that these task conditions affect overall intensity, the impact on fatigue levels and the subsequent decline in technical execution and tactical decision-making remains underexplored. Few studies have analyzed how variations in these constraints modulate physical stress and cognitive overload, and how this, in turn, affects players' ability to perform technical skills (Clemente, 2024a) and make tactical decisions (Teoldo et al., 2024). This research aims to fill these gaps by examining the effects of different task constraints on the psychophysiological load experienced by players and how this influences both technical and tactical performance. By providing information on the optimal configuration of SSGs for maintaining high performance and minimizing fatigue-induced errors, this study offers novel information that can contribute to refining training methodologies and enhancing player development in the soccer community. Thus, the innovation and contribution of addressing a research question on the impact of psychophysiological intensities on technical and tactical decision-making is clear and represents a meaningful advancement in the current state of the art. Based on these reasons, the aim of this study was to investigate the effects of manipulating the 3v3 format across three different field sizes (75, 100, and 125 m² per player) and two scoring methods (ball possession and small goals) on the psychophysiological intensities experienced during SSGs, as well as their subsequent impact on technical execution and tactical decision-making.

Methods

Study design

This study employed a repeated-measures (within-subject) design in which players participated in 3v3 games under varying conditions combining field dimensions (75, 100, and 125 m² per player) and scoring methods (ball possession versus small goals). The aim was to examine how these variations influenced psychophysiological intensities as well as technical and tactical decision-making. Additionally, the study focused on analyzing potential correlations between the experienced intensities and the accuracy of technical and tactical performance.

The study took place over four consecutive weeks, with participants completing each combination of factors at least twice during this period, following different sequences to minimize potential sequence effects. Each player had an equal number of match participations. It was conducted during the last four weeks of the season, ensuring that all players experienced every experimental condition. The study involved two different teams competing in the same age category and training in the same environment.

Participants

An a priori power analysis was conducted prior to data collection using the pwr package in R to determine the minimum sample size required. Assuming six repeated-measures conditions (3 field dimensions × 2 scoring methods), a significance level of 0.05, and desired power of 0.80, the analysis indicated that at least 19 participants would be necessary to detect a medium effect size ($f = 0.25$).

Participants were recruited using a convenience sampling approach by collaborating with two local soccer teams competing in the same age category and training within the same environment. Initial contact was made through the teams' coaching staff, who facilitated communication and access to the players. Information sessions were held to explain the study's objectives, procedures, and requirements, allowing players and their guardians to ask questions before providing informed consent. Inclusion criteria required participants to be active players regularly training (> 2 years of experience) and competing with their respective teams, aged between 16 and 17 years old, and free from injuries or medical conditions that could affect performance or participation. Exclusion criteria included goalkeepers, any player currently experiencing musculoskeletal injuries, or other health problems contraindicating soccer training. The exclusion criteria also included players who missed any of the SSG sessions.

Based on the recruitment strategy, a total of 36 male players were enrolled to ensure sufficient statistical power to detect smaller effect sizes and to mitigate the impact of potential data loss. No participants dropped out during the study period. Each of the two participating teams contributed 18 players who voluntarily agreed to take part in the study. All participants were regional-level youth soccer players, aged between 16 and 17 years. The sample had a mean age of 16.5 ± 0.5 years, a mean body mass of 63.8 ± 6.2 kg, a mean height of 174.3 ± 5.4 cm, and a mean body mass index of 21.0 ± 1.5 kg/m². On average, players had 4.8 ± 1.9 years of soccer training experience. During the study period, all players followed a consistent weekly training schedule consisting of three team-based sessions per week, each lasting approximately 100 minutes, which included technical-tactical drills, physical conditioning, and small-sided games, in addition to regular weekend match play.

This study was conducted in accordance with the ethical standards of the Declaration of Helsinki and received prior approval from the Biomedical Ethics Committee of Anqing Medical College (approval number: 2025-04-001). Before the commencement of data collection, all participants and their legal guardians were provided with detailed information about the study's purpose, procedures, potential risks, and benefits. Written informed consent was obtained from their guardians. Participation was entirely voluntary, and players were informed of their right to withdraw from the study at any time without penalty. All data were anonymized to protect participant confidentiality, and no personal identifiers were used in reporting the findings.

Small-sided games

The SSGs were implemented at the beginning of each training session in synthetic turf, following a standardized warm-up. Temperature ranged between 16ºC and 22ºC, and relative humidity varied from 53% to 63% across all data collection days. The warm-up started with 5 minutes of light jogging, followed by dynamic stretching exercises targeting mobility and muscle activation. Players then performed walking lunges with a torso twist across the field, completing 2 sets of 10 repetitions per leg to emphasize hip flexibility and core engagement. The warm-up concluded with 3 sets of short accelerations (10 meters) and 5 vertical jumps to enhance neuromuscular readiness and power output.

After a three-minute rest period, participants began the SSGs, consistently performing three 4-minute repetitions per session, each separated by a 2-minute rest, for each format and condition selected that day. The 3v3 format was used throughout, with field dimensions set according to the player-area ratio: 18.4 × 24.5 m (75 m²/player), 21.2 × 28.3 m (100 m²/player), and 23.3 × 31.0 m (120 m²/player). The length-to-width ratio was consistently maintained at 0.75 across all field dimensions. Each combination of format and field dimension was paired with a task condition - either maintaining ball possession or scoring in a small goal positioned at the center of the field. All games were played without the offside rule, and ball repositioning was conducted by foot. In games involving goals, participants were only allowed to score after crossing the halfway line. To facilitate quick ball repositioning, three balls were placed around each field. All games were supervised by a coach or staff member, who ensured that the rules were followed but provided no technical instructions or verbal encouragement. Rest periods between games were passive.

Table 1 presents the order and sequence of games, which combined variations in format, field dimensions, and scoring method. The sequence was established a priori, with each condition repeated twice over the course of the study to account for within-player variability. To avoid potential sequencing bias, the order of conditions was randomized. Games were conducted three times per week over four consecutive weeks. The first session each week took place 48 hours after the weekend match, the second session occurred 48 hours after the first, and the third session was held 24 hours after the second, in accordance with the teams' regular training schedule.

Players were assigned to fixed teams of three, which remained unchanged throughout the study. Teams were formed based on player positions, ensuring each team included a defender, a midfielder, and an attacker. Coaches distributed players according to their judgment of technical proficiency, aiming to create balanced teams. Opponent pairings varied randomly across sessions. To promote competitiveness, a championship-style points system was implemented: winning teams earned 2 points, while losing teams received 1 point. However, if the goal difference exceeded two goals, the winning team received 3 points and the losing team received none. In the case of a draw, each team earned 1 point. Rankings were not shared with players during the study to prevent strategic behavior and to maintain focus on performance in each individual game.

Procedures and Measurements

Throughout each game and bout, participants were monitored using heart rate monitors. Immediately after each bout, they reported their perceived exertion using the Rating of Perceived Exertion (RPE) scale to assess subjective effort intensity. All bouts were recorded using video cameras to enable post-game analysis of technical and tactical performance. A research team composed of trained observers supervised all sessions, overseeing the distribution and collection of heart rate monitors, administration of RPE assessments, and management of video recordings for subsequent analysis.

Rating of perceived exertion

To assess exercise intensity through subjective perception, the CR10 Borg Scale was employed to measure Ratings of Perceived Exertion (RPE). The CR10 scale is a category-ratio scale ranging from 0 to 10, where 0 represents "no exertion at all" and 10 corresponds to "maximal exertion." (Borg, 1998) Participants were thoroughly instructed on how to use the scale prior to the start of the intervention. Standardized verbal and visual explanations were provided to ensure consistency in interpretation, emphasizing that ratings should reflect the overall feeling of effort during the

Table 1. Sequence of small-sided games conducted throughout the duration of the study.

	Session 1	Session 2	Session 3
Week 1	3v3, 75m^2 + ball possession	3v3, 125m^2 + ball possession	3v3, 100m^2 + ball possession
Week 2	3v3, 75m^2 + goal	3v3, 125m^2 + goal	3v3, 100m^2 + goal
Week 3	3v3, 100m^2 + ball possession	3v3, 75m^2 + ball possession	3v3, 125m^2 + ball possession
Week 4	3v3, 100m^2 + goal	3v3, 75m^2 + goal	3v3, 125m^2 + goal

SSGs bout rather than localized muscular pain. The scale was administered immediately post-bout to capture acute subjective exertion levels, with participants asked to indicate a single value that best represented their perceived effort during the entire bout. The collected RPE values were later analyzed to examine trends in perceived intensity across bouts and to determine correlations with delta values of technical and tactical behaviors.

Heart rate monitoring

Heart rate (HR) monitoring was conducted using the Polar Team system (Polar Electro Oy, Kempele, Finland), a wireless telemetry technology designed for real-time tracking of physiological responses during exercise. Each participant was equipped with a chest-worn sensor that transmitted HR data continuously throughout all bouts. The primary outcomes extracted from the HR data included the mean heart rate (HRmean) across the entire session, and the percentage of bout time spent in heart rate zone 5, defined as ≥90% of an individual's maximal heart rate (HRmax). To ensure accurate HR zone classification, maximal heart rate was individually assessed using the Yo-Yo Intermittent Recovery Test Level 1 (Yo-Yo IR1) prior to the intervention (in the week before). Previous findings have shown that the HR_{max} obtained from the Yo-Yo IR1 test is approximately 99 ± 1% of the HR_{max} measured during a treadmill test, indicating its validity (Krustrup et al., 2003). This field-based test was implemented to evaluate near-maximal cardiovascular exertion, offering a valid estimate of HRmax to each participant's. Data during the SSGs bouts were collected and stored using the Polar Team software platform. The proportion of time in zone 5 (%) was used as an indicator of high-intensity effort.

Technical execution

Technical execution was assessed through an observational analysis using a specifically developed ad hoc observational instrument, designed to collect technical actions in the SSGs. The instrument focused on the absolute number of successful and unsuccessful passes, dribbles, and shooting actions (goals and unsuccessful shots) performed by each participant during the bouts. Operational definitions were established for each variable to ensure consistency: a successful pass was defined as a deliberate ball transmission to a teammate that maintained team possession; an unsuccessful pass included any pass intercepted, misdirected, or resulting in loss of possession. A successful reception was coded when a player securely controlled a received ball within one or two touches, whereas an unsuccessful reception involved a loss of control or immediate dispossession. Successful dribbles required the player to beat an opponent in 1v1 scenarios or maintain control under pressure, while unsuccessful dribbles ended in a turnover. Shooting was categorized into goals, defined as successful attempts resulting in a score, and unsuccessful shots, which included all attempts on goal that did not result in scoring, such as shots saved, blocked, or off target.

To ensure the consistency and reliability of observations, intra-observer reliability was assessed. The primary observer analyzed a randomly selected 10% of the recorded sessions twice, with a two-week interval between evaluations to mitigate recall bias. Agreement between the two coding instances was quantified using Cohen's Kappa (κ), yielding values ranging from 0.86 to 0.94 across the different technical actions, indicating strong to almost perfect agreement. All bouts were recorded using an AKASO (4k, 20fpm, China), securely mounted on a tripod at an elevated and central position along the sideline to ensure full coverage of the playing area. The camera was set to record in 4K resolution at 20 frames per second.

Tactical decision-making

Building on a previous study (Gantois et al., 2020), player actions were categorized based on the Game Performance Assessment Instrument (GPAI), while soccer-specific decision-making criteria followed the classification of passing choices (Romeas et al., 2016). A pass was deemed appropriate if it was directed toward an unmarked teammate who either contributed directly or indirectly to creating a goal-scoring opportunity, or was positioned advantageously relative to opponents. Video analysis was independently performed by two analysts, ensuring unbiased evaluation. The inter-rater agreement between the analysts was high (kappa = 0.89). The Passing Decision-Making index (PDM) was calculated as the percentage of appropriate actions out of total passing actions (Gantois et al., 2020).

Statistical analysis

A two-way repeated-measures ANOVA was employed to assess the main and interaction effects of field dimension (75, 100, and 125 m² per player) and scoring method (ball possession vs. small goals) on psychophysiological intensity, technical execution, and tactical decision-making. Assumptions of normality were verified using the Shapiro–Wilk test, and sphericity was tested with Mauchly's test; where sphericity was violated, Greenhouse–Geisser corrections were applied. Post hoc comparisons were conducted using Bonferroni-adjusted pairwise tests. Effect sizes for ANOVA outcomes were reported as partial eta squared (ηp^2), interpreted as small (≥ 0.01), medium (≥ 0.06), and large (≥ 0.14). To explore the relationships between psychophysiological intensities and the accuracy of technical and tactical performance, Pearson's correlation coefficients (r) were calculated. Correlation strength was interpreted as very weak (0.00 - 0.19), weak (0.20 - 0.39), moderate (0.40 - 0.59), strong (0.60 - 0.79), and very strong (0.80 - 1.00). All tests were two-tailed, and statistical significance was set at $p < 0.05$. All statistical analyses were conducted using IBM SPSS Statistics version 28.0 (IBM Corp., Armonk, NY, USA).

Results

The two-way repeated measures ANOVA revealed significant interactions across game conditions (field size and scoring method) for HRmean ($p < 0.001$; $\eta p^2 = 0.521$, large), HR Zone 5 ($p < 0.001$; $\eta p^2 = 0.219$, large), successful passes ($p < 0.001$; $\eta p^2 = 0.242$, large), and unsuccessful passes ($p < 0.001$; $\eta p^2 = 0.272$, large). No significant interactions were found for RPE ($p = 0.714$; $\eta p^2 = 0.010$, small), successful dribbles ($p = 0.954$; $\eta p^2 < 0.001$, trivial), unsuccessful dribbles ($p = 0.445$; $\eta p^2 = 0.023$, small), or the

Table 2. Mean and standard deviations of the various outcomes across combined conditions of different field sizes and scoring methods over the different sessions.

	75m²/player BP	100m²/player BP	125m²/player BP	75m²/player G	100m²/player G	125m²/player G
Rating of perceived exertion (A.U.)	7.92 ± 0.47	8.11 ± 0.57	8.45 ± 0.53	7.50 ± 0.57	7.72 ± 0.58	8.10 ± 0.60
Heart Rate mean (%)	84.17 ± 2.74	85.30 ± 2.57	87.77 ± 2.67	82.47 ± 2.66	84.36 ± 2.62	87.03 ± 2.43
Time in HRzone5 (min)	2.50 ± 0.17	2.62 ± 0.14	3.11 ± 0.15	2.42 ± 0.15	2.59 ± 0.17	2.97 ± 0.16
Successful passes (n)	15.26 ± 4.12	16.24 ± 3.97	16.22 ± 4.05	9.90 ± 3.88	13.31 ± 4.73	12.38 ± 3.67
Unsuccessful passes (n)	3.19 ± 1.24	5.50 ± 1.18	5.99 ± 1.55	3.07 ± 1.3	4.10 ± 1.09	5.29 ± 1.12
Successful dribbles (n)	2.57 ± 1.23	3.46 ± 0.79	4.46 ± 0.77	3.67 ± 1.33	4.58 ± 1.83	5.58 ± 1.62
Unsuccessful dribbles (n)	1.18 ± 0.90	2.11 ± 0.96	2.94 ± 0.87	2.01 ± 1.17	2.78 ± 1.02	3.61 ± 0.95
Successful shoots (n)	n.a.	n.a.	n.a.	0.99 ± 0.66	1.44 ± 0.79	1.43 ± 0.75
Unsuccessful shoots (n)	n.a.	n.a.	n.a.	1.29 ± 0.64	1.75 ± 0.72	1.92 ± 0.72
Passing Decision-Making index (%)	61.82 ± 17.70	57.47 ± 15.81	42.89 ± 17.20	57.78 ± 9.46	50.53 ± 19.23	42.50 ± 13.35

n.a.: not applicable; HRzone5: Heart rate zone above 90% of maximum; BP: ball possession; G: small-goals

Passing Decision-Making Index ($p = 0.128$; $\eta p^2 = 0.057$, medium). Table 2 shows the mean and standard deviations of the various outcomes across combined conditions of different field sizes and scoring methods over the different sessions.

Significant differences in RPE were found between scoring methods ($p < 0.001$; $\eta p^2 = 0.749$, large) and field sizes ($p < 0.001$; $\eta p^2 = 0.428$, large). Ball possession games were significantly more intense than small-goal games at 75 ($p < 0.001$), 100 ($p < 0.001$), and 125 m² per player ($p < 0.001$). The 125 m² condition was significantly more intense than the 75 m² condition ($p < 0.001$) during ball possession games, with similar results observed for small-goal games.

Significant differences in HRmean were found between scoring methods ($p < 0.001$; $\eta p^2 = 0.932$, large) and field sizes ($p < 0.001$; $\eta p^2 = 0.909$, large). Ball possession games were significantly more intense than small-goal games at 75 ($p < 0.001$), 100 ($p < 0.001$), and 125 m² per player ($p < 0.001$). The 125 m² condition was significantly more intense than both the 75 m² ($p < 0.001$) and 100 m² conditions ($p < 0.001$) during ball possession games, while the 75 m² condition was less intense than the 100 m² condition ($p < 0.001$). Similar statistical results were found for small-goal games.

Significant differences in time at HRzone5 were found between scoring methods ($p < 0.001$; $\eta p^2 = 0.824$, large) and field sizes ($p < 0.001$; $\eta p^2 = 0.917$, large). Time spent in HRzone5 was significantly greater in ball possession games than small-goal games at 75 ($p < 0.001$), 100 ($p = 0.001$), and 125 m² per player ($p < 0.001$). The 125 m² condition had significantly greater time in HRzone5 than both the 75 m² ($p < 0.001$) and 100 m² conditions ($p < 0.001$) during ball possession games, while the 75 m² condition had significantly smaller time than the 100 m² condition ($p < 0.001$). Similar statistical results were found for small-goal games.

Significant differences in successful passes were found between scoring methods ($p < 0.001$; $\eta p^2 = 0.891$, large) and field sizes ($p < 0.001$; $\eta p^2 = 0.535$, large). The number of successful passes was significantly greater in ball possession games compared to small-goal games at 75 ($p < 0.001$), 100 ($p = 0.001$), and 125 m² per player ($p < 0.001$). While no significant differences in the number of successful passes were found between field dimensions in ball possession games ($p > 0.05$), in the small-goal condition, the number of successful passes was significantly lower in the 75 m² condition compared to both the 100 m² ($p < 0.001$) and 125 m² ($p < 0.001$) conditions.

Significant differences in unsuccessful passes were found between scoring methods ($p < 0.001$; $\eta p^2 = 0.358$, large) and field sizes ($p < 0.001$; $\eta p^2 = 0.861$, large). The number of unsuccessful passes was significantly greater in ball possession games compared to small-goal games at 100 m² per player ($p = 0.001$) and 125 m² per player ($p = 0.017$), but not at 75 m² ($p = 0.568$). In ball possession games, the number of unsuccessful passes was significantly lower in the 75 m² condition compared to both the 100 m² ($p < 0.001$) and 125 m² ($p < 0.001$) conditions, while no significant difference was observed between the 100 m² and 125 m² conditions ($p = 0.066$). In the small-goal condition, the number of unsuccessful passes was significantly lower in the 75 m² condition than in both the 100 m² ($p < 0.001$) and 125 m² ($p < 0.001$) conditions, with a greater number of unsuccessful passes observed in the 125 m² condition compared to the 100 m² condition ($p < 0.001$).

Significant differences in successful dribbles were found between scoring methods ($p < 0.001$; $\eta p^2 = 0.358$, large) and field sizes ($p < 0.001$; $\eta p^2 = 0.901$, large). The number of successful dribbles was significantly greater in small-goal games compared to ball possession at 75 ($p < 0.001$), 100 ($p = 0.001$), and 125 m² per player ($p < 0.001$). In ball possession games, the number of successful dribbles was significantly greater in the 75 m² condition compared to both the 100 m² ($p < 0.001$) and 125 m² ($p < 0.001$) conditions, while significant difference was observed between the 100 m² and 125 m² conditions ($p < 0.001$). In the small-goal condition, the number of successful dribbles was significantly lower in the 75 m² condition than in both the 100 m² ($p < 0.001$) and 125 m² ($p < 0.001$) conditions, with a greater number of successful dribbles observed in the 125 m² condition compared to the 100 m² condition ($p < 0.001$).

Significant differences in unsuccessful dribbles were found between scoring methods ($p < 0.001$; $\eta p^2 = 0.795$, large) and field sizes ($p < 0.001$; $\eta p^2 = 0.770$, large). The number of unsuccessful dribbles was significantly greater in small-goal games compared to ball possession at 75 ($p < 0.001$), 100 ($p = 0.001$), and 125 m² per player ($p < 0.001$). In ball possession games, the number of unsuccessful dribbles was significantly smaller in the 75 m² condition compared to both the 100 m² ($p < 0.001$) and 125 m² ($p < 0.001$) conditions, while significant difference was observed between the 100 m² and 125 m² conditions ($p < 0.001$). In the small-goal condition, the number of unsuccessful dribbles was significantly lower in the 75 m² condition than in both the 100 m² ($p = 0.001$) and 125 m² ($p < 0.001$) conditions, with a greater number of unsuccessful dribbles observed in the 125 m² condition compared to the 100 m² condition ($p < 0.001$).

Significant differences in the passing decision-making index were found between scoring methods ($p = 0.028$; $\eta p^2 = 0.130$, medium) and field sizes ($p < 0.001$; $\eta p^2 = 0.569$, large). A significantly greater passing decision-making index was observed in ball possession games compared to the small-goal condition at the 100 m² field ($p = 0.008$), while no significant differences were found at the 75 m² ($p = 0.134$) and 125 m² ($p = 0.869$) fields. In ball possession games, the passing decision-making index was significantly lower at 125 m² compared to both 75 m² ($p < 0.001$) and 100 m² ($p < 0.001$), and the index was also lower at 100 m² compared to 75 m² ($p = 0.001$). In the small-goal condition, the passing decision-making index at 125 m² was significantly lower than at 75 m² ($p < 0.001$).

Regarding successful shots, significant differences were observed between field dimensions ($p < 0.001$; $\eta p^2 = 0.187$, large), with significantly fewer successful shots occurring in the 75 m² field compared to the 100 m² ($p = 0.005$) and 125 m² ($p = 0.003$) fields, despite no differences between the 100 m² and 125 m² fields ($p > 0.999$). For unsuccessful shots, significant differences were found between field dimensions ($p < 0.001$; $\eta p^2 = 0.383$), with significantly fewer unsuccessful shots in the 75 m² field compared to the 100 m² ($p = 0.009$) and 125 m² ($p < 0.001$) fields, despite no significant differences between the 100 m² and 125 m² fields ($p > 0.999$).

The correlations between pooled outcomes are presented in Figure 1. A significant and very large correlation was found between HRmean and HRzone5 ($r = 0.777$; 95% CI: 0.603 - 0.881; $p < 0.001$). Moderate correlations were observed with successful shots ($r = -0.346$; 95% CI: -0.606 to -0.019; $p = 0.039$), unsuccessful shots ($r = 0.366$; 95% CI: 0.043 - 0.620; $p = 0.028$), and PDM ($r = -0.442$; 95% CI: -0.673 to -0.132; $p = 0.007$). A strong positive correlation was observed between HRz5 and unsuccessful shots ($r = 0.521$; 95% CI: 0.233 - 0.726; $p = 0.001$), indicating a relationship between time spent in high-intensity heart rate zones and the frequency of unsuccessful shooting attempts. A very large positive correlation was also observed between successful passes and PDM ($r = 0.887$; 95% CI: 0.788 - 0.941; $p < 0.001$), while a moderate negative correlation was evident between HRz5 and PDM ($r = -0.363$; 95% CI: -0.618 to -0.040; $p = 0.029$). Similarly, unsuccessful dribbles were very strongly correlated with successful dribbles ($r = 0.770$; 95% CI: 0.591 - 0.877; $p < 0.001$). A moderate negative correlation was also found between unsuccessful passes and PDM ($r = -0.343$; 95% CI: -0.604 to -0.017; $p = 0.040$), suggesting that increased unsuccessful passing was associated with lower PDM scores.

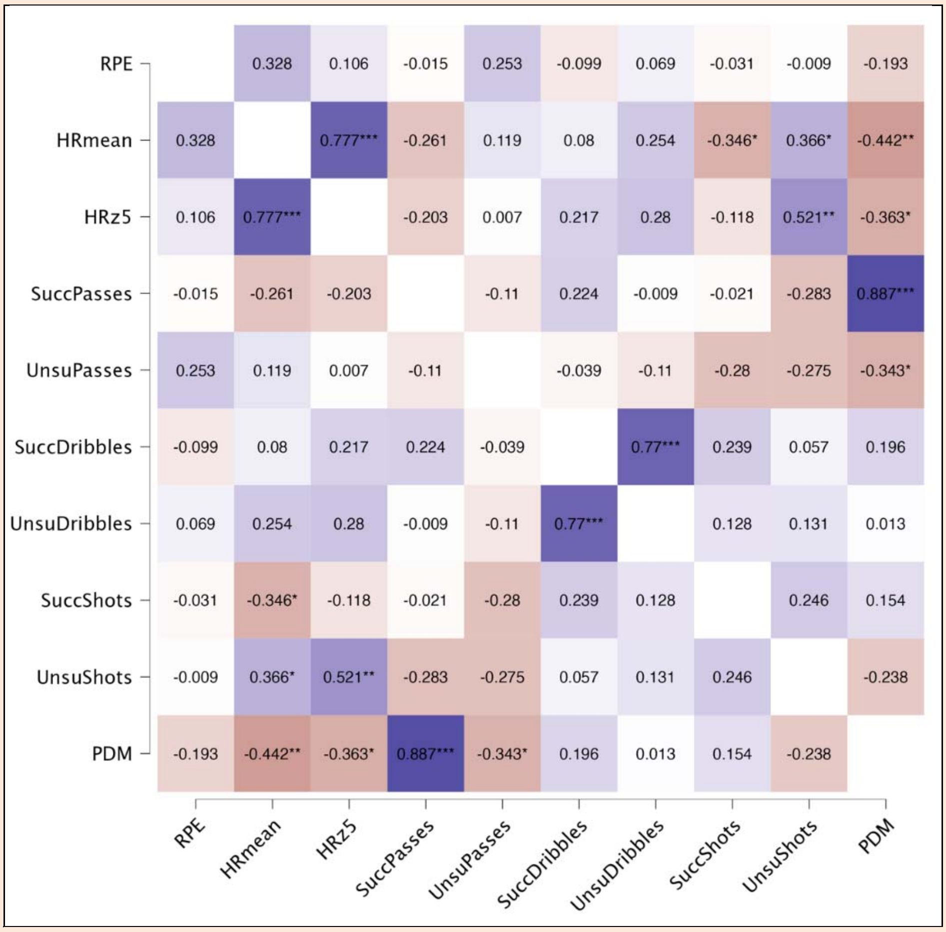

Figure 1. Pearson's heat map of the pooled outcomes. *$p < 0.005$; **$p < 0.010$; *** $p < 0.001$. RPE: rating of perceived exertion; HR: heart rate; HRz5: heart rate at zone 5; Succ: successful: Unsu: unsuccessful; PDM: Passing Decision-Making index.

Discussion

The present study showed that both field size and scoring method significantly affect players' physiological responses, technical performance, and decision-making during game-based drills. Ball possession games consistently elicited higher mean heart rates, greater time spent in high-intensity heart rate zones (HRzone5), and elevated RPE compared to small-goal games across all field sizes. Larger playing areas, particularly the 125 m² per player condition, were associated with increased physiological intensity and more successful passes, whereas smaller fields tended to limit technical actions. Successful dribbles were more frequent in small-goal games, contrasting with the passing dominance in ball possession formats. While successful passes and passing decision-making were strongly positively correlated - indicating that better decision-making leads to more effective passing - the data also revealed that higher physiological intensity was associated with reduced technical efficacy. Specifically, increased time in HRzone5 was moderately negatively correlated with the passing decision-making index and positively correlated with unsuccessful shots, suggesting that as players experience greater physical strain, their technical performance and decision-making quality tend to decline.

The analysis showed no significant interaction effects on RPE across different game conditions. However, RPE was significantly influenced by both scoring methods and field sizes. Specifically, ball possession games elicited higher RPE scores than small-goal games across all field sizes (75, 100, and 125 m² per player), with larger field sizes consistently producing greater perceived intensity. Similarly, mean heart rate (HRmean) and time spent in the highest heart rate zone (HR Zone 5) showed significant interactions influenced by scoring method and field size. Ball possession games induced higher HRmean and longer durations in HR Zone 5 compared to small-goal games across all field dimensions. Additionally, larger playing areas were associated with increased cardiovascular demands, as indicated by elevated HRmean and extended time in HR Zone 5, particularly in the 125 m² condition compared to the smaller field sizes. Our results aligns with a previous study which found that larger playing areas generally promote higher RPE, particularly for younger players (Nunes et al., 2021). This is also consistent with a study showing that increasing the relative pitch area per player in youth soccer increases heart rate and physical demands (Castellano et al., 2015), and meta-analysis showing the same trend (Praca et al., 2022).

The higher RPE and HR demands observed in ball possession games compared to small-goal formats likely stem from the continuous physical engagement required to maintain possession under pressure (Clemente et al., 2019). Unlike small-goal games, which may provide breaks during shooting attempts or ball retrieval, possession-based play may limit stoppages (Castellano et al., 2013). The need for constant rapid decision-making, and frequent movements to create or close passing lanes may contribute to greater efforts. Similarly, larger field sizes increase the physical load by expanding the distances between players, necessitating more continued movements and efforts, to cover space effectively (Casamichana and Castellano, 2010). This increased locomotor demand, combined with possible less frequent recovery opportunities, eventually explains the elevated heart rate responses and prolonged time in high-intensity heart rate zones (Lacome et al., 2018).

Ball possession games resulted in a higher number of successful passes compared to small-goal games across all field sizes, while the number of unsuccessful passes was also greater in ball possession games, particularly in the larger field conditions. The increase in exposure to passes can ultimately lead to a higher likelihood of failure. Successful dribbles were more frequent in SSGs, with both scoring methods showing increased dribbling activity as field size expanded. Unsuccessful dribbles followed a similar pattern, increasing with field size and being more prevalent in small-goal games. In terms of tactical decision-making, the passing decision-making index was significantly higher in ball possession games on the 100 m² field, but performance declined as the field size expanded to 125 m². This decline can be attributed not only to the increased intensity of play but also to the greater spatial demands and increased complexity of decision-making associated with a larger field. Likely players faced greater challenges in maintaining optimal passing decisions due to the increased distance between players and the more dispersed positioning of teammates and opponents. Overall, larger fields and the type of scoring method influenced players' technical execution and decision-making, with ball possession games promoting more passing activity and small-goal games encouraging greater dribbling frequency. Our results align with a previous study that found altering the relative space per player - through changes in field size or player numbers - affects inter-individual coordination. Specifically, modifying the number of players creates more free space around individuals, whereas adjusting the field size leads to broader spatial distributions (Silva et al., 2015). Our results also align with a study that found changes in pitch size affect players' ability to maintain possession, with smaller pitches offering fewer opportunities (Vilar et al., 2014).

Ball possession games inherently prioritize collective ball retention, likely promoting more frequent passing as players seek to maintain control (Fernández-Espínola et al., 2020). This structure fosters higher successful pass rates, but also more unsuccessful passes - especially on larger fields where increased interpersonal distances challenge pass accuracy and timing (Silva et al., 2014b). Conversely, small-goal games place a goal-oriented actions, creating more opportunities and incentives for dribbling (Pulling et al., 2016). As field size increases, the additional space facilitates more dribble attempts, but also likely raises the likelihood of failure due greater exposure to defensive pressure. The elevated passing decision-making index in ball possession games at the mid-sized field (100 m²) may reflect an optimal balance between space and player density, however further research is needed.

The correlational analysis revealed trivial to small non-significant associations between physiological responses and technical-tactical performance. Higher HRmean and increased time spent in HR Zone 5 were inversely correlated with the number of successful passes. Moreover, HRmean and HR Zone 5 showed weak or non-significant correlations with dribbling-related variables, suggesting that dribbling actions may be less influenced by overall physiological load. However, future research will be needed to determine whether player skill level plays a role in these findings. Additionally, RPE was moderately associated with HRmean and HR Zone 5, but showed limited relationships with technical or tactical indicators, implying that subjective effort may reflect physical demand more than task execution. Interestingly, the passing decision-making index showed a weak negative correlation with HRmean and HR Zone 5, suggesting that excessive physical load might slightly impair tactical decision-making efficiency.

Correlational analyses revealed that higher physiological load was generally associated with decreased technical efficiency and decision-making quality, as evidenced by negative relationships between heart rate measures and successful shots and passing decision-making indices. These findings suggest that increased physiological stress, as indicated by elevated heart rate, may impair certain aspects of technical and tactical performance. This is consistent with a previous study that reported strong correlations between lost ball possessions and heart rate during 2v2 and 4v4 games (Clemente, 2024a), with players exhibiting higher heart rates losing significantly more balls. This also aligns with a study showing that higher physiological intensities in small-sided games have a greater negative impact on technical and tactical performance in amateur soccer players compared to professionals (Dellal et al., 2011). Physiological stressors can lead to cognitive and motor impairments through mechanisms such as reduced cerebral oxygenation and compromised executive functioning (Travers et al., 2022). Consequently, athletes experiencing elevated heart rates may show diminished motor control and slower or less accurate decision-making (Schmit and Brisswalter, 2020), thereby reducing successful shot execution and passing decisions.

While this study shows how field size and scoring methods influence physiological load, technical performance, and decision-making in small-sided games, several limitations should be acknowledged. First, the sample, which focuses on youth male players, may limit the generalizability of the findings to other populations, such as elite players. Additionally, the controlled drill environment may not fully capture the complexities of competitive match play, including variable tactical demands and psychological pressures. Additionally, the use of match points throughout the games to maintain player motivation may introduce variability, as players may respond to this incentive differently. Moreover, fatigue was not specifically monitored - whether muscular or cognitive impairment - and therefore, more robust methods would be necessary to establish a relationship with the mechanisms potentially underlying the associations observed in our study. Longitudinal studies examining how players adapt over time to different game formats and field sizes would be valuable, as would research into the cognitive mechanisms underlying decision-making impairments under high physiological loads. In this regard, more refined tools will be necessary to fully capture tactical behaviors, particularly because these behaviors are influenced by factors beyond technical execution - such as competitiveness, game speed, and opponent pressure - which future research should take into account. Finally, the influence of playing position on specific actions and demands is an area worth exploring in future research, particularly in larger game formats. From a practical perspective, coaches and practitioners can use these findings to design drills that balance physiological intensity with technical and tactical development by manipulating field size and scoring methods. For example, ball possession games on larger fields may be used to improve cardiovascular fitness and passing skills, while small-goal games can emphasize dribbling and decision-making within tighter spatial constraints. Moreover, based on the results, ball possession games on larger fields (100 and 125 m² per player) induce higher cardiovascular intensity and more time spent in the highest heart rate zone (HRzone5), making them more appropriate for aerobic-targeting training days. In contrast, small-goal games, especially on smaller fields (75 m² per player), generate lower cardiovascular load and intensity, making these formats better suited for recovery or lower-intensity days.

Conclusion

In conclusion, this study highlights the significant influence of both field size and scoring method on players' physiological demands, technical execution, and decision-making during small-sided games. Ball possession games consistently elicited higher cardiovascular and perceptual loads compared to small-goal games, particularly in larger playing areas, which in turn affected players' passing and dribbling behaviors. Larger fields promoted greater physical intensity and passing success but also posed challenges to decision-making efficiency under increased physiological stress. Conversely, smaller fields and small-goal formats encouraged more frequent dribbling actions but limited overall technical variety. The observed correlations between heightened heart rate demands and diminished technical-tactical performance suggest the importance of balancing physical demands with skill development in training design.

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Key points

- Higher heart rate intensity - especially in larger fields and ball possession formats - correlates with reduced technical accuracy and tactical decision - making quality in small - sided games.
- Small - goal games promote successful dribbling and lower physiological load, while ball possession games increase heart rate and passing frequency but may impair execution and decisions under fatigue.
- Manipulating field size and scoring method can balance physical demands with technical and cognitive performance in youth soccer training.

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