Effect of boards in small-sided street soccer games on movement pattern
and physiological response in recreationally active young men

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The present study investigated whether street soccer might be proposed as an alternative to recreational small-sided games on grass as a health-enhancing activity, and specifically the effects of the boards surrounding the pitch. Eleven recreationally active young males (28.4±4.2 (±SD) yrs, 19.9±4.2% body fat, 47.7±6.0 ml-min⁻¹·kg⁻¹), after familiarization, completed one to two sessions of 20x13-m 3v3 street soccer games with boards (WB) and one to two sessions without boards (WOB) in a randomized order. Movement pattern was measured using GPS and heart rate recordings, blood sampling and RPE scales were used to evaluate exercise intensity and physiological strain. Total number of accelerations (19%) and Player Load (18%) were higher ($p < 0.05$) in WB than in WOB, whereas total distance covered (12%), high-speed running (59%) and peak speed (11%) were lower ($p < 0.05$) in WB than in WOB. Moreover, $HR_{mean}$ was higher in WB than in WOB (85.7±5.4 vs. 81.3±8.2%$HR_{max}$, $p = 0.012$, $ES = 0.64$), whereas time with $HR>90\%HR_{max}$ did not differ between WB and WOB (42±34 vs. 32±30%, $p = 0.243$, $ES = 0.32$). Plasma ammonia increased more in WB than in WOB, with no differences found in mean and peak blood lactate. RPE was higher after WB than after WOB (7.1±1.0 vs. 5.5±1.2, $p < 0.001$, $ES = 1.39$). In conclusion, intensity was sufficiently high in both game formats to expect short- and long-term health improvements as a result of regular participation. Boards affected movement pattern and physiological demands, producing higher number of accelerations, Player Load, average heart rate, plasma ammonia, and rating of perceived exertion, but lower total distance, number of intense runs and peak speed.

Keywords: Association football, GPS, high-intensity exercise, blood lactate, Small-sided games
INTRODUCTION

In the last decade, small-sided soccer games, defined as any game format with fewer players than normal soccer, have been proven to be an effective health-enhancing activity for young, adult and elderly untrained but healthy men and women as well as various patient groups (19, 20). The best evidence for the health benefits of sports disciplines has been found for recreational soccer and running (26), and recreational soccer has a potential as a contributor to health of nations (17). Given that physical inactivity is a major cause of chronic diseases and early death (4), interventions to promote physical activity are essential in the prevention of these diseases (27). The potential of a given sport is not solely based on the health effects of the sport but also the participation and accessibility (17). The potential of soccer is therefore huge, as soccer is the World’s most popular organized sport and with new types of soccer such as Soccer Fitness new participant groups are attracted (19).

Street soccer is another type of soccer, which potentially can increase the accessibility to the sport. Normal soccer pitches are scarce in larger cities, and as urban areas have undergone renewal, the number of small pitches for street soccer has increased and, consequently, the popularity of street soccer. Local facilities for physical activity such as pocket parks often have a small area for physical activity, and popular activities are street basketball or street soccer in “cages”. These cages are often small (typically 8–15 m wide and 12–25 m long) and surrounded by boards and a net to keep the ball inside the pitch.

This game format differs substantially from the game formats used in previous studies leading to an increased health profile after 12–64 weeks of recreational soccer training (13, 19, 20, 22, 23, 30, 32). In these studies, intensity of the small-sided games for untrained and recreational players has been shown to be high irrespective
of age, gender, and social background. Mean heart rate was 81–87% of peak heart rate was higher than 90% for 11–48% of playing time, which is considered sufficient to increase aerobic fitness in untrained subjects (26,31). Moreover, small-sided games consist of several activity changes, high-speed runs and sprint as well as specific actions such as accelerations, decelerations, and changes of direction, which challenges the musculoskeletal system. Playing small-sided games with boards keep the ball in play, thereby lowering the time with the ball out of play and potentially increasing intensity. However, the boards also limit the playing area and, thereby, the possibility of players achieving high running speed and accumulating high distance at high speed, which have been considered related to the broad-spectrum benefits of Soccer Fitness (19). To propose a sport or an activity as a health promoting activity it is necessary to analyze and understand the acute physiological response and the movement pattern in that activity or sport.

The movement pattern and acute physiological response to street soccer with or without boards is unknown, thus, the aim of this study was therefore to investigate the effect of boards on movement pattern and acute physiological response to small-sided street soccer games in untrained and recreationally active men in order to evaluate whether street soccer might be proposed as an activity with expected improvements in health profile as an outcome and whether street soccer should be played with or without boards. We hypothesize, that boards have effect on the movement pattern and that the intensity is increased in street soccer with boards.
METHODS

Experimental approach to the problem

To test the hypothesis, subjects completed one to two sessions of street soccer with boards (WB) and one to two sessions without boards (WOB) in a randomized order during spring. To compensate for any possible training effect, half of the subjects started playing WB, whereas the other half started with WOB. In all sessions, movement pattern and physiological response were measured with GPS-tracking devices and heart rate monitors, blood samples were collected for metabolic analysis and questionnaires for perceived exertion were completed (see procedures for exact information). The size of the pitch was 20x13 m and all games were 3v3, giving a consistent area per player (~43 m²). The WB pitch were surrounded by 1.5m high boards and on top of that a net to keep the ball in play. Sessions were carried out on the same weekday one week apart to allow the players to fully recover. Prior to the sessions, subjects were familiarized with small-sided street soccer on one to two occasions. If a subject completed two sessions of either WB or WOB, a mean value was calculated from the two sessions.

Subjects

Eleven untrained or recreationally active men (age: 28.4±4.2 (±SD) yrs; BMI: 24.2±2.4 kg·m⁻²; fat%: 19.9±4.2%; VO₂max: 47.7±6.0 mL·min⁻¹·kg⁻¹) participated in the study. Subjects had not been playing regular soccer for at least 6 months prior to the study, but some subjects regularly used a bike for transportation.
One to two familiarization sessions were completed followed by 2-4 sessions of small-sided street soccer with and without boards. Prior to participation in the study, all subjects were fully informed of procedures and risks before written informed consent was obtained from the subjects. The study was carried out in accordance with the guidelines contained in the Declaration of Helsinki and approved by the local ethics committee of the Capital Region of Denmark (H-2-2013-034).

Procedures

On a separate day prior to the familiarization sessions subjects completed a laboratory test day including height and weight measurement as well as a skinfold measurement according to the method by Durnin and Womersley (9) to estimate fat percentage. Moreover, an incremental treadmill test until voluntary exhaustion was conducted. The treadmill test consisted of 3 min of walking at 6 km-h⁻¹ before increasing the speed by 1 km-h⁻¹ every 60 seconds. When to switch from walking to running were chosen by the subjects.

A session consisted of a standardized 10-min warm-up followed 5 min break before four 12-min game-periods interspersed with 4 min of rest. Subjects showed up at the test site minimum 30 min prior to warm-up. A catheter was placed in an antecubital vein and blood samples were drawn from the catheter at prior to warm-up, between warm-up and the first game period, after each game period and 30 min after the last game period. Blood samples was drawn from each subject in the same order following each period and in each session to ensure similar time delays between the end of a period and the drawing of a blood sample. In the samples, 4 ml of blood was drawn using a heparinized syringe and 2 ml of blood was centrifuged for ~3 min before collecting plasma, which was stored at -20°C until analyzed.
Plasma free fatty acid (FFA) was analyzed using a Hitachi 912 automatic analyzer (Roche Diagnostics, Germany). Plasma ammonia (NH$_3$) was determined spectrophotometrically. Plasma creatine kinase and plasma uric acid were analyzed using Roche kits on a Hitachi 912 automatic analyzer (Roche Diagnostics, Basel, Switzerland). The remaining whole blood samples were stored on ice until analyzed within 3 h for lactate on an ABL 800 (ABL 800 Flex, Radiometer, Copenhagen, Denmark).

Heart rate (HR) was recorded in 1-s intervals in each session using short-range radio telemetry (Polar Team2 System, Polar Electro Oy, Kempele, Finland). The highest observed HR in the treadmill test on a separate day prior to a training session or in any training session was used as individual maximal heart rate (HR$_{max}$) for calculating individualized HR zones. Only HR data from the four 12-min game periods were analyzed, together with the GPS and accelerometer data, using Catapult Sprint version 5.0.9.2 (Catapult Innovations, Canberra, Australia).

Movement pattern were measured in all sessions using portable global positioning system (GPS) units (MinimaxX S4, Catapult Innovations, Canberra, Australia). A GPS unit was placed into the manufacturer-designed harness on the top of the back between scapulas as prescribed by the manufacturer. Similar high number of satellites (11.9±0.6 and 12.0±0.6) and low horizontal dilution of precision (0.88±0.10 and 0.90±0.08) were observed for WB and WOB, respectively. A sample rate of 10 Hz was used and subjects wore the same unit in all sessions to exclude any possible intra-model variability. Data were analyzed using Catapult Sprint version 5.0.9.2 (Catapult Innovations, Canberra, Australia). Total distance, number of efforts and distance covered at 0–2, 2–5, 5–9, 9–13, 13–16, 16–20 and >20 km·h$^{-1}$ were measured.
The bands were summarized to low-speed movement (<9 km·h⁻¹), moderate-speed running (9–13 km·h⁻¹) and high-speed running (>13 km·h⁻¹). Moreover, maximal speed and Player Load were measured. Accumulated Player Load (r) is an estimate of physical demand combining the instantaneous rate of change in acceleration in three planes (forward/backward, side/ side, and up/down). The accelerometers in the GPS units were also used to measure accelerations, which were summarized as low (1.5–2.14 m·s⁻²), moderate (2.14–2.78 m·s⁻²) and high (>2.78 m·s⁻²) accelerations. The validity and reliability of the GPS units and the incorporated accelerometers have been described elsewhere (5,7).

Borg’s CR10 scale was used as a measure of perceived exertion (13). Each subject’s RPE was collected 30 min after the end of the last period to ensure that the rating reflected the whole training session and not only the last period. A Danish translation of the CR10 scale was used.

Statistical analysis

Data are presented as means ± SD. All data were checked for normality using a Kolmogorov-Smirnov normality test. Differences in movement pattern, HR and RPE were evaluated by a Student’s t-test. Blood and plasma data were evaluated using a two-way analysis of variance (ANOVA) with repeated measures. When a significant interaction was detected, data were analyzed using a Student-Newman-Keuls post hoc test. A significance level of 0.05 was chosen. Effect sizes (ES) were calculated using Cohen’s d (8), and interpreted as suggested by Hopkins and colleagues (16): < 0.2 trivial, 0.2–0.6 small, 0.6–1.2 moderate, 1.2–2.0 large, 2.0–4.0 very large, > 4.0 extremely large. All statistical tests were performed using SigmaPlot (Ver. 12.0).
RESULTS

Heart rate and rating of perceived exertion

HR\text{mean} was higher in WB than in WOB (85.7±5.4 vs. 81.3±8.2%HR\text{max}, p = 0.012, ES = 0.64), whereas HR\text{peak} tended to be higher in WB than WOB (96.7±3.1 vs. 94.7±4.9 %HR\text{max}, p = 0.066, ES = 0.49). HR was higher than 90%HR\text{max} in 42±34% of total playing time in WB, which was not significantly different from WOB (32±30%, p = 0.243, ES = 0.32, Fig. 1). Rating of perceived exertion (RPE) was higher after WB than after WOB (7.1±1.0 vs. 5.5±1.2, p < 0.001, ES = 1.39).

*** Figure 1 about here ***

Movement pattern

Total distance covered was 12% lower in WB than in WOB (2677±318 vs. 3053±477 m, p = 0.003, ES = 0.93), corresponding to 56±7 and 64±10 m-min\textsuperscript{−1}, respectively. Lower distances (p < 0.05) were covered in WB than in WOB in all speed zones between 2 and 20 km-h\textsuperscript{−1}, whereas more distance (p < 0.05) was covered at speed < 2 km-h\textsuperscript{−1} in WB (Table 1). Distance covered at moderate (9-13 km-h\textsuperscript{−1}) and at high speed (>13 km-h\textsuperscript{−1}) was lower in WB than in WOB (244±81 vs. 457±147 m, p = 0.001, ES = 1.79 and 46±26 vs. 112±61 m, p = 0.002, ES = 1.41, respectively; Fig. 2).

*** Figure 2 about here ***

Total number of speed zone entries did not differ between WB and WOB (507±50 vs. 509±41, p = 0.891, ES = 0.05).
However, differences between game formats in specific speed zones were found (Table 1). Moreover, differences ($p < 0.05$) were found in the mean length of each movement in all speed zones $< 16 \text{ km-h}^{-1}$ (Table 1). Peak running speed was lower in WB than in WOB ($16.1\pm1.8$ vs. $18.1\pm1.9 \text{ km-h}^{-1}$, $p = 0.002$, $ES = 1.08$).

*** Table 1 about here ***

Total number of accelerations was higher in WB than in WOB ($672\pm200$ vs. $565\pm180$, $p = 0.005$, $ES = 0.56$), due to a higher number of low and moderate accelerations in WB than in WOB ($593\pm178$ vs. $501\pm157$, $p = 0.007$, $ES = 0.55$, and $58\pm18$ vs. $48\pm17$, $p < 0.001$, $ES = 0.63$, respectively), whereas no difference was found in number of high accelerations ($21\pm8$ vs. $17\pm8$, $p = 0.145$, $ES = 0.46$). PL was 18% higher in WB than in WOB ($413\pm68$ vs. $350\pm62 \text{ AU}$, $p < 0.001$, $ES = 0.98$).

*** Figure 3 about here ***

**Blood variables**

No significant differences were observed between WB and WOB in mean blood lactate ($4.9\pm1.8$ vs. $4.1\pm1.6 \text{ mmol-L}^{-1}$, $p = 0.082$, $ES = 0.43$) or peak blood lactate ($6.1\pm2.0$ vs. $5.3\pm1.9 \text{ mmol-L}^{-1}$, $p = 0.107$, $ES = 0.42$), but blood lactate concentrations after the second and third 12-min periods were higher ($p < 0.05$) in WB than in WOB (Fig. 4a).

*** Figure 4 about here ***
A significant time x group interaction was found in plasma NH$_3$ ($p = 0.048$, $F = 2.272$). In WB, plasma NH$_3$ was $85.1\pm21.0\ \mu$mol·L$^{-1}$ at rest, increased by 19% after warm-up, and further increased and stayed at 63–83% higher than rest throughout all four game periods before dropping to 20% above rest at 30 min post game. In WOB, plasma NH$_3$ was $79.6\pm8.8\ \mu$mol·L$^{-1}$ at rest, increased by 25% after warm-up, and further increased to 62–68% higher than rest throughout all four game periods before dropping to 10% above rest at 30 min post game (NS). Plasma NH$_3$ was higher ($p < 0.05$) in WB than in WOB after the three final game periods and 30 min post game (Fig. 4b).

Plasma UA increased from pre game to 30 min post game in WB ($297\pm43$ to $344\pm38\ \mu$mol·L$^{-1}$, $p = 0.005$, $ES = 1.18$) and in WOB ($286\pm35$ to $308\pm55\ \mu$mol·L$^{-1}$, $p = 0.005$, $ES = 0.48$) with no significant time x group interaction ($p = 0.279$, $F = 1.310$).

No differences were observed between WB and WOB in changes in plasma FFA concentration ($p = 0.130$, $F = 1.726$). In WB, plasma FFA was $249\pm88\ \mu$mol·L$^{-1}$ at rest and dropped (NS) after warm-up before progressively increasing throughout all four game periods and peaking 30 min post game at $779\pm340\ \mu$mol·L$^{-1}$. Similarly, in WOB plasma FFA was $310\pm163\ \mu$mol·L$^{-1}$ at rest and dropped (NS) after warm-up before increasing and peaking 30 min post game at $674\pm280\ \mu$mol·L$^{-1}$ (Fig. 4c).

Plasma CK increased from pre game to 30 min post game in WB ($221\pm124$ to $326\pm187\ \text{U} \cdot \text{L}^{-1}$, $p < 0.001$, $ES = 0.67$) and in WOB ($159\pm92$ to $233\pm128\ \text{U} \cdot \text{L}^{-1}$, $p < 0.001$, $ES = 0.66$) with no significant time x group interaction ($p = 0.159$, $F = 2.318$).
DISCUSSION

The major finding of this study was that movement pattern and physiological response to small-sided street soccer games were affected by the boards, as the intensity was higher than when playing with compared to without boards. Mean heart rate, blood lactate, NH₃, Player Load, number of accelerations, and rate of perceived exertion were higher with boards even though total distance, distance at moderate and high speed running, number of intense runs, mean length of each run, and peak speed were higher in games without boards.

Boards had a moderate effect on mean heart rate, which was higher in games with boards. Mean heart rate was high in both game formats (81–86%HR\text{max}) and within the range often reported (81–89%HR\text{max}) in small-sided games for elite and recreational players (15,31). However, time spent with HR above 90%HR\text{max} (31–41% of the playing time corresponding to 15–20 minutes) and above 80%HR\text{max} (63–83% of the playing time corresponding to 30-40 min) was not different between formats. Time spent in these HR zones is higher than observed in street soccer for homeless (32) and similar to or higher than observed in recreational small-sided games (29, 31, 33). Street soccer may therefore be considered as very effective cardiovascular training, as high intensity training has been linked to several positive effects on cardiovascular fitness (25).

The moderate effect of boards on mean heart rate may have been due to the fact that the ball was kept in play for the entire 12 min, whereas there were short breaks when the ball was out of play in games without boards. It is very interesting that heart rate was so high given that total distance covered was only 2.7–3.1 km, corresponding to 56–64 m-min⁻¹.
The total distance covered is 15–50% lower than observed in 3v3 recreational football on larger pitches and without boards (29,33). Moreover, distance covered at moderate and high speed in the game formats in the current study were only 31–59% and 13–32%, respectively, of the distance covered at moderate and high speed in 3v3 on a 31x15.5-m grass pitch (29) and 30–56% and 8–19%, respectively, in 3v3 on a 40x20-m grass pitch (33). Thus, the heart rate response in 3v3 street soccer with or without boards was similar to 3v3 on larger pitches even though the distances covered in all speed categories were much lower in street soccer. Hence, these results support the theory that specific actions such as accelerations, decelerations, dribbles, and rapid changes of direction have a significant impact on the overall load during small-sided soccer games and especially during street soccer.

A small to moderate effect of boards was found on total number of accelerations as well as low and moderate intensity accelerations as values were higher in games with boards than those without boards. Compared to 3v3 on larger pitches, total number of accelerations was 26–51% higher during street soccer (29,33). On smaller pitches, the area per player decreases and players need to perform more rapid actions and short accelerations to create space. A study by Varley and Aughey (38) showed that 85% of all maximal accelerations in normal soccer ended at a speed less than 15 km·h\(^{-1}\). Thus, a high number of accelerations do not necessarily result in a high number of runs at high speed, which is in line with the findings in the present study.

From a health perspective, the high number of accelerations and changes of direction may lead to improved bone health, because diverse and dynamic strains on the bone have an osteogenic effect (17). Thus, street soccer could possibly also be consider as an effective training for musculoskeletal fitness.
In support to this, osteocalcin, a bone formation marker, has been shown to be elevated after 12 weeks of street soccer training (14). Maximal running speed is another parameter during training, which impacts musculoskeletal fitness (18). In the present study, a moderate effect of boards was found on peak speed, as lower speed was found in games with compared to without boards (16.1 vs. 18.1 km-h\(^{-1}\)). The peak speed in this study was only 71–86% of the peak speed (21.2–22.6 km-h\(^{-1}\)) reached in 3v3 on larger pitches (29,33), which may be due to the small pitch size (20x12m) used in street soccer.

Mean and peak blood lactate did not differ between the two game formats, but blood lactate was higher in the second and third game periods in WB, indicating higher anaerobic energy turnover in WB than in WOB. Mean and peak lactate in 3v3 street soccer games were 16–45% lower than observed for recreational (29,33) and amateur players (28) in 3v3 on larger pitches. The lower blood lactate during street soccer compared to 3v3 on larger pitches is related to differences in movement pattern as more distance with high speed is covered during that type of 3v3. Another indicator of anaerobic energy turnover is increased plasma ammonia, an indication of adenosine monophosphate deaminase reaction. Plasma ammonia increased to a higher level in WB than in WOB (155 vs. 135 µmol-L\(^{-1}\)), and the plasma ammonia level was higher or similar to the level observed in 3v3, 5v5 and 7v7 games on larger pitches (29,33), but less than seen in 11v11 match play (2,20). The increase in plasma ammonia indicates that the intensity and the metabolic demands are very high in periods of street soccer, even though running speed is low, which also underlines the impact of the specific actions such as accelerations, decelerations, changes of direction.
The triaxial accelerometer built into the GPS unit is able to monitor small abrupt movements and thereby shine light on these specific actions that increases demands compared to straightforward running (34,35). Player Load has recently been introduced to activity profiling, as it is an indicator of external load obtained by triaxial accelerometry. Player Load is related to total distance covered and to speed, as higher Player Load is observed at higher running speed (6,29). Accumulated Player Load was higher in games with than without boards, although the distances covered in total and in individual speed categories were lower. This supports that the specific movements have significant impact on the overall training load in small-sided soccer games.

From a health perspective one may argue that training with such high intensity increases oxidative stress, which are related to development of atherosclerosis and cardiovascular diseases (11). Increased uric acid is a marker of oxidative stress as superoxide, which is able to form several reactive oxygen species (ROS), is released in the formation of uric acid (12). In the present study uric acid was elevated following both formats of street soccer. However, regular participation in street soccer will lead to increased antioxidant levels and decreased oxidant production (3, 11, 12), and the long-term training effects on the health profile by far exceed the possible negative effects of acute oxidative stress. Elevated levels of creatine kinase in the plasma are another sign of oxidative stress (12), although the major cause of the increased creatine kinase levels is probably mechanical muscle damage due to eccentric muscle contraction and collisions. Exercise-induced muscle damage is known to have negative effects on insulin sensitivity, glucose uptake and glycogen resynthesis (24,37) and it could therefore be argued that street soccer is not usable as training intervention for type 2 diabetics.
However, the increase in creatine kinase in the plasma after street soccer was smaller than seen after 11v11 matchplay (1,24), and recreational football has been shown to improve fasting glucose and HbA1c in type 2 diabetics (36). Thus, the muscle damage in street soccer is not expected to have a negative impact on the possible improvements in blood glucose regulation.

Another important factor when considering a sport as a possible health improving activity with long-term adherence is how participants perceive the exertion. Boards had a large effect on RPE, with higher RPE scores in games with boards than in those without boards (7.1 vs. 5.5). RPE was higher during street soccer with boards than seen previously in small-sided games on grass for recreational players (10, 29, 33). In fact, RPE in street soccer with boards was as high as seen in very intense intermittent running (10,26). The lower RPE previously observed in small-sided games has been linked to higher enjoyment in team sports compared to more individually based exercises, which may have importance for long-term adherence to an activity (25). Moreover, being part of a team and experience improvements and success, e.g. scoring goals are also important for long-term adherence. In street soccer, there are a lot of goal-scoring opportunities, and this game format may therefore be perceived as more fun than normal soccer, particularly for recreational and health-promoting purposes. The boards surrounding the pitch may help soccer novices to control the ball and keep the intensity high. On the other hand, soccer novices may find it confusing and stressful that the ball remains in play leading to very high game intensity.

In conclusion, intensity in street soccer with and without boards was high irrespective of game format, and both game formats are expected to lead to improvements in cardiovascular and musculoskeletal health profile.
This should, however, be confirmed in short and long-term randomized controlled training studies. Boards affected movement pattern and physiological demands compared to playing without boards, as the use of boards resulted in a higher number of accelerations, Player Load, average heart rate, blood variables, and RPE, but a lower total distance, number of intense runs, and peak speed compared to street soccer without boards. Urban renewal planning should incorporate facilities for street soccer, e.g. small (20x12-m) “cages” with soccer goals as these facilities may promote activities that could be efficient in promoting health.

**PRACTICAL APPLICATIONS**

The results of the present study suggest that street soccer may be a very effective health-promoting activity, as $HR_{\text{mean}}$ and time above 90% $HR_{\text{max}}$ are very high. Street soccer, especially when played with boards that keep the ball in play, is therefore expected to lead to marked improvements in cardiovascular fitness. Moreover, the many changes in activities and specific actions are expected to have a major impact on musculoskeletal health profile. Both cardiovascular response and the number of activity changes that put a high load on bones are higher than seen in recreational small-sided games, which have led to significant improvements in the musculoskeletal fitness. An even greater improvement in health profile may therefore be expected after a training period involving street soccer, but this would need to be confirmed in future studies. Nevertheless, street soccer with or without boards offers a great alternative to small-sided games, especially in larger cities where grass facilities for soccer are scarce.
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REFERENCES


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FIGURE LEGENDS

Fig. 1: Heart rate distribution, presented as percentage of total time in various heart rate zones of < 60, 60–70, 70–80, 80–90, and 90–100% of individual maximal heart rate (%HR$_{max}$) in small-sided street soccer with boards (WB, filled bars) and without boards (WOB, open bars). *denotes significant difference between WB and WOB. Significance level is $p < 0.05$.

Fig. 2: Distance covered at low speed (< 9 km·h$^{-1}$), moderate speed (9–13 km·h$^{-1}$) and high speed (>13 km·h$^{-1}$) in small-sided street soccer with boards (WB, filled bars) and without boards (WOB, open bars). *denotes significant difference between WB and WOB. Significance level is $p < 0.05$.

Fig. 3: Number of accelerations in various intensity zones of 1.5–2.14 m·s$^{-2}$, 2.14–2.78 m·s$^{-2}$, and >2.78 m·s$^{-2}$, as well as in total, in small-sided street soccer with boards (WB, filled bars) and without boards (WOB, open bars). *denotes significant difference between WB and WOB. Significance level is $p < 0.05$. 
Fig. 4: Blood lactate (A), plasma ammonia (NH$_3$; B) and plasma free fatty acids (FFA; C) in small-sided street soccer with boards (WB, filled circles) and without boards (WOB, open circles). *denotes significant difference between WB and WOB. Significance level is $p < 0.05$. 
Table 1: Distances covered, efforts, and mean distance in various speed categories in street soccer with (WB) and without (WOB) boards.

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<td>142±23</td>
<td>43±15</td>
<td>5±3</td>
<td>1±1</td>
<td>0±0</td>
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<tr>
<td>WOB</td>
<td>296±39</td>
<td>134±21</td>
<td>64±21</td>
<td>11±6</td>
<td>3±2</td>
<td>0±0</td>
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<td>1.19</td>
<td>1.25</td>
<td>1.43</td>
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<td>Mean distance (m)</td>
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<td>WB</td>
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<td>5.1±0.5</td>
<td>5.2±1.2</td>
<td>5.7±2.6</td>
<td>n.a.</td>
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<tr>
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<td>7.0±0.9</td>
<td>6.5±0.5</td>
<td>6.1±0.8</td>
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<tr>
<td>P</td>
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<td>0.000</td>
<td>0.000</td>
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Figure 1

Percentage of total training time

Heart rate zones (% of HR_{max})

WB
WOB
Figure 2

![Bar graph showing distance (m) for movement categories: Low speed, Moderate speed, High speed. The graph compares WB and WOB conditions.](image-url)
Figure 3