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Physical and Heart Rate Responses of Male Minifootball Players: A Case Study of an Elite Minifootball Match

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Abstract

Objectives: The purpose of this research was to explore the physical parameters and the heart rate responses of elite minifootball players during an international match.
Methods: Ten male elite players from two national teams (Tunisia vs. Switzerland) participated in this study (26.2 ± 1.9 years, 175 ± 7 cm, 79.2 ± 5.8 kg). Heart rate was recorded by polar team system all the time that players spent moving on the pitch (walking, jogging, and running). For physical parameters, data (i.e., indicator of workload, sprints, total distance, acceleration and deceleration) were gathered using wearable GPS.
Results: Results showed that the minifootball match induced high intensity exercise (86% HRmax). Moreover, total distance and high-intensity running distance were significantly higher in favor of the first half than in the second half. Likewise, sprints, acceleration and deceleration at high intensity were significantly higher in the first half.
Conclusions: Minifootball is a physically intense sport, necessitating high intensity. Thus, its physical demands should be taken into consideration by coaches when designing and implementing training sessions.

Keywords: Minifootball, Elite, Physical, Heart Rate, Global Positioning System

1. Background

Minifootball (the noted name for six-a-side outdoor soccer) was started in order to promote, supervise, and direct minifootball in the world as a means to contribute to the positive development of society. Many minifootball leagues (amateur and professional) have been launched for years all over the world (men and women). World Minifootball Federation (WMF) is the organizing and the official body, under whose auspices international competitions are arranged. Minifootball may be characterized with high physical, physiological, technical, and tactical demands, also, is an intermittent sport. It is played on a court of 46 × 26 m, with 4 × 2 m goals, on an artificial playing surface. Two 25-min periods are scheduled with an unlimited number of substitutions.

Given the reduced pitch dimension and smaller number of players [like small-sided games (SSG)], minifootball players perform activities with high intensity such as sprints, acceleration, deactivation and changes in the direction of the game, creating separate burdens on aerobic and anaerobic metabolism (1-4). Moreover, in futsal, many researchers have evaluated the requirements of competition using both internal and external performance indicators. Commonly, movement analysis (5, 6) and measurement of physiological parameters (internal indicators), such as heart rate (7), has been employed. Though resembling SSG soccer and futsal, minifootball has its own character by possessing unique features requiring distinct activity profiles and physiological demands, including, for instance, the game rules, number and position of the players, or the pitch size.

To our knowledge, no research has been undertaken during minifootball match-play and the specific activity patterns remain unclarified. Understanding minifootball

skills would allow practitioners to transfer beneficial information to the player and so a deep explanation of the physical, physiological and skill requirements would aid in the development of this sport.

2. Objectives

Therefore, using heart rate monitoring and physical analysis, the aim of the present study was to examine the activity profile and physiological demands of elite minifootball players during an international match.

3. Methods

3.1. Participants

A match from an international minifootball tournament (Confederation Cup, Mars 2019. Tunisia) was chosen for this case study, reflecting the competitive elite nature of participants. Ten elite players from the two national teams (Tunisia vs. Swiss) participated in this study (26.2 ± 1.9 years, 175 ± 7 cm, 79.2 ± 5.8 kg). The match was played in an outdoor official court (46 × 26 m), lasting 25 × 25 min with a 10 min interval, considering minifootball official rules. Players agreed to participate in the study after being fully informed of what was required of them and providing their written consent. The Declaration of Helsinki (2013) and the Sfax University ethics committee (CPP-02/18) approved the methodology and procedures used in this study.

3.2. Experimental Protocol

We sought to investigate the physiological responses (HR) and the physical parameters to an international minifootball match, from the Confederation Cup tournament (Tunisia 2019). In the match, players were supervised by a Polar Team System and GPS tracker devices. All players were monitored (except the goalkeepers).

3.3. Heart Rate Monitoring

The HR of each player was recorded at 5-Hz intervals during the match via short-range radio telemetry (PolarTeam Sports System; Polar Electro Oy, Kempele, Finland). The HR data was recorded and downloaded to a portable PC using dedicated software and subsequently exported and analyzed using the Excel XP software program. HR mean values were utilized to determine the utilized percentage of HRmax (%HRmax) during the match. Continuous heart rate recordings were successfully recorded for the participants throughout the match.

3.4. Physical Parameters

Parameters (i.e., indicator of workload, sprints, total distance acceleration and deceleration) were gathered using wearable GPS (Playertek, Catapult Innovations, sampling frequency = 10 Hz, Melbourne, Australia). The activation of GPS device was 15 min before the start of the match. After recording, the data collected by the Playertek Pod were interpreted on the Playertek app. Acceleration distances were recorded using the category (2 - 3 m/s^2 and > 3 m/s^2) and the type (i.e., acceleration or deceleration) (8). Data was based on four zones of speed (9, 10): 0 - 6.9 km/h (walking), 7.0 - 12.9 km/h (low-intensity running), 13.0 - 17.9 km/h (moderate-intensity running), and >18 km/h (high-intensity running). Similarly, sprints (i.e., duration and distance) were recorded based on these four speed zones.

3.5. Statistical Analysis

The data are reported as mean and SD and were analyzed using STATISTICA software (StatSoft®, Maisons-Alfort, France). The Shapiro Wilk test was applied to check the normality of the data; and to compare physical data between the two halves, the paired Student's *t*-test was used. Statistical significance was set at $P < 0.05$.

4. Results

The results show that the mean HR during the match was 178 bpm and the %HRmax was 86%. (Table 1). Moreover, the total distance covered during match play was 4100 m. The statistical analysis revealed that total distance and high-intensity running distance were significantly higher during the first half compared to the second half (Table 2). In contrast, walking distance was significantly higher during the second half compared to the first half. No significant differences were observed between halves for the low-intensity running distance and the moderate-intensity running distance (Table 2).

Table 1. Mean Heart Rate (HR) Values, Percentage of Maximum Heart Rate (%Hrmax) of Minifootball Players During the Match [a]

Variables	Values
HR (bpm)	178 ± 2.89
%HRmax	86

Abbreviation: Bpm: beats per minute.
[a] $P < 0.05$.

Moreover, the indicators of workload (player load, maximal velocity, and power) were significantly higher in favor of the first half than the second half of the match (Table 3). Likewise, sprints, acceleration, and deceleration

Table 2. The Total Distance in the First, Second and Overall Round of Minifootball Match at Four Zones of Speed [a]

Variables	First Half	Second Half	Total Distance
Distance (m)	2200 [b] ± 750	1900 ± 620	4100 ± 920
Walking (m)	182 ± 77	218 [b] ± 85	400 ± 160
Low intensity (m)	920 ± 320	900 ± 289	1820 ± 630
Moderate intensity (m)	699 ± 150	681 ± 130	1380 ± 480
High intensity (m)	290 [b] ± 90	210 ± 80	500 ± 155

[a] Values are expressed as mean ± SD.
[b] Significant difference ($P < 0.05$).

at high intensity were significantly higher in the first half compared to the second half (Table 4).

5. Discussion

The aim of this study was to explore performance in minifootball match during an international tournament, analyzing HR responses and physical parameters. Accordingly, we found high mean heart rate values were observed during the match (178 bpm), which as a percentage of maximum heart rate (%HRmax) was 86%. Secondly, we noted very high levels in physical parameters, which significantly differed between the first and second half of match play.

Given that there is a distinct paucity of studies investigating HR response and physical parameters in minifootball players, the present study's findings will be discussed in the context of futsal and SSG, since they are similar, albeit with some small differences (fields' dimension, players' number, game duration).

The mean heart rates and percentage of maximum heart rate recorded during the minifootball match in the present study appear to be comparable to those recorded in minifootball with amateur players (11). In Halouani et al. (11), the authors evaluated HR responses during minifootball match with amateur players, and indicated that the match induced high intensity (174 bpm and %HRmax was 84.2%). Moreover, in futsal, many studies have examined HR responses with elite players (12-14). Indeed, Barbero-Alvarez et al. (12) showed a higher HR (90% HRmax), in comparison to the present study. In addition, Dos-Santos et al. (14) have found high HR responses (88.79% HRmax) while analyzing a futsal match with Brazilian players. Moreover, Arslanoğlu et al. (13) reported a mean HR value of 170 bpm; the comparably higher HR observed minifootball might be attributable to the short and incomplete rest periods, which elicits greater physical effort from players. Indeed, physiological evaluation indicates that minifootball is a sport that requires sustained high intensity movement, concomitant to a great capacity of intermittent endurance.

In another context, HR responses in this study were concordant with studies conducted with the SSG (i.e., 5 vs. 5) format in professional players. In this regard, Rampinini et al. (15) investigated HR responses of professional soccer players (5 vs. 5), and while pitch dimensions were 35 × 25m, higher exercise intensity was observed during SSG (88.8% HRmax) compared to minfootball. In addition, Aguiar et al. (16) reported a HR response of 84.56% HRmax in professional players, whilst Little and Willams (17), on a 41 × 27 m pitch with professional players, reported a mean HR response of 89.3% HRmax. Indeed, the concordance between SSG and minifootball may be indicative of the comparable internal loads, and high intensitiy, intermittent nature of both sports. Thus, given the comparable physical profiles, SSG represents a valid method to train minifootball players, physically, which is relevant for practitioners and coaches considering SSG as an efficient developmental tool for aerobic training.

To our knowledge, this study is the first to describe the physical parameters of players in an international minifootball match (six-a-side outdoor soccer) with elite players. There is an acknowledged relationship between the external loads of a sport and the physiological responses of players, and thus, the physical responses characterized in our study represent an important addition to the literature. In contemporary practice, the GPS offer an accurate method of supervising players' movements during match and training (18); permitting insight into distances covered by players, with the physiological responses, to determine exercise intensity (19). In the present study, the mean total distance covered was 4100 m. Similar to our results, in futsal, Barbero-Alvarez et al. (12) investigated external loads of futsal match in Spanish professional players, and found that total distance covered by players during the match was 4313 m. In the same context, Dogramaci et al. (20) analyzed the time-motion characteristics of elite Australian futsal players, and noted that distance covered

Table 3. Indicator of Workload in the First, Second and Overall Round of Minifootball Match [a]

Variables	First Half	Second Half	Total
Player load (A.U)	140.3 [b] ± 16.4	114.7 ± 15.2	250.6 ± 32.3
Maximal velocity (km/h)	24 [b] ± 3.5	18.5 ± 2.75	42.5 ± 6.3
Power (w/kg)	10.7 [b] ± 3.85	8.7 ± 2.5	19.4 ± 8.5

Abbreviation: A.U, arbitrary units.
[a] Values are expressed as mean ± SD.
[b] Significant difference (P < 0.05).

Table 4. Sprints, Acceleration and Deceleration at High Intensity in the First, Second and Overall Round of Minifootball Match [a]

Variables	First Half	Second Half	Total
Sprints (> 18 km.h^{-1})			
Sprint duration (s)	1.44 [b] ± 0.4	1.06 ± 0.3	2.5 ± 0.6
Sprint distance (m)	15.3 [b] ± 2.75	12 ± 2.20	27.3 ± 3.50
Acceleration and Deceleration Number (> 3 m.s^{-2})			
Acceleration	21.3 [b] ± 5.33	16.1 ± 3.70	37.4 ± 9.5
Deceleration	22.2 [b] ± 4.90	18 ± 4.20	40.2 ± 10.3

[a] Values are expressed as mean ± SD.
[b] Significant difference (P < 0.05).

during the match was 4277 m.

In the present study, players covered a distance of 2200 and 1900 m, corresponding to the first and second half, respectively. In the same context, walking distance was higher during the second half compared to the first half (218 vs. 182m, respectively). These findings may be in relation with the decrease of the intensity at the end of the match, which result a muscular fatigue (12). This decline in performance was related to a reduction in glycogen reserves in the leg muscles (21), other factors could be implicated such as dehydration (21, 22). Minifootball players covered high amount of distance at high intensity (500 m), which is comparable to the study of Barbero-Alvarez et al. (12) (i.e., 571 m). This comparability may be due to: (1) the shorter and more powerful actions occurring in a minifootball match; and (2) the internal logic, tactics, and players positions (23).

Although aerobic capacity is an important variable in minifootball, this sport also requires a high anaerobic capacity, which is an equally important variable (24). Indeed, major game incidents may be decided by actions that do not last more than 5 seconds, carried out at high speed and intensity (25).

In general, accelerations, decelerations and changes of speed, are important parameters (26). While sprinting is a major factor of soccer (27), in minifootball, like futsal, although the reduced court dimensions, a greater significance of acceleration over short distances was found (28). During this study, players performed a large number of accelerations (37.4) and decelerations (40.2) at high intensity (> 3 m.s^{-2}). This may be attributable to the reduced pitch area and the smaller players' number, resulting in numerous high-intensity movements, such as sprinting and acceleration (29). In SSG, Rebelo et al. (8) and Halouani et al. (30) showed a greater number of accelerations and decelerations in the 4 vs. 4 SSG format, vs. the 5 vs. 5 format, which reflect mechanical loading of the neuromuscular system and a higher metabolic in the smaller format. Thus, the reduced pitch dimensions appear to induce more frequent high intensity actions.

The results of this case research also show that the number of acceleration and deceleration were significantly higher in favor of the first half than to the second half. Although there is a notable lack of comparable data in the literature, Rico-González et al. (23) found a decrease of the number of acceleration and deceleration in the second half, vs. the first half, in professional futsal players. This finding may be due to high-intensity actions, such as sprinting and acceleration, that influence the anaerobic energy systems. Indeed, Krustrup et al. (31) showed a selective depletion of muscle fibres which may impair repeated sprint ability as a player approaches exhaustion (32). Moreover, leg muscle power is an essential feature required for acceleration; maintaining leg power could be a necessity to futsal and minifootball players who execute many repeated sprints (12, 20).

The development of aerobic capacity is essential in minifootball training, which is based on the apparent

reliance on recovery in the match (33). This may assist in performing a greater frequency of movement activities, which may facilitate enhanced recovery (34). A superior aerobic capacity may also result to cover a greater distance at a higher intensity during match play (35). Moreover, because repeat sprint ability and high-intensity activity are an essentials elements for successful performance, including minifootball, this should also be made a priority in training (36).

5.1. Conclusion

In conclusion, the results of this case study can provide a lot of information to minifootball practitioners and coaches. This study presents new information on elite minifootball match play, including the quantification of physiological (HR) and physical parameters. Information about external loads (e.g. total distance, sprint, accelerations and decelerations) has a great importance in the design of specific minifootball training protocols. Given that minifootball is a very physically intense sport and its physical demands are important and should be taken into consideration by coaches in applying training for competitions in order to improve performance. With these information, coaches can modulate minifootball training sessions, and appropriately quantify the workload.

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Footnotes

Authors' Contribution: Jamel Halouani, Cyrine H'mida, data collection and analysis; Jamel Halouani and Cyrine H'mida, writing the first version of the manuscript; Khaled Trabelsi, Hamdi Chtourou and Cain Clark, drafting and revising the manuscript. All authors have participated in preparation of the final version of the manuscript, whose contents they approve.

Conflict of Interests: No conflict of interest exists.

Data Reproducibility: The data presented in this study are openly available in one of the repositories or will be available on request from the corresponding author by this journal representative at any time during submission or after publication. Otherwise, all consequences of possible withdrawal or future retraction will be with the corresponding author.

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