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Physiological demands and activity profiles during futsal match play according to competitive level

N. MAKAJE [1], R. RUANGTHAI [1], A. ARKARAPANTHU [1], P. YOOPAT [2]

[1]Faculty of Sports Science, Kasetsart University Kamphaeng-Saen Campus, Nakornpathom, Thailand
[2]Department of Medical Science, Faculty of Science Rangsit University, Pathumthani, Thailand

***Aim*. The aims of this study were to examine and compare the physiological demands and activity profiles of players at different competitive levels during futsal match play.**
***Methods*. Fifteen professional futsal players (elite group) and 15 university futsal players (amateur group) participated in the study. The players in each group were divided into three teams; each team consisted of 1 goalkeeper and 4 outfield players. All players were observed during two match simulated competitive games. The physiological demands were analyzed by measuring heart rate, estimated $\dot{V}O_2$ from an individual HR-$\dot{V}O_2$ relationship, and earlobe-blood lactate concentration before and at the end of the match. Activity profiles were analyzed for whole game movement patterns using a computer-based tracking system.**
***Results*. The physiological demands of the outfield players in the elite group was higher (P<0.05) than in the amateur group (%HR_{max}: 89.8±5.8 *vs*. 86.2±6.7%, %$\dot{V}O_{2max}$: 77.9±9 *vs*. 73.1±6.2% and blood lactate: 5.5±1.4 *vs*. 5.1±1.5 mmol/L, respectively). Analysis of activity profiles of outfield players showed that the total distance covered of the elite group was higher (P<0.05) than that of the amateur group: (5087±1104 *vs*. 4528±1248 m, respectively). However, there were no significant differences in the physiological demands and activity profiles between the goalkeepers in the two groups (P>0.05).**
***Conclusion*. These results demonstrate that the higher physiological demands and activity profiles placed on elite players during the game could indicate the players' physical fitness reserves for the formulation of an optimized specific training program as well as being useful in the preparation of the athletes for competition.**

KEY WORDS: Heart rate - Lactic acid - Movement.

Futsal, is a form of football (also known as soccer in some countries) played indoor between team with five-a side. It is a popular team sport that is officially sanctioned by the Federation International de Football Association (FIFA) and is played at professional, amateur and recreational levels all over the world.

Futsal is an intermittent high-intensity strenuous team sport that places heavy emphasis on running speed, endurance and requires substantial strength levels to kick, tackle, turn, change pace and sprint during game actions. Available research [1, 2] demonstrated that futsal players must be able to recover rapidly following high-intensity exercise and be able to repeat the work-rate pattern for the entire matches, resulting in high physiological and movement demands on players.

The performance of athletes can be improved by appropriate training. Fitness training should be closely related to the activities of the athlete during competition.[3, 4] A better understanding of the physiological demands and activity profiles is important, in order to assist in the creation of sports-specific training schedules that develop optimal training for players.[3] Despite the growing popularity of futsal, scientific knowledge regarding the physiological demands and activity profiles of players during games is rather limited. There have only been a few scientific studies that have investigated amateur [5] and elite futsal players.[1, 2] In addition, no study has yet to focused on the goalkeeper. There is no detailed in-

Corresponding author: N. Makaje, Faculty of Sports Science, Kasetsart University, Kamphaeng-Saen Campus, Nakornpathom73140, Thailand. E-mail: lee2804@hotmail.com

formation or study on the differences in physiological demands and activity profiles between elite and amateur players. Therefore, it is hypothesized that physiological demands and activity profiles are factors that are dependent on the level of competition in futsal. This information could identify development requirements that need to be assessed so that specific training program for elite and amateur futsal players can be developed.

Therefore, the aims of this study were to determine and quantify and determine the extent to which differences occur both in physiological demands and activity profiles during futsal match play by the outfield players and goalkeepers, according to competitive levels.

Materials and methods

Subjects

Thirty male Thai futsal players were divided into two groups according to competition level. The first group consisted of 15 professional futsal players (elite group, all data in the text is shown as mean±SD: age 24.2±5 years, body mass 66.9±4.5 kg and height 174±3 cm). The elite players had competed in national competitions for three years and they had trained five times per week for 2 h per training session and participated in a professional match once a week. The second group consisted of 15 university futsal players (amateur group: age 20.7±3 years, body mass 65.4±6 kg and height 170±5 cm). They had at least three years of futsal training, usually trained three-five times per week for 1.5 h and participated in one match per week.

The 15 players in each group were divided into three teams, each team consisting of five players. All teams employed a regular 1-2-1 formation: 1 goalkeeper, 1 defender, 2 wing midfielders and 1 attacker. All players were fully informed of all experimental procedures before giving their informed consent to participate. The study protocol was approved by the Ethical Committee on Human Research, Ministry of Public Health, Thailand.

Physiological performances test

A few days before the simulated futsal match competition, the anthropometric and physiological performances were evaluated. All players performed three physiological performance tests: an incremental maximal test (IMT) [2, 6] the yo-yo intermittent endurance test level 2 (YYIE2),[7] and the repeated-shuttle-sprint ability test (RSSA).[8] Each test was separated by at least 48-72 h.

An individual HR-$\dot{V}O_2$ relationship and maximal oxygen uptake ($\dot{V}O_{2max}$) was determined using an incremental running test on a motorized treadmill. After an individually adjusted warm-up (5 min), players ran for 6 min at 8 km/h and at an inclination of 1%. Then. the velocity was increased by 1 km/h every minute until exhaustion.[2] Achievement of$\dot{V}O_{2max}$ was considered as the attainment of at least two of the following criteria: 1) a plateau in$\dot{V}O_2$ despite increasing speeds (150 mL/min); 2) a respiratory exchange ratio above 1.10; 3) a HR±10 beats/min of age-predicted maximal HR (220-age) and (4) a blood-lactate concentration higher than 8 mmol/L 3 min after the end of the test.[6] Expired gases were analyzed using a breath-by-breath automated gas analysis system (VMAX29, Sensormedics, Yorba Linda, CA, USA). Heart rate was recorded every 5 s using telemetric devices (Polar S810, Kempele, Finland).

The YYIE2 test consisted of repeated 2×20 m runs back and forth between the starting, turning, and finishing line at a progressively increased speed controlled by audible beeps from a computer. Between each running bout, the subjects had a 5 s period of active recovery during which they walked/jogged to and back from a cone, which was set 2.5 m from the finish line. The test was considered completed when the participant twice failed to reach the front line in time or he felt unable to complete another shuttle at the dictated speed. The score on the test was taken as the number of successful bouts completed multiplied by 40 m to determine the total distance covered.[7]

The RSSA test was performed according to the procedures suggested by Impellizzeri *et al*.[8] This test was designed to measure both repeated sprint and change in direction abilities. The protocol consisted of six 40 m (20+20 m sprints with 180˚ turns) shuttle sprints separated by 20 s of passive recovery. The score on the RSSA was taken as the best time in a single trial (RSSA best), mean time (RSSA mean) and decrement (RSSA decrement). Specifically, the RSSA $_{decrement}$ (%) was calculated as:

$$RSSA_{decrement}(\%) = ([RSSA_{mean}]/[RSSA_{best}] \times 100) - 100$$

Physiological demands measurement

Physiological demands were assessed five-seven days after the physiological performance test. All players were observed during highly competitive games (two half, each half consisting of 2×10 min with 5 min recovery and 10 min for the half-time interval). This protocol was used, as observation official matches showed that players were involved for an average of 10 min (total time) before being substituted. Each team played two simulated matches (three matches for the elite group and three matches for the amateur group). Therefore, this study observed six matches. All futsal competition was completed on a 34×20 m court.

Heart rate during the games was measured at 15 s intervals using Polar S810 heart rate monitors (Polar, Kempele, Finland). A chest monitor and wrist receiver, weighing 100g, was placed on each player approximately 30 min before kickoff. The stopwatch on the heart rate monitor was synchronized with the starting time of the game and the heart rate was averaged to calculate the mean value over the total time and the mean value during live time, respectively. Total time was defined as the time during which the player was on the court (*i.e.*, excluding breaks between quarters and at half time). The relative aerobic load was calculated as % HR_{max}. The recorded heart rate was also divided into three intensity zones (<65% HR_{max}, 65-85% HR_{max}, and>85% HR_{max}).[1] The time spent within each intensity zone was calculated to provide an additional indication of the physiological stress associated with match play.

$\dot{V}O_2$ during the game was then calculated for each subject from the mean HR and the individual linear regression equation between $\dot{V}O_2$ and the HR obtained in the lab. Furthermore, the relative aerobic load was calculated as $\%\dot{V}O_{2max}$. Energy expenditure was extrapolated from individual heart rates measured during match play and juxtaposed on the HR-$\dot{V}O_2$ regression lines determined during the incremental treadmill test. Individual total energy cost of the game was estimated from the HR-$\dot{V}O_2$ relationship [3, 9, 10] where 1 liter of oxygen consumed was equated to 5 kcal or 21.1 kJ of energy expended.

Blood samples were drawn from each players ear lobe before and at the end of each match. For each of the six games studied, all players were tested. To avoid methodological bias linked to the diffusion time of lactate from the muscles to the blood, sampling always took place within 1 min of the cessation of play.[11] Sampling was conducted with players sitting on a bench; a pin-prick sample (0.5 μL) was taken from an ear lobe by a trained experimenter and placed in a capillary tube. Blood samples were immediately analyzed for blood lactate concentration by a calibrated portable analyzer (Lactate SCOUT, Germany) placed 5 m away from the bench. The values for the validity, intra-rater reliability and inter-rater reliability of the Lactate SCOUT were r=0.84, r=0.91 and r=0.95, respectively.[12]

Analysis of activity profiles

The activity profiles of the futsal players were established from the analysis of the simulated competition using a computer-based tracking system and estimations from video footage using Trak Performance Software (SportsTec Pty Ltd., Sydney) from 60 individual game performances (15 players × 2 matches × 2 groups). Video recordings of matches were taken using a video camera (Sony DCR SR82, Japan) with a wide angle conversion lens (Sony VCL-0630x, Japan). The video camera was placed on the side of the court at the median line level and slightly elevated to allow full coverage of the court. The Trak performance software supports a measure of user-determined speed categories. One recorder operating one dedicated computer was required for each player being tracked. The recorder tracked the player continuously and recorded player movements with a conventional mouse or a mouse pen and commercially available drawing tablet. The miniaturized playing field represented on the tablet was calibrated so that any given movement of the mouse or mouse-pen corresponded to the scaled linear distance travelled by the player.[13]

The intervals were determined using the following movement categories based on the researcher's opinion of gait, with the velocities selected from the methodologies of several researchers in futsal and other team sports [1, 14, 15] as: 1) standing (0-0.9 km/h); 2) walking (1.0-4.9 km/h); 3) jogging (5-7.9 km/h); 4) low-speed running (8-11.9 km/h); 5) moderate-speed running (12-17.9 km/h); 6) high-speed running (18-23.9 km/h) and 7) sprinting (>24 km/h). The time spent and distance covered using each movement category and the totals were calculated for complete matches.[16-18]

Statistical analysis

Data were presented as means and standard deviations (SD). Mean values for physiological demands and activity profiles were compared. Before using parametric tests, the assumption of normality was verified using the Shapiro-Wilks W-test. Differences between the two groups for outfield players were compared using an independent t-test and goalkeepers differences were compared using a Mann-Whitney U test. Significance level was set at P<0.05 (95% confidence intervals). Cohen's effect sizes (ES) were applied (pooled SD), with values of 0.2, 0.5 and 0.8 considered to represent small, moderate and large differences, respectively.

Results

Physiological performances test

Descriptive physiological performances (Table I) showed that, for the outfield players, the elite group had higher $\dot{V}O_{2max}$ (P<0.05) than the amateur group (60.4±5.1 *vs*. 57.2±6.2 mL/kg/min, respectively). The total distance cover of the yo-yo intermittent endurance test level 2 in the elite group was 1558±451 m, which was higher (P<0.05) than the amateur group (1203±660 m). $RSSA_{best}$, $RSSA_{mean}$ and $RSSA_{decrement}$ of the repeated-shuttle-sprint ability test in the elite group were lower (P<0.05) than the amateur group (6.70±0.21 *vs*. 6.92±0.24 s, 7.04±0.41 *vs*. 7.37±0.26 s and 3.8±2.3 *vs*. 4.9±2.8%, respectively). There were no differences in all physiological performances between the goalkeepers in the two groups (P>0.05).

Physiological demands measurement

Data on the physiological demands of futsal match play (Table II) showed that, for the outfield players, the HR, $\%HR_{max}$, $\dot{V}O_2$, $\%\dot{V}O_{2max}$ and lactate of whole game of the elite group was also higher (P<0.05) than of the amateur group (HR: 175±12 *vs*. 170±10 beat/min, $\%HR_{max}$: 89.8±5.8 *vs*. 86.2±6.7% $\dot{V}O_2$: 43.7±5.8 *vs*. 38.7±7.9 mL/kg/min, $\%\dot{V}O_{2max}$: 77.9±9 *vs*. 73.1±6.2 % and blood lactate: 5.5±1.4 *vs*. 5.1±1.5 mmol/L, respectively). There were no differ-

TABLE I.—*Physiological performance test between elite and amateur players.*

Physiological Performance Test	Outfield players		Goalkeepers	
	Elite (N.=12)	Amateur (N.=12)	Elite (N.=3)	Amateur (N.=3)
An incremental maximal test – $\dot{V}O_{2max}$ (mL/kg/min)	60.4±5.1	57.2±6.2*	54.6±5.7	52.4±3.5
The Yo-Yo intermittent endurance test level 2 – Total distance cover (m)	1558±451	1203±660*	900±403	726±316
The repeated-shuttle-sprint ability test				
– $RSSA_{best}$ (s)	6.70±0.21	6.92±0.24*	7.18±0.12	7.23±0.15
– $RSSA_{mean}$ (s)	7.04±0.41	7.37±0.26*	7.64±0.14	7.86±0.30
– $RSSA_{decrement}$ (%)	3.8±2.3	4.9±2.8*	5.1±0.9	5.2±2.2

Values are mean±SD. * Significant (P<0.05) difference between groups.

TABLE II.—*Physiological demands of futsal match play between elite and amateur players.*

Physiological demands	Outfield players		Goalkeepers	
	Elite (N.=12)	Amateur (N.=12)	Elite (N.=3)	Amateur (N.=3)
HR (beat/min)	175±12	170±10*	147±7	145±11
HR_{max} (%)	89.8±5.8	86.2±6.7*	73.7±5.1	72.2±8.6
$\dot{V}O_2$ (mL/kg/min)	43.7±5.8	38.7±7.9*	31.5±4.7	29.7±5.9
$\dot{V}O_{2max}$ (%)	77.9±9.0	73.1±6.2*	63.2±8.9	61.8±11.7
Energy Expenditure (kcal)	595±50	543±67*	422±80	415±65
Blood Lactate (mmol/L)	5.5±1.4	5.1±1.5*	4.2±1.3	4.0±1.9

Values are mean±SD. * Significant P<0.05difference between groups.

ences in all variables between the goalkeepers in the two group (P>0.05).

Table III shows the percentages of time spent in selected HR intensity zones during the futsal match play**.** The results show that the outfield players of the elite group spent less low intensity and moderate intensity playing time (P<0.05) than the amateur group (low intensity: 1.3±0.8 *vs*. 6.4±2.1% and moderate intensity: 17.3±7.1 *vs*. 20.1±5.5%, respectively) and spent more (P<0.05) time of high intensity than the amateur group (81.4±16.3 *vs*. *s* 73.5±21.4%). There were no differences in the intensities of any activity between the goalkeepers of the groups.

Analysis of activity profiles

Analysis of the activity profiles of futsal match play (Table IV) showed that in the outfield players, the walking distance of the elite group was lower (P<0.05) than of the amateur group (514±112 *vs*. 551±127 m) and jogging distance, low-speed running, moderate-speed running, high-speed running, sprinting and total distance in the elite group were also higher (P<0.05) than in the amateur group (jogging: 1302±671 *vs.* 1220±664, low-speed running: 1165±526 *vs.* 1019±573 m, moderate-speed running: 1050±355 *vs.* 896±381 m, high-speed running: 636 ± 248 *vs.* 534±276 m, sprinting: 422±186 *vs.* 308±203 m and total distance cover: 5087±1104 *vs.* 4528±1248 m, respectively). There were no differences between the goalkeepers in the groups for the distance covered in each activity and in the total distance covered.

The results of time spent in different speed categories (Table V) showed that, for the outfield players, the elite group spent less (P<0.05) time standing and walking than the amateur group (standing: 4.2±1.1 *vs.* 6.9±1.7 and walking: 26.1±1.8 *vs.* 27.8±2.2% respectively). In contrast, time spent jogging, low-speed running, moderate-speed running, high-speed running and sprinting were higher (P<0.05) than for the amateur group (jogging: 18.0±1.6 *vs.* 17.2±1.3%, low-speed running: 19.4±2.4 *vs.* 18.6±1.7%, moderate-speed running:17.1±2.2 *vs.* 16.2±2.6%, high-speed running: 8.7±1.3 *vs.* 7.7±1.6% and sprinting: 6.5±1.5 *vs.* 5.6±1.8%, respectively). For the goalkeepers, the elite group spent less (P<0.05) time standing than the amateur group (8.2±2.7 *vs.* 12.4±2.3 %), but there were no discernable differences in the time spent on other activities between the goalkeepers of the groups.

TABLE III.—*Percentages of time spent at low intensity, moderate intensity and high intensity in selected HR intensity zones of futsal match play between elite and amateur players.*

Percentages of Time Spent	Outfield players		Goalkeepers	
	Elite (N.=12)	Amateur (N.=12)	Elite (N.=3)	Amateur (N.=3)
Low intensity (<65% HR_{max})	1.3±0.8	6.4±2.1*	24.3±10.4	27.8±13.2
Moderate intensity (65-85% HR_{max})	17.3±7.1	20.1±5.5*	60.6±25.9	58.7±29.8
High intensity (>85% HR_{max})	81.4±16.3	73.5±21.4*	15.1±9.9	13.5±8.6

Values are mean±SD. * Significant (P<0.05) difference between groups.

TABLE IV.—*Distance covered of futsal match play between elite and amateur players.*

Distance covered	Outfield players		Goalkeepers	
	Elite (N.=12)	Amateur (N.=12)	Elite (N.=3)	Amateur (N.=3)
Walking (m)	514±112	551±127*	993±143	960±126
Jogging (m)	1302±671	1220±664*	352±152	280±184
Low-speed running (m)	1165±526	1019±573*	265±189	189±127
Moderate-speed running (m)	1050±355	896±381*	196±130	159±107
High-speed running (m)	636±248	534±276*	127±85	95±41
Sprinting (m)	422±186	308±203*	110±57	87±46
Total distance covered (m)	5087±1104	4528±1248*	2043±702	1770±854

Values are mean±SD. * Significant (P<0.05) difference between groups.

TABLE V.—*Time spent of futsal match play between elite and amateur players.*

Time spent	Outfield players		Goalkeepers	
	Elite (N.=12)	Amateur (N.=12)	Elite (N.=3)	Amateur (N.=3)
Standing (%)	4.2±1.1	6.9±1.7*	8.2±2.7	12.4±2.3*
Walking (%)	26.1±1.8	27.8±2.2*	51.0±5.2	50.6±4.2
Jogging (%)	18.0±1.6	17.2±1.3*	15.2±4.2	14.1±4.3
Low-speed running (%)	19.4±2.4	18.6±1.7*	10.4±2.2	9.1±2.5
Moderate-speed running (%)	17.1±2.2	16.2±2.6*	8.3±1.5	7.8±1.5
High-speed running (%)	8.7±1.3	7.7±1.6*	4.7±1.3	4.2±1.3
Sprinting (%)	6.5±1.5	5.6±1.8*	2.2±0.7	1.8±0.8

Values are mean±SD. * Significant (P<0.05) difference between groups.

Discussion

The purpose of the study was to verify differences between competitive levels and to quantify the physical demands placed on outfield players and goalkeepers during futsal match play.

HR measurements were used to provide information about the aerobic energy turnover during the match play.[3] When considering total time, the mean heart rate of the outfield players recorded in the present study showed that the elite group had 175 beat/min, which corresponded to 89.8% of HR_{max} and was higher than that of the amateur group (170 beat/min or 86.2% of HR_{max}). This result was similar to observations in other studies investigating elite futsal players.[1, 2, 19]

The higher heart rate in the elite group may have been a result of the higher load on their anaerobic metabolism than that in the amateur group. This difference suggests a higher HR, which is consistent with the observation that elite players were engaged in more moderate and high-intensity movements. In relative terms, the mean heart rate of the elite futsal players remained above 85% of the maximum heart rate for 81.4% of actual playing time. These values indicate that for more than 80% of the time spent on the court, these players were performing very vigorous activity at a high-intensity. In the amateur group, vigorous activity only accounted for 73.5% of actual playing time. However, there were no differences in HR and % HR_{max} during the match between the elite and amateur goalkeepers. The results indicated that for goalkeepers, different competitive levels did not affect their HR response during the game. This may have been due to the similarity between the elite and amateur groups in the roles played and movement patterns by the goalkeepers.

The results obtained during treadmill running showed that the relative intensity during games was around 77.9% and 73.2% $\dot{V}O_{2max}$ in the elite and amateur outfield players and 63.2 and 61.8% $\dot{V}O_{2max}$ in the elite and amateur goalkeepers respectively. These differences could have resulted because the elite players engaged in more high-intensity activity during the game than the amateur players, primarily because the elite players covered a greater distance and spent more time in high-speed running and sprinting. Thus, the greater high-intensity demands placed on elite players during game might cause increased intensities ($\dot{V}O_{2max}$) during the game. Furthermore, the % $\dot{V}O_{2max}$ attained by the elite outfield players in the present study was higher than that reported by previous studies;[2, 19] however, the % $\dot{V}O_{2max}$ reported by Castagna *et al*.[5] for recreational five-a-side players was higher than the amateur outfield players in the present study. Reilly[3] reported that the differences in of % $\dot{V}O_{2max}$ in a the soccer game depended on the method of $\dot{V}O_2$ measurement. In the present study, $\dot{V}O_2$ was estimated by HR- $\dot{V}O_2$ regression lines determined during the incremental treadmill test, while in the study by Castagna *et al*.,[5] the researchers measured the actual $\dot{V}O_2$ by portable gas analyzer. Thus, the differences in % $\dot{V}O_{2max}$ for both elite and amateur players compared with previous studies could have been due to the different method used to measure oxygen consumption.

The findings of the present indicate that, during a futsal game, the substantial physical demands of futsal evidenced by $\dot{V}O_2$ requirements were around 43 and 38.7 mL/kg/min in the elite and amateur outfield players, respectively, and around 31.5 and 29.7 mL/

kg/min in the elite and amateur group goalkeepers, respectively. This may suggest that the elite futsal players have greater $\dot{V}O_2$ requirements than the amateur players. In addition, the results showed that the $\dot{V}O_{2max}$ values, that were within the ranges that Barbero *et al*.,[1] and Baroni *et al*.[20] considered to be advisable to play futsal at the elite level. A recent study showed that $\dot{V}O_{2max}$ may be considered as a discriminative physiological variable in futsal played at different competitive levels.[20] As a consequence of the $\dot{V}O_2$ demands during a game and the individual level of $\dot{V}O_{2max}$, a well developed maximal aerobic power seems to be advisable in the elite futsal players.[2, 19, 20] The aerobic system provides the main source of energy in futsal match play, where players have to sustain a high rate of work. However, futsal is characterized by an intermittent activity profile with high-intensity anaerobic efforts superimposed on a background of aerobic activity. This means that, during a futsal match, an alternating aerobic/anaerobic metabolic system takes place, in response to intense technical-tactical situations.

Determination of $\dot{V}O_2$ demand during the competition allows the calculation of athlete's energy expenditure with reasonable precision.[3, 9] Indirect measurements from a HR- $\dot{V}O_2$ relationship are generally used to estimate energy expenditure during matches.[3] In the present study, energy expenditure of the outfield players during the futsal match showed that the elite group expended more energy than the amateur group (595 *vs.* 543 kcal, respectively). This was supported by the observation that the elite group exhibited more strenuous movement and greater metabolic demand. In general, energy expenditure depends on the intensity of activity.[3] The present showed that the elite group spent more time undertaking high-intensity activity than the amateur group. However, there were no differences in energy expenditure between the elite and amateur goalkeepers. This was corroborated by the similar metabolic demand and intensity of activity observed between the goalkeepers.

Blood lactate concentrations are traditionally used to estimate the contribution of anaerobic glycolysis to metabolism during team sports.[21] The mean blood lactate concentration of the outfield players recorded in the present study was 5.5 and 5.1 mmol/L in the elite and amateur groups, respectively. These amouts are very close to the values reported in recent studies on Spanish professional male futsal players (5.3 mmol/L).[1, 2] However, in the present study, no differences were indicated between the elite and amateur group in goalkeepers (4.2 and 4 mmol/L, respectively). Other limitations, including the small number of samples collected in the present study, preclude any additional comparisons between the goalkeepers. The present results show that the elite players' blood lactate concentrations during the game were higher than in the amateur players. This finding was partially supported by the greater amounts of high-intensity activity in which elite players were involved throughout game and the anaerobic system related to an increase in the frequency and duration of high intensity exercise.[22] Nevertheless, it is not possible to make any determination on the muscle lactate concentrations. The main limitation of blood lactate measurement is that it is representative of a balance between lactate production and its removal within the muscles. In this context, Krustrup *et al*.[21] studied the evolution of muscle and blood lactate in different periods of an intermittent field test simulating the activity experienced in a football match. Their findings were in line with those reported during continuous exercise, showing that the speed of blood lactate removal was slower than the rate of lactate removal in the muscle. Their report highlighted that these differences must be taken into account when interpreting blood lactate values measured during intermittent exercise.

Analyses of game activities are used to quantify physical and technical movement patterns of team sports and so provide important guidelines for training in a specific sport.[23, 24] The results of the present study show that the distance covered of each activity and total distance cover during futsal match play were significantly different between groups, and the average distance covered was 5087 m and 4532 m in the elite and amateur outfield players, respectively. These results differed only slightly from those reported in similar studies.[1, 2, 23] The results may be affected by many different parameters including the participants who took part in the studies, the method used to analyze match demand, the position on the field, and tactical disposition.[3, 24, 25] The higher distance covered of the elite players in the present study is probably a result of the tactics of the play. Barbero-Alvarez *et al*.[1] reported that the development of offensive (4 in line) and defensive (pressure over

all parts of the court) tactics increased the demands made by competition, a fact reflected in the greater distance covered per minute. In the present study, the team of the elite players used defensive tactics with pressure over all parts of the court, while the amateur players used defensive tactics in the half court. This difference in tactics could have accounted for the increased distance covered by the elite group.

Furthermore, there was a significant difference in the distances covered at high intensity (high-speed running and sprinting) between the elite and amateur groups. This indicated that elite players run using more frequent high-intensity efforts during a game. Krustrup *et al*.[10] and Mohr *et al*.[14] showed that the distance covered at high intensity is closely related to the aerobic fitness of the players. Several observations also show that $\dot{V}O_{2max}$ is an important determinant of the ability to perform high-intensity intermittent exercises.[1, 2] In the present study, the elite players had $\dot{V}O_{2max}$ values that were greater than for the amateur players. Higher levels of endurance capacity (higher $\dot{V}O_{2max}$) will give elite players a better base for on-court performance regarding the high-intensity demands of futsal match play.

However, there was no difference in the distance covered of each activity between the elite and amateur goalkeepers. In general, most of a goalkeeper's movement during a match can be classified as standing, walking and low intensity running. Although there are fewer high-intensity actions, they are most decisive in a match, especially the sprints between 0 and 5 m, which are most common. However, in it seem the average distance covered by the elite goalkeeper was higher than for the amateur goalkeeper (2043 m and 1770 m, respectively), this could have been because the elite goalkeepers participated in offensive tactics with the outfield players and probably reacted to the attacking pressure of the opposing team more than the amateur goalkeeper, but no data are available on the goalkeepers for comparison with this study. Furthermore, given the small sample size it did not seem appropriate to focus on a comparison between the two competitive levels. This was a limitation of this study.

Interestingly, in each activity during the game, the outfield players in the amateur group spent more time standing and walking than the elite group, which suggests they spent less time for jogging, low-speed running, moderate-speed running, high-speed running and sprinting than the elite group. In addition, the elite goalkeepers spent less time standing than the amateur goalkeepers. These facts probably reflect the fact that the amateur group had lower physical fitness when compare with the elite group, as evidenced by the former's lower aerobic and anaerobic performance tests (Table I). Greater levels of aerobic and anaerobic performances appear to be advantageous for playing futsal at the elite level.[1, 2] Reilly [3] and Bangsbo *et al*.[4] reported that the higher the fitness level of the player, the more frequently the player is capable of high intensity phases of play and that a high level of fitness in all players in a team contributes to a high work rate and maintenance of good technique throughout a match. Thus, an elite player should ideally be able to maintain a high level of intensity throughout the game.

Conclusions

This study described the physiological demands and activity profiles of elite and amateur futsal players during match play. The elite players seem to require higher physiological demands and activity profiles than amateur players. This information may be useful for designing specific training drills for individual players for specific positions and to assist in the planning of a training program for futsal players at both elite and amateur levels.

Further research is needed to study and futsal match play and determine the physiological demands and activity profiles of players in different outfield positions and the characteristics of different playing styles.

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