

## PHYSIOLOGICAL AND NEUROMUSCULAR RESPONSES DURING THE GAME IN FEMALE FUTSAL PLAYERS

### RESPOSTAS NEUROMUSCULARES E FISIOLÓGICAS DURANTE O JOGO EM ATLETAS DE FUTSAL FEMININO

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#### RESUMO

O presente estudo testou se existem diferenças, nas respostas fisiológicas e neuromusculares em atletas de futsal durante um jogo amistoso. A amostra foi composta por seis atletas de futsal do sexo feminino ( $21,8 \pm 3,9$  anos;  $57,4 \pm 4,1$  kg;  $159,0 \pm 2,7$  cm de altura;  $19,0 \pm 3,3\%$  gordura corporal e  $7,8 \pm 1,8$  anos de tempo de prática). A frequência cardíaca (FC) foi monitorada durante toda a partida. O salto com contramovimento, resistência de força explosiva de membros inferiores e lactato sanguíneo foram avaliados antes, após o final do primeiro e segundo tempo de jogo. Para comparação das variáveis neuromusculares e fisiológicas entre os diferentes momentos, nós utilizamos as diferenças de médias estandardizadas (DME), intervalo de confiança (IC = 90%) e probabilidades de haver diferenças com relevância clínica. A FC máxima (FCmáx) foi de  $186,6 \pm 10,6$  e  $185,8 \pm 8,3$ , primeiro e segundo tempo, respectivamente. Houve um aumento substancial do lactato do momento que antecedeu o início da partida para o final do primeiro ( $2,1 \pm 0,3$  para  $6,3 \pm 2,3$  mmol/L<sup>-1</sup>, DME = 5,25 (3,28: 7,21), 100/0/0; *most likely*) e segundo tempo ( $2,1 \pm 0,3$  para  $5,4 \pm 1,3$  mmol/L<sup>-1</sup>, DME = 4,62 (3,19: 6,04), 100/0/0; *most likely*) de partida. Embora tenha ocorrido um aumento do lactato sanguíneo, a performance de atletas femininas de futsal não foi suprimida durante e logo após uma partida amistosa, sugerindo que, o sistema neuromuscular possa estar restaurado logo após o término do jogo.

**Palavras-chave:** Monitoramento. Esporte. Desempenho.

#### ABSTRACT

This study has evaluated the differences in the physiological and neuromuscular responses in female futsal athletes during a friendly game. Sample comprised six female futsal players ( $21.8 \pm 3.9$  years;  $57.4 \pm 4.1$  kg;  $159.0 \pm 2.7$  cm height;  $19.0 \pm 3.3\%$  body fat and  $7.8 \pm 1.8$  years of practice). Heart rate (HR) was monitored during the whole game. Countermovement Jump (CMJ), Resistance Explosive Power (REP) lower limb and blood lactate have been evaluated before and after the final of the first and second periods. To compare physiological and neuromuscular variables between the different moments we have used standardized mean difference (SMD), confidence interval (CI = 90%) and the probabilities of differences with clinical relevance. Maximal heart rate (HRmax) was  $186.6 \pm 10.6$  and  $185.8 \pm 8.3$ , first and second periods, respectively. There has been a substantial lactate increasing in the moment prior to the start of the game to the final of the first ( $2.1 \pm 0.3$  to  $6.3 \pm 2.3$  mmol/L<sup>-1</sup>, SMD = 5.25 (3.28: 7.21), 100/0/0; *most likely*) and the second periods ( $2.1 \pm 0.3$  to  $5.4 \pm 1.3$  mmol/L<sup>-1</sup>, SMD = 4.62 (3.19: 6.04), 100/0/0; *most likely*). Although there has been an increase in blood lactate, the performance of female futsal players was not suppressed during and immediately after a friendly game, suggesting that the neuromuscular system may be restored immediately after the end of the game.

**Keywords:** Monitoring. Sport. Performance.

#### Introduction

Over the last years futsal has become popular and currently has more than 12 million players over than more 100 countries<sup>1</sup>. Futsal presents intermittent characteristics and it is considered to be one of the most physiological demanding team sport, causing high stress in the aerobic and anaerobic systems<sup>2,4</sup>. Hence, during the games, heart rate (HR) (i.e. 90% of maximal HR) high reactive sprints ( $118.4$  and  $110.5$  m · min<sup>-1</sup>, first and second periods, respectively)<sup>5</sup> and 1:1 effort - rest are a constant of this modality<sup>1,2,5</sup>. Additionally, the unlimited player substitutions contribute to a high intensity sport. On the other hand, the game

determinant actions, scoring a goal, dribble, displacements and defences are associated to lower limb muscle strength and power<sup>6</sup>.

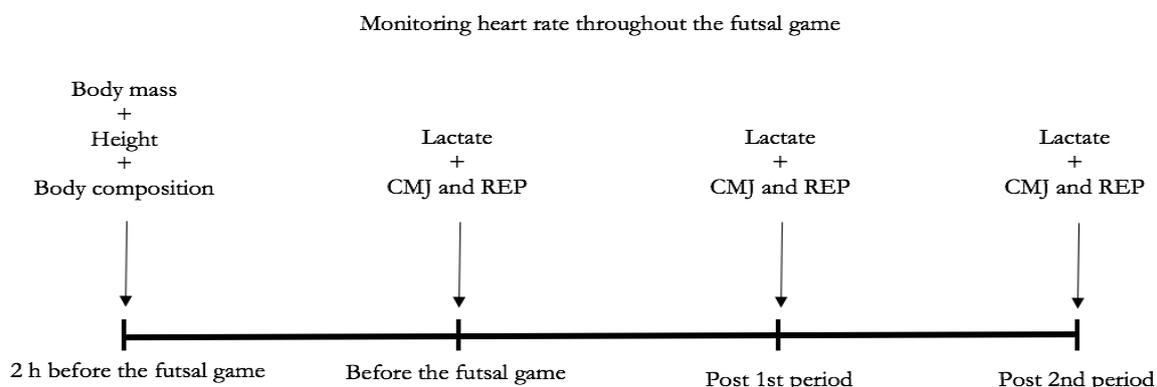
In this context, the neuromuscular system has been requested during the match. Due to the reduced dimensions, when compared to the other sports (i.e. soccer), it requires players to perform frequent bouts of high-intensity with limited rest periods that do not allow a complete recovery<sup>7</sup>. These high demands of futsal induce match-related fatigue, which may resulting in impaired performance, as evidenced by reductions in total distance peccored and maximal isometric force of knee extension after first e second game period<sup>8</sup>. In this sense, methods for assess the neuromuscular system may contribute for monitoring of demands match<sup>9</sup> and adoption of strategies aimed at recovery or maintaining performance<sup>7</sup>.

Regarding the monitoring of neuromuscular fatigue, countermovement jump (CMJ) is a valid and reproducible measure in futsal<sup>7,10,11</sup>. Parallel, decreases in vertical jump is related to the accumulation of metabolities (i.e. lactate)<sup>7</sup>. These measures, together, can provide an overview of the effects of futsal match on neuromuscular and metabolic parameters. Additionally, there is scant information regarding the physical demands imposed on women players during match. Whereas there is difference in performance<sup>12,13</sup> and fatigue<sup>14</sup> between men and women, the monitoring of the demands of match according to sex becomes determinant. Hence, this investigation aimed to assess the effects of futsal match on the physiological and neuromuscular responses of female players.

## Methods

### Sample

Sample comprised six semi-professional female futsal players ( $21.8 \pm 3.9$  years;  $57.4 \pm 4.1$  kg;  $159.0 \pm 2.7$  cm height;  $19.0 \pm 3.3\%$  body fat and  $7.8 \pm 1.8$  years of practice), playing in the futsal team of University of Fortaleza, Ceará, Brazil. These players practiced five days a week, twice a day (morning and afternoon), totalling four hours a day of training, and played official games at the weekends. The team was champion of Ceará State (category adult and sub-20) and northeast league, boths in the year 2015. All the participants provided written informed consent and the study has been approved by the Ethics Committee of Research of University of Fortaleza, with the n. 225/2010.



**Figure 1.** Study design

Source: Authors

### Sample characterization

To characterize the sample, body mass, height and body composition have been evaluated. Body mass and height have been respectively measured with a digital electronic scale *Slim Line (EKS)* and a stadiometer (*Sanny*) fixed on the wall. Body composition has been assessed through an electric bio impedance apparatus (*BIODYNAMICS Model 410*).

Athletes met the following guidelines: no eating nor drinking in the four hours before testing; no practicing during the 24 hours prior to the assessment; urinate 30 min before the test; no alcohol consumption in the 48 hours before the test and do not have diuretics in the last seven days. The exams were performed by a same professional.

#### *Neuromuscular Parameters*

Resistance Explosive Power (REP) lower limb has been assessed by performing three vertical countermovement jumps (CMJ). Athletes have been asked to perform vertical jump reproducing the motor gesture of heading the ball. REP has been estimated through the height of the jumps, consecutively for 30 s. We used the average of vertical jumps height analysis. All the vertical impulse assessments have been performed using a 50x60 cm platform (*Plataforma Jumptest*® - Hidrofit Ltda, Brasil), connected to *software Multisprint*® (Hidrofit Ltda, Brasil).

#### *Physiological Parameters*

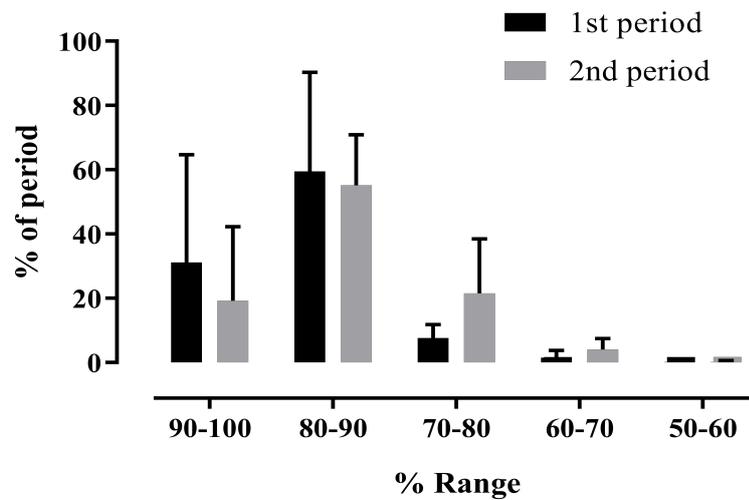
Blood lactate samples have been collected from the index finger (15-50 µl) and assessed through Accutrend BM-Lactate test strips (*Accutrend*® Plus). HR has been monitored in real time using a Polar H7 sensor on athletes' body. Data was collected via *Bluetooth*® and recorded into an *Ipad*® utilizing the software *1 Hz, Polar Team Sports System, Polar Electro OY, Finland*. After, these values were normalized to heart rate maximum (HRm) percentages targeting five heart rate zones: very light (50-60%); light (60-70%); moderate (70-80%); hard (80-90%) and maximum (90-100%)<sup>4</sup>.

#### *Statistical analysis*

Data have been analysed using mean and standard deviation. Comparisons between moments were assessed by standardized mean difference (SMD) with their Confidence Interval (CI = 90%)<sup>15</sup>. Further, magnitude of effect has been evaluated using the scale: 0 to 0.2 trivial, >0.2 to 0.6 small, >0.6 to 1.2 moderate, >1.2 to 2 large and >2.0 very large<sup>16</sup>. The odd of finding differences between moments has been qualitatively assessed through the scale: < 1%, almost certainly not; 1-5%, very unlikely; 5-25%, unlikely; 25-75%, possible; 75-95%, likely; 95-99%, very likely; > 99%, almost certain. When the results of both categories (better and poorer) were > 5%, the true (unknown) effect was classified as unclear<sup>17</sup>.

## **Results**

Figure 2 presents the time spent in the different intensities during the futsal match. Mean HR during the first and the second periods was respectively,  $173.8 \pm 9.7$  and  $169.0 \pm 9.3$  beats per minute (bpm). HRm was  $186.6 \pm 10.6$  in the first period and  $185.8 \pm 8.3$  in the second. Our findings have shown no substantial differences in the mean HR [SMD = -0.63 (-1.53: 0.26), 6/14/80; *Unclear*] and HRmax [SMD = -0.22 (-1.01: 0.58), 18/30/51; *Unclear*] between the two game periods.

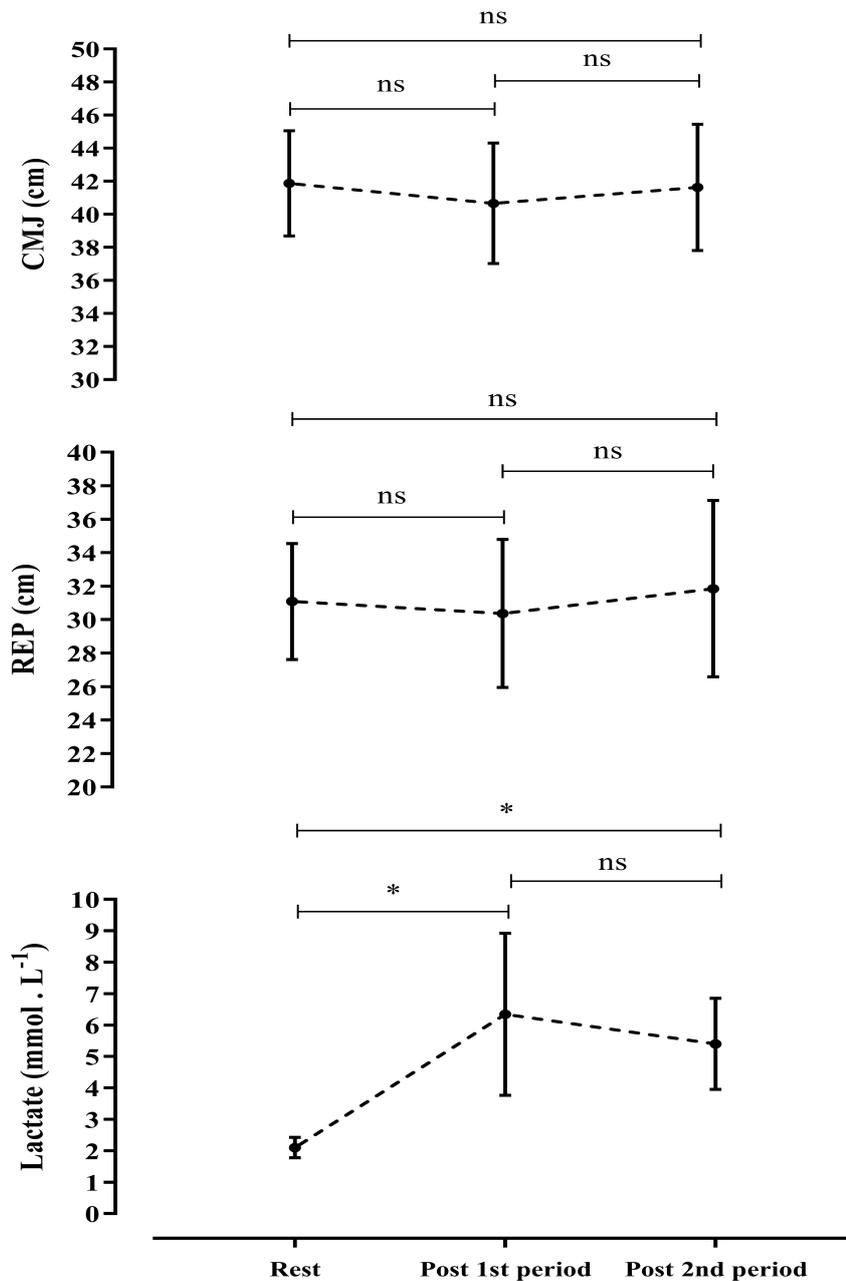


**Figure 2.** Percentage of time spent in HR intensity zones

Source: Authors

Figure 3 presents the results of comparisons among pre-game, final of first and second periods regarding CMJ, REP and blood lactate. The CMJ was  $41.9 \pm 2.9$ ,  $40.7 \pm 3.3$  and  $41.6 \pm 3.5$  cm. No substantial differences have been found between the rest and post first period (SMD = -0.32 (-1.28: 0.63), 17/54/29; Unclear) and between rest and post second period (SMD = -0.07 (-1.06: 0.92), 31/28/41; Unclear).

REP was  $31.1 \pm 3.1$ ,  $30.4 \pm 4.0$  and  $31.9 \pm 4.8$  cm in the rest, after the first and second period, respectively. No substantial differences have been found between the different moments: REP [SMD = -0.20 (-1.24; 0.83), 25/25/50; Unclear and SMD = 0.14 (-1.02: 1.30), 46/24/30; Unclear, respectively]. Blood lactate concentration has shown a substantial increasing [SMD = 5.25 (3.28: 7.21), 100/0/0; most likely] from the pre-game to post first period ( $2.1 \pm 0.3$  to  $6.3 \pm 2.3$  mmol/L<sup>-1</sup>, respectively) and kept significantly high [SMD = 4.62 (3.19: 6.04), 100/0/0; most likely] in the post second game period ( $2.1 \pm 0.3$  to  $5.4 \pm 1.3$  mmol/L<sup>-1</sup>, respectively).



**Figure 3.** Neuromuscular and physiological responses during and after the end of the futsal game

**Note:** ns = no substantial; \* = substantial difference (most likely, 100/0/0)

**Source:** Authors

### Discussion

This research aimed to evaluate if the physiological and neuromuscular responses of female futsal players differed in the pre-game moment to the final of the first and second periods. Our main findings have shown that futsal female athletes stay ~80% of the whole game at a HR > 80% of the HRmax, without noteworthy drops from the first to the second period. Moreover, we have not found relevant differences in the neuromuscular parameters during the game, although we have reported a considerable increasing in the blood lactate concentrations from the pre-game moment to the post first and second periods.

We observed that HR during the game has presented mean values of 174 bpm and 163 bpm max and minimum during a female futsal match. Barbero-Alvarez, Subiela<sup>13</sup> have monitored elite female futsal athletes' HR and reported a 197 and 199 bpm HR<sub>m</sub>, in lab tests (e.g. progressive treadmill) and on the field (e.g. FIET test), respectively. Findings of the current investigation associated to Barbero-Alvarez, Subiela<sup>13</sup> characterize the high cardiovascular demand requested during both a female and a male futsal game<sup>4,5</sup>, as the athletes throughout all the game play at a constant intensity close to their HR<sub>max</sub>. This high request, as discussed in previous researches carried out with male athletes, is possibly due to the unlimited quantity of substitutions during the game, which triggers a greater dynamics and the maintenance of both intensity and high relative speed<sup>4,5,8</sup>.

As regards the time spent in different zones of intensity, our findings reveal that female players play a mean of 80% of the game at an intensity above 75% of their HR<sub>max</sub>, which emphasizes even more the role played by the anaerobic metabolism<sup>4,13</sup>. Castagna, D'ottavio<sup>4</sup> have reported that professional male futsal athletes spend a mean of 52% of the game at an intensity above their 90% HR<sub>max</sub>. These differences might be due to the fact that male athletes have a greater VO<sub>2</sub>max when compared to same level female athletes<sup>13</sup>. This discrepancy of the above ability is directly associated to the capacity of recovery between high intensity stimuli, that is, to a same amount of work, male athletes suffer less cardiovascular stress, when compared to female athletes<sup>2,13</sup>. In this sense, Castagna, D'ottavio<sup>4</sup> have found an inverse relationship between VO<sub>2</sub>max and time spent in intensities above 90% of HR<sub>max</sub> ( $r = -0.79$ ,  $p = 0.01$ ), suggesting that athletes holding a better aerobic capacity are more economic when performing actions during the game (i.e. playing at a smaller intensity). However, these conclusions need further data on female futsal athletes.

Concerning the monitoring of neuromuscular fatigue, several studies have been using vertical impulse to assess status fitness/fatigue of athletes' neuromuscular system from different modalities<sup>10,11</sup>. These investigators have been reporting that CMJ is suitable to detect variations in neuromuscular performance according to futsal athletes' training load<sup>10,11</sup>. Therefore, our findings have not shown substantial differences on vertical impulse and on REP between the moments assessed, thus suggesting that a futsal match has not generated neuromuscular fatigue in futsal female players. Notwithstanding, recently, Milioni, Vieira<sup>8</sup> have reported that a futsal game played by elite male athletes showed a decreasing of relative speed and neuromuscular performance (i.e. isometric strength of knee extensors). On the other hand, the acute changes due to the match have not affected speed and kicking efficacy.

Simultaneously monitoring neuromuscular parameters, we assessed the kinetic of lactate during the match. Blood lactate concentrations have shown substantial differences when comparing the pre-game moment and the end of the first and the second periods. Indeed, futsal game comprises high intensity actions (3-4 sprints) with short rest intervals (20-30 s of moderate to low intensity actions) in crucial moments of the match<sup>18</sup>. In this modality, the skill to perform repeated sprints with low interval between them is a determinant ability to be successful in futsal<sup>4</sup>. Accordingly, this high intensity actions with short recovery intervals may cause a lowering in performance due to the accumulation of some metabolites (i.e. ions H<sup>+</sup>, inorganic phosphate, lactate dehydrogenase), increasing of acidosis and the consequent decreasing of contractile function of skeleton muscle at the cross-bridge level<sup>19</sup>. Despite these signs, to conclude on fatigue and on the role played by the anaerobic metabolism from blood lactate, mainly in intermittent sports, should be done with caution, as these are not linear behavioural modalities in the lactate curve and furthermore, other molecules play an important role in the muscle contractile process<sup>4,20</sup>. The accumulation of ions H<sup>+</sup>, inorganic phosphate and adenosine diphosphate contribute to diminish sensitivity of Ca<sup>2+</sup>, to a lower renew of adenosine triphosphate (ATP) and consequently to the reduction of strength levels<sup>19</sup>.

Although comparisons among different modalities are limited due to different rules, i.e. pitch dimension and duration, some comparisons with other intermittent sports are useful to understand the characteristics and responses in different contexts<sup>5</sup>. The findings of the current study are similar to those found in other intermittent modalities, as football<sup>21</sup> ( $5.5 \pm 1.7$  mmol/L<sup>-1</sup>), and rugby<sup>22</sup>, during the first and the second periods (8.4 and 5.4 mmol/L<sup>-1</sup>, respectively), as well as in male futsal it self<sup>8</sup> (5.6 and 5.5 mmol/L<sup>-1</sup>). On the other hand, when comparing a research conducted on beach volleyball<sup>23</sup>, we can verify that lactate values are smaller, not overcoming 4.3 mmol/L. Probably, such difference is due to the distance covered by futsal players and their mean speed<sup>4,5,8</sup>, which are greater than a beach volleyball players, as well as the number of time-outs/rest in beach volleyball is much bigger than in futsal, which can contribute to a restoring of balance between the production-removing / use of plasma lactate.

Lastly, our study have some limitations. For example, we do not take into account the position of players. On the other hand, there are data that support the hypothesis that there are no differences between the positions of players in the distance traveled and time spent at different intensities throughout a futsal match<sup>5</sup>. Another possible limitation would be the absence of other biochemical markers that provide an overview of the internal load in response to the one or more futsal matches. Ultimately, further studies should investigate the indicators throughout a female futsal competition, where the athletes play longer game sequences, as well as the assessment of other parameters, e.g. speed and kicking efficacy.

## Conclusion

This investigation has found that the physiological and neuromuscular responses during a futsal game have presented substantial differences only in the blood lactate concentrations, where a considerable increasing could be found in the comparison between the pre-game and the end of the first and second periods. Neuromuscular parameters remained relatively stable, with no substantial increasing or decreasing on the performance of variables monitored. Our findings are important for providing information about neuromuscular and metabolic status of female players during and after a futsal match and directing decision making by coaches concerning substitutions and, consequently, adjust strategies tactical-techniques during the match.

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