Original Article

Neuromuscular parameters and anaerobic power of U-20 futsal players

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ABSTRACT

The current investigation aimed to find the difference between right and left lower limb strength of quadriceps and hamstring muscles and describe young futsal players' explosive strength and anaerobic power. The study comprised 12 university male U-20 futsal players (74.5 ± 9.7 kg;173.2 ± 7.2 cm; 18.7 ± 1.2 yrs.). Isometric strength was measured using an isometric dynamometer, lower limb explosive strength was assessed through the Countermovement Jump and anaerobic power was estimated with the Wingate test. Initially, results were displayed through descriptive statistics. Magnitude-based inference with respective Confidence Intervals (CI=90%) and effect size were used to compare inter-lower limb strength. No substantial differences were found between right and left lower limb, to knee extension and flexion. Team's explosive strength and anaerobic power were 36.7 ± 7 cm and 998.3 ± 125.9 W, respectively. These findings suggest that young futsal players' performance may be less affected due to inter-lower limb asymmetries. **Keywords:** Muscle strength, Asymmetry, Sport, Performance, Youth athletes.

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INTRODUCTION

Futsal is officially recognised by the Fédération International de Football Association (FIFA) and is one of the world's most popular team sports, played by more than 12 million people all over 100 countries (Beato et al., 2016). Futsal is characterised by intermittent and high intensity efforts (sprints, jumps and kicks), different displacing needs, changes of direction and short recovery intervals (Arins et al., 2015; Makage et al., 2012).

Its popularity has continued to grow and so the investigation of its physiological demands and specific adaptations to its practice (Barbero-Alvarez et al., 2015). In this aspect, scientists investigated the role played by lower limb muscle power in performance and injury prevention (Croisier et al., 2008; Milioni et al., 2016). Quadriceps and hamstrings are determinant to specific futsal actions, being crucial when jumping, kicking and at stabilising the knee joint during sprints and actions that demand change of direction (Ramos-Campo et al., 2016).

As in other team sports, motor actions demanded by futsal are mainly executed with unipedal stance (run, kicks, dribbles, jumps), leading to possible asymmetric adaptations of lower limbs muscle skeleton function (Fousekis et al., 2010). A recent systematic review (Bishop et al., 2017), has shown that the great imbalance of lower limbs strength is associated to decreasing on performance during sprints, jumps and kicks.

Strength assessment provides valuable information either to training (Makage et al., 2012) and to the diagnosis of possible lower limb asymmetry (Fousekis et al., 2010), which is one potential injury risk factor in team sports (Fort-Vanmeerhaeghe et al., 2016). In fact, U-17 and U-20 young football players' quadriceps and hamstrings strength was assessed and it has been found that almost half study sample presented muscle unilateral or bilateral imbalance (Herdy et al., 2017), thus representing a risk scenario to injuries (Fousekis et al., 2010). To the date, no studies have approached this topic on young futsal players.

Castagna et al. (2007) conducted an investigation on energetic systems and demonstrated that during a futsal game, the players play at a mean intensity equivalent to 85-90% of maximal heart rate and to 75% of $VO_{2máx}$, covering a total of more than 4500 m per game (Beato et al., 2016; Makage et al., 2012), thus stressing the aerobic and anaerobic systems (Arins et al., 2015). The latter is associated to the ability of performing repeated and consecutive sprints, hence mentioned as one of the most important aspects of futsal athletes' performance (Castagna et al., 2009).

Due to the importance of lower limbs strength on performance, as well as the risks that a probable muscle imbalance may trigger upon futsal players, this study aimed: (i) assess lower limb strength; (ii) testing any substantial differences between the left and the right lower limbs on quadriceps and hamstrings; (iii) describe futsal athletes' lower limb anaerobic power and explosive strength.

METHODOLOGY

Participants

The study comprised 12 male players (74.5 ± 9.7 kg; 173.2 ± 7.2 cm; 18.7 ± 1.2 yrs.; 8.6 ± 3.1 yrs. practice) from U-20 futsal team of Federal University of Ceará, Brazil. Players and coaches have been told about the methodological procedures and provided written informed consent to take part in this study. Local institutional ethics committee of Federal University of Ceará approved the study design (Ethic review 1.723.563).

Procedures

All the tests have been carried out in the same day, according to Harman's proposal (Harman, 2008). Players height and body mass were assessed using a Líder® scale with stadiometer, at a lab temperature of 22°C. After, the Moir (2015) procedures were applied.

Maximal voluntary isometric strength of knee extensors and flexors was unilaterally assessed, through an isometric dynamometer (Flexion/Extension Chair, Cefise, São Paulo, Brazil). Isometric strength was sampled at 100 Hertz. Before the test, athletes performed three submaximal bouts to get acquainted with the procedures and the equipment. Athletes performed three repetitions for each muscle action, at a 90° angle (Milioni et al., 2016), with 5 s duration and 1m rest-time (Moir, 2015). The repetition displaying the highest athletes' strength (N) was considered for the analysis. Athletes have been verbally encouraged to perform the highest strength contraction throughout all bouts.

The players executed the Wingate test with a cycle ergometer (Biotec 2100, Cefise, São Paulo, Brazil). They performed a 5- minute warm-up, with 50 rpm without additional overload. Testing load was estimated in 5% of athlete's body weight (Karakoç et al., 2012). After warming-up, the players were guided to pedal the fastest they could until 160-170 rpm. The overload increased and the athletes kept pedaling as fastest as they could for 30 seconds (Karakoç et al., 2012). The software Ergometric 6.0 (Cefise, São Paulo, Brazil) was used to automatically estimate peak, mean and relative anaerobic power, and fatigue index.

Lower limb explosive strength was assessed by the countermovement jump (CMJ) using the Jump System Optical (Cefise, São Paulo, Brazil). Players were instructed to perform a squat with ~ 90° knee flexion, hands on hips, followed by a jump with a full knee extension (Nakamura et al., 2016). Three bouts were performed with a 1 m interval and the highest jump was recorded.

Statistical Analysis

Results are presented using descriptive analysis (mean, standard deviation, minimum and maximum limit). Furthermore, aiming to compare right and left lower limb isometric strength, we estimated the effect magnitude based on the inference through the standardized mean differences (SMD) with respective confidence intervals (CI = 90%) (Cohen, 1988). The quantitative probability of finding differences among the tested variables was qualitatively evaluated by 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. If results of better and poorer are both > 5%, the probability of existing a difference is classified as unclear. Additionally, effect size was used according to the scale (Hopkins, 2010): 0-0.2 (trivial), >0.2 (small), >0.6 (moderate), >1.2 (large), >2.0 (very large).

RESULTS

Table 1 presents the mean values and standard deviation of maximum, mean and relative voluntary isometric strength of players' body mass of right and left lower limb found during knee extensor and flexor muscles, as well as percentage differences (∆ %) between right and left lower limb strength.

Table 1. Voluntary maximal isometric strength of knee extensor and flexor muscles and the difference (∆ %) between right and left lower limb strength

	Variables	Right lower limb	Left lower limb	∆ %
Extensor	Maximum voluntary isometric strength (N)	247.5 ± 40.4	231 ± 30.7	18.7 ± 10.5
	Mean voluntary isometric strength (N)	237.8 ± 38.9	217.4 ± 29.7	19.6 ± 17.3
	Relative voluntary isometric strength (N/kg)	3.4 ± 0.6	3.2 ± 0.6	18.9 ± 11.3
Flexor	Maximum voluntary isometric strength (N)	140.6 ± 27.1	143.3 ± 34.2	9.7 ± 9.8
	Mean voluntary isometric strength (N)	128.3 ± 26.2	127.8 ± 34.9	11.6 ± 11.8
	Relative voluntary isometric strength (N/kg)	1.9 ± 0.4	1.9 ± 0.3	9.7 ± 10.0

**N = Newtons; kg = kilograms*

Figure 1 presents SMD, CI (90%), effect size and the probability of difference of maximum and relative isometric strength between players' left and right lower limbs. Results show no substantial differences between the isometric strength (maximum and relative to body mass) produced between the right and left lower limbs (effect size small to trivial).

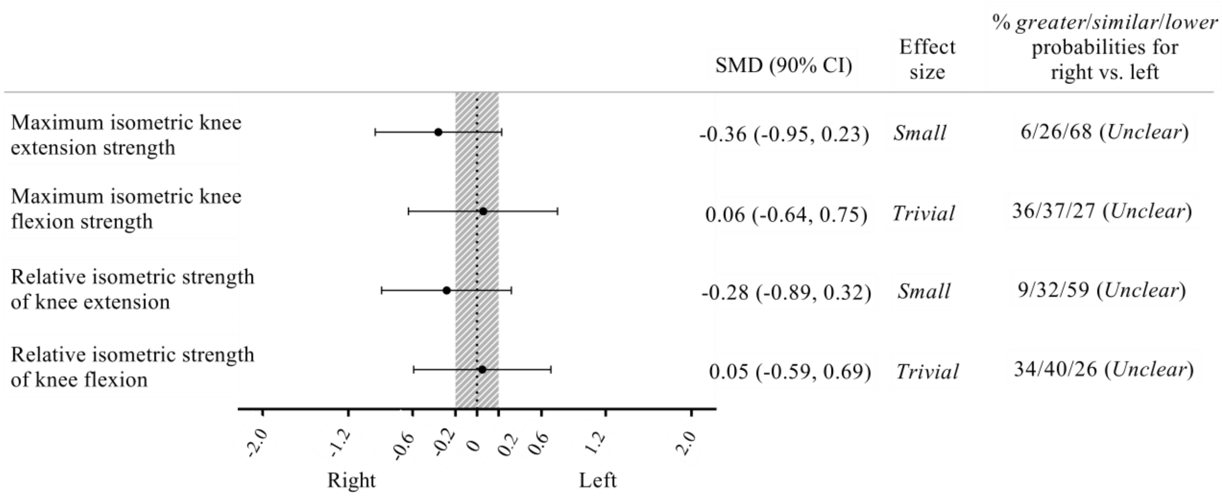

Figure 1. Comparison between right and left lower limb for maximum isometric and relative isometric knee strength

Table 2. presents teams' lower limbs explosive strength, peak, mean and relative anaerobic power of body mass, fatigue index and maximal heart rate during the Wingate test.

Table 2. Lower limbs explosive strength and variables obtained with Wingate test

Variables	Mean ± SD	Minimum	Maximum
Explosive strength (cm)	36.7 ± 7	27.3	48.8
Peak anaerobic power (W)	998.3 ± 125.9	809.5	1157.9
Mean anaerobic power (W)	724 ± 122.7	505.1	952
Relative anaerobic power (W/kg)	13.2 ± 1.3	11.8	16.1
Fatigue Index (%)	58 ± 11.8	36.2	73.5
Maximal heart rate (bpm)	169.5 ± 12.3	146	185

**SD = Standard deviation; cm: centimeters; W = watts; kg = kilograms; bpm = beats per minute*

DISCUSSION

This investigation is pioneering probable asymmetries of U-20 futsal players' lower limbs strength and presents the comparison between maximum isometric voluntary strength of quadriceps and hamstrings and the description of anaerobic power and explosive strength. No substantial differences were found between both lower limbs isometric strength.

Bilateral assessment of external strength provides important data on muscle asymmetries and consequently, increasing injury risks (Morel et al., 2015). A study conducted with elite football players in different categories (U-17, U-20 and professional), has noticed that nearly half (49%) of the sample had lower limb muscle imbalance and the youngest presented greater asymmetry (Herdy et al., 2017).

A possible justification for a greater asymmetry in young players might be explained by the type of training, as shown by Fousekis et al. (2010), who observed the longer the training time, the lower the asymmetries between the right and left lower limb, suggesting that skilful athletes use more proportionally their limbs during training and game actions. Notwithstanding, authors observed when conducting another investigation with female futsal players, that no differences have been found between the dominant and non- dominant lower limb strength. Hence, this is in agreement with the findings of the current study, evidencing the lower injury risk due to asymmetries of lower limbs muscle strength (Croisier et al., 2008) and a better performance in motor actions, kicks, jumps and sprints (Bishop et al., 2017).

Croisier et al. (2008) reported that asymmetric football players presented 4.7 times more odds of injury when compared to symmetric players. The same investigation has found that asymmetric players who had participated in a recovering training program reduced 1.4 times the injury risk (Croisier et al., 2008). These findings reinforce the importance of assessing strength levels to a coaches' better training, aiming to lower injury risks and trigger performance.

Evidence (Impellizzeri et al., 2007; Noyes et al., 1991) suggests that lower limb strength asymmetries (≥ 15%) indicate a potential injury risk. Fort-Vanmeerhaeghe et al. (2016) have unilaterally evaluated volleyball and basketball athletes' lower limb strength through the CMJ and observed a 10 to 15% asymmetry. Ferreira et al. (2010) have also found differences between the dominant and non-dominant limb, however, the standard cut-off points have not been overcome (Croisier et al., 2008). Although the present study has presented no substantial strength difference, some players presented significant differences (>15%). These results suggest that this sample needs a training plan designed to reduce these differences to decrease injury risk, as well as an intervention in performance during specific motor gestures (Croisier et al., 2008).

A futsal game demands different strength actions, such as maximal, resistant and explosive strength (Makage et al., 2012; Ramos-Campo et al., 2016). Miloski et al. (2015) y Miloski et al. (2012) assessed elite futsal players lower limb strength and reported greater values than those presented in the current investigation (49.8, 50.5 and 37.6 cm, respectively). Results found in the above-mentioned researches suggest that lower limbs explosive strength is a performance level discriminating variable (i.e. U-20 and professional) in futsal. However, Nakamura et al. (2016) y Ramos-Campo et al. (2016) reported no significant differences in explosive strength when comparing elite futsal players vs. sub elite.

The results of anaerobic power are in agreement with those reported by Souza et al. (2014) in young futsal players (998 and 749 W, respectively). Junior et al. (2016) presented a mean value of 686 W for players of the same modality and category. Anaerobic power has been evaluated through the Running-based Anaerobic

Sprint Test (RAST) (Junior et al. 2016). Anaerobic power related to body mass found in the current study corroborates the results presented by Junior et al. (2016) y Souza et al. (2014) who presented 9.7 and 10.7 W, respectively. These findings indicate that peak and relative to body mass anaerobic power have not been discriminating variables in futsal players' performance belonging to different categories. Fallon et al. (2014) demonstrated that elite female football players obtained a mean value of 533 W in peak anaerobic power.

One of the main limitations in the current investigation is related to the lack of control of specificity in the players' position, which could have influenced the results of some physical capacities (Junior et al., 2016). Furthermore, the ecological validity of the study can be weakened, as some authors recommend field testing instead of lab tests, (i.e. isometric and isokinetic dynamometer) which do not reproduce the functional aspects of the sport (Ferreira et al., 2010; Lehance et al., 2009). However, specialized literature accepts the use of dynamometers to assess the deficits of muscle strength (Lehance et al., 2009). Another parameter that should be taken into consideration is the rate of strength development (Morel et al., 2015). This variable is a determinant factor during the execution of movements with reduced time of contraction (< 250 ms), such as sprints and kicks (Morel et al., 2015). Further investigations can focus on probable connections between asymmetries of lower limbs, decreasing of performance and the development of injuries in futsal players.

CONCLUSION

U-20 futsal players assessed in this investigation are symmetric in the right and left lower limb strength, during knee extension and flexion. These findings suggest that young futsal players may be less harmed due to a lower risk of muscle injuries caused by inter-lower limb asymmetries.

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CONFLICT OF INTEREST

The authors state no conflict of interest.

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