Isokinetic Knee Muscle Strength Profile in Brazilian Male Soccer, Futsal and Beach Soccer Players

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Abstract: The main objective of this study was to investigate isokinetic knee muscle strength, hamstring to quadriceps strength ratio, and bilateral strength deficit in professional futsal, soccer and beach soccer players. We hypothesized that athletes of different soccer modalities have a specific isokinetic profile due to physiological, playing surface and biomechanical demands and specificities.

1 INTRODUCTION

Soccer is the most popular sport in the world, with an estimated 265 million active players (Fifa, 2007). Performance depends upon a myriad of factors such as technical, biomechanical, tactical, physiological and musculoskeletal health condition. Considering soccer, beach soccer and futsal, the technical and skills principles behind the games remain the same, however there are some differences between them, such as in number of players, number of substitutions, size of the court and duration of the match. Thus, athletes of different soccer modalities can present specific muscle adaptations.

To assess muscular strength profile, isokinetic testing has been used by clinicians and physical therapist (Aagaard et al., 1995). Several studies have been carried out to establish strength profiles in soccer players (Fousekis et al., 2010). However, only one study has investigated this situation in futsal (Reis et al, 2013) while none have been conducted in beach soccer.

The main objective of this study was to investigate isokinetic knee muscle strength, hamstring to quadriceps (H/Q) strength ratio, and bilateral strength deficit in professional futsal, soccer and beach soccer players. We hypothesized that athletes of different soccer modalities have a specific isokinetic profile due to physiological, playing surface and biomechanical demands and specificities.

2 METHODS

This study included 112 professional athletes who had been playing for at least five years, training regularly for five sessions per week and had no history of major lower limb injury or chronic disease. The sample of volunteers comprised soccer (n=70) players (19.3±4.8 years, 177.8±7.3 cm and 73.9±8.2 kg), futsal (n=30) (21.3±6.1 years, 175.8±5.3 cm and 72.3±8.8 kg) and beach soccer (n=12) (29.7±4.4 years, 177.1±6.1 cm and 74.7±6.5 kg). All experimental procedures were approved by the University Human Research Ethics Committee (Federal University of São Paulo) and conformed to the principles outlined in the Declaration of Helsinki.

To isokinetic assessment, the participants assumed a seated position on the isokinetic dynamometer (Biodex Medical Systems Inc., Shirley, NY, USA) with their hips flexed at approximately 85 degrees, and standard stabilization strapping was placed around the trunk, waist and the distal femur of the limb being tested in order to minimize additional movement and ensure the same conditions for all participants. The parameters evaluated (for concentric contractions at an angular speed of 60 degrees/second in dominant and non dominant limb) were isokinetic absolute hamstring and quadriceps muscles peak torque (in Nm), H/Q concentric peak torque ratio in %, and bilateral strength deficit in %. Peak torque values were

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normalized by body mass (Nm/kg) to enable comparison with values of other studies, eliminating the effects of subject heterogeneity as was named in current study of relative peak torque. The H/Q strength ratio was calculated by dividing the maximum torque values of the hamstring by the maximum torque values of the quadriceps at the same angular speed and multiplying by 100 (Aagaard et al., 1995). Those athletes that presented H/Q peak torque ratio below than 60% were classified with knee imbalance. Bilateral lower limb muscular strength deficit was calculated by: [(dominant limb peak torque – non dominant limb peak torque) / dominant limb peak torque]*100. Those athletes that presented bilateral strength deficit higher than 15% were classified as asymmetric.

All variables presented normal distributions according to the Kolmogorov-Smirnov test. Data were expressed as mean and standard deviation. To evaluate the anthropometric differences among the three groups, one-way analysis of variance (ANOVA) was used. To evaluate the influence of soccer modality and side on isokinetic variables, a 2x3 design side (D *versus* ND) and sport (soccer *versus* futsal *versus* beach soccer) ANOVA was used. Newman-Keuls post-hoc procedures were used to identify specific differences when significant interactions were present on the ANOVA test. In the absence of interactions, only main effects were analyzed. Statistical significance was set at an alpha of 0.05. All statistical analyses were performed using the Statistica (version 7.0, Statsoft Inc., Tulsa, OK, USA) software package.

3 RESULTS

Regarding to the dominant limb, absolute quadriceps concentric muscle peak torque values of futsal players (223.9±33.4 Nm) were lower than those of soccer (250.9±43.0 Nm, p=0.02) and beach soccer (253.1±32.4 Nm, p=0.03) players, while there were no significant group differences in flexor muscle performance (128.6±27.6 Nm vs. 133.1±25.7 Nm vs. 140.5±11.2 Nm for futsal, soccer and beach soccer, respectively). Considering the peak torque values relative to body mass, the same differences can be seen. Futsal players quadriceps values (3.1±0.3 Nm/kg) were lower than those of soccer (3.4±0.4 Nm/kg, p=0.01) and beach soccer (3.4±0.4 Nm/kg, p=0.04) players, while there were no significant group differences in hamstring muscle strength (1.8±0.3 Nm/kg vs. 1.8±0.3 Nm/kg vs. 1.9±0.2 Nm/kg for futsal, soccer and beach soccer, respectively).

Regarding non dominant limbs, absolute and relative quadriceps concentric peak torque values were significantly lower in futsal (224.0±35.8 Nm and 3.1±0.3 Nm/kg, respectively) than in beach soccer players (256.8±39.8 Nm [p=0.03] and 3.4±0.4 Nm/kg [p=0.04], respectively). There were also no significant intergroup differences in hamstring muscle performance for absolute (124.1±20.1 Nm vs. 127.6±25.0 Nm vs. 136.2±11.4 Nm for futsal, soccer and beach soccer, respectively) and relative peak torque values (1.7±0.2 Nm/kg vs. 1.7±0.3 Nm/kg vs. 1.8±0.1 Nm/kg for futsal, soccer and beach soccer, respectively).

Regarding H/Q strength ratios for dominant (57.6±10.1 % vs. 53.5±8.8 % vs. 56.3±8.4 % for futsal, soccer and beach soccer, respectively) and non dominant limbs (55.7±6.8 % vs. 53.2±7.2 % vs. 53.9±7.1 % for futsal, soccer and beach soccer, respectively), there were no significant differences between groups for this measure.

Finally, regarding bilateral strength deficit, no group presented significant difference, neither for quadriceps nor for hamstring muscles. Futsal players had deficits of -0.32±9.6% and 1.7±14.5% for extensors and flexors muscles, respectively. Soccer players had bilateral deficits of 3.3±11.2% and 4.2±11.5% for extensor and flexor muscles, respectively. Beach soccer players had bilateral deficits of -1.7±12.3% and 2.4±11.4% for extensor and flexor muscles, respectively. Despite means values were always lower than 15%, some athletes presented higher bilateral strength deficit.

4 DISCUSSION

Lower strength values for quadriceps muscles in futsal players could be expected because the match is played in a restricted space in which the kicks and passes are performed over shorter distances than in soccer. Cheung et al. (2012) compared the isokinetic strength of field (soccer) and court sports players (basketball and volleyball) and found higher strength values for soccer players. Comparing the current results with those of Cheung et al. (2012), we found higher peak torque relative to body mass values for the extensor muscles in soccer [present study: 3.4±0.4 Nm/kg *versus* Cheung et al. (2012): 1.89±0.25 Nm/kg] and court soccer players [present study: 3.1±0.3 Nm/kg *versus* Cheung et al. (2012): 1.68±0.24 Nm/kg]. These results are expected since the soccer volunteers in the present study were

professionals while those studied by Cheung et al. (2012) were drawn from College teams. On the other hand, our results were similar to those reported in the study by Ardern et al. (2015) and Ruas et al. (2015) comparing the peak torque of extensors and flexors muscles of soccer players.

There were no significant differences in H/Q ratio among the three groups studied. However, the three groups presented lower mean values lower than 60%, which has been traditionally associated with a higher incidence of knee injuries (Ruas et al., 2015). An individual data analysis revealed lower values (≤60%) for dominant limbs in 80% of soccer, 67% of futsal, and 67% of beach soccer players, which indicate muscle strength imbalance and a predisposing factor for injury (Ruas et al., 2015). Therefore, the results highlight the need for hamstrings strength training program.

In addition to H/Q ratio, muscular bilateral asymmetry also has been considered a risk factors for lower limb injuries (Ruas et al., 2015), and it also may affect sport performance (Young et al., 2002). In the present study, athletes had low mean values (<10%) for bilateral deficit. Menzel et al. (2013) also found low mean values for bilateral peak torque deficit (9.14±8.65%). Despite the low mean values of bilateral deficit found in volunteers of the present study (<10%), individual values ranged from -37% to 34%. Therefore, the fact that elite soccer, futsal, and beach soccer players presented symmetrical strength for the lower limbs does not preclude the need to conduct individual evaluations for injury control and prevention.

In sum, H/Q ratio did not differ significantly among soccer, futsal and beach soccer players, while extensors muscles were stronger in soccer and beach soccer players. In the three soccer modalities, mean values for H/Q ratio were lower than the recommended literature values. Thus, strength prevention programs for hamstring muscles can be useful to improve H/Q ratio. In addition, beach soccer is a relatively new sport for which no national professional leagues exist in many countries. Thus, future studies investigating other characteristics of beach soccer players, such as physiological response to exercise, are warranted.

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