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Core stability of male and female football players

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Summary

Study aim: To investigate into core stability measures and to establish the preliminary normal data.
Material and methods: Three groups of football players were studied: male players, members of an amateur club (Division IV; n = 20), female players, members of a Division I club (n = 28) and male adolescent club players (n = 17). They were subjected to 4 tests of core stability (muscular endurance of trunk flexors and extensors, and of left and right lateral bridge) at the beginning of the 2009/2010 season.
Results: No significant between-group differences were found for trunk flexors endurance. Female players were significantly ($p<0.01$) superior to both male groups with respect to trunk extensors endurance and inferior with respect to flexors-to-extensors ratio.
Conclusions: The results may have practical implications for football training and injury prevention.

Key words: Muscle strength – Age groups – Football – Trunk stability

Introduction

Performance in football is determined by physiological, psychological, biomechanical and environmental factors. Physiological factors include 5 components of health-related fitness (body composition, cardiorespiratory fitness, muscular strength and endurance, flexibility) and sport-specific characteristics like speed and reaction time. Many studies on cardiorespiratory fitness [9], flexibility [4], speed [9] and other factors were conducted. On the other hand, muscular endurance, i.e. the ability of muscles to output power for an extended time, was not so frequently studied, at least in football players.

The question of the contribution of core stability to sport performance, injury prevention and health has been addressed recently. Core stability may provide several benefits to the musculoskeletal system, ranging from maintaining low back health and preventing knee ligament injury [14] to providing a foundation for greater force production by upper and lower extremities in sport performance [13]. However, there is a deficiency of comparative research and normative data, especially in athletes, which hinders the optimal exercise prescription.

Core stability was defined as the ability to control the position and motion of the trunk over the pelvis to allow optimal output, transfer and control of force and motion to the terminal segment in integrated athletic activities [7], or as the ability of the lumbo-pelvic hip complex to prevent buckling and to return to equilibrium after instability [14].

Decreased core stability was reported to be associated with a higher risk of injuries of low back or knee [1]. Since the prevalence of knee injuries is very high in football, a widely practiced activity whether recreationally or competitively, the assessment of core stability in football players is of great importance. The aim of this study was thus to investigate into the core stability of male, female and adolescent football club players in order to establish some preliminary normative data which might be useful in injury prevention and interesting to e.g. physiotherapists, athletic coaches and researchers.

Material and Methods

Subjects: Three groups of football players were studied: male players, members of an amateur club (Division IV; n = 20), female players, members of a Division I club (n = 28) and male adolescent club players (n = 17). They were subjected to 4 tests of core stability, regarded as part of their health-related and sport-related fitness, at the beginning of the 2009/2010 season (Table 1). All subjects gave their informed consent to participate and the study was approved by the local Committee of Ethics.

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The measurements on adolescents were conducted in the presence of one of his/her parents.

Methodology: Body height mass, 10 skinfold sites (cheek, neck, chest I, chest II, triceps, subscapular, abdominal, suprailiac, thigh and calf) on the dominant body side, two girths (arm and calf) and two breadths (*humerus* and femur) were measured. Body mass index (BMI) and the somatotype (according to Heath-Carter method) were computed. Relative body fat content was estimated from skinfolds according to Heller [5]. The following equipment was used in the measurements: Portable stadiometer (body height; accuracy 0.1 cm), medical balance (Tanita HD352; body mass; accuracy 0.1 kg), Harpenden caliper (skinfolds; accuracy 0.5 mm), measuring tape (Seca S203; girths; accuracy 1 mm) and a small Lafayette anthropometric caliper (breadths; accuracy 1 mm).

Muscle endurance was determined according to Hoogenboom and Bennett [6]. Trunk flexors test: the subject was in a sit-up position at an angle 60° from the floor (Fig. 1 A). Trunk extensors test: the subject was in the Biering-Sørensen position, upper body unsupported out over the end of a plinth table, pelvis, knees and hips secured with a belt (Fig. 1 B). Lateral trunk endurance test: the subject was lying in the full, right and then left, side-bridge position (Fig. 1 C). Maximum duration (s) of maintaining the required position was recorded in each test. Moreover, the flexors-to-extensors ratio was computed.

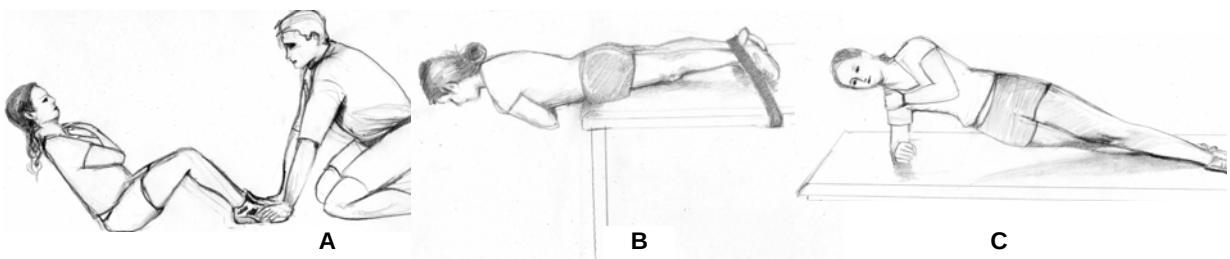


Fig. 1. Positions for endurance tests
A – Trunk flexors; B – Trunk extensors; C – Lateral

Data analysis: For the purpose of comparing own data with literature reports, arithmetic means and standard deviations were shown in the tables. However, the distributions of muscle endurance measurements proved skewed and were transformed to square roots for the purpose of statistical analysis – one-way ANOVA followed by the Tukey-Kramer's *post-hoc* test, the level of $p \leq 0.05$ being considered significant. The NCSS (v. 2007) software was employed to data analysis.

Results

No between-group comparisons were made with respect to age, body height or body mass. Adolescent male players had significantly ($p<0.05$) lower BMI, mesomorphy and ectomorphy than their older mates while female players had significantly ($p<0.01$) higher relative body fat content and endomorphy than either Division IV or adolescent male players (Table 1).

Female football players had significantly ($p<0.01$) higher trunk extensor endurance and lower flexors-to-extensors endurance ratio than either male group by ANOVA followed by the Tukey-Kramer's *post-hoc* test (Fig. 2).

Table 1. Anthropometric characteristics of participants

Variable	Male players	Female players	Adolescent male players
n	20	28	17
Age (years)	20.0 ± 3.1	21.1 ± 4.4	13.8 ± 0.6
Body mass (kg)	73.2 ± 8.8	61.1 ± 7.7	57.8 ± 9.2
Body height (cm)	176.0 ± 6.0	163.9 ± 4.0	166.0 ± 6.0
BMI	23.6 ± 1.9	22.7 ± 2.8	21.0 ± 2.4*
Body fat (%)	15.5 ± 3.7	23.2 ± 4.3 º	17.1 ± 4.0
Endomorphy	3.3 ± 1.2	5.3 ± 1.6 º	3.9 ± 1.5
Mesomorphy	5.1 ± 0.9	5.1 ± 1.4	4.3 ± 1.4*
Ectomorphy	2.1 ± 1.0	1.9 ± 1.4	2.9 ± 1.1*

* Significantly ($p<0.05$) different from male players; º Significantly ($p<0.01$) different from other groups

Discussion

The applied method of determining body fat percentage from skinfolds is relatively inexpensive and renders results comparable to those obtained by bioelectric impedance [12]; moreover, only approximate values were needed for our purposes. The assessment of core stability

employing back extension, trunk flexion and left/right bridges was previously applied to Division I football players [10,11], untrained subjects and those with back disorders [8].

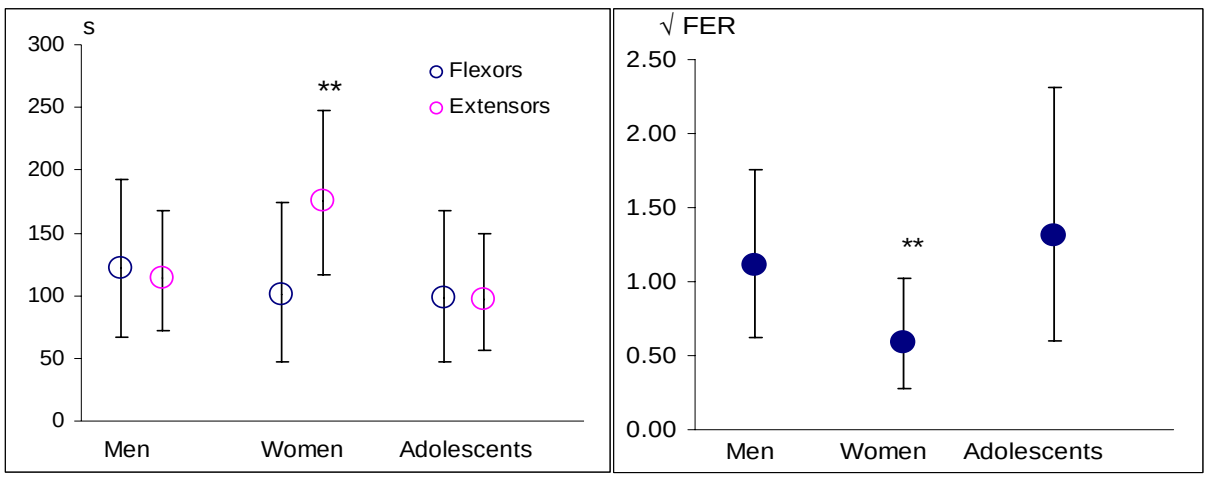


Fig. 2. Muscle endurance indices (means and SD's retransformed from square root values) in 3 groups of football players: endurance time (s) of trunk flexors and extensors (left) and flexors-to-extensors ratio (right)

Legend: Men – Division IV football players aged 17 - 31 years (n = 20); Women – Division I football players aged 14 - 30 years (n = 28); Adolescents – Male club players aged 13 - 15 years (n = 17); ** Significantly ($p<0.01$) different from other groups

Table 2. Muscle endurance indices recorded in male football players

Variable	Untrained subjects [8]	Young players	Adolescent players
Extension (s)	161 ± 61	119 ± 48	102 ± 47
Flexion (s)	136 ± 66	129 ± 70	107 ± 81
Right lateral (s)	95 ± 32	81 ± 39	60 ± 31
Left lateral (s)	99 ± 37	78 ± 36	59 ± 21
FER	0.84	1.18 ± 0.59	1.11 ± 0.58

Legend: Untrained subjects [8] – n = 92; Young players – Division IV male players (n = 20); Adolescent players – Male club players (n = 17); FER – Flexors-to-Extensors Ratio. Data presented as means ±SD for comparison purposes.

Table 3. Muscle endurance indices recorded in female football players

Variable	Untrained subjects [8]	Division I players [6]	Division I players Own data
Extension (s)	185 ± 60	182 ± 70	181 ± 63
Flexion (s)	134 ± 81	216 ± 83	111 ± 71*
Right lateral (s)	75 ± 32	129 ± 57	62 ± 25*
Left lateral (s)	78 ± 32	123 ± 36	71 ± 31*
FER	0.72	1.19	0.65 ± 0.42

Legend: Untrained subjects [8] – n = 137; [11] – Nesser's *et al*. data (n = 28); Own data – Female players (means ±SD; n = 28); * Significantly ($p<0.05$) different from Nesser's *et al.* [11] data

Our findings were scrutinised in the light of relevant recent studies, e.g. of Nesser and Lee [11] on NCAA Division I female football players (n = 16) and of McGill [8] involving untrained male (n = 92) and female (n = 137) subjects aged 21 years. As compared with the latter ones, our male players were markedly inferior with respect to trunk flexor endurance (Table 2) while female players were similar; the latter were, however, markedly inferior to those studied by McGill [8] (Table 3) or by Nesser *et al*. [10,11] and the same applied to the flexors-to-extensors ratio.

A study on the core stability of workers with or without back disorders indicated these to be associated with an increased flexors-to-extensors endurance ratio [8]. In the present study that ratio was higher in young and in adolescent male football players (1.18 and 1.11, respectively) than in untrained subjects (0.84) which was suggestive of a flexors/extensors misbalance in football players, which was also noticed in another research in female football players (1.19; [11]). Such a misbalance, combined with sport-specific asymmetric work, may bring about postural disorders [3] in addition to other implications in performance induced by misbalances between agonist and antagonist muscles [2].

The results of this study confirmed previous observations [11] that women had higher trunk extensors en-durance and lower flexors-to-extensors endurance ratio than men. However, a novel finding was the quantification of core stability measures in the sport context,

particularly in the widely popular football, indicating practical implications for sport training and injury prevention. Further research in this area is expected to focus on the effects of a specific training on core stability measures in order to quantify that relationship and, therefore, to provide guidelines for optimal exercise prescription.

The recommended measures of core stability can be employed in any sport or exercise setting with minimum equipment, enabling sport instructors and coaches to evaluate muscular endurance and to determine optimal dosage of basic exertions such as sit-ups and back exercises. Inasmuch establishing precise normative data from this preliminary research was not directly possible, due to small numbers of subjects studied, this study gave guidelines for such a task by having emphasised e.g. the necessity of transforming raw data into square roots or logarithms due to distribution skewness.

References

1. Borghuis J., A.L.Hof, K.A.Lemmink (2008) The importance of sensory-motor control in providing core stability: implications for measurement and training. *Sports Med*. 38:893-916.

2. Drid P., M.Drapsin, T.Trivic, D.Lukac, S.Obadov (2009) Asymmetry of muscle strength in elite athletes. *Biomedical Human Kinetics* 1:3-5. DOI: 10.2478/v10101-009-0002-1

3. Grabara M., A.Hadzik (2009) Postural variables in girls practicing volleyball. *Biomedical Human Kinetics* 1:67-71. DOI: 10.2478/v10101-009-0017-7

4. Grabara M., G.Kołodziej, M.Wojcik (2010) Spine flexibility and the prevalence of contractures of selected postural muscle groups in junior male football players. *Biomedical Human Kinetics* 2:15-18. DOI: 10.2478/v10101-010-0004-z

5. Heller J. (2004) Laboratory Manual for Human and Exercise Physiology. Charles University, Prague.

6. Hoogenboom B.J., J.L.Bennett (2007) Core stabilization training in rehabilitation. In: M.L.Voight, B.J.Hoogenboom, W.E.Prentice: Musculoskeletal Interventions, Techniques for Therapeutic Exercise. McGraw-Hill, USA, pp. 333-358.

7. Kibler W.B., J.Press, A.Sciascia (2006) The role of core stability in athletic function. *Sports Med*. 36:189-198.

8. McGill S. (2004) Ultimate Back Fitness and Performance. Wabuno Publishers, Waterloo.

9. Michalczyk M., B.Łapcińska, S.Poprzecki, S.Jagsz, E.Sadowska-Krępa, E.Kimsa, K.Kempa, J.Chmura (2010) Aerobic capacity and sprint velocity of Leagues I and IV football players. *Biomedical Human Kinetics*, 2:9-14. DOI: 10.2478/v10101-010-0003-0

10. Nesser T.W., K.C.Huxel, J.L.Tincher, T.Okada (2008) The relationship between core stability and performance in Division I football players. *J.Strength Cond.Res*. 22:1750-1754.

11. Nesser T.W., W.L.Lee (2009) The relationship between core strength and performance in division I female football players. *J.Exerc.Physiol.online* 12(2):21-28.

12. Socha M., W.Jonak, M.Bolanowski, A.Chwalczynska. (2008): Assessment of body fat content in young men by using selected somatic indices and skinfolds. *Physical Education and Sport*, 52, 84-87. DOI: 10.2478/v10030-008-0018-2

13. Willardson J.M. (2007) Core stability training: applications to sports conditioning programs. *J.Strength Cond.Res*. 21:979-985.

14. Willson J.D., C.P.Dougherty, M.L.Ireland, I.M.Davis (2005) Core stability and its relationship to lower extremity function and injury. *J.Am.Acad.Orthop.Surg*. 13:316-325.

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