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The Effect of Somatotype Characteristics of Athletes on the Balance Performance

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Abstract

Our study aims to investigate the effects of somatotype characteristics of elite athletes on the balance performances. The study has included 46 elite athletes totally. The heights, body weights, skinfold thicknesses, periphery and diameter of skinfold of the subjects included in the study have been measured and somatotype characteristics have been determined by using Heath-Carter method. The balance performances of the athletes have been evaluated by using Biodex Balance System. It has been determined that the dynamic balance performance of the athletes has changed in accordance with the endomorph, mesomorph and ectomorph characteristics of the athletes; however, static balance performances have not changed. Accordingly, no difference has been observed between the oscillation indexes and static balances of the athletes ($p>0.05$), whereas a significant difference has been found as the balance level increases in accordance with the endomorph, mesomorph and ectomorph characteristics of the athletes in terms of dynamic balances ($p<0.01$, $p<0.05$, $p<0.001$). In conclusion, it is assumed that the athletes having endomorphic characteristics may be more successful in the sports branches that put an emphasis on the balance.

Keywords: balance, athletes, somatotype

1. Introduction

Balance can be defined as keeping body stable in various limitations or the ability of protecting the center of gravity. Although establishing the balance is considered as an easy motor skill, it needs a complex one (Emery, Cassidy, Klassen, Rosychuk, & Rowe, 2005). The movements that are necessary to establish the balance need a complex structure of the joint movements including ankle, knee and hip (Nashner, 1993). Balance should involve the complex mutual interaction of visual, vestibular, proprioceptive and joints (Harringe, Halvorsen, Renstrom, & Werner, 2008; Radebold, Cholewicki, Polzhofer, & Greene, 2001). Balance acts as a well transmitter for neural system as well as provides a basis for performance. It is stated that the improvements occuring in balance are also determining factors of improving other motor systems (Erkmen, Suveren, Göktepe, Yazıcıoğlu, 2007). In hu man's growing and developing period, differences are observed not only in capacity and size of their bodies but also in body parts' ratio of one another (Cameron, 2002). Somatotype, too, is to present the body types that human possesses. The classical method is still commonly practiced (Carter, 1990). Somatotype, morphologically, examines the human body under three basic components namely endomorphic, mesomorphic and ectomorphic. Endomorphic is related to the height of the body fat rate; mesomorphic is related to the development and strength of the structure of skeleton and muscle; ectomorphic is related to the weakness of the skeleton and muscle structure. Besides varying across many sports branches these rates mentioned here also affect the performance (Bektaş, Özer, Gültekin, Sağır, & Akın, 2007). The data shows that somatotype characteristics affect the sportive performance as well as the evaluation of balance may be needed for various potential implementations. The classification and selection of talented athletes, various bio mechanic analysis, preventing injuries and treatment process can be given as examples (Ross & Marfell-Jones, 1991). It is stated that balance control of the elite athletes improve according to their practice needs (Perrin, Deviterne, Hugel, &

Perrot, 2002). To achieve this, athletes can dominantly utilize their sensory knowledge that their branches require (Perrin, Schneider, Deviterne, Perrot, & Constantinescu, 1998; Vuillerme et al., 2001). However, there are no related studies searching the characteristics of balance that their branches require and how somatotype levels affect their balance performances.

The purpose of the present study is to examine how body components affect the balance performances of elite athletes and to determine whether it is affected by the differences related to somatotype.

2. Method

2.1 Data Gathering Tools

The measurements of the participants' height, body weight and body composition, skinfold thickness, circumference, diameter and balance were carried out. Whereas the height of the participants was carried out with stadiometer (SECA, Germany) with a sensitivity level of 0.01m., for determining body weight and body composition bioelectric impedence analyser (SC-330, Tanita, Japan) was used. In determining skinfold thickness measurements, skinfold caliper device (Holtain, UK) was utilized with +2 mm. fault and executing 10 gr. pressure on 1mm^2 in each expansion and circumference measurements with anthropometric measuring tape (Holtain, UK) and diameter meaurements were obtained with Harpenden calliper (Holtain, UK) along with +1mm. fault. Present study consists of two parts: in the first part, participants' height, body weight, skinfold thickness, circumference measurements and somatotypes were determined; in the second part their balance performance tests were obtained.

2.2 Measurements for Height

The measurements of the participants' height were carried out by measuring the distance between head vertex and foot as the head was on Frankfort plane and following a deep inspiration (Gordon, Chumlea, & Roche, 1998).

2.3 Body Weight and Body Composition

The participants were scaled with barefoot and in sportswear with a sensitivity of 0.1 kg. Percentage of body fat was determined with impedence analyser using standard method (Gordon, Chumlea, & Roche, 1998).

2.4 Body Mass Index

BMI of the participants were calculated through Body Weight/Height^2 (kg/m^2) Formula (Heyward & Stolarczyk, 1996).

2.5 Measurements of Skinfold Thickness

The measurements of skinfold thickness were carried out on triceps, subscapula, suprailiac, biceps and calf and these measurements were gained from the right side of the participants. In skinfold thickness measurement, subcutaneous fat layer thickness between thumb and index finger was pulled lightly upwards as to separate it from muscle tissue. Calliper was placed almost 1 cm. far from fingers and pulled subcutaneous fat layer thickness was recorded in terms of millimeter, having read the calliper display in 2-3 seconds (Harrison et al., 1998). Skinfold thickness test-retest reliability coefficient and accumulative error of measurements were determined (Formula 1).

$$\boldsymbol{Th} = \sum (d^2/2n) \tag{1}$$

%Th=100(Th/Öo)

Th= Accumulative Error

d= Measurement differences

n= Number of measurement

Öo= Average measurement

2.5.1 Triceps Skinfold Thickness

By bringing the right elbow to 90^0, the distance between acromion process and olecranon process, which are located on the posterior side of the arm, was measured by tape and the midpoint was marked. After that, the measurement was carried out from this midpoint in parallel to the axis of the arm as Harrison et al. mentions (Harrison et al., 1998). The test-retest reliability coefficient of triceps skinfold thickness is R=0.990. Accumulative error of the measurements for triceps skinfold is 0.14 mm. (1.2%).

2.5.2 Subscapular Skinfold Thickness

Below the left hand thumb, index finger, middle finger and scapula, in obedience to the natural orientation of the skin (the natural orientation of the skin extends to the vertical axis of the body with an angle of 45^0), skin thickness measurement was carried out by pulling the skin and skin fat layer as Harrison et al suggests (Harrison et al., 1998). The test-retest reliability coefficient of subscapular skinfold thickness is R=0.999. Accumulative error of the measurements for subscapular skinfold is 0.15 mm (1.3%).

2.5.3 Suprapinale Skinfold Thickness

As the participant standing in an upright position and hanging down the arms, the measurement over iliac crest and axilla line was crosswise acquired as Harrison et al (1998) suggests. The test-retest reliability coefficient of suprapinale skinfold thickness is R=0.999. Accumulative error of the measurements for suprapinale skinfold is 0.15 mm (1.3%).

2.5.4 Calf Skinfold Thickness

The measurement was acquired by retaining the skin and fat tissue of the medial of right calf's broadest area. Later on, the measurement was performed in parallel to calf's axis as Harrison et al (1998) suggests. The test-retest reliability coefficient for calf skinfold thickness is R=0.990. Accumulative error of the measurements for calf skinfold is 0.16 mm (1.3%).

2.5.5 Circumference Measurements

Circumference measurements were carried out from the right side of the participants' wrists, biceps on flexion and calves. During the measurements of circumference, the "0" end of the tape was hold on the left hand, and the other part on the right hand and was wrapped around the area and the number overlapping "0" was saved on the test form. The test-retest reliability coefficient and accumulative error of the measurements of circumference measurements were determined.

2.5.6 Biceps Circumference on Flexio

As the participant standing in an upright position, putting the elbow to 90^0 without flexing the arm and bringing the humerus parallel to the ground, from the broadest part of the biceps, measurements were carried out with 0.1 accuracy rate. The test-retest reliability coefficient of the biceps circumference on flexion is R=0.998. Accumulative error of the measurements for biceps circumference on flexion is 0.38 mm (1.2%).

2.5.7 Calf Circumference

As the participant standing in an upright position and legs were shoulder-wide open, the measurement was carried out with 0.1 accuracy rate from the area that provided the broadest circumference measurement (Callaway et al., 1998). The test-retest reliability coefficient of the calf circumference measurements is R=0.997. Accumulation error of the measurements for calf circumference on flexion is 0.24 mm. (1.1%).

2.6 Diameter Meauremets

Diameter measurements were carried out from humerus and femur epicondyles. Before measuring, appropriate points were identified and the tip of the calliper was used to exert pressure as much as possible. The test-retest reliability coefficient and accumulative error of the measurements of diameter measurements were determined.

2.6.1 Humerus Epicondyle

As the angle of the elbow was in 90^0 and the humerus was parallel to the ground, the width between lateral epicondyles was measured with 0.1 cm. accuracy rate. The test-retest reliability coefficient of the diameter measurements of humerus epicondyles is R=0.991. Accumulative error of the measurements for humerus epicondyle is 0.8 mm. (1.0%).

2.6.2 Femur Epicondyles

As the knee angle in 90 degrees on flexion and the participant sitting, the distance between the medial and lateral epicondyles of femur was measured with 0.1 cm. accuracy rate (Wilmore, Frisancho, Gordon, 1998). The test-retest reliability coefficient of femur epicondyles diameter measurements is R=0.990. Accumulative error of the measurements for femur epicondyle diameter measurements is 0.9 mm. (0.9%).

2.7 Evaluation of Somatotype

The somatotype values of the participants were determined with Heath Carter Somatotype Method. According to that method, the formulas using the somatotype values were determined for body weight, height, biceps on flexion and calf circumference and diameter measurements of femur with triceps, subscapula, suprailiak, biceps and calf skinfold thickness and the values are shown below (Carter, 2002).

2.7.1 The Calculation of Endomorph

- A = triceps + subscapular + suprailiac
- B= (170.18 / height) (coefficient for correction according to height)
- Corrected total X=A.B

Endomorph= $-0.7182 + 0.145X - 0.00068X^2 + 0.0000014X^3$

2.7.2 The Calculation of Mesomorph

- H= Humerus epicondyle (cm)
- F= Femur epicondyle (cm)
- BC= biceps circumference - (triceps skinfold /10) (mm)
- CC= calf circumference (calf skinfold /10) (mm)
- B= height (cm)

Mesomorph = 0.858H + 0.601F + 0.188BÇ + 0.161CÇ - 0.131B + 4.5

2.7.3 The Calculation of Ectomorph

- Height is recorded as cm and Weight as kg.
- Ponderal index is calculated by dividing height to cubic root of weight
  RPI= Height/ Weight (1/3)
- Ectomorph is calculated according to the Ponderal index by using one of the formulas below.
- If RPI ≥ 40.75 ise, *Ectomorph* = 0.732×RPI - 28.58
- If 38.25 < PI < 40.75, *Ectomorph* = 0.463×RPI - 17.63
- If RPI ≤ 38.25, *Ectomorph* = 0.1

2.8 Balance Measurement

In the study, for measuring the balance, Biodex Balance System (BBS) (Biodex, Inc, Shirley, New York) was used. Biodex balance device is constituted of a movable platform which enables the participants both to stand still and move backward, forward and sidewise. For the balance skill among the measured balance index, OA is considered to be the best indicator. Balance scores that are "0" indicate the maimum balance rate. The high level of OA index value indicates the loss of high balance. The moveable platform has mobility level of 1-12. While 12 is the most stable platform, 1 constitutes the most moveable platform. In this study, static balance test, dynamic balance test at 2nd, 4th and 8th levels and index of oscillation test with eyes open were used. Tests were carried out on feet and in an upright position. Feet balance tests were performed for 30 seconds with 10 seconds interim and repeated three times. Before the actual tests, athletes were practiced the test for 10 seconds long to adapt recognize the static and dynamic tests. The participants were asked not to speak or move during these tests. The test of the participants who lost the balance was restarted. The balance performances of the athletes were considered as static and dynamic balance. The dynamic balance performances were measured as good, fair and low.

2.9 Statistical Analysis

For analyzing the data after completing descriptive statistics, the relation between somatotypes and balance was confirmed by correlation analysis. For analysis, Windows SPSS 22.0 software program was used and significance level was considered as 0.05.

3. Results

Table 1. Demographic data of the participants

(N=46)	Age	Height	Weight	BMI	Endomorphy	Mesomorphy	Ectomorphy
X±Sd	24.04±3.14	173.82±7.01	80,31±14.07	26.42±3.05	2,74±0,92	6,32±1,26	1,57±0,88

Table 2. The correlation between somatotype values and balance results of the athletes

(N=46)		Endomorphy	Mesomorphy	Ectomorphy	Index of Oscillation	Dynamic Balance Level 1	Dynamic Balance Level 2	Dynamic Balance Level 3
Mesomorphy	**R**	.539***						
	p	.000						
Ectomorphy	**R**	-.561***	-.722***					
	p	.000	.000					
Index of Oscillation	**R**	.069	-.068	-.101				
	p	.648	.651	.505				
Dynamic Balance Level 1	**R**	.373*	.440**	-.548***	-.140			
	p	.011	.002	.000	.353			
Dynamic Balance Level 2	**R**	.296*	.296*	-.388**	-.210	.692***		
	p	.046	.046	.008	.160	.000		
Dynamic Balance Level 3	**R**	.291*	.211	-.249	-.315*	.588***	.687***	
	p	.050	.160	.095	.033	.000	.000	
Static Balance	**R**	-.055	-.004	.201	-.326*	.061	.205	.289
	p	.716	.980	.181	.027	.688	.171	.051

Note. *p<0.05, ** p<0.01, *** p<0.001.

Between endomorphy and Dynamic Balance Level 1 (r=.37, p< 0.05) positively significant;

Between endomorphy and Dynamic Balance Level 2 (r=.29, p< 0.05) positively significant;

Between endomorphy and Dynamic Balance Level 3 (r=.29, p< 0.05) positively significant;

Between mesomorphy and Dynamic Balance Level 1 (r=.44, p< 0.01) positively significant;

Between mesomorphy and Dynamic Balance Level 2 (r=.29, p< 0.05) positively significant;

Between ectomorphy and Dynamic Balance Level 1 (r=-.548, p< 0.001) negatively significant;

Between ectomorphy and Dynamic Balance Level 2 (r=-.38, p< 0.01) negatively significant.

It is stated that dynamic balance performances of the athletes change according to endomorphic, mesomorphic and ectomorphic properties but static balance performances do not change. According to that, whereas no differences are stated between the index of oscillation and static balance of the athletes (p<0.05), according to endomorphic, mesomorphic and ectomorphic properties in terms of dynamic balance a significant difference is stated when the balance level increased (p<0.01, p<0.05, p<0.001). With this, it is stated that the athletes with endomorphic properties have the best balance scores, athletes with mesomorphic properties have the second degree and athletes with ectomorphic properties have the lowest scores.

4. Discussion

As a result of extrinsic factors, many changes occur in human body and it accommodates itself to the environmental conditions. Movements that are performed according to the sports branches help body to gain structure as required. Consequently, that increases the body performance and body structure is tried to be made favorable in terms of mechanic (Bektaş, Özer, Gültekin, Sağır, & Akın, 2007). In the present study, it is determined that the dynamic balance performances change according to the endomorphic, mesomorphic and ectomorphic properties of the athletes, whereas their static balance performances do not change. In addition, while no differences are determined between the index of oscillation and static balance performances of the athletes (p>0.05), in terms of dynamic balances according to endomorphic, mesomorphic and ectomorphic properties, a significant difference is determined as the balance level increases (p<0.05). With this, it is stated that the athletes with endomorphic properties have the best balance scores, athletes with mesomorphic properties have the second degree and athletes with ectomorphic properties have the lowest scores. In order to get a better performance, it is stated that firstly the body type is needed to fit to that branch. It is also known that body type has a determining role on physical activity level and the person's tendency to sports, however, regularly performed physical activities can cause changes on the physical structure of the body. In the studies, it is also mentioned that somatotype characteristics would be beneficial in order to designate exercise programs aiming to identify abilities, aerobic performances and improve technical skills (Gualdi-Russo & Zaccagni, 2001). In the studies searching the relation between somatotype components with performance, between mesomorphic and motor skills, such as, stamina, power and speed a positively significant relation is stated, however a negatively significant relation is stated with endomorphic, and no relation is found with ectomorphic. While no relation is observed between somatotype components and flexibility, balance and skill (Sharma & Dixit, 1985; Slaughter, Lahmann, & Misner, 1980), in their study (Serbes, Yalçın, Kaplan, & Özer, 2010) found a positive correlation between ectomorphic point and balance performance (r=0.949, p<.01). Balance has a major importance on sports in terms of performance, such as, shooting which requires static or maximum agility and that is sustained by dynamic integration of intrinsic and extrinsic factors (Şimşek & Ertan, 2011).

When the acquired results are evaluated in consideration of the literature, it is confirmed that, somatotype characteristics of the athletes affect their balance performances, athletes with endomorphic properties get the best results and following that athletes with mesomorphic and ectomorphic properties come right after. In conclusion, during selecting talent, it is thought the athletes with endomorphic properties can contribute success to the branches which require balance when they are selected.

References

Bektas, Y., Ozer, B. K., Gultekin, T., Sagır, M., & Akın, G. (2007). Anthropometric characteristics of female basketball players: somatotype and body composition values. *Nigde University Physical Education and Sport, 1*(2), 52-62.

Callaway, C. W., Chumlea, W. C., Bouchard, C., Himes, J. H., Lohman, T. G., & Martin, A. D. (1998). *Circumference.* In T. G. Lohman, A. F. Roche, & R. Martorell (Eds.), *Anthropometric Standardization Reference Manual*. Champaign, USA: Human Kinetics Books.

Cameron, N. (2002). *Human Growth and Development.* USA: Academic Press.

Carter, J. E. L. (2002). The *Heath-Carter Anthropometric Somatotype, Instruction Manual.* San Diego, USA.

Carter, J. E. L., & Heath, B. H. (1990). *Somatotyping-Development and Applications.* New York: Cambridge University Press.

Emery, C. A., Cassidy, J. D., Klassen, T. P., Rosychuk, R. J., & Rowe, B. B. (2005). Development of a clinical static and dynamic standing balance measurement tool appropriate for use in adolescents. *Physical Therapy. 85*(6), 502-514.

Erkmen, N., Suveren, S., Goktepe, A. S., & Yazıcıoglu, K. (2007). The comparison of balance performance of the athletes who are in different branches. *Spormetre, 5*(3), 115-122.

Gordon, C. C., Chumlea, W. C., & Roche, A. F. (1998). Stature, recumbent length, and weight. In T. G. Lohman, A. F. Roche, & R. Martorell (Eds.), *Anthropometric standardization reference manual.* Champing, III: Human Kinetics Books.

Gualdi-Russo, E., & Zaccagni, L. (2001). Somatotype, role and performance in voleyball players. *Journal of Sports and Medical Physical Fitness, 41*(2), 256-262.

Harringe, M., Halvorsen, K., Renstrom, P., & Werner, S. (2008). Postural control measured as the center of pressure excursion in young female gymnasts with low back pain or lower extremity injury. *Gait & Posture, 28*(1), 38-45. https://doi.org/10.1016/j.gaitpost.2007.09.011

Harrison, G. G., Buskirk, E. R., Carter, J. E. L., Johnston, F. E., Lohman, T. G., & Pollock, M. L. (1988). Skinfold thicknesses and measurement technique. In T. G. Lohman, A. F. Roche, & R. Martorell (Eds.), *Anthropometric standardization reference manual.* Champaign, IL: Human Kinetics Books.

Heyward, V. H., & Stolarczyk, L. M. (1996). *Applied body composition assessment*. Champaign, IL: Human Kinetics.

Nashner, L. (1993). *Practical biomechanics and physiology of balance.* In G. Jacobson, C. Newman, & J. Kartush (Eds.), *Handbook of Balance Function and Testing* (pp. 261-279). St. Louis, MO: Mosby Year Book.

Perrin, P., Deviterne, D., Hugel, F., & Perrot, C. (2002). Judo, better than dance, develops sensorimotor adaptabilities ınvolved in balance control. *Gait and Posture, 15*(2), 187-194. https://doi.org/10.1016/S0966-6362(01)00149-7

Perrin, P., Schneider, D., Deviterne, D., Perrot, C., & Constantinescu, L. (1998). Training improves the adaptation to changing visual conditions in maintaining human posture control in a test of sinusoidal oscillation of the support. *Neuroscience Letters, 245*(3), 155-158. https://doi.org/10.1016/S0304-3940(98)00208-0

Radebold, A., Cholewicki, J., Polzhofer, G. K., & Greene, H. S. (2001). Impaired postural control of the lumbar spine is associated with delayed muscle response times in patients with chronic idiopathic low back pain. *Spine Journal, 26*(7), 724-730. https://doi.org/10.1097/00007632-200104010-00004

Ross, W. D., & Marfell-Jones, M. J. (1991). Physiological testing of the high-performance athlete. In J. D. MacDougall, H. A. Wenger, & H. J. Green (Eds.), *Kinanthropometry*. Illinois: Human Kinetics Books.

Serbes, S., Yalçın, O., Kaplan, N., & Ozer, M. K. (2010). Physical Features, Balance And Performance Relationship in Wind Surfers. *11th International Sport Sciences Congress,* 10-12 November, pp. 237-239. Antalya / Turkey.

Sharma, S. S., & Dixit, N. K. (1985). Somatotype of athletes and their performance. *International Journal of Sports Medicine, 6*(3), 161-162. https://doi.org/10.1055/s-2008-1025831

Simsek, D., & Ertan, H. (2011). Postural control and sport: muscular fatigue and postural control relationship. *Spormetre, 9*(4), 119-124.

Slaughter, M. H., Lahmann, T. C., & Misner, J. E. (1980). Association of somatotype and body composition to physical performance in 7-12 year-old girls. *The Journal of Sports Medicine and Physical Fitness. 20*(2), 189-198.

Vuillerme, N., Danion, F., Marin, L., Boyadjian, A., Prieur, J. M., Weise, I., & Nougier, V. (2001). The effect of expertise in gymnastics on postural control. *Neuroscience Letters, 303*(2), 83-86. https://doi.org/10.1016/S0304-3940(01)01722-0

Wilmore, J. H., Frisancho, R. A., & Gordon, C. C. (1988). Body breath equipment and measurement technique. In T. G. Lohman, A. F. Roche, & R. Martorell (Eds.), *Anthropometric Standardization Reference Manual.* Illinois: Human Kinetics Books.