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CORRELATIONS BETWEEN SOME ANTHROPOMETRIC CHARACTERISTICS, ANKLE MOBILITY AND BALANCE

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Abstract

Artistic gymnastics belongs to the branch of aesthetically designed sports whose technically complex movements are repeating in acyclic order on gymnastic devices. Complex and often associated motor movements are manifested through numerous gymnastic elements such as jumps, rotations and turns, while the emphasis is on maintaining a controlled and balanced body position. Furthermore, deficiency of standardized sport-specific test represents a problem in balance testing in sports generally. Therefore, the aim of this study was to examine and validate a newly-constructed gymnastic balance test that will be applicable in the assessment of balance in sport gymnastic. The sample of respondents in this study were female students (N = 22) of the second year of undergraduate university study of Kinesiology in Split, aged 19 to 23 years, and with the different sports orientations. Two samples of variables were observed. Body weight and height, body mass index, leg length, foot length and foot width as anthropometric measures, and in domain of motoric abilities, ankle mobility, postural stability test on Biodex Balance System and newly constructed sport-specific balance test. Results showed that anthropometric variables have negative impact on balance performance. This impact showed to be bigger on the generic, laboratory balance test, then on the sport-specific test. Finally, there is no association between mobility and observed balance tests. Future studies should be directed towards validation of reliable sport-specific balance tests.

Keywords: Biodex balance system, gymnastic, stability, anthropometry, morphology, mobility

Introduction

Artistic gymnastics, belongs to the branch of aesthetically designed sports, whose technically complex movements are acyclic repeated on gymnastic devices. The complexity of gymnastics consists of motor skills such as balance, strength of the muscles of the whole body, flexibility and coordination. Because of the wide range of abilities and skills that unites, gymnastics is a basic sport and therefore also used as additional training method in different sport disciplines and games (Côté, Salmela, & Russell, 1995). The complexity of motor movements in gymnastics is manifested when performing various gymnastic elements such as jumps, rotations and turns. Those movements are often associated, and require athletes to control movement, while the emphasis is on maintaining a balanced body position with well-timed involvement of individual muscles (Sekulić, Metikoš, & Sveučilište, 2007).

Balance, as a psychomotor ability, is defined in a similar way by different authors. Considering different views at this ability there are various interpretations from one profession to another. According to Sekulić (2007), it is ability to maintain balance using kinesthetic and visual receptors (Sekulić et al., 2007). Shumway-Cook describe it as ability to maintain balance under the influence of the gravity, while Prskalo (2004) define it as maintaining static balance in stationary position and dynamic balance in motion (Prskalo, 2004; Shumway-Cook, Anson, & Haller, 1988).

In sports, balance can be most simply defined as keeping the center of gravity of the body within the surface of the support when performing more or less complex movements. The basic classification of balance is into *basic* and *specific*. The specific balance should not have a positive transfer to other balanced demanding tasks (Sekulić et al., 2007). Therefore, looking at the requirements of individual sports, the balance can be sport-specific static or dynamic. In sports such as archery, balance is predominantly static, while in sports such as sailing and skiing, performance is manifested in maintaining a dynamically balanced position, and the ability to maintain a sport-specifically balanced position.

In top level sports, balance trainings are increasingly being implemented, with or without props, which provoke balance mechanisms, in order to activate and exclude certain muscle groups in time or just change muscle tone, and thus maintain a balanced position. The innate factor in this ability is of great importance, and is also the reason why the development of balance

is a complex and modified process. Accordingly, the trainings contain specific balance positions, characteristic of the sport in which the athlete is engaged. In order for training planning and programming to be successful, it is necessary to determine the initial state of the athletes' abilities. As so, diagnostics is the starting point in the process of developing and improving the motor skills of athletes. The balance test can be performed in different positions and movements. There are static and dynamic types of tests depending of balance performance dynamics. Dynamic balance tests examine the maintenance of balance while changing body position, while static balance tests assess the balance of subjects during static position. An example of such test is standing on one leg, which observes the oscillations of individual body segments. Some of the well-known dynamic balance assessing tools are: *BIODEX limits of stability test*, *OPTO JUMO – GYKO*, *Fukuda balance test, Y - balance test, and Star excursion balance test*. Popular tools for measuring static balance are: Flamingo test, *BIODEX postural stability test*, and *Body sway test* (Zekić & Vučetić, 2016). Generally speaking, in sports, as well as in gymnastics, there is a problem when it comes to balance testing. There are no standardized sport-specific balance tests. Anyway, because of balance importance, there is a need for construction and evaluation of such tests. In gymnastics, the ability to maintain a balanced position at rest, as well as maintaining a balanced position while performing complex motor tasks, indicates the importance of this ability. Given the high demands of this sport and the specific training processes of developing balance from early childhood, it is obvious that gymnasts have a higher degree of development of balance. Furthermore, balance testing in gymnastics is quite complex, and is most often performed through handstand, which is a basic gymnastic balance for further performance of more complex motor tasks. Standing on one leg is the basis of balance when performing motor tasks on a gymnastic beam. It is necessary to modify the balance test of standing on one leg, due to the already mentioned high level of development of balance in gymnasts; which will examine the maintenance of sports-specific body position on a gymnastic beam.
Accordingly, the aim of this research was to examine and evaluate a newly-constructed gymnastic balance test that will be applicable in the assessment of balance in gymnasts. The test can be used in the identification and selection of children or as indicator of their further progress in gymnastics. The implementation of the test in the control of training process will indicate their current state of development of psycho-motor balance skills.

Methods

Subjects in this study were 22 female students of kinesiology. Average age of the students was 20.68 ± 0.89 years, and they had different sport background. Research was conducted in gymnastic sports hall. Participation in this study was voluntary. All students were informed about the purpose of the study and signed an informed consent form prior to study.
Variables were divided in 2 major groups: morphological variables and motor abilities variables. Set of morphological variables included: body height (BH), body mass (BM), body mass index (BMI), foot width (FW), foot length (FL)and leg length (LL). Variables that estimated motor abilities were: specific gymnastic beam balance (SGB), one-leg static balance on Biodex system (PS), and ankle mobility (AM). Statistical analyses included the calculation of descriptive statistical parameters (arithmetic means, standard deviations, and normality of distribution) and correlation analysis. For all analyses, Statistica 13.0 (TIBCO Software Inc, USA) was used, and a p-level of 95% was applied.

Results

Table 1 show results of descriptive statistics. All variables showed normal data distribution except variable BMI. Normal distribution of majority of variables indicate usage of parametric statistical methods for correlation calculation between morphological and motor ability variables.

Table 1. Descriptive statistics data (N=22)

Variable	MEAN	SD	MIN	MAX	K-S test	p
AGE	20.68	0.89	19.00	23.00	0.16	$p > .20$
BH	167.73	5.44	157.00	176.00	0.22	$p < .20$
BM	62.32	7.12	52.00	77.00	0.13	$p > .20$
BMI	22.13	2.01	18.70	25.70	0.51	$p < .01$
SGB	5.19	13.41	0.00	40.29	0.11	$p > .20$
AM D	29.01	8.56	16.00	44.20	0.18	$p > .20$
AM P	44.84	11.09	16.50	61.40	0.13	$p > .20$
FW (cm)	9.11	0.46	8.45	9.99	0.15	$p > .20$
FL (cm)	24.62	0.87	22.40	25.90	0.10	$p > .20$
LL (cm)	88.95	3.88	83.00	95.00	0.11	$p > .20$
PS	1.13	0.45	0.30	2.00	0.16	$p > .20$

LEGEND: MEAN-arithmetic mean, SD-standard deviation, MIN-minimal result, MAX-maximal result, K-S test-Kolmogorov-Smirnov test of distribution normality, p-statistical significance, AGE- chronological age, BH-body height, BM-body mass, BMI- body mass index, SGB-specific gym, AM D-ankle mobility/dorsal, AM P-ankle mobility /plantar, FW-foot width, FL-foot length, LL-leg length, PS-Biodex postural stability

Table 2 show correlations between anthropometric variables and balance tests. Higher correlations could be noticed between anthropometric variables and laboratory balance test. Also, negative correlation between measures of longitudinal dimensionality and balance in general. It can be concluded that longer and higher subjects perform balance with less efficiency, especially in laboratory conditions.

Table 2. Correlations between anthropometric variables and balance (N=22)

Variable	PS	SGB
BH	0.60*	-0.31
BM	0.52*	-0.36
BMI	0.20	-0.25
FW (cm)	0.39	-0.42
FL (cm)	0.52*	-0.47*
LL (cm)	0.59*	-0.25

LEGEND: BH-body height, BM-body mass, BMI- body mass index, SGB-specific gym, FW-foot width, FL-foot length, LL-leg length, PS-Biodex postural stability

In table 3 results of correlations between balance tests and ankle mobility are presented. Evidently, no significant correlations were noticed. It can be stated, opposite of author's hypothesis, that ankle mobility doesn't influence balance performance in female students of kinesiology.

Table 3. Correlations between balance tests and ankle mobility (N=22)

Variable	AM D	AM P	PS	SGB
AM D	1,00			
AM P	-0,18	1,00		
PS	0,21	-0,02	1,00	
SGB	-0,33	0,05	-0,17	1,00

LEGEND: SGB-specific gym, AM D-ankle mobility/dorsal, AM P-ankle mobility /plantar, PS-Biodex postural stability

Discussion

There are two important findings of this study. First of all, results showed negative effect of certain anthropometric characteristics on the balance. Second, no association was found between ankle mobility and scores on balance tests.

The obtained results of measurements of body height (BH), body weight (BW), leg length (LL) and foot length (FL) show a negative impact on the ability to maintain balance. These results are probably influenced by participant's BH. Accordingly, a higher position of the centre of mass relative to the support surface will have a negative effect on maintaining the equilibrium position (Hue et al., 2007; Kolic, O'Brien, Bowles, Iles, & Williams, 2020). Considering that taller people, usually have higher body weight and longer leg and foot, negative correlation between these variables and balance tests can be explained with their relation with BH (Popovic, Bjelica, Georgiev, Krivokapic, & Milasinovic, 2016; Sovio et al., 2009). Body mass index (BMI) can be explained as a parameter whose result is not relevant in this study because it does not show a detailed body composition, and for example more, more muscular people will generally have a higher body mass index, although the proportion of adipose tissue will be relatively low (Prentice & Jebb, 2001). Contrary to these results, the study on 22 adult Turkish athletes, showed that body weight, knee joint diameter, BMI, thigh and calf circumference were significantly related to the balance scores in the positive direction (Patlar, Yilmaz, Tatlici, & Cakmakci, 2020). These was primarily influenced with muscle mass that generated greater balance ability (Patlar et al., 2020).

The analysis of the research results showed a greater influence of anthropometric characteristics on the laboratory test of static balance on BIODEX than on the sport-specific test. An explanation should be found in the fact that maintaining balance in a sport-specific position on the beam does not allow detailed insight into the oscillatory movements of the body as is the case when conducting a laboratory test. During the performance of a sport-specific test, certain minimized body movements can compensate deficiencies in anthropometric characteristics which are important factors of this ability.

Looking at the mobility of the ankle in relation to static and dynamic balance, it can be expected that it will have an impact on the dynamic balance. This is confirmed by the research of balance conducted in rhythmic gymnastics (Kesilmiş, Kesilmiş, & Akın, 2017). Namely, the authors examined the correlation between ankle mobility and dynamic balance and proved their association in the study. Assuming that ankle mobility would have an impact on balance, dorsal and plantar flexibility measurements were performed, but results indicated no significant association of ankle mobility with static balance. Starting from the fact that a certain position of static balance requires immobile maintenance of all body segment with a certain muscle tone, it can be concluded that balance will not depend on the mobility of the ankle, as is the case with dynamic balance affected by gravity and other external forces. A more mobile joint will allow more precise movements and better control of movements in maintaining dynamic balance. In contrast, static

balance does not have the stated requirements to maintain static position in balance, and thus is not dependent on the mobility of a particular joint segment.

Conclusion

Balance in gymnastics is one of the main factors in performing complex motor movements. Specific equilibrium positions, turns, rotations around the transverse and longitudinal axes largely depend on the stated motor ability. The high level of development of balance in gymnasts is a problem in the construction of new sport-specific tests aimed at examining the specific balance. With the aim of constructing a new sport-specific gymnastic balance test, the conducted research indicated certain connections of some morphological-motor factors with balance.

The research proved that the anthropometric characteristics of the subjects have a negative impact on the balance, with a greater influence on the laboratory unilateral static balance. Also, the mobility of the ankle did not significantly affect the balance. It is important to mention that the construction of a new sport-specific gymnastics test has its limitations in terms of use because the research was conducted on a sample of female students, and the validation of the test is also questionable. Future studies should be conducted on gymnasts to examine its measurement characteristics and the possibility of its use in gymnastics as a measurement instrument for assessing sport-specific balance.

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