**Gymnastics Skill Level and Fitness in Students Selected for Physical Education Programs**

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# *Abstract*

The primary purpose of this study was to determine the relationships between fitness tests, and results in selected gymnastic skills in students selected for physical education programs. A secondary purpose of this study was to establish which assessment tests best represent, or correspond, with performance. A total of 170 male students were recruited from the Faculty of Sport in Prishtina to participate in the study. The participants were tested for several fitness tests, and performance in selected gymnastic skills. There were significant correlations between fitness tests and performance in gymnastic skills. In conclusion, the significant association was found between flexibility, abdominal muscle strength and endurance and performance in gymnastics. Moreover, several fitness tests were found as significant predictor for results in several gymnastic skills. The results of this research suggest the conclusion that, in the students of the Faculty of Sport and Physical Education, abdominal strength and flexibility, are significant predictor for the successful acquisition of the program contents of gymnastics.

**Key words**: gymnastics, motor abilities, assessment, correlation

Introduction

Gymnastics is a sport that consists of several disciplines: Artistic Gymnastics, Rhythmic Gymnastics, Aerobic Gymnastics, Acrobatic Gymnastics and Trampolining. In addition to a great number of young gymnasts participating in gymnastics, the number of male athletes competing at the recreational and collegiate levels is reportedly on the rise. It is well known that flexibility, speed, power, strength, muscular endurance, agility, and balance have all been associated with gymnastics (Sleeper, Kenyon, Elliott, & Cheng, 2016). However, according to Visscher, Louer, & Elferink-Gemser, (2012) it is impossible to determine which characteristics seem to be most important or which characteristics are definitely needed to be good in gymnastics. Nevertheless, an improved ability to accurately measure strength, power, speed, balance, flexibility, and agility may assist in identifying and remediating deficits in the physical performance characteristics needed in gymnastics (Lindner & Caine, 1990). Some studies have emphasized the crucial importance of possessing a broad level of physical fitness in the athletic development of gymnastics (Di Cagno et al, 2008; Hutchinson, Tremain, Christiansen, & Beitzel, 1998). Sawczyn (1985) underlined the importance of physical fitness in gymnastics, showing systematically increasing differences over time between gymnasts and non-trained subjects in flexibility, speed, strength, agility and endurance tests. A large number of gymnastic elements have been noticed to indicate significance and applicability in the realization of basic and special educational and anthropological tasks. Based on the mentioned fact, we can say that exercise has an important role in students’ training because it enhances life quality, thus effectively changes the properties and develop skills which directly provide health promotion as an irreplaceable factor in all human activities (Findak, Prskalo & Pejcic, 2003).

Gymnastics, as a content of the physical education curriculum, includes a variety of movements which could influence the students’ overall specificities (morpho-functional, motor, psychological, musical), since, among other things, the specificity of physical education is the development of psycho-motor abilities (Višnjić, Jovanović, & Miletić, 2004). As a form of physical exercise it can provide great possibilities of achieving the goals and tasks in physical education. The greatest number of studies has been dealing with determining the relations between the structure of motor abilities and the success in performing the elements of gymnastics. Moreover, there is a great importance of systematically monitoring comprehensive, targeted, and specific indicators of physical fitness during the gymnastics training process. Finally, and the most important, there is a strong relationship between skill and fitness (Webster et al., 2014). Barnett et al. (2008) sought to determine whether childhood fundamental motor skill proficiency predicts subsequent cardiorespiratory fitness in later ages. They found that fundamental motor skill development in childhood may be an important component of interventions aiming to promote long-term fitness. Stodden et al. (2009) showed the strongest evidence on the relationship skill competence and health-related aspects of physical fitness. The aforementioned authors examined the relationship between competence in three fundamental motor skills (throwing, kicking, and jumping) and six measures of health-related physical fitness in young adults (ages 18–25) and found that developing motor skill competence may be fundamental in developing and maintaining adequate physical fitness into adulthood. Webster et al. (2014) examined the relationship between teacher fitness and movement competence in a series of gymnastics skills. Results showed that gymnastics performance was significantly correlated with muscular strength/endurance after controlling for previous gymnastics experience which suggests that muscular strength, especially core (abdominal) strength, could be an important factor in teachers’ ability to competently demonstrate certain fundamental skills in gymnastics.

This study is significant because the standards for Physical Education Teacher Education state that Physical Education teachers should achieve and maintain a level of fitness consistent with that expected of young learners, and movement competency functions to increase demonstration accuracy when presenting skills to learners. It raises the question if a relationship exist between physical education students’ fitness and motor skill levels in gymnastics? Therefore, the primary aim of this paper was to examine the relationship between fitness and gymnastic skills among the students of the Faculty of Sport and Physical Education. A secondary aim of this study was to establish which assessment tests best represent, or correspond, with performance.

Materials and methods

*Participants*

Table 1. Descriptive characteristics of the participants. Data are mean±SD.

|  |  |  |  |
| --- | --- | --- | --- |
| N | Age (years) | Body height (cm) | Body weight (kg) |
| 170 | 21.2±2.3 | 178.53± 6.730 | 73.62±7.35 |

A total of 170 male students were recruited from the Faculty of Sport in Prishtina to participate in the study. Participant characteristics are shown in Table 1. All participants read and signed an informed consent form approved by the university’s Institutional Review Board. Inclusion criteria required the subjects to be male, between 19 and 28 years of age, regularly practicing three to six days per week. Approval for the study was obtained from the Faculty of Sport in Prishtina. Exclusion criteria included musculoskeletal pathology currently limiting the student’s ability to train or compete; a history of, or current systemic illnesses including cardiovascular or pulmonary disease; musculoskeletal disease or rheumatoid arthritis; and a lack of informed assent given by the subject.

*Procedure*

On arrival at the testing site, each participant was asked to complete the informed consent form, which described all the assessment procedures to be followed. Testing was administered in university gyms, with identical physical conditions during both testing sessions. Prior to testing, subjects completed their regular, coach-directed warm-up routines without regard to the requirements of the tests. Given that field-tests comprised of multiple items are often administered in stations each consisting of an individual item, subjects were placed into groups of 5-10 and moved through each of the stations to complete the testing. Data were collected by gymnastics coaches with a minimum of five years of coaching experience, the principal investigator, and another licensed physical therapist with gymnastics experience.

Fitness tests were: Plate Tapping (PLT), Standing broad jump (SBJ), the 20 meter run, bent arm hang (BAH), grip strength (GS), sit ups, Sit and reach (SAR).

***Arm plate tapping*.** For fifteen seconds the child has to alternately tap the two plates on the tapping board with his dominant hand, while holding the other hand in between the two plates. The result is the number of alternate double hits.

***Standing broad jump test***. The maximum horizontal distance attained, with feet together, was measured. This test evaluates lower limb explosive-strength. The broad jump trials were performed along the side of a steel measuring tape, which was fixed to the floor. Subjects began the broad jump with their toes on a marked line fixed at the 0-cm mark of the tape. The distance from the rearmost heel strike to the starting line was marked and measured. The best score of the 3 trials was recorded to the nearest centimetre.

***The 20 m dash*.** The result is the time it takes a child to run a 20 meter distance from a standing start. The children run in pairs.

*Sit and Reach test*. The subjects sat with their feet approximately hip-wide against the testing box. They kept their knees extended and placed the right hand over the left, and slowly reached forward as far as they could by sliding their hands along the measuring board. Test indicative of amplitude of movement or flexibility.

***Hand Grip test*.** By use of a digital Takei TKK 5101 dynamometer (range, 1-100 kg), the

maximum grip strength was measured for both hands.

***Bent Arm Hang test*** (upper limb endurance strength assessment): The participants hangs from a bar for as long as possible, with the arms bent at 90 degrees. The palms face forward and the chin must be over the bar’s plane. The time spent in this position, to the nearest tenth of a second, is recorded. A cylindrical horizontal bar and a stopwatch were used to perform the test.

***Sit-up Test for 30 seconds Test***: The aim of this test is defining the abdominal strength and muscles endurance by defining the pull-up exercise which the participant can do possibly at maximum in 30 seconds. The subjects on the soles of the feet mat, knees bent 90 degrees and the body of an upright position. help you grasp the subjects' feet, sits behind an element of the subjects knees. Sit up during the movement of the elbows must touch the string. The subject makes the movement of the shuttle during the 30 seconds and within this period the number of sit-ups as the value of the subject is recorded.

Selected gymnastic skills were: **Straddle vault**, **Round off**, **Backward roll passing through handstand (BRTH)**, **front uprise on parallel bars (FUPB**).

The group of applied variables was taken from the research in Kurelic, Momirovic, Stojanovic, Sturm, Radojevic, & Viskic-Stalec, (1975) and Marinšek & Veličković (2010).

*Statistical analysis*

All variables are shown as mean and SD. The Kolmogorov- Smirnov test was used to confirm the normality. Descriptive and inferential statistics were performed. Pearson’s product-moment correlations (r) were used to evaluate relationships between test variables: fitness tests, specific gymnastic tests, and performance in selected gymnastic skills. A stepwise multiple regression analysis was conducted to determine which independent variables in fitness tests and specific gymnastic tests were significant predictors of performance in gymnastics. The level of significance was set at p ≤ 0.05 for all the tests. SPSS 17.0 software for Windows (SPSS, Inc., Chicago, IL, USA) was used for the statistical analysis.

Results

The assessments of fitness and gymnastics skill for all variables are shown in Table 2. The results are means of the best attempt in each test for the total sample (Table 2).

Table 2. Descriptive statistics for fitness and gymnastics skill tests

|  |  |  |  |
| --- | --- | --- | --- |
|  | Mean±SD | Minimum | Maximum |
| Plate taping | 35.21±4.61 | 18 | 51 |
| Sit and reach | 29.16±8.11 | 20.5 | 48.0 |
| Standing broad jump | 237.46±16.88 | 200 | 285 |
| 20 dash | 3.29±0.169 | 2.80 | 4.13 |
| Bent arm hang | 54.93±18.47 | 11.03 | 106.00 |
| Sit ups | 19.53±2.38 | 13 | 27 |
| Handgrip strength | 56.68±8.73 | 36.40 | 85.10 |
| Straddle vault | 3.62±1.24 | 2 | 6 |
| Round off | 3.24±1.23 | 1 | 6 |
| BRTH | 3.22±1.08 | 2 | 6 |
| FUPB | 3.35±1.38 | 1 | 6 |

PLT-Plate Tapping, SBJ- Standing broad jump, 20m- the 20 meter run, BAH- bent arm hang, GS- grip strength, SAR-Sit and reach; Vault- Straddle vault, BRTH- Backward roll passing through handstand, FUPB- Front uprise on parallel bars

Subsequently, a bivariate correlation analysis was carried out between the results obtained from the variables in the fitness tests and the results from gymnastic skills. These results are presented in Table 3. There were significant correlations between fitness tests, and performance in gymnastic skills (Table 3). The Vault was positively correlated with PLT, SBJ, BAH, Sit ups, SAR and HST. However, the Vault showed no correlated with 20m, and GS.

Significant correlations between Round off and specific gymnastic tests were found (Table 3). The Round off was positively correlated with PLT, sit ups and SAR but has no correlation with SBJ, 20m dash, BAH and GS. The BRTH was positively related with all fitness variables except GS. The FUPB was related with SBJ, sit ups, BAH and SAR. No significant correlations were found between any of the performance skills and GS and 20m dash tests.

Table 3. Correlations between fitness tests, specific gymnastic tests, and performance in selected gymnastic skills (n =170)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Vault | | Round off | | BRTH | | FUPB | | |
| r | | | p | r | p | r | p | r | p | |
| PLT | .169\* | | .026 | .213\*\* | .005 | .205\*\* | .007 | .076 | | .323 |
| SBJ | .151\* | | .048 | .127 | .097 | .221\*\* | .004 | .269\*\* | | .000 |
| Sit ups | .215\*\* | | .005 | .246\*\* | .001 | .232\*\* | .002 | .227\*\* | | .003 |
| 20M | .136 | | .074 | .088 | .250 | .154\* | .044 | .140 | | .067 |
| BAH | .161\* | | .035 | .111 | .149 | .227\*\* | .003 | .268\*\* | | .000 |
| GS | .167 | | .790 | -.065 | .400 | .053 | .490 | -.009 | | .908 |
| SAR | .306\*\* | | .000 | .273\*\* | .000 | .336\*\* | .000 | .324\*\* | | .000 |

PLT-Plate Tapping, SBJ- Standing broad jump, 20m- the 20 meter run, BAH- bent arm hang, GS- grip strength, SAR-Sit and reach; Vault- Straddle vault, BRTH- Backward roll passing through handstand, FUPB- front uprise on parallel bars

Lastly, data about linear regressions (Table 4), which determine the relationship between variables, were obtained to check the linearity established between the independent variables and performance in gymnastic skills. The multiple regression analysis included all independent variables and identified SAR, sit ups, PLT, BAH, and SBJ as significant predictors of performance in gymnastic skills. These variables accounted for more than 30% of the variability in all gymnastic skills.

TABLE 4. Stepwise multiple linear regressions between fitness and performance in gymnastics.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Dependent variable | Independent variable | Adjusted R2 | Significance | *SEE* |
| Vault | SAR | 0.105 | 0.001 | 1.179 |
| Round off | SAR | 0.132 | 0.011 | 1.194 |
| Sit ups | 0.015 | 1.175 |
| PLT | 0.020 | 1.159 |
| BRTH | SAR | 0.172 | 0.001 | 1.027 |
| BAH | 0.009 | 1.012 |
| PLT | 0.014 | .997 |
| FUPB | SAR |  | 0.005 | 1.308 |
| SBJ | 0.154 | 0.012 | 1.285 |
| Sit ups |  | 0.046 | 1.274 |

Discussion

The primary purpose of this study was to determine the relationships between fitness tests, and results in selected gymnastic skills, and the secondary purpose was to identify assessment tests that best predict, or represent, performance. We assessed motor fitness through tests that measure speed, strength, power, and flexibility. Specific gymnastic tests were taken from several studies on the basis of required movements and muscle groups involved. The gymnastic skills tests were selected according to authors’ experience and based on several programs in the faculty of sport and physical education.

Several significant positive correlations were identified between fitness tests and performance variables. Sit ups had significant correlations with all of the results in gymnastic skills. Even though Sit ups was used to examine muscle endurance of the trunk, subjects had to use their trunk muscles to stabilize their upper body in an upright position. This means that the core muscles were contracted isometrically throughout the test despite dynamic movements. These similarities in muscle contraction and activation types may have resulted in their significant correlations. Next, significant correlations were identified between flexibility and all gymnastic skills. Nelson, Johnson, & Smith (1983) investigated the relationship between gymnasts’ flexibility and strength and varying training intensity levels. The gymnasts at the highest level of training were reported to be the most flexible, weighed less, and demonstrated higher amounts of both functional and absolute strength especially in the upper body. Faria & Faria (1989) concluded that the top gymnasts possessed greater overall flexibility through the hip region, shoulder girdle, and back.

Živcic Markovic, Sporiš & Cavar (2011) concluded that there is a disturbingly low level of the prior knowledge of gymnastics, which dictate the way of thinking about implementation in primary and secondary school children. Accordingly, Tabaković, Ibrahimović & Tabaković (2013), try to determine if applied contents of artistic gymnastics program have significant effects of some motor abilities on male students of the Faculty of sport and physical education. The aforementioned authors found changes in strength and flexibility and in the area of coordination following the gymnastics program. Gymnastic elements are irreplaceable contents that have an overall impact on the anthropological status of children, so they should play a more important role in the physical education curriculum at each level of education, especially in the lower elementary school classes (Delas Kalinski, Miletic, & Bozanic, 2011). Sands (2000) suggested that a gymnast routinely and repeatedly performs difficult skills but may not possess the overall physical abilities and fitness levels necessary for prolonged, successful participation in the sport. There is a great annual injury rate in male and female gymnasts. Using the fitness tests and specific gymnastic testing to identify deficits in sport-specific physical abilities that can be targeted as part of a gymnast’s individual training regime may prove useful in injury prevention. Although SAR, sit ups, PLT, BAH, and SBJ were best predictors in performance, reliance on these variables could not be recommended because the final adjusted r-square was low, which means that our predictors account around 30% of the variance in overall satisfaction. This is somewhat disappointing but pretty normal in social science research. This study was limited by several factors. The total number of participants at any level ranged from 18 to 28. Moreover, the participants were students of the faculty of sport and physical education that are engage in numerous activities throughout studies. Future studies should try to determine the potential impact of content courses on the content knowledge of Physical Education students, and thus their ability and willingness to teach that content to their future students.

Conclusions

In conclusion, there is significant correlation between flexibility, abdominal muscle strength and endurance and performance in gymnastics. Moreover, the fitness tests showed low but significant associations with results in several gymnastic skills. Gymnastics is included in all curricula of physical education, at each level of education. Moreover, an important fact that influences the importance of gymnastics in the curriculum is that it is particularly suitable for the adoption of basic movement structures that are stored in the motor base in the form of motor fundamentals necessary for efficient movement and their application in everyday life (Novak, Kovac, & Cuk, 2008). The establishment of a fitness or gymnastics-specific field test, which assesses the physical abilities of students or gymnasts, is a first step in identifying and subsequently improving the physical abilities and content knowledge of physical education students or probably the competitive gymnasts across the world too. Moreover, it is a possible attempt to reduce the injury rate in gymnastics.

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