DIFFERENCES BETWEEN THE STUDENTS AND ATHLETES-JUNIORS IN CERTAIN MOTOR CAPABILITIES

Abstract
Motor skills are an essential segment of the anthropological premises of man and are often the subject of scientific research. Due to their complex structure, it is very often in studies of this segment, a different approach in defining a model that will serve as the basis for the selection and definition of manifest variables. Usually, there is a phenomenological approach, but not rare studies that are based on a functional model of motor skills. This paper analyzes the area of motor skills of the population of students and athletes, youth ages with the aim of determining the difference in the space of the mechanism of central regulation. The study included 90 students who were involved in various sports teams and 90 athletes from four athletic clubs. Measured is 12 manifest variables from the space motor mechanism of central regulation. In analyzing the data, using t-test and canonical discriminant analysis were obtained statistically significant results (p<0.01) that explain the differences among the respondents. The seven variables pupils have achieved a better result, and the four variables, the difference is statistically significant. The only variable MISP, MSPA, MSPOO, MFLA synergistic regulation of space and tone and variable room MKOP of structuring movements are not recorded statistically significant differences. Athletes have been better in tests of flexibility, MDPK, MSRAR which are very important in racing and high jump events.

Key words: COORDINATION / FLEXIBILITY / BALANCE / CENTRAL REGULATION.

INTRODUCTION

Athletics includes racing, throwing, jumping and walking disciplines characterized by motor movements and can be successfully applied in the educational process or through other forms of exercise, by which is made a significant impact on raising the general mental and physical abilities. In any aspect of sports, including athletics, it is necessary to know certain characteristics that correspond to different ages, and are influenced by endogenous or exogenous factors. There are numerous studies which look at specific segments in the space of anthropological characteristic age periods (junior, intermediate and senior school age). Some are oriented to the younger and middle schoolers studying the motor status of children and young athletes (Anastasovski, 1981; Despot, & Viskić-Štalec, 1983; Kukolj, Bokan, Koprivica, & Ugarković, 2001; Bratić, Đurašković, & Randelović, 2001; Bresauler, Delija, & Mesarić, 2006; Pavlović, Marković, Branković, & Kocić, 2008; Cools, Christiane, & Mrjesničk, 2012; Vandorpe at al., 2012; Frank, 2012). Very often as a research problem are defined the differences in morphological and motor dimensions of different populations of the same age (Silva et al., 2012). Sometimes it comes to determining the differences in sports performance (Delija, Šimenc, & Vuleta, 1995; Bojić, Kocić, & Milenković, 2007; Prahović, & Protić, 2007; Gabbett, Jenkins, & Abernethy, 2011) in motor space, and some research
based on the study of morphological dimensions between athletes and students (Trent, 1996; Bresauler et al. 2006; Pelemiš, & Stević, 2009; Kos, Sitar, & Andrović, 2010, Lepers, & Stapley, 2010). Interests for this study are based on the knowledge of existence of possible differences, if certain groups are engaged in a form of physical activity in relation to the groups that are not, or within the same sport discipline when it comes to implementing the training process and the effects of this process on possible modifications of the subject. It is very important the proper dosage and performing of physical activity at a time when the young organism is in the process of growth and development (Mihajlović, 1996). When it comes to acceleration, primarily locomotor system and other systems in the body (muscle, cardiovascular, respiratory) on the basis of whose features is determined a certain based training process in order to avoid possible adverse consequences hazardous to health (Mihajlović, 1996; Tončev, & Mihajlović, 1999; Pavlović, 2010, Kazemi, 2012).

An important segment of the human area consists of motor capabilities on the basis of which we get information about the motor functioning of the human and as such ones have a very important role in achieving sporting results. In the analysis of motor skills, manifest variables are often defined by the functional model (includes changes in the CNS during execution of movement) rather than by phenomenological model (includes the method of execution motor task). In the functional model (Stojiljkovic, 2003), the certain capabilities from central control regions of movement has a mean (flexibility) to a high genetic component (balance, coordination).

The effects of training in order to improve the results of these abilities are so small or slightly higher when it comes to flexibility (Stojanovic, Kostic, & Ahmetovic, 2006). The studies that have been done so far, especially the more recent ones (Bojic et al., 2007; Pelemiš, & Stević, 2009, Cools et al. 2011; Kazemi, 2012) are dealing with the person as a biopsychosocial being and its ability of transformation from one form to another through a directed physical exercise, various modifications of training work or differences between certain populations.

Problem of the studies are the differences between the students and athletes in the area of motor skills (central control variables). The aim of this research is to examine any existing differences between students and athletes in the space of defined motor skills.

**METHOD**

**The sample**

The sample population consisted of junior athletes from athletic clubs: Prijedor, Borac (Banjaluka), Doboj, Prnjavor and the population of secondary school of mechanical engineering in Prijedor, age 15 years ± 0.5 years. A total of 90 runners and jumping athletes (mean height 173.37 ± 8.94 cm, weight 60.21 ± 10.46 kg and BMI 20.13 ± 2.34 kg/m²) from these clubs that have more than one year of athletic training and 90 students (average height of 172.82 ± 9.01 cm, weight 60.76 ± 12.06 kg and BMI 20.59 ± 3.23 kg/m²), which also have more than one year of training some of the sports (23 football, basketball 18, 14 handball, volleyball 19, box 2, karate 8, judo 6. All subjects gave consent and voluntarily participated in the survey.

**Sample of variables**

For the purposes of this study a sample of 15 variables have been identified. To assess the status of morphology three variables were measured: body height-AVIS, AMAS-body weight, Body Mass Index-BMI (Heyward & Stolarczyk, 1996). For the assessment of motor skills (the mechanism of central control of movement) was applied a set of variables drawn from the research Kurelić et al., 1975, Ivanić, & Ivanic, 1999:

**To assess the coordination of movement tests were applied:**
1. keeping the ball around the stands (MVLS)
2. agility in the air (MOZ)
3. dribble around the leg stands (MVLSN)
4. coordination with the bat (MKOP);

**To assess the flexibility the tests were applied:**
1. deep reach the bench (MDPK)
2. flex rod (MISP)
3. lateral split (MŠPA),
4. forward bend while sitting feet apart (MRAS)
To assess the balance the tests were applied:

1. standing on one leg in longitudinal beam eyes open (MSUOO)
2. standing on one leg transversely to the beam with open eyes (MSPOO)
3. standing on one leg transverse to the beam with eyes closed (MSPZO)
4. flamingo (MFLA).

All measurements were performed in the first semester of school year 2011/12 year. In order to obtain relevant results based on which we received responses, we applied basic statistical parameters, and in terms of determining the differences the analysis has been conducted using t-test for independent samples of high-level univariate and canonical discriminant analysis on the multivariate level.

RESULTS AND DISCUSSION

Table 1 contains the basic statistical parameters of motor abilities and morphological dimensions of the investigated sample of students and athletes, as well as the T-test results. For each variable, relevant central and dispersion parameters were calculated as well as measures of variability.

Table 1. Mean values, standard deviations (SD), minimum (Min) and maximum (Max) values of students and athletes, and the t-test

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pupils</th>
<th>Athletics</th>
<th>T-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ±SD</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>MDPK</td>
<td>23.04±7.47</td>
<td>7.00</td>
<td>43.00</td>
</tr>
<tr>
<td>MISP</td>
<td>44.36±10.25</td>
<td>8.00</td>
<td>63.00</td>
</tr>
<tr>
<td>MŠPA</td>
<td>162.86±19.94</td>
<td>79.00</td>
<td>195.00</td>
</tr>
<tr>
<td>MŠRAS</td>
<td>29.34±10.38</td>
<td>9.00</td>
<td>57.00</td>
</tr>
<tr>
<td>MVLS</td>
<td>9.16±2.25</td>
<td>5.90</td>
<td>15.50</td>
</tr>
<tr>
<td>MOZ</td>
<td>13.81±1.86</td>
<td>6.00</td>
<td>17.50</td>
</tr>
<tr>
<td>MVLSN</td>
<td>13.87±5.15</td>
<td>7.40</td>
<td>33.30</td>
</tr>
<tr>
<td>MKOP</td>
<td>18.07±4.13</td>
<td>11.80</td>
<td>28.60</td>
</tr>
<tr>
<td>MSUOO</td>
<td>34.38±14.42</td>
<td>10.20</td>
<td>68.60</td>
</tr>
<tr>
<td>MSPOO</td>
<td>19.05±10.83</td>
<td>2.80</td>
<td>45.80</td>
</tr>
<tr>
<td>MSPZO</td>
<td>11.37±8.00</td>
<td>2.00</td>
<td>33.80</td>
</tr>
<tr>
<td>MFLA</td>
<td>37.93±11.59</td>
<td>13.20</td>
<td>60.60</td>
</tr>
<tr>
<td>AVIS (cm)</td>
<td>172.82±9.01</td>
<td>150.00</td>
<td>193.00</td>
</tr>
<tr>
<td>AMAS (kg)</td>
<td>60.76±12.06</td>
<td>45.00</td>
<td>90.00</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>20.59±3.23</td>
<td>20.00</td>
<td>24.19</td>
</tr>
</tbody>
</table>

**Sig. (p<0.01)

Most of the variables are within the boundaries of normal distribution. If we look at the result values of the variables of coordination and balance, the smallest deviation is in term of the distribution of results. Of course, one should bear in mind the fact that the familiar way of a specific motor task implementation gives more of its successful implementation. It is known that training has a small effect on coordination and balance, but on the other hand it has a bigger effect on the flexibility. The basis of these changes may cause a shift of the initial state of these capabilities. In this regard, their embodiments (variables) are...
related on that way and they express their numerical values, as opposed to those that may be affected to a smaller extend. One should bear in mind the fact that a number of respondents are actively engaged in sports, as opposed to those who are not involved, and so these are the limiting factors for the eventual distribution of different variables, depending on the type of motor tasks. Through the analysis of the results of the motor capabilities among the athletes (Table 1), SD values are within the boundaries on the basis of which we can evaluate significant test sensitivity. In some variables of coordination, mezocurtic or leptokurtic distribution of results is presented, which shows the homogeneity of the sample expressed in these variables. Significant differences between better and weaker performances in motor tests of the athletes can be explained by assuming that these factors played a decisive role: dealing with other physical activity (training in sport clubs), which can increase the performance of tests, pre-motor experience, maturity of CNS, and a number of exogenous and endogenous factors. In any case, here is the distribution of the results more clearly expressed in the positive direction as a result of targeted physical activity, particularly with the training process among the athletes. It can be concluded that the respondents are in the turbulent phase of psychosomatic changes, and that among the sample of the athletes, motor abilities were accessible to certain modifications and transformations in a positive direction, and among the students these abilities were accessible to a lesser extent. Situation is almost identical in morphological area where three variables (height, weight, BMI) were tested, which showed almost the same numerical mean values among the students and athletes, that is the representation of homogeneity of the sample dealing with morphological dimensions. It follows that on the basis of these indicators of central and dispersion of statistic parameters, we can predict the changes and differences in multivariate level, its strength and reliability.

Through the analysis of differences in mean values of the variables of flexibility (Table 1) we can notice statistically significant differences between the students and athletes in 50% of measured tests. These differences were for the benefit of the athlete’s sample (in the case of three variables) and one was for the benefit of students (MISP). In variables dept forward bend (MDPK) and sitting forward bend (MSP- RAS) athletes achieved better results, which created significant differences dealing with mean values. The remaining two variables are bipolar, that is, one is in favor of the students, flex rod (MISP) and the other is in favor of the athlete, string (MSPA), but those differences are not significant. This suggests that athletes are more flexible in the region of the pelvis and trunk, and students are more flexible in the region of arms and shoulders. Also, the flexibility as a motor ability is accessible to change due to focused training process (Kurtz, 1994 by Stojiljkovic, 2003) and it participates in the implementation of most motor tasks (Agrez, 1975). Limits of optimal flexibility are difficult to determine precisely .They primarily dependent on age, sex, and sports (trainers) activities (Heimar et al., 1997).Flexibility of pelvic is important with the race and jump discipline and the results are maybe expected due to the increase of length of stride and the length of the flight and movement during the flight. Flexibility is also very important in other branches of sports (handball, basketball, football, volleyball, dance and sports or rhythmic gymnastics) for better implementation of the specific motor tasks (skills) and in order to reduce the possibilities of injuries (Bojic at al., 2007).

From Table 1 we can notice statistically significant differences of means, standard deviations, in three of the four variables that were evaluated coordination of students and athletes. This relates primarily to ball dribbling around the stands (MVLS), agility in the air (MOZ), dribbling around the stands with legs (MVLSN). Only in the variable coordination of bat (MKOP) participants did not achieve statistical significance, and only that difference is in favor of athletes. It can be said that these results are expected if we bear in mind the fact that these are students whom coordination is more important in their sport branches than in racing or jumping disciplines. On one side are the cyclic structure of running and jumping, and on the other side are sports games and other sports that have acyclic and cyclic-acyclic structures of the movements. Coordination as motor skill, as well as speed, is highly genetically conditioned over 80% so it is called motor intelligence (Gajic, 1985; Weeds, 1996; Ničin, 2000) and is dominant in those activities where we need to solve some complex motor tasks in which shorter time (Gajic, 1990). Such tasks are just in sports games during an attack, defense, or in some other sports (sports, rhythmic gymnastics, acrobatics...).
Statistically significant differences of means are presented in variables of balance. In two variables (standing on the bench along with open eyes - MSUOO and standing cross on the bench with eyes closed) differences were visible, one in favor of the student, and the other in favor of the athlete. In flamingo test athletes were better but statistically significant difference was not achieved. This result was expected because of the assumption that neither the ones nor the others pay enough attention to motor skill despite the nature of the activities they are involved. In gymnastics or in any other sport where the dominant balance ability, the results would probably have been better but for the benefit of the gymnast. Generally it can be concluded that the results of both populations are extremely weak and they should be improved.

Compared to the results of univariate analysis, the conclusion is that of the total number of manifest variables (12), statistically significant differences are achieved in seven variables. It is approximately 58% in terms of percentage. In most of the variables (seven) students were those who achieved a better result, especially in those variables that are dominant and important in sports performance (coordination, balance). In four variables that difference is statistically significant. Only the variables MISP, MSPA, MSPOO, MFLA from the space of synergistic regulation and tone and MKOP variables from the space of structuring movement did not achieve statistical significance. The fact that among the large number of students exist those who are actively involved in various sports clubs and directly in the training process is more important to practice. These students achieved more superior results compared to the athletes of the same age. Athletes were better in MDPK, MSRAS tests of flexibility which are very important in racing and jumping disciplines.

The differences in motor skills among the students and athletes were analyzed at the multivariate level using canonical discriminative analysis. In the space of 12 motor variables, an important function of defined variables (R = 0.84) was isolated. This high correlation indicates the correlation of motor abilities, on the basis of which the discriminative analysis of motor space was performed. The results of discriminative strength of variables and determination coefficient of motor abilities function are extremely high (Wilks’ Lambda =0.69) which indicates that the differences between the students and athletes in the area of energetic regulation are very significant. (p=0.001)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Root 1</th>
<th>St.Coeff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDPK</td>
<td>-0.34</td>
<td>-0.18</td>
</tr>
<tr>
<td>MISP</td>
<td>0.18</td>
<td>-0.16</td>
</tr>
<tr>
<td>MSPA</td>
<td>-0.15</td>
<td>-0.17</td>
</tr>
<tr>
<td>MŠRAS</td>
<td>-0.29</td>
<td>-0.22</td>
</tr>
<tr>
<td>MVLS</td>
<td>0.31</td>
<td>0.02</td>
</tr>
<tr>
<td>MOZ</td>
<td>0.34</td>
<td>-0.20</td>
</tr>
<tr>
<td>MVLSN</td>
<td>0.38</td>
<td>-0.08</td>
</tr>
<tr>
<td>MKOP</td>
<td>0.19</td>
<td>-0.15</td>
</tr>
<tr>
<td>MSUOO</td>
<td>0.31</td>
<td>-0.10</td>
</tr>
<tr>
<td>MSPOO</td>
<td>0.21</td>
<td>0.14</td>
</tr>
<tr>
<td>MSPZO</td>
<td>-0.29</td>
<td>-0.16</td>
</tr>
<tr>
<td>MFLA</td>
<td>0.19</td>
<td>0.10</td>
</tr>
</tbody>
</table>

In Table 2 the factor structure of the discriminative function is presented and participation of motor abilities in its formation. Among the total of 12 variables, the greatest contribution of discriminative function achieved those which defined coordination (MVLSN, MOZ, MVLS), flexibility (MDPK, MŠRAS) and balance (MSUOO, MSPOO, MSZP) with low numerical projections. The main variable is dribbling ball around the stands with legs (MVLSN), agility in the air (MOZ) and slalom dribbling (MVLS). Also, the equilibrium variables had a significant contribution to the discriminative function (MVLSN), (MOSPZ), (MSPOO) and the two variables of flexibility where athletes achieved better results (MDPK) and (MŠRAS). A positive sign for all variables of central regulation is interesting. Positive signs indicate that these variables among students were directly discriminated in regard to athletes, because they are in correlation with the positive position of centroid population of pupils. Estimating the differences between the arithmetic means, we can notice differences, which were confirmed by Mahalanob’s distance (Table 3). This function could be defined as a function of movement coordination, based on isolated variables that determine the discriminative function of motor space. From the values of centroid sign, which is a negative among athletes’ samples, their direct relationship with the variables that discriminate them from the sample of students can be explained. These variables have negative values.
In order to check the significance of the function and adequacy of results, F-value was calculated. Based on these indicators, we can conclude that the isolated discriminative function is statistically significant, with the relevant parameters of functions and that in most motor abilities is different, heterogeneous. Generally speaking, the results of the univariate analysis of motor skills are also confirmed on the multivariate level. The differences are in favor of the students in most of central regulation mechanism variables (structured movement, and synergistic regulation of muscle tone), in coordination, in some measures of flexibility and balance, in all those structures of movement that have more influence and importance in sports and other acyclic movements compared to racing and jumping athletic discipline.

**CONCLUSION**

The research was done on a sample of 180 respondents chronologically 15 ± 0.5 years old, with the aim of determining the difference between a student and junior athletes in the area of central regulation. By analyzing the differences in means of tested measures of motor space among the students and athletes we can conclude that there exist significant differences in almost all measures but only in 7 cases that difference is statistically significant, that difference is 58% of the total number of measured variables. These differences were noted in almost all variables of coordination in favor of students compared to the athletes, whereas in the measures of flexibility and balance these differences quantitatively were almost identical. Generally speaking, students had better results within the mechanism of structuring movement, while the athletes achieved better results in the flexibility especially in those variables that were significant and dominant in athletic racing and jumping disciplines.

In the area of balance, two variables noted statistically significant differences, one in favor of an athlete (MSPZO), and one for the benefit of students (MSUOO). The students and athletes have similar abilities in the mechanism area of synergistic regulation and in the regulation of muscle tone. The remaining four variables from the area of balance and flexibility made the difference in favor of the athletes or students, but they are not statistically significant differences. This result is not surprising since students practice mostly sports games where coordination is probably more important in a given activity than in a racing or jumping disciplines. Also, the results of the canonical discriminative analysis in motor behavior showed a statistically significant difference, and that function is defined with measures of coordination for the benefit of students and measures of flexibility and balance in favor of the students and athletes, in other words it was defined in a bipolar way in a single space.

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