

THE STRUCTURE OF DIFFICULTIES IN THE ROUTINES OF THE BEST WORLD AND SERBIAN RHYTHMIC GYMNASTS

Abstract

This paper contains a comparative analysis of competition routines with a hoop, ball or rope of the top six competitors at the World Championship in Moscow 2010 and the top six competitors at the Serbian Championship in Belgrade 2010. This analysis was conducted on the basis of the proportion of body difficulties from various structural groups (leaps, balances, pirouettes, flexibilities and waves) comprised within the routines of the competitors with corresponding apparatus (hoop, ball, rope) in both championships. The aim of this research was to identify the similarities and differences in the structure of leaps, pirouettes, balances and elements of flexibilities and waves of the first six competitors in both championships by analyzing their routines on video recordings. The findings discovered that the competitors in the World Championship demonstrated a considerably higher level of technical value in their routines compared to the Serbian competitors. The competitors at World level perform difficulties of greater average difficulties from all structural groups in their routines with a hoop, ball and rope and these differences are generally important from a statistical point of view. The greatest differences were noticed in pirouettes, whereas differences in the structure of flexibilities were the least, compared to other structural groups.

Key words: TECHNICAL VALUE / BODY DIFFICULTY / RHYTHMIC GYMNASTICS / STRUCTURAL GROUPS

INTRODUCTION

In order to achieve results of the highest level and quality in sport it is necessary to constantly monitor the general place and latest trends in the development of the respective sport, as well as to analyze the individual state and progress of the sportsman/woman through the process of training and competing. This paper was written with an intention to contribute to a multi-sided approach to viewing the problems concerning rhythmic gymnastics by analyzing the routines of the top Serbian and World rhythmic gymnasts from the aspect of the technical value of their performances..

The Code of points of the International Gymnastic Federation (Federation Internationale de

Gymnastique, 2009) is issued every four years, i.e. for each Olympic cycle, but can be modified during the contemporary cycle when it is accompanied by official changes and supplements. The development of the Code follows developments in the actual practice of sport but the Code also dictates the direction in which rhythmic gymnastics will evolve. Special attention is paid to ensure that compositions do not turn into a series of performed difficulties as this would compromise the artistic elements of the routines, the very spirit of this sport, as well as endanger the health of the gymnasts themselves.

The routines included in this paper have been analyzed from the aspect of the content of body difficulties. Body difficulties are exercises which belong to any of the compulsory groups of body elements (the term “element” will henceforth be used to denote any form of exercise, movement): leaps, balances, pirouettes or the group of flexibilities and waves. The basis of every difficulty is the movement of the gymnast (body element) but it cannot be recognized on its own unless it is accompanied by the respective movement of the apparatus. The Code defines body difficulties, according to their complexity and difficulty of performing, as body difficulties of a specific level and prescribes a specific point value (from 0,10 to 1,00 point and more).

Points given for the technical value of a routine are very often decisive in the final placement of a gymnast, especially at big competitions. Former research in the segment of the technical values of routines has shown that in the last two Olympic cycles the highest number and highest level of difficulties were achieved in leaps and elements of flexibilities (Aleksić, 2005; Aleksić, & Moskovljević, 2007). Leaps have been present, as the predominant structural group in routines since the previous century 80ties. (Milićević, 1988; Radisavljević, 1986; Radisavljević, Medić, & Moskovljević, 1996). For more than two decades balances, as a structural group, have been the least used in the constructing of difficulties (Milicević, 1988; Radisavljević, 1986; Aleksić, 2005; Aleksić, & Moskovljević, 2007). Only for a short period of time, in the first half of the 90ties, instigated by changes in the Code, balances, were equally represented in content with leaps in the construction of difficulties (Radisavljević, 1993; Radisavljević, Medić, & Moskovljević, 1996). It is, of course, always keep in mind that the successful execution of the above structural group is associated with a good motor preparation (Brooks, 2003; Hume, Hopkins, Robinson, Robinson, & Hollings, 1993; Hutchinson, Tremain, Christiansen, & Beitzel, 1998), with some morphological characteristics of competitors (Di Cagno, et al., 2008), as well as their age (Moskovljević, Radisavljević, & Dabović, 2013).

The items of this research were the structures of difficulties in the routines with apparatus of the top six Serbian and World rhythmic gymnasts. The aim of this research was to establish the similarities and

differences in the structure of difficulties between the best Serbian and World rhythmic gymnasts.

METHOD

The course and procedure of research

This paper presents a transversal research where an empiric approach is used as the basic method and a descriptive approach is secondary.

The technique of viewing video recordings from the World Championship in RG in Moscow and the Serbian Championship in RG in Belgrade, both held in 2010, was used to acquire the relevant data.

The gathering of facts was carried out according to a previously established protocol and three judges of the highest federal level took part in the proceedings. Each routine on the recording was analyzed at least twice and the option of viewing the recordings in slow motion was often employed in order to ensure the maximum credibility of the facts. This manner of analysis excludes possible problems which might arise in the evaluation of the composition of the routines. (Radisavljević, 1986; Popović, & Samuilidu, 1997; Popović, 2000).

Sample of subjects

Twelve rhythmic gymnasts are the subject of this research and they include:

- 6 best-placed sportswomen in the World Championship in Moscow;
- 6 best-placed sportswomen in the Serbian Championship in Belgrade.

The research comprises 36 routines; 12 routines for each of the following apparatus – hoop, rope and ball.

Sample of variables

All the variables of scrutiny, according to criteria of measurement, belong to the group of qualitative (attributive) variables. The variables researched were:

- leaps (\wedge),
- balances (\top),
- pirouettes (\circ),
- flexibilities and waves (\perp).

The evaluation of variables using the official Code of points was carried out by watching and analyzing the video-recorded material.

The statistical processing of the data

All the facts gathered in the process of research were processed by procedures of descriptive and comparative statistics.

In the field of descriptive statistics the following facts were defined:

- frequency distribution;
- mean;
- variance;
- standard deviation.

In the field of comparative statistics the T-test was used for testing the differences in arithmetic means of small independent samples (Peric, 2001).

RESULTS AND DISCUSSION

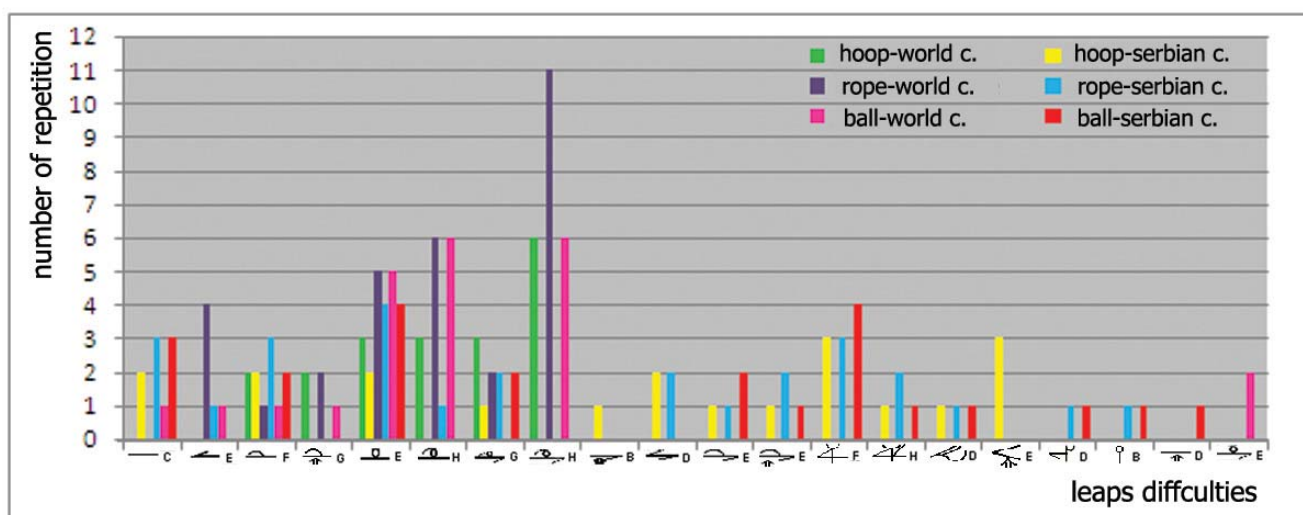
The results of the research are represented by corresponding graphs for the body element groups in the routines with each of three of the previously mentioned apparatus. The importance of the differences of the arithmetic means of performed difficulties from all structural groups was tested by the T – test.

In order to simplify this presentation, henceforward in the text the sample rhythmic gymnasts are named “World” (referring to the top six rhythmic

gymnasts in the World Championship 2010) and “Serbian” (referring to the top six rhythmic gymnasts in the Serbian Championship 2010) in the interpretation of the results.



Comparative analysis of the structure of leaps in the competition routines of the finalists in the World Championship and Serbian Championship





Based on the results (Graph 1), the differences in the performance of leaps of sample competitors can clearly be discerned. In routines with a **hoop** World contestants performed a total of 19 leaps, 6 of which were different, with a range of difficulty from E (0.5) to H (0.8) while Serbian competitors performed 20 leaps, 12 of which were different, with a range of difficulty from B (0.2) to H (0.8). The most frequently performed leap by World contestants was the turning stag leap with back bend (↻) performed six times and the turning split leap with back bend performed three times, level of difficulty H (0.8). The Serbian competitors most frequently performed „Cossack“ leap with a turn of 180° (↻) and the „straddle“ leap (↻), with a level of difficulty F (0.6) and E (0.5), which the World competitors did not perform at all. The turning split leap with back bend (↻), level of difficulty H (0.8) was performed by the



Graph 1. The distribution of leaps in the routines of World and Serbian rhythmic gymnasts


World contestants three times whereas the Serbian contestants did not perform it at all. World contestants mainly performed leaps with higher levels of difficulty with frequent back bands and rotations, which were very rarely executed by Serbian contestants. Serbian competitors performed 10 leaps of lower difficulty levels which the World competitors did not use in their routines at all. The mean value of all performed leaps in the routines with a hoop by Serbian contestants was 0.51 points, while the World contestants had an average of 0.71 points. By analyzing the performance of leaps in the routines with a hoop, a distinct advantage in the favour of World rhythmic gymnasts against Serbian can be noticed.

In routines with a rope World competitors performed a total of 31 leaps, 7 of which were different and had a range of difficulty from E (0.5) to H (0.8), while Serbian contestants performed a total of 24 leaps, 14 of which were different with a range from B (0.2) to H (0.8). World contestants performed no less than 17 leaps with a level of difficulty H (0.8), whereas the Serbian contestants performed only 3 leaps of the same value. The turning stag leap with back bend () was performed 11 times by the World competitors (35.48%), whereas the Serbian contestants did not perform it at all. The Serbian contestants most frequently performed leaps of E difficulty (0.5) - 8 times, and the turning split leap () - 4 times. World contestants did not perform any leaps with a level of difficulty below 0.5, whereas the Serbian competitors performed 13 leaps of this level. The mean value of difficulty of all performed leaps in routines with a rope by Serbian contestants is 0.52 points, while the mean value of World contestants is 0.69 points.

As far as routines with a ball are concerned, it can be stated that the Serbian competitors performed a higher total of leaps than World competitors, but regarding the levels of difficulty of the leaps we can discern a considerable difference in their mean values. World contestants performed 8 different types of jumps; 12 leaps with a difficulty of H (0.8) where the turning split leap with back bend () and the turning stag leap with back bend () were predominant; both were executed 6 times each (26.09% of the total of performed number of leaps). The Serbian contestants did not perform these leaps at all. Instead, they performed 13 different leaps, where jumps of level E (0.5) were predominant amounting to a total of 7; they performed „Cossack“ leap with 180° rotation () and the turning split leap () 4 times each.

„Cossack“ leap, of B level difficulty which was most frequently represented in the routines of Serbian contestants was not performed by World competitors at all. Again, leaps with rotations were most frequently performed by World contestants. The mean value of difficulty of all performed leaps in routines with a ball amounted to 0.50 points for Serbian competitors and 0.67 points for World competitors.

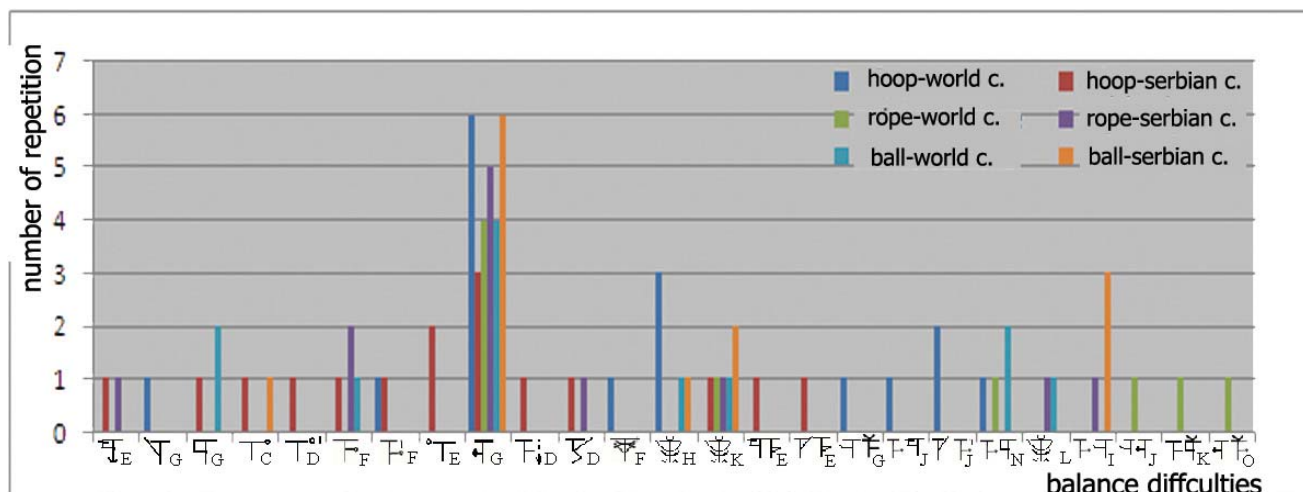
A comparative analysis of the structure of balances in competition routines of finalists in the World Championship and Serbian Championship

By analyzing balances (Graph 2) in competition routines with a hoop we can see that the World contestants performed a total of 17 balances where 7 different ones were in the range of difficulty from F (0.6) to up to as high as N level (1.4). Serbian contestants performed a total of 16 balances, where 13 were different, ranging from level C (0.3) to K (1.1). The most frequently performed balance was the balance with free leg high up and back backward () G level of difficulty in both contestant groups: 6 times by World (35.29% of the total number of executed balances) and 3 times by Serbian contestants (18.75% of the total number of performed balances). By analyzing the level of difficulty of performed balances we can conclude that World rhythmic gymnasts executed 8 balances of G (0.7) level, three of levels H (0.8) and J (1.0) each, while Serbian contestants most frequently executed balances of E level (0.5), a total of five. World contestants performed 7 balances over G level (0.7), whereas Serbian competitors performed only one higher than G level. It can also be noticed that Serbian contestants performed 9 balances under F level (0.6) while World competitors did not have any balances under that value. The analysis showed the dominance of the World contestants in performing combined balances both in respect to structure and difficulty value. The mean value of difficulty of all executed balances in the routines with a hoop was 0.56 points for Serbian contestants and 0.79 points for World contestants.

In routines with a rope World contestants performed 7 different balances out of a total of 9 (level of difficulty from G 0.7 to O 1.5), while Serbian contestants executed 7 different balances (level of difficulty from D 0.4 to L 1.2) out of a total of 12. As in routines with a hoop, both groups of contestants

most frequently used with free leg high up and back backward (𐄀) difficulty G level in their routines with a rope. This balance showed a presence in the routines of Serbian contestants of 41,6%, and in the routines of World competitors 44,4 %, of the total of performed balances. World contestants dominated in the execution of balance combinations where the level of difficulty of performance rises as far as level O - 1.5 points. Serbian competitors performed „four-

ette“ balances with leg above horizontal (𐄁) twice, and one of them was L level. The mean value of difficulty of all performed balances in the routines with a rope was 0,71 points for Serbian contestants, while it was 0,88 points for World contestants. Regarded from this aspect we can once again notice the advantage World contestants hold over Serbian ones in the execution of balances in routines with a rope.



Graph 2. The distribution of balances in the routines of World and Serbian rhythmic gymnasts

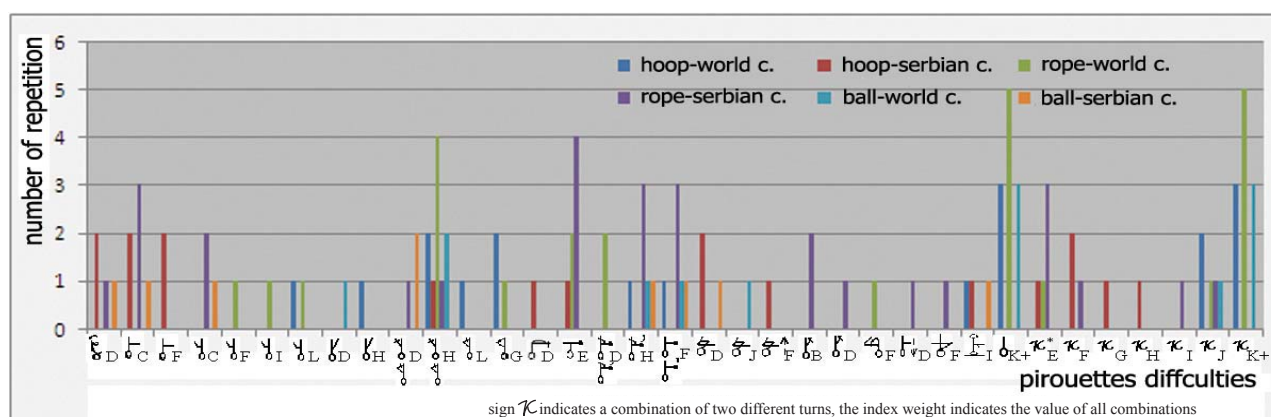
In routines with a ball World contestants performed 7 different balances level F (0.6) to N (1.4) out of a total of 12, while Serbian contestants performed 6 different balances level of difficulty from C (0.3) to K (1.1) out of a total of 13. Balances of G level (0.7) were most frequently performed by both World and Serbian competitors (a total of six by each). As in the case of previously analyzed apparatus, the most frequently performed balance in the routines with a ball was the balance with free leg high up and back backward (𐄀), G level of difficulty. This balance was represented by 33.33% of the total of all performed balances in the routines of World rhythmic gymnasts and by 46.15% in the routines Serbian rhythmic gymnasts. The combinations of balances performed by World competitors are of a higher level of difficulty than the ones performed by Serbian gymnasts. The mean value of difficulty of all performed balances in the routines with a ball by Serbian contestants is 0.73 points, while it amounts to 0.93 points for World contestants.

A comparative analysis of the structure of pirouettes in the competition routines of the finalists in the World Championship and the Serbian Championship

The results of the analysis of the distribution of pirouettes in the routines (Graph 3) show that World rhythmic gymnasts executed a total of 17 pirouettes in routines with a hoop and while none of them was repeated, they had a range from F (0.6) as high as V level of difficulty (2.2). Serbian contestants performed a total of 19 pirouettes, 15 of which were different and discernibly of a lower level of difficulty, namely within the range from C (0.3) to I (0.9). Serbian rhythmic gymnasts mainly performed pirouettes of the level of difficulty D (0.4), 6 in total. They did not execute any pirouettes over level (0.9), while World contestants performed as many as 11, including a combination of pirouettes (𐄂 𐄃) of the value of 2.2 points (V level). Sampled rhythmic gymnasts coincided only in two out of the total of 30 executed pirouettes. World competitors dominate over Serbian in both isolated difficulties and combinations

of pirouettes. The pirouettes combined by the World contestants are of a far higher value than the combinations of pirouettes used in the routines of Serbian rhythmic gymnasts. Comparing the mean value of difficulty of executed pirouettes we can clearly

perceive the advantage of World rhythmic gymnasts over Serbian. The mean value of difficulty of all executed pirouettes in routines with a hoop amounts to 0.57 points for Serbian contestants, while the amount for World competitors was 1.13 points.



Graph 3. The distribution of pirouettes in routines of World and Serbian rhythmic gymnasts

In routines with a rope World contestants performed a total of 24 pirouettes, 20 of which were different with levels of difficulty ranging from D (0.4) to S (1.9). They mostly performed difficulties of H level (0.8), 6 times in all. Serbian contestants performed 16 different pirouettes out of a total of 26, with a level of difficulty ranging from 0.2 to 1.0 points. They mostly performed pirouettes of D level (0.4), 7 in all. Out of the total of 35 pirouettes performed at both Championships, the rhythmic gymnasts coincided in only one (pirouette with free leg in high up back position, with help, 720° - D). The World contestants performed pirouettes and combinations of pirouettes at a far higher level, namely pirouettes with a greater number of rotations and therefore of a higher point value than the Serbian contestants. World level competitors executed 10 pirouettes above the level of difficulty J (1.00), whereas Serbian competitors did not perform any pirouette of such a high value. „Fuede“ pirouette (D) which appeared in the routines of World contestants was performed at a value as high as Q level of difficulty, 1.7 points (8 consecutive pirouettes with free leg in horizontal front position), whereas the Serbian contestants did not perform it at all, even with a lesser number of rotations. Pirouettes with free leg in back position appeared more often in the routines of World contestants, whereas Serbian contestants rarely performed them and with a lesser number of

rotations. The mean value of difficulty of all executed pirouettes in routines with a rope by Serbian competitors amounted to 0.48 points, while the amount for World contestants was 0.98 points. Taking into account that these body elements are compulsory for routines with a rope this fact reveals a great shortcoming in the technical preparations of the Serbian rhythmic gymnasts.

In routines with a ball World contestants performed 12 different pirouettes with a level of difficulty ranging from D (0.4) up to as high as V (2.2), whereas Serbian competitors performed 11 different pirouettes ranging from level of difficulty from C (0.3) to I (0.9). Just as in routines with a hoop and a rope, pirouettes of a very high level of difficulty appear in routines with a ball. World contestants executed „fuede“ pirouette (D), of a value of 1.6 points, i.e. P level of difficulty (7 pirouettes of 360° with free leg in horizontal front position). Changes in the form of pirouettes without heel support were present in both groups of gymnasts however World contestants performed a higher number of rotations which raised their value of difficulties considerably. The mean value of difficulty of all the pirouettes in the routines with a ball performed by Serbian contestants was 0.58 points, while it amounted to 1.17 points in the routines of the World contestants.

in all. World contestants performed flexibility with free leg high up and back bend, with floor start and rotation of 360° ($\uparrow \curvearrowright$) level G 5 times, whereas the Serbian contestants did not execute it at all. World contestants performed 7 flexibilities above level H (0.8), the Serbian not even one. The mean value of difficulty of all performed flexibilities and waves in routines with a ball was 0.50 points for Serbian and 0.71 points for World contestants.

Results of comparative statistical analysis

World contestants accomplish higher mean values of difficulty than Serbian in all groups of body elements in routines with all apparatuses. In most cases these differences are statistically significant as well (Table1.).

Table 1. The significance of differences in the mean values of difficulty (t-test)

		leaps	balances	pirouettes	flexibilities
Hoop	world c./serbian c.	M=0.71 / M=0.51	M=0.79 / M=0.56	M=1.13 / M=0.57	M=0.67 / M=0.45
		3.0395	3.8079	3.3156	1.8122
Roope	world c./serbian c.	M=0.69 / M=0.53	M=0.88 / M=0.71	M=0.98 / M=0.48	M=0.47 / M=0.37
		3.9752	0.1891	4.5331	0.4833
Ball	world c./serbian c.	M=0.67 / M=0.50	M=0.94 / M=0.73	M=1.17 / M=0.58	M=0.71 / M=0.50
		2.584	1.2107	2.8993	3.7057
				P _{0.05} =2.228	P _{0.01} =3.169

Where leaps are concerned there is a significant difference in the mean value of difficulty in routines with apparatuses included in this paper. In routines with a hoop and ball this difference shows a level of significance of 0.05, while in routines with a rope it shows a level of significance of 0.01. As previously mentioned, leaps are a characteristic group of body elements in routines with a rope.

As far as balances are concerned a statistically significant difference ($p=0.01$) exists only in routines with a hoop, whereas the observed differences in the values of difficulty in routines with a rope and ball did not prove to be significant. Once again it is necessary to state that balances are not a characteristic group of body elements for a rope and ball, while the hoop demands a presence of difficulties from all groups of body elements.

Where pirouettes are concerned a statistically important difference in the mean value of difficulties appears in the case of all apparatuses. In routines with a hoop and rope this difference shows a level of significance of 0.01, while in routines with a ball the level of significance is 0.05.

In the case of flexibilities and waves a statistically significant difference appears only in routines with a ball ($p=0.01$), for which this group of body elements is characteristic.

The biggest differences in levels of difficulties in the routines of World rhythmic gymnasts compared to Serbian can be detected in the groups of

body elements characteristic for a specific apparatus. Thus World rhythmic gymnasts demonstrate a high level of physical training and skill together with an ability to master all groups of body elements and in this respect show a significant advantage over Serbian rhythmic gymnasts.

CONCLUSION

A comparative analysis of contestant compositions was made between the six best placed rhythmic gymnasts at the World championship in Moscow 2010 and the six best placed rhythmic gymnasts at the Championship of Serbia in Belgrade 2010. The contestants in both Championships were compatible as regards their routine performances predominantly in the chosen three apparatuses (accessories/ utensils) – hoop, rope and ball so that these were included in the analysis.

Thirty six contestant compositions, in total, were judged by three top, federal level judges who studied the video recordings, at least twice, utilizing also slow-up viewing of the video recordings. An analysis of all compositions was made from the aspect of inclusion of body difficult diverse structural groups: leaps, balance, turns as well as elements of flexibility and waves. The aim of the analysis was to determine

the existence of similarities and differences in the performance of mentioned structures within compositions of world leading and Serbian rhythmic gymnasts.

The results obtained were processed using descriptive and comparative statistical methods. The following conclusions were determined:

- Regarding compositions with hoop, rope and ball, the top world competitors performed leaps of greater mean bodily difficulty than Serbian competitors. The variances in their performances were further also denoted as statistically significant for all three apparatuses. This fact gains in importance by the mere fact that leaps are a characteristic group of body elements for all stated apparatuses, proscribed by the code of points. Taking into consideration the basic characteristics of leaps, the reason for the higher performance quality of world contestants can be found in the training procedure, i.e., their better physical advancement as well as work on the actual technique of leaps performance. Leaps used in compositions with one apparatus were also repeated in compositions with other apparatuses both by world and Serbian competitors which can be explained by the requirements of the code of points which according to subjective opinion “requires” performance of elements at high body difficulty levels (more points – higher placement) thus disabling a satisfying variability of the same.
- Concerning the performance of balances, world contestants compared with Serbian competitors had greater mean body difficulties in their compositions although a statistically important difference was only discernible in compositions with hoops. In this segment also Serbian competitors have much space for advancement regarding performance techniques. The most frequently performed balance for both world and Serbian competitors was the balance with free leg high up and back backward
- The differences in the performance of turns in the compositions of top world and Serbian rhythmic gymnasts come to be the greatest in comparison with all other analyzed body difficulty structures. World contestants performed turns of a far greater level of difficulty than Serbian competitors. The difference in the mean value of turn difficulty was also statistically significant in compositions with all apparatuses included in the analysis. In view of

this fact it can be stated that the training of Serbian rhythmic gymnasts requires work of great intensity to achieve an improved technique of turn performance as well as a greater number of hours spent in ballet tuition within the training program structure.

- In the performance of flexibility elements and waves there is also a visible predominance of world rhythmic gymnasts, especially in relation to those in Serbian contestants’ compositions. Statistical essential differences are visible in compositions with the ball which is characteristic for this group of elements. The difference in the structure flexibilities top world contestants’ compositions and those of Serbian contestants is less than in the previously analyzed groups of body elements.

An analysis of the structure of body performance difficulties in compositions with hoop, rope and ball between the top world and Serbian rhythmic gymnasts for the year 2010 renders the conclusion that the performance of world contestants is by far on a more advanced level than Serbian contestants. Improvement of this situation can be attained both by changes in the actual training process as well as in technical training conditions. Solutions to problems concerning the training process should be directed toward improvement rhythmic gymnasts physical condition, work on the difficulties performance techniques; special attention should be paid to the improvement of the ballet training program. Furthermore, progressive advancement of Serbian trainers should be carried out and possibilities for improving technical conditions for training researched, primarily gym facilities with a sufficient number of hours for coaching. These and similar questions are considered as subjects of interest of numerous experts form the sphere of rhythmic gymnastics in our country.

The code of points requires extremely high standards for both rhythmic gymnasts and their trainers. An analysis of compositions showed that to attain requirements set by the code, contestants have to perform a precisely prescribed number of obligatory difficulties thus setting a head-spinning level of achievement in order to reach high placement. The question remains open whether the variability of composition content, artistic components, the spirit of rhythmic gymnastics as well as the health of gymnasts, will be overshadowed by a set of proscribed and strict rules.

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