IMPROVEMENT OF THE SYSTEM FOR THE ASSESSMENT OF FLEXIBILITY OF 10-12-YEAR OLD MALE ARTISTIC GYMNASTS

Georgi Sergiev
National Sports Academy „Vassil Levski", Sofia, Bulgaria

ABSTRACT

One of the main purposes of this paper is to perfect sports preparation in artistic gymnastics at the stage of initial sports specialization. This stage coincides with the sensitive period for development of flexibility. This manuscript deals with the issue of flexibility being one of the most significant motor qualities. High level of flexibility development guarantees the successful performance with maximum amplitude of a great number of exercises in artistic gymnastics.

The aim of the research was updating the system for tracing the improvement and evaluation of young male gymnasts' flexibility. The main tasks of the survey were selecting suitable tests for evaluation of the quality flexibility as well as carrying out testing with competitors of all age groups. In the end, a 50-grade scale for evaluation of flexibility was designed along the different indexes (tests).

The research was done among 38 male 10-12-year old gymnasts with the help of 8 tests. On this basis specification tables were designed for each test with the use of a 50-grade (point) scale. The specification tables allowed for the quick evaluation of competitors along a certain test right after their measurement.

On the basis of the conducted research, testing, collected information and specification tables made, it will be possible to improve the evaluation of the temporary state of competitors' flexibility at each stage of the preparation. We will also be able to evaluate (notice) the smallest changes (increase) in the indexes during the preparation both in positive and negative aspect.

***Key words*:** *artistic gymnastics, flexibility, testing, specification tables.*

INTRODUCTION

One of the main objectives of this paper is to perfect artistic gymnastics sports training during the initial sports specialization stage. We believe that on this basis a more purposeful and rational management of an education-training process will be achieved as regards the different components of sports training in male artistic gymnastics. The system of control and evaluation of competitors' sports technical qualities will also be perfected as regards the development of their motor qualities and flexibility in particular.

Control, being part of the mechanism of sports training management (Hadzhiev, Andonov, Mineva, 2011), is an irreplaceable factor related to the successful planning and management of the education-training process in gymnastics. Tracing the development and evaluation of the components of sports training at all stages of gymnasts' preparation ensures the quality of the training and guarantees high achievements. Generally, flexibility is an important parameter associated with health-related physical fitness, more – hamstring flexibility plays a substantial role in maintaining a correct spinal posture and preventing possible injuries (Muyor et al, 2014).

This manuscript deals with the issue of flexibility as one of the most important qualities. Its high level guarantees the successful execution with maximum amplitude of a great num-

ber of exercises peculiar to all sports related to gymnastics – sports aerobics (Mineva, 1986), rhythmic gymnastics (Gancheva, 2013), artistic gymnastics (Dimitrova, 2014), (Kyuchukov, Andonov, 2003), (Hadzhiev et al, 2011), as well as other spheres such as physical education at schools (Andonov, 2019), (Borisova, Andonov, 2004), (Ilieva, Andonov, 2005), stuntmen preparation (Videv, 2003). Moreover, in classic, modern and folklore dances (as part of the musical and rhythmic preparation in gymnastics) a high level of flexibility is needed. Research in this area showed that a positive increase of the flexibility level had also been established by the use of the contrast principles (with alternation of load and stretching exercises) in the training process in the Bulgarian folk dances (Angelov et al., 2014).

Flexibility is perhaps the single greatest discriminator of gymnastics from other sports (Sands et al, 2015). Flexibility in artistic gymnastics is developed in a complex way which is due to the specificity of the exercises. Namely the specificity of artistic gymnastics exercises supposes the development of the quality flexibility of shoulder joints, coxofemoral joints, increase in the overall mobility of the spinal column in all directions, flexibility of the knee and ankle joints, which will help the gymnasts to perform exercises with a perfect technique according to the code of points. According to Radulov (1982), flexibility is a primary quality of gymnasts and those who do not possess it have great difficulty in learning the exercises and hardly ever reach perfection in their execution. A previous study also showed that specialists in the field of gymnastics (48%) considered the quality flexibility of the most importance as regards gymnasts' preparation (Ivanova, Gancheva, 2016).

The sensitive period of development of motor abilities as regards flexibility is 7-9 years (Dimitrova, 2014). According to Beighton et al. (2012), the range of normal joint movements decreases rapidly throughout childhood. This is one of the reasons why the quality flexibility is one of the main factors in selection of 10-12 years old gymnasts (Hadzhiev, Andonov, Dimitrova, 2011). Nevertheless, the efforts to develop flexibility and its control should be ceaseless due to its significance for the execution of the most difficult exercises mostly at the final stages of the sports career. For instance, according to Gaverdovski (2002) the technique of the Italian giants on a high bar depends on flexibility of the shoulder joints. Also, the use of extraordinary, artificial "working" positions and movements in gymnastics (split, bridge, maximal bends, leg swings with big amplitude, and so on) require a high level of the quality flexibility (Smolevski, Gaverdovski, 1999).

Tracing the improvement and evaluation of the motor qualities, such as flexibility, in artistic gymnastics is carried out with tests (Tŭrnichkova et al., 2016). These tests should be updated regularly, which is applicable to a great extent to specification tables as well. They should be renewed in response to the much higher requirements gymnasts have faced in the recent years.

METHODOLOGY

The aim of the study was updating the system for tracing the improvement and evaluation of young male gymnasts' flexibility.

The main *tasks* of the research are the following:

1. To select suitable tests for evaluation of the quality flexibility.
2. To carry out testing with 10 – 12 years old competitors.
3. To design a 50-grade scale for evaluation of flexibility along the different indexes (tests).

Subject of the research: The quality flexibility.

Object of the research: The different indexes (tests) providing information about the level of development of the quality flexibility of 10-12-year-old male gymnasts.

The research was done among thirty-eight 10-12-year old male gymnasts.

Organization of the research

We present the organization of the research along its different stages which follow the above-mentioned tasks:

Stage one – January – March 2015

During the first stage we selected the appropriate tests needed for the quality evaluation of flexibility. They are described in detail in the method section.

The analysis and selection of the flexibility tests (8 tests) were done on the basis of the level of modern artistic gymnastics and the requirements competitors face as regards the execution of the exercises on the different apparatuses. The tests corresponded to the specifics of the gymnastics exercises. For example: flexibility in coxofemoral joints, registered in tests 3, 4 and 5 (splits) is important for exercises such as "*flair*" on Pommel horse (Thomas circles) and split leaps and jumps on floor. Flexibility in shoulder joints, registered in tests 6 and 8 is important for the exercises "*Slow inlocate from hang" on rings and* "*Adler*" on a high bar, Tests 1 and 2 are important for the exercises *Endo* (*straddled and legs together*), and *Stalder* (*straddled and legs together*) on a high bar. The tests are well-known by the gymnastics coaches in Bulgaria and have been used for more than 50 years now, i.e. their objectivity and validity has been proven. The only new tests are tests 2 and 6 and they require more data (researched individuals) in order to check their validity and objectivity. The standard check is made with a re-test which determines whether the results from the second testing coincide or are similar within certain limits.

The tests are expedient and provide quantitative and qualitative information about the state and preparation of the athletes as regards the researched issue – flexibility.

Stage two – April - June 2015

During this stage we carried out the testing with the competitors of all age groups 10 - 12 years.

The rationale behind organizing these groups was based on the fact that the group (10 - 12 years old) performs compulsory routines and the development of the quality flexibility is built and refers to the exercises included in these routines to a great extent. Even if we take a brief look at the exercises included in the routines of the gymnasts in this age group, we can see the necessity of the high level of development of flexibility. This age period comprises the second stage of the sports preparation of many years – initial sports specialization (Hadzhiev, Andonov, Sergiev, 2010).

Stage three – July – October 2015

During this stage we analyzed the results from the testing (Variation analysis) and designed specification tables for control and evaluation of the different indexes along a 50-grade (point) scale. 50-grade (point) scale is well-known and used by sports specialists for evaluation of athletes' motor qualities (Kurmulis, 2009). As mentioned below, it allows for the evaluation of the achievement and its increase with 2%. We believe that whether or not the 50-point scale is suitable, depends on the range (R) ($R = X_{max} - X_{min}$). When there is a "big" range, a 100-point scale could be used as well.

Research methods

We used the following research methods:

- Analysis and synthesis of the movements.
- Sports-pedagogical testing.
- Math statistical methods.
  - Variation analysis – $\overline{X}$ (mean), S (standard deviation), V (variation), minimum, maximum, As (asymmetry), Ex (excess).
  - Method of sigma variance.

In order to design the specification tables, we used the method of the sigma digressions. According to this method for evaluation of the condition of the researched subjects, the evaluated index is compared with the average level of the same index. The main characteristics used are mean arithmetical value and standard

deviation (Tsarova, 2013).

The sigma method for evaluation enables the quantitative evaluation of (in our case) flexibility with respect to the different tests. The values are calculated on the basis of the average level of each of the researched combinations, which is a prerequisite for the design of specification tables for control over sports preparation. The received values are specified and presented in 50-grade point system (from 1.0 to 50.0 – with 1.0 in between). This enables the comparison of the achievements along different tests and indexes measured in sec, m, kg, number, etc. The average level is 25 points. In case a higher quality (e.g. time for running a distance) corresponds to a lower value of the result along a certain index, the scale is reversed (Borukova, 2018).

Specification tables provide us with the opportunity to quickly evaluate a certain individual along a particular index right after the testing. Also, the 50-grade point system (unlike the 5-grade one, 7-grade one, etc.) enables the evaluation of a smaller increase in the achievements, which practically affects, on the one hand, the optimal management of the training process, and on the other hand, influences positively athletes' motivation.

For example, for the design of 7-point scale specifications with the use of percentiles, P_2, P_{16}, P_{30}, P_{70}, P_{84} and P_{98} must be calculated. A drawback of this assessment scale is the fact that a rather big percentage (40%) of the cases fall into the zone (between P_{30}, and P_{70}) around the mean value which makes the specification not selective enough. In fact, an achievement coinciding with the mean value and later increased by 15% is not registered as an achievement along the 7-point scale. This problem is solved with the 50-grade point system. If we look at test 7 (Bridge) in table 3 (below), we will see that at angle 90°, the gymnast receives 12 points for this achievement, and at angle 100° he will receive 23 points, i.e. with 10° increase, which is almost 20% achievement, it will be registered on the scale and will give the gymnast (in this case) twice as many points.

Tests (indexes):

1. Test (index)

The gymnast gets on a bench; the legs are brought together; the toes are on the edge of the bench – a bend forward is performed with extended legs. The distance between the upper edge of the bench and the tips of the fingers is measured. (Figure 1)

After the execution of the bend, when the gymnast reached the final position, we took a photo from 2 m distance with a high definition camera, so that we could later, by using the zoom option (1a), record the result on the evaluation scale.

Figure 1. *Test Bend on a gymnastics bench.*

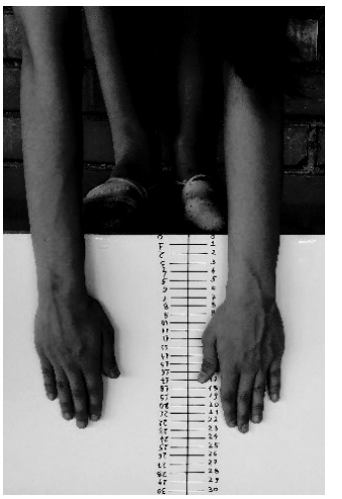

Figure 1a. *Zoom of test №1.*

2. Test (index)

A sitting straddle position on the floor; the heels of both feet are placed on the bench so that there is a 90^o – 100^o angle between the legs. A bend forward is performed (below the bench) – the distance between the floor and chest (the most upper part of the breast bone) is measured. (Figure 2).

Prior to the execution of the exercise, we measured the angle between the legs (Figure 2c) with a goniometer shown in Figure 2a and 2b.

We took a frontal photo of the gymnast from a distance of 2 m with a high definition camera, so that we could later, by using the zoom option (Figure 2d), record the result on the evaluation scale.

Figure 2. *Bend with legs extended to the sides, placed on a 40 cm high gymnastics bench.*

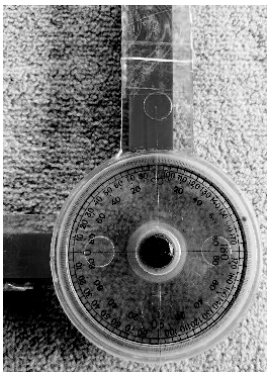

Figure 2a. *Goniometer (Close view)*

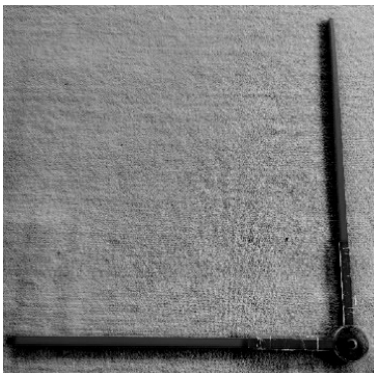

Figure 2b. *Goniometer*

Figure 2c. *Measuring the angle between the legs.*

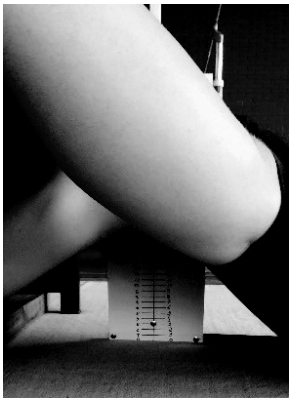

Figure 2d. *Zoom of Figure 2*

3. Test (index)

It is performed in a straight line. The pelvis should be against the wall. The distance between the floor and the lowest part of the pelvis is measured. (Figure 3).We took a photo of the gymnast from a distance of 2 m, so that we could later, by using the zoom option, record the result on the evaluation scale on the wall (Figure 3a).

Figure 3. *Side split (in cm)*

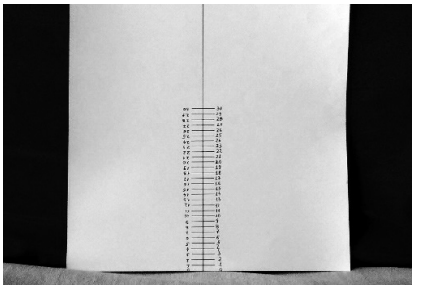

Figure 3a. *Measurement scale*

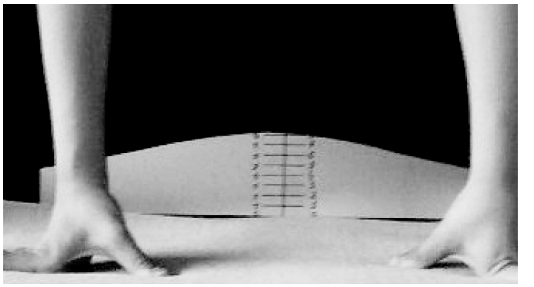

Figure 3b. *Zoom of the picture in Figure 3 of flexibility of the splits (in cm)*

4. Test (index)

The gymnast performs a Left front split. It is performed in a straight line. The gymnast's left shoulder should be against the wall. The distance between the floor and the lowest part of the pelvis is measured. (Figure 4).

The way we measured the result was the same as the one shown in Figure 3 (Side split). We used the measurement scale in Figure 3a.

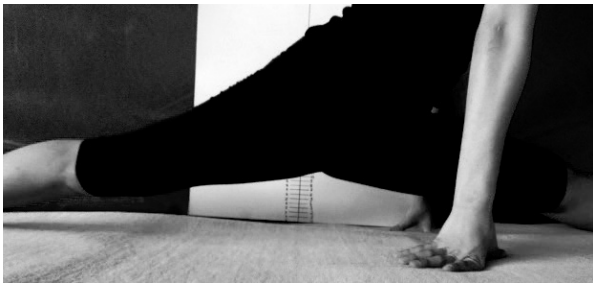

Figure 4. *Left front split.*

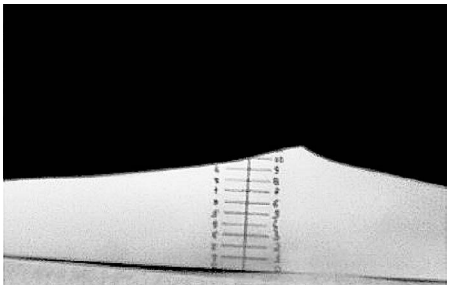

Figure 4b. *Zoom of the picture in Figure 4*

5. Test (index)

The gymnast performs right front split. It is performed in a straight line. The right shoulder should be against the wall. The distance between the floor and the lowest part of the pelvis is measured (Figure 5).

The way we measured the result was the same as the one used in Figure 3a (Side split). We used the measurement scale in Figure 5a.

Figure 5. *Right front split.*

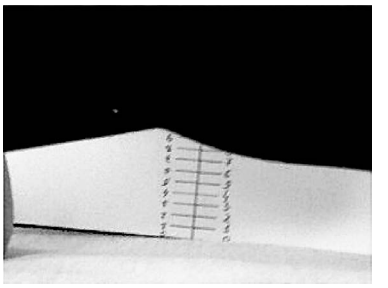

Figure 5a. *Zoom of the picture in Figure 5*

6. Test (index)

From a pike sit – hands slip backwards / in cm/. The distance between the floor and the armpit is measured (in cm). (Figure 6).

Figure 6. *From a pike sit – hands slip backwards (in cm)*

Requirements for the test: extended arms, palms on the floor next to each other (Figure 6a).

As soon as the gymnast reached the final position, after sliding his hands backwards, we placed the measurement scale (Figure 6b), after that we took a photo.

The way we measured the result was the same as the one in Figure 3a (Side split). We used the measurement scale in Figure 6b.

Figure 6a. *Position of arms for execution of the test.*

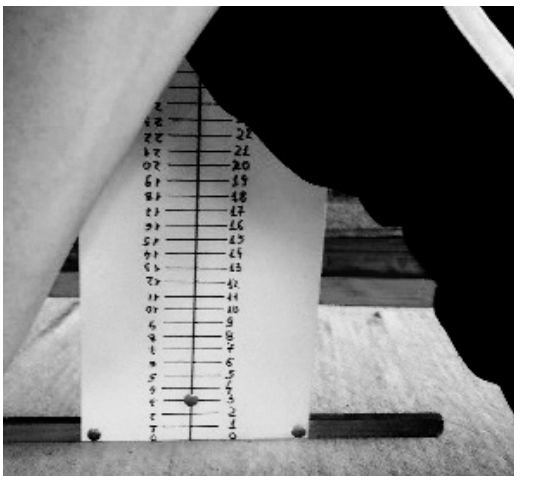

Figure 6b. *Measurement scale.*

7. Test (index)

The inner angle between the floor and the shoulders is measured. (Figure 7).

We measured the angle with a goniometer, shown in Figure 2b. The requirements for execution of the bridge were: extended legs and arms, feet and hands on the floor approximately shoulder-width apart.

Generally, the angle we measured is a function of the sum of the flexibility of the shoulder joints and the spinal column, i.e. the test had to measure the sum of the flexibility regardless of the fact which joint was more flexible – the shoulder joint or the spinal cord. The aim of this test is not the correct technical execution of a bridge. The aim is the gymnast to open the measured angle as much as possible. In this case the angle in the shoulder joints can reach over 180°. There are other flexibility tests which register flexibility only in the shoulder joints or only in the spinal column, separately.

„More modern approaches to spine stretching in gymnastics encourage the position" in Figure 7, while discourage the position in Figure 7d (Sands et al, 2015).

Figure 7. *Bridge measured with goniometer*

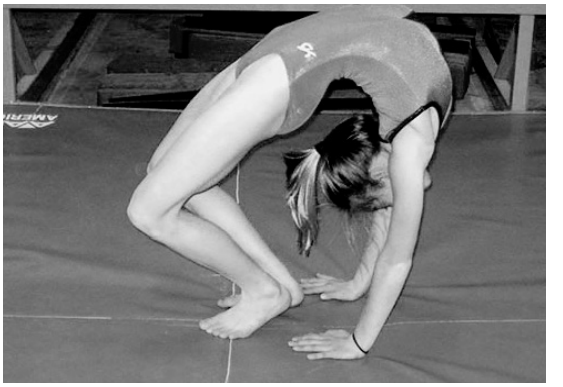

Figure 7d. *Bridge.*

8. Test (index)

Shoulder dislocates with a rod (Figure 8a, 8b).

The distance between the wrists is measured. (Figure 8c)

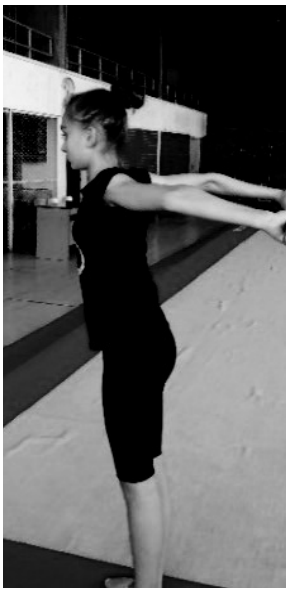

Figure 8a, Figure 8b. *Shoulder dislocation.*

Figure 8c. *Distance between the wrists.*

RESULTS

The indexes characterizing flexibility are shown in Table 1. The measurement units, the accuracy of measurement and the direction of increase can be seen. Only with two of the indexes (№ 1 and 7) the direction of increase is positive, while along the other indexes – it is negative.

Table 1. *List of indexes characterizing flexibility*

№	Indexes \ Parameters	Units	Accuracy of measurement	Direction of increase
1.	Bend with legs brought together (gymn. bench)	cm	1,0	+
2.	Bend with extended legs to the sides (gymn. bench)	cm	1,0	-
3.	Side split (floor)	cm	1,0	-
4.	Left front split (floor)	cm	1,0	-
5.	Right front split (floor)	cm	1,0	-
6.	Pike sit, sitting position, slip (floor)	cm	1,0	-
7.	Bridge (floor)	degrees	1,0	+
8.	Shoulder dislocates with a rod (floor)	cm	1,0	-

The results from the variation analysis are shown in Table 2. It can be observed that only along one of the indexes (№ 7) the group is homogeneous ($V = 9.5$ %), and along the other indexes – the group is highly non homogeneous, coefficient of variation (V) is over 30%. Also, as regards excess and asymmetry, we can claim that the distribution is not a normal one, except for indexes № 1, 7 and 8, which have a normal distribution. The critical values of asymmetry (As) and excess (Ex) at a significance level 0.05 are 0.58 and 0.85 respectively. The critical values of the coefficient of excess and asymmetry are determined from well-known statistical tables on the basis of the number of the researched individuals (n) and the significance level of α (in our case $\alpha = 0.05$). When the obtained values are below the critical value in the table of the critical values, there is a normal distribution, as we can see in tests 1, 7 and 8.

Table 2. *Variation analysis of the indexes characterizing flexibility – 10 - 12 years of age*

№	Indexes \ parameters	$\overline{X}$	S	V (%)	min	max	As	Ex
1.	Bend with legs brought together (gymn. bench)	16,29	10,35	63,55	0	26	-0,94	-0,92
2.	Bend with extended legs to the sides (gymn. bench)	3,37	7,46	221,55	28	0	2,55	6,46
3.	Side split (floor)	0,16	0,69	435,89	3	0	4,36	19,00
4.	Left front split (floor)	0,26	1,15	435,89	5	0	4,36	19,00
5.	Right front split (floor)	0,24	1,14	475	5	0	4,32	19,05
6.	Pike sit, sitting position, slip (floor)	9,34	2,42	25,86	16	5	0,98	2,16
7.	Bridge (floor)	101,53	9,65	9,50	71	127	0,09	-0,95
8.	Shoulder dislocates with a rod	20,63	14,71	71,31	51	0	0,38	-0,51

Table 3. *Specification table – gymnasts 10 - 12 years of age*

Points	1. Bend with legs brought together (gymn. bench) cm	2. Bend with extended legs to the sides (gymn. bench) cm	3. Side split (floor) cm	4. Left front split (floor) cm	5. Right front split (floor) cm	6. Pike sit, sitting position, slip (floor) cm	7. Bridge (floor) degrees	8. Shoulder dislocates with a rod (floor) cm
50	27,88	0,00	0,00	0,00	0,00	4,34	124,03	2,88
49	27,41	0,09	0,00	0,01	0,00	4,54	123,13	3,59
48	26,95	0,22	0,01	0,02	0,01	4,74	122,23	4,30
47	26,49	0,35	0,02	0,03	0,02	4,94	121,33	5,01
46	26,02	0,48	0,02	0,04	0,03	5,14	120,43	5,72
45	25,56	0,61	0,03	0,05	0,04	5,34	119,53	6,43
44	25,10	0,74	0,04	0,06	0,05	5,54	118,63	7,14
43	24,63	0,87	0,04	0,07	0,06	5,74	117,73	7,85
42	24,17	1,00	0,05	0,08	0,07	5,94	116,83	8,56
41	23,71	1,13	0,06	0,10	0,08	6,14	115,93	9,27
40	23,24	1,27	0,06	0,11	0,09	6,34	115,03	9,98
39	22,78	1,41	0,07	0,12	0,10	6,54	114,13	10,69
38	22,31	1,55	0,07	0,13	0,11	6,74	113,23	11,40
37	21,85	1,69	0,08	0,14	0,12	6,94	112,33	12,11
36	21,39	1,83	0,09	0,15	0,13	7,14	111,43	12,82
35	20,92	1,97	0,09	0,16	0,14	7,34	110,53	13,53
34	20,46	2,11	0,10	0,17	0,15	7,54	109,63	14,24
33	20,00	2,25	0,11	0,18	0,16	7,74	108,73	14,95
32	19,53	2,41	0,11	0,19	0,17	7,94	107,83	15,66
31	19,07	2,57	0,12	0,20	0,18	8,14	106,93	16,37
30	18,61	2,89	0,13	0,21	0,19	8,34	106,03	17,08
29	18,14	2,73	0,13	0,22	0,20	8,54	105,13	17,79
28	17,68	3,05	0,14	0,23	0,21	8,74	104,23	18,50
27	17,22	3,21	0,15	0,24	0,22	8,94	103,33	19,21
26	16,75	3.29	0,15	0,25	0,23	9,14	102,43	19,92
25	**16,29**	**3,37**	**0,16**	**0,26**	**0,24**	**9,34**	**101,53**	**20,63**
24	15,56	4,11	0,28	0,46	0,44	9,58	100,67	22,10
23	14,83	4,86	0,41	0,66	0,63	9,82	99,81	23,57
22	14,10	5,61	0,53	0,85	0,83	10,06	98,95	25,04
21	13,37	6,35	0,66	1,05	1,03	10,30	98,09	26,51
20	12,64	7,10	0,78	1,25	1,23	10,54	97,23	27,98
19	11,91	7,84	0,91	1,45	1,42	10,78	96,37	29,45
18	11,18	8,59	1,03	1,64	1,62	11,02	95,51	30,92
17	10,45	9,34	1,16	1,84	1,82	11,26	94,65	32,39
16	9,72	10,08	1,28	2,04	2,01	11,50	93,79	33,86
15	8,99	10,83	1,41	2,23	2,21	11,74	92,93	35,33
14	8,31	11,57	1,53	2,43	2,41	11,98	92,07	36,80
13	7,63	12,32	1,66	2,63	2,60	12,22	91,21	38,27
12	6,95	13,07	1,78	2,82	2,80	12,46	90,35	39,74
11	6,27	13,81	1,91	3,02	3,00	12,70	89,49	41,21
10	5,59	14,56	2,03	3,22	3,20	12,94	88,63	42,68
9	4,91	15,30	2,16	3,42	3,39	13,18	87,77	44,15
8	4,30	16,05	2,28	3,61	3,59	13,42	86,91	45,62
7	3,69	16,80	2,41	3,81	3,79	13,66	86,05	47,09
6	3,08	17,54	2,53	4,01	3,98	13,90	85,19	48,56
5	2,47	19,03	2,66	4,20	4,18	14,14	84,33	50,03
4	1,86	19,78	2,78	4,40	4,38	14,38	83,47	51,50
3	1,25	20,53	2,91	4,60	4,57	14,62	82,61	52,97
2	0,64	21,27	3,03	4,79	4,77	14,86	81,75	54,44
1	0,00	22,02	3,16	4,99	4,97	15,10	80,89	55,91

The specifications for each index are shown in Table 3. They are distributed in a 50-grade scale. The competitor receives certain number of points for each achievement.

For example: Test № 1 – if the competitors have achieved a result of 26 cm, they get 46 points.

There are a few options for calculation of the total grade on the base of all indexes of flexibility:

- ✓ The sum of the number of points received along all indexes. Thus, the maximum number of points is 400 points.
- ✓ $\overline{X}$ The use of an average grade index – mean arithmetic value – the total number of points from all the tests is divided by 8. Thus, the maximum number of points is 50.
- ✓ The third approach requires more profound studies. We should establish the factor weight of each index, i.e. every index will have a different weight when forming the total grade. However, this will be subject of future research.

At this stage, we can successfully use the first two options for calculation of the total grade for evaluating the quality flexibility.

CONCLUSIONS

The obtained results are interesting for the specialists since they can be viewed as a database which was not available in the past.

The results from the tests will help the upgrading of the specification tables for observing, tracing of the improvement and evaluation of flexibility.

Based on the testing, collected information and specification tables made we can improve the management and evaluation of the temporary state of competitors' flexibility at each stage of the preparation. We will also be able to evaluate (notice) the smallest changes (increase) in the indexes during the preparation both in positive and negative aspect.

In conclusion we can say that gathering more data (testing) will allow the precision of these specification tables so that they could become more informative. Because the researched individuals are some of the best in the age group 10-12 years, we can claim that the results from the tests could be considered model characteristics for the gymnasts of this age as regards flexibility.

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Corresponding author:

Georgi Sergiev
Department of Gymnastics
National Sports Academy "Vassil Levski"
Studentski grad, 21, Acad. Stefan Mladenov str.
Sofia 1700, Bulgaria
E-mail: sergiev_nsa@abv.bg