The Journal of International Anatolia Sport Science

Volume: 7, Issue: 3, 2022

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Ref. Num.	JIASS-93585
Manuscript Category	Movement and Training Science
Manuscript Type	Original research

https://doi.org/10.5505/jiasscience.2022.93585

THE INFLUENCE OF SPORTS GYMNASTICS ON THE MOTOR SKILLS OF FEMALE STUDENTS

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ABSTRACT

Aim: The wealth of movements and positions in sports gymnastics allows the person who exercises them to create a huge fund of motor knowledge. The aim of the research is to determine the influence of the sports gymnastics program on the motor skills of female students. **Material and Method:** The research was conducted on a sample of 15 regular female students aged 20-22 years ± 6 months. The experimental program of sports gymnastics was conducted for the duration of 15 weeks x 2 hours during the week. A sample of specific motor tests for sports gymnastics: push-ups, pull-ups, sweeps, long jump, trunk lifting, leg lifting, lunge, squat. **Results:** Based on the applied T test for paired samples, a statistically significant difference was found in all tested variables. **Conclusion:** : It can be concluded that the sports gymnastics program significantly raised the level of motor skills among female students.

Keywords: Female students, Tests, Training effects, Gymnastics

Received: December 2022

Accepted: December 2022

Published: December 2022

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Source of Finance

During this study, no financial or spiritual support was received from any company that has a direct connection with the research subject, which could negatively affect the evaluation process of the research.

https://doi.org/10.5505/jiasscience.2022.93585

INTRODUCTION

Sports gymnastics is a polystructural, conventional sport based on complex movements, performed in accordance with aesthetic criteria and strictly defined rules. As one of the basic sports, gymnastics has a significant impact on the transformation of an individual's psychosomatic status (Sweeney et al., 2018). Sports gymnastics is characterized by an extraordinary richness and complexity of elements, arranged in structural groups, within the framework of competitive disciplines (Fulurija et al., 2019).

Basic motor skills can predict the level of physical functioning and abilities in later life stages (Barnett et al., 2008; Barnett et al., 2009; Jaakkola et al., 2015). Physical activity is not only important for proper growth and development, but also for the development of motor skills and abilities (Pedrycz et al., 2016). In the testing of motor abilities, appropriate measuring instruments, or tests, are systematically used, with the aim of quantifying their motor behavior and thereby monitoring their motor development (Mohsen et al., 2011; Aksović et al., 2021; Bjelica et al., 2021; Manojlović et al., 2022).

Gymnastics training has a positive effect on the development of balance and enables almost perfect stability, even in difficult conditions (Atilgan et al., 2012). There are numerous factors that affect balance, the most important of which are genetic determination, the condition of the vestibular apparatus, age, support surface, height of the body's center of gravity, and numerous motor habits (Nar, 2011). As a basic sport, gymnastics affects the development of motor skills: strength, coordination, flexibility and balance (Arruda & Farinatti, 2007; Carrick et al., 2007). In terms of coordination, gymnastic elements are classified as the most complex movements. Testing and periodic monitoring of the abilities of young athletes is also important for defining training programs adapted to the demands of sport and age. In this way, a harmonious and optimal development of fundamental motor skills is achieved in accordance with the athlete's physical development (Ricotti, 2011). The largest number of tests refers to motor skills, but also the assessment of psychological characteristics (Waples, 2003). The specificities of athletes in sports disciplines are the result of selection and, on the other hand, the specific effects of activities that that discipline creates (Čuk et al., 2007). The wealth of movements and positions in exercising on the devices enables the person who exercises them to create a huge fund of motor knowledge. A large fund of motor knowledge, along with good physical preparation and health, makes a person live better, but also to be ready to react adequately in any sudden situation in everyday life (Fulurija et al., 2017). Therefore, the aim of the study is to determine the influence of the sports gymnastics program on the motor skills of female students. The research hypothesis is that a 15-week gymnastics training program will have positive effects on the motor skills of female students.

MATERIALS AND METHODS

Research Pattern

The study was designed as a pre-test and post-test experimental study without a control group.

Participants

The research was conducted on a sample of 15 regular female students aged 20-22 years ± 6 months who attended and successfully completed the third-year gymnastics program at the study program of sport and physical education of the State University in Novi Pazar. For the period of one semester (15 weeks), the practice frequency is 2 hours a week. Since all subjects were volunteers, they were allowed to withdraw from the experimental treatment at any time during the program. During the experiment, they did not participate in any other physical activity, and were advised to continue with their daily life activities and with their usual diet. The study was conducted accordingly the Declaration of Helsinki and the protocol was fully approved by the Ethics Committee of the of the State University in Novi Pazar and the Sport and Physical Education study

https://doi.org/10.5505/jiasscience.2022.93585

program before commencement.

Sample of Variables

The following variables were used to assess the motor skills of gymnasts (Fulurija et al., 2016; Paunović et al., 2018; Miletić et al., 2019; Kravchuk et al., 2020):

Push-ups (MSKL),

Pull-ups (MUZM),

Sweeps (MMET),

Long jump (MSKD),

Trunk lifting (MODT),

Leg lifting (MODN),

Lunge (MPRD),

Squat (MCUC).

Test Description

Push-ups (MSKL)

The starting position of the test subjects is holding on to the hands, straight legs and feet slightly apart. The back should be kept in a straight line from head to toes throughout the body. From the initial position, he has the task of touching the ground with his chin at least 10 cm in front of the line where his hands are placed, in such a way that he will bend his arms at the elbows and lower his body, while the bent elbows must be next to the body (do not separate them from the body inside). The task is finished when the subject is no longer able to perform the given movement correctly. The number of correctly executed attempts is evaluated.

Backlash on the shaft - Pull-ups (MUZM)

The starting position of the test subjects is the position of Vise on the Swedish ladder. From the starting position, he has the task of performing the maximum number of swings, with his legs extended, touching the top rung of the Swedish ladder with his toes and returning to the starting position. The number of correct repetitions in a time interval of 30 seconds is entered.

Sweeps (MMET)

The starting position of the test subjects is the front stance on the horse with the grips, by taking off the left or right leg, pass over the grip of the hand with which we started with the leg, take the grip while riding. Then follows the same exercise with the free leg in order to change the position of the rear support from the rear support, we move with the leg with which we performed the first movement and immediately after it the second leg moves to change the position of the front support. This represents one sweep.

Long jump (MSKD)

The starting position of the test subjects is shoulder width apart, with the face turned towards the subjects, with the tips of the fingers placed directly behind the line. The task of the respondent is to with a powerful swing of the arms and a reflex of the feet jump forward as far as he can. After the subject has performed the correct jump, she approaches the mat and reads the result. The better result from two attempts is entered, and the result is read in centimeters.

Trunk lifting (MODT)

The starting position of the subjects is lying on the Swedish chest, so that the ridges of the pelvic bones are right on the edge of the chest, and the trunk is vertically down with the legs fixed. He has his hands crossed behind his neck. The examiner stands on the right or left side of the subjects and counts the lifts. On cue, the subject straightens the trunk to a horizontal position at a moderate pace, without stopping, until failure. The task is over when the subject is no longer able to perform the given movement correctly. The result is the total number of correctly performed trunk lifts.

Leg lifting (MODN)

The initial position of the subjects is lying on their back on the mat. He has his hands crossed behind his neck. The examiner stands to the right or left

https://doi.org/10.5505/jiasscience.2022.93585

of the subject and counts the lifts. On cue, the subject raises her legs at a moderate pace, up to 90° without stopping, until failure. The task is over when the subject is no longer able to perform the given movement correctly. The result is the total number of correctly performed leg raises.

Forefoot on the loom - Lunge (MPRD)

The initial position of the test subjects is resting on the parallel bars. The test subject places her stretched legs in front, on a transversely placed stick. At the sign of the gauge, hold on in the lead. The test is stopped when he touches the stick with his feet or bends his legs, and the time achieved in seconds is recorded.

Squat (MCUC)

The initial position of the test subjects is in a straddling stance with feet shoulder width apart. The test subject's task is to do as many squats as she can in the given time, in such a way that the trunk is upright and the lower leg and upper leg in a deep squat form an angle of about 45°.The task is completed after the subject performs the correct exercises in time, and the number of correctly performed squats in seconds is entered.

Research Design

The program consisted of the realization of gymnastic elements from sports gymnastics that were realized in the summer semester and lasted continuously until May 26, 2022. year, more specifically, one semester. Students applied the plan and program that they had to take in the practical part of the exam. At the beginning of the implementation of the program, an initial, and finally a final measurement of the tests represented in the research was carried out, with the aim of determining the variability of the results of the initial and final condition in the students' motor abilities (a detailed description of the program is given in the Appendix at the end of the paper). The initial and final evaluation was done by professors in the subject of theory and methodology of sports gymnastics. The initial assessment was carried out on February 22, 2022. On the first day of work in the 6th semester when, according to the curriculum, the implementation of the Theory and Methodology of Sports Gymnastics course began. The final evaluation was carried out on May 24, i.e., at the end of the 6th semester. The evaluation was done in the afternoon at a temperature of 18-22 C^{o} (Attachment 1).

Data analysis

In the first phase of the analysis of the results, the basic descriptive statistical indicators were calculated, especially for the initial and especially for the final assessment. The evaluation of the effectiveness of the teaching of sports gymnastics was performed by testing the differences of arithmetic means using the student T-test of paired samples.

RESULTS

Table 1 shows the basic descriptive parameters of the motor skills of female students at the initial measurement.

Table 1. Basic statistical parameters of female students at the initial measurement

Variables	Min	Max	Mean	Std. Dev.	Skewness	Kurtosis
MSKL	0	20	10.07	5,365	,172	-,120
MUZM	1	15	6,13	4,373	,748	-,610
MMET	2	14	6,13	3,701	1,147	,315
MSKD	170	233	202.27	19,341	-,229	-,553
MODT	10	50	26,20	10,988	,129	,337
MOD	0	25	9.47	6,323	,998	1,490
MPRD	3	18	9.07	4,682	,679	-,781
MCUC	16	38	26.00	6,448	,232	-,909

https://doi.org/10.5505/jiasscience.2022.93585

Skewness values show that there are no significant deviations from the normal distribution, given that the values do not exceed 1. This means that the distribution of all variables at the initial measurement is symmetrical, that is, that the distribution curve of the results is within normal limits and that there are the most results around the mean value. Only in the case of the MMET variable (Skewness=1.147), where this value is positive and slightly above the limit, making the distribution curve inclined towards smaller values.

Kurtosis values in all tests are below 2.75, which indicates a platykurtic distribution, i.e., smaller values of the flattening of the result distribution curve indicate that for all variables at the initial measurement the flattening is within the limits of the platykurtic curve. The obtained results of motor abilities do not deviate from the results of similar research on this population of participants, and thus the application of statistical methods of processing the results in this research is enabled.

Table 2 shows the basic descriptive parameters of motor skills of female students at the final measurement.

Table 2. Basic statistical parameters of female students at the final measurement

Variables	Min	Max	Mean	Std. Dev.	Skewness	Kurtosis
MSKL	5	22	13,27	4,350	,050	,109
MUZM	3	15	7.27	3,973	,774	-,490
MMET	13	29	20,20	4,601	,329	-,813
MSKD	200	240	217.07	11,190	,123	,060
MODT	17	50	30.93	7,630	,487	2,460
MOD	7	27	12.60	5,475	1,414	2,169
MPRD	6	20	12.00	4,472	,381	-1,131
MCUC	16	41	29.67	6,241	-,376	,544

Skewness values show that there are no significant deviations from the normal distribution, given that the values do not exceed 1. This means that the distribution of all variables at the initial measurement is symmetrical, that is, that the distribution curve of the results is within normal limits and that there are the most results around the mean value. Only in the case of the MMOD variable (Skewness=1.141), where this value is positive and slightly above the threshold, making the distribution curve inclined towards smaller values.

Kurtosis values in all tests are below 2.75, which indicates a platykurtic distribution, i.e., smaller values of flattening of the result distribution curve indicate that for all variables at the initial measurement the flattening is within the limits of the platykurtic curve. The obtained results of motor abilities do not deviate from the results of similar research on this population of participants, and thus the application of statistical methods of processing the results in this research is enabled.

The results of the T-test of paired samples to determine the differences between the initial and final measurements in the applied variables for the assessment of motor abilities between the initial and final measurements are shown in Table 3.

https://doi.org/10.5505/jiasscience.2022.93585

Table 3. Results of T test of paired samples - significance

Statistics	Paired Differences					t	df	p
	Mean	Std. Dev.	Std. Error Mean	95% Con. Interval of the Diff. Lower	Upper			
Pair 1 MSKL-MSKL	-3,200	2,455	,634	-4,560	-1,840	-5,048	14	,000
Pair 2 MUZM-MUZM	-1,133	1,246	,322	-1,823	-,443	-3,523	14	,003
Pair 3 MMET-MMET	-14,067	4,431	1,144	-16,521	-11.61	-12,294	14	,000
Pair 4 MSKD-MSKD	-14,800	10,157	2,623	-20,425	-9,171	-5,643	14	,000
Pair 5 MODT-MODT	-4,733	5,713	1,475	-7,897	-1,570	-3,209	14	,006
Pair 6 MODN-MODN	-3,133	2,850	,736	-4,712	-1,555	-4,258	14	,001
Pair 7 MPRD-MPRD	-2,933	2,963	,765	-4,574	-1,292	-3,834	14	,002
Pair 8 MCUC-MCUC	-3,667	3,109	,803	-5,388	-1,945	-4,568	14	,000

By looking at the results, it can be concluded that after the experimental gymnastics program there were statistically significant differences between the initial and final measurements at the level of statistical significance ($p<0.05$) in all variables MSKL (t=-5.048; p=.000), MUZM (t=-3.523; p=.003), MMET (t=-12.294; p=.000), MSKD (t=-5.643; p=.000), MODT (t=-3.209; p=.006), MODN (t=-4.258; p=.001), MPRD (t=-3.834; p=.002), MCUC (t=-4.568; p=.000).

DISCUSSION

The primary purpose of the study was to determine the effects of the sports gymnastics program on the motor skills of female students. The obtained results showed that the experimental group, which applied the sports gymnastics program, made statistically significantly greater progress compared to the initial measurement among female students. This means that the experimental gymnastics program lasting 15 weeks (2 hours per week) had positive effects on improving the results between the two tests of motor skills in female students. The results obtained in this way can be said to be expected. The reason for such a statement lies in the fact that the subjects subjected to the experimental program, in their classes, implemented the plan and program of sports gymnastics according to the curriculum within the subject of theories and methods of sports gymnastics.

The age characteristic of the subjects who were subjected to the experimental program is an important component. The sample of respondents in this research consisted of female students (20-22 years ± 6 months), whose age is suitable for using adequately planned sports gymnastics exercises. Maturity of the bone-nervous system is an important component and greatly affects the motor skills of gymnasts (Thomas et al., 2019) and gymnasts (Miletić et al., 2022). It should be emphasized that gymnastics programs are recommended for adolescents (Trajković et al., 2016; Miletić et al., 2022) as well as for students at younger school age (Zetaruk, 2000), because the bone-joint system is in the phase of growth and hardening, because more intensive ossification begins after the age of nine, but not evenly in all parts of the body (Hassmannová et al., 2019). Therefore, experimental gymnastics programs are fully recommended for all ages as a means of improving motor skills.

Each gymnastics class in the conducted study

https://doi.org/10.5505/jiasscience.2022.93585

consisted of a part in which exercises were performed with the aim of warming up the organism of the test subjects, raising the body temperature of the body, preparation of muscles, tendons and ligaments, for the realization of tasks in the main part of the lesson. The fact that no injuries were recorded during the entire experimental program indicates proper planning and dosage of the load. The recommendation for the duration of an experimental gymnastics program with positive effects on motor skills is 12 weeks or more (Paunović, 2018; Miletić et al., 2019; Kravchuk et al., 2020). The experimental gymnastics program in this study lasted 15 weeks (2 hours per week), after which the results confirmed the positive impact on motor skills and the recommendations of previous research.

However, there are studies that indicate that experimental gymnastics programs of shorter duration can have positive effects on the motor skills of gymnasts. Ahmed (2016) obtained results showing that an eight-week gymnastics coordination program has a positive effect on the accuracy and speed of performance. Similar results are confirmed by Hall et al. (2016) where the authors on a sample of young gymnasts obtained results that show the positive effects of plyometric training in combination with gymnastics training for six weeks on the strength and explosive power of the gymnasts. Therefore, further studies are necessary in order to fully clarify the impact of the gymnastics program on the motor skills of female gymnasts.

The positive effects of gymnastic exercise programs on motor skills are confirmed by other studies (Rudd et al., 2017; Dallas et al., 2019). Rudd et al. (2017) conducted a study to determine the effectiveness of an eight-week gymnastics program on coordination. The results of the study showed that the lower age group showed significant improvement in basic movement skills, while the older age group showed significant improvement in general body coordination and basic movement skills. Dallas et al. (2019) conducted a study on a sample of female gymnasts with the aim of determining the effects of dynamicragrips on speed and agility. The results of the study show that the training program has a positive effect on speed and agility. Interesting results were obtained in the study Santos et al. (2016) where the results showed that the top gymnasts of the national team do not achieve the expected superiority in tests of explosive strength, compared to the gymnasts of the junior team. Positive effects of the sports gymnastics program the transformation of motor skills is also proven by studies (Phew, 2013; Rudd 2016; Dabović, 2017; Paunović, 2018).

Phew (2013) obtained results that show that a gymnastic exercise program implemented in physical education classes has a positive effect on the transformation of young gymnasts' motor skills. Similar results are confirmed by (Rudd 2016; Dabović, 2017), which indicate that the gymnastics program implemented in the physical education curriculum develops motor fitness better than the regular curriculum. In his doctoral dissertation, Paunović (2018) obtained results that showed that after an experimental gymnastics program lasting 16 weeks, the experimental group achieved statistically significantly greater progress than the control group on all variables that assessed the body composition, flexibility and motor skills of young gymnasts. Therefore, the implementation of sports gymnastics in the curriculum for primary and secondary school students and female students has a positive effect on the transformation of motor skills.

Although the obtained results clearly show that a 15-week gymnastics training program (2 hours per week) has a positive effect on the motor skills of female students, the limitations of the study should certainly be pointed out. The first limitation of this study is the relatively small sample of respondents (n=15). Second, in order for the results to be more objective, it is certainly advisable to have a control group. Third, although the results in point to the positive effects of gymnastics on the motor skills of female students, the applicability of the obtained results remains limited to other ages,

levels of competition (level of competition) and men. Therefore, further studies are necessary in order to fully clarify the impact of gymnastic exercise programs of different durations on the motor skills of male and female gymnasts, which is a recommendation for future researchers.

CONCLUSION

The research was carried out on a sample of 15 female students aged 20-22 years ± 6 months who attended and successfully completed the third-year course in the sports and physical education study program of the State University in Novi Pazar. For the period of one semester, the practice frequency is 2 hours a week. The results showed that the score measurements for all variables differ significantly in the final phase from those measured at the beginning (in the initial phase). Despite numerous limitations, we can conclude that the influence of sports gymnastics teaching is on the success of mastering the technique of sports gymnastics. So, our hypothesis is confirmed. Based on the analysis of the results of the research, where we found that the sports gymnastics program significantly raised the level of motor skills among female students, it is also a way to achieve quality in the continuous professional work of the teaching process in the subject of sports gymnastics. It should also be mentioned that gymnastics programs are also recommended for students at younger school age.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author(s).

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APPENDICES

[Attachment 1]

PLAN AND PROGRAM
PRACTICAL EXAM FOR FEMALE STUDENTS

GROUND FLOOR

PART	DESCRIPTION OF THE EXERCISE	VALUE
I	With 2-3 steps of running, jumping into a flying reel, with persistence to the halting position, hand over.	1.50
II	Reel forward to the stop in stride, with the trunk bending the arms forward in relinquishment.	0.50
III	By placing the head on the ground by pulling through the legs until connected, stand on the head, hold on.	0.70
IV	By extending the arms, hold on the hands, crouched through to the hold in front of the hands, indicate, turn 180* to the hold on the hands, and sp. sločnosti upor standing, slošno, to cause.	0.80
V	With a deep forward bend, sit and s.p. roll back through the stance on the fists, standing still.	1.00 am
VI	Leaning and with a high foreleg of the right, the page is turned to the right and sp. with a ¼ turn to the right of the hand in a handstand (preparation for the stance on the fists)	1.00 am
VII	Stance on the fists, indicate also sp. roll forward to squat.	0.80
VIII	Lateral circles down in the back of the shoulders to create a "wave" with the trunk, leaning into a standing stance, step forward ld In a jump forward with a change of legs - "back jump"	0.70
IX	By stepping forward with the right and swinging the left, the scale (scale) on the right, hold on.	0.50
X	Leaning, bending and lunging to the position of the fists and sp.	0.50
XI	"Kurbet jump" - jump from hands to feet, cross-legged jump and sp. turn for 180* with arms, frontal circles, landing in a crouch, stance braced to hand.	2.00 am
	TOTAL	**10.00**

HORSE WITH GRIPPERS

PART	DESCRIPTION OF THE EXERCISE	VALUE
I	Swing forward with the right leg, swing with the left, and sp. swing with the right leg back to the stop of the front and sp.	1.50
II	Swing forward with the left leg, swing with the right, and sp. swing with the left leg back to the support of the front and sp.	1.50
III	Move forward with right leg then left leg, right leg then left leg back "throwing" and so on.	0.70
IV	Forefoot one-legged circuit left to right.	1.50
V	Move forward with right leg then left leg, right leg then left leg back "throwing" and so on.	0.80
VI	Premah with the right leg and then the left forward and sp. round with one leg left to right to the rear stop.	2.00 am
VII	Premah immediately with the right and then with the left back to the abutment of the front and sp.	0.50
VIII	Premah with the right foot "deflects" a jump left flank towards the device-disconnect.	1.50
	TOTAL	**10.00**

https://doi.org/10.5505/jiasscience.2022.93585

CIRCLES

PART	DESCRIPTION OF THE EXERCISE	VALUE
I	From a simple height, with a reinforced grip and pull.	2.00 am
II	Advantage, hold on.	0.50
III	With the body slowly bent, pull forward until the head is straight, hold on.	0.50
IV	High brought out and sp., with a strengthened backward swing, for them and sp.	1.00 am
V	Spin forward to the top and sp.	2.00 am
VI	Strengthened for them and sp.	1.00 am
VII	With the forehand, a wide back kick "Raznoška" jump to a stance on the ground, a break.	3.00 am
	TOTAL	**10.00**

SKIP

JUMP	HORSE - GOAT HEIGHT 135cm	VALUE
I	Dispensing with overhanging above the horizontal.	8.00
II	A crunch with a stretch above the horizontal.	9.00
III	Suffix with a drop above the horizontal.	10.00

LOOM

PART	DESCRIPTION OF THE EXERCISE	VALUE
I	On the first third of the loom, jump into the support, take the front to the support and strengthen it by swinging it, advantage, hold on.	2.50
II	By slowly pulling the stance on the shoulders, hold on.	1.50
III	Handstand, crossing the body through the lower vertical, front support, behind them.	2.00 am
IV	The former fall into the support and sp. with the "Spad splka" stop, for them.	2.50
V	Front leg to the right with a 180* turn to the left.	1.50
	TOTAL	**10.00**

SHAFT

PART	DESCRIPTION OF THE EXERCISE	VALUE
I	From a still height by pulling up, the front stop is connected.	0.50
II	Roll forward in support of the front and sp.	1.50
III	Underhand swing, for them and forehand	1.00 am
IV	Naupor with the curtain on the right lower leg, to the butt of the rider - indicate.	2.00 am
V	With an overhand grip in a move, roll forward in a riding position, a handover in a move.	2.00 am
VI	Premach with the right leg back to the point of the front one.	0.50
VII	One-handed roll back and sp. underhand jump to stance on the ground, disqualify.	2.50
	TOTAL	**10.00**

Cite this article as:

Mekic, R., Bjelica, B., Aksovic, N., Muric, B., Kahrovic, I., Chortane, O.G., & Zelenovic, M. (2022). The influence of sports gymnastics on the motor skills of female students. *The Journal of International Anatolia Sport Science*, *7*(3), 14-25.
Doi: 10.5505/jiasscience.2022.93585