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EFFECT OF PLYOMETRIC EXERCISE AND LEG MUSCLE ENDURANCE ON THE AGILITY AND VO_2max OF BADMINTON ATHLETES

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Abstract

Study purpose. This study aimed to determine: (1) the difference in the effect of plyometric ladder drill and hurdle drill exercises on agility and VO_2max, (2) the difference in the effect of badminton athletes' high and low leg muscle endurance on agility and VO_2max, (3) interaction between plyometric ladder drill and hurdle drill exercises with high and low leg muscle endurance on agility and VO_2max.

Materials and methods. This research was an experimental study with a 2×2 factorial design. The study sample was badminton athletes, totaling 24 people who were randomly selected from a population of 45 people. The instrument to measure agility was the T Drill Test, and that to measure VO_2max was the Multistage Fitness Test (MFT). The data analysis technique used was the two-way ANOVA at a significance level of 0.05.

Results. The study findings are as follows: (1) there is a significant difference in the effect of ladder drill and hurdle drill exercises on the agility of badminton athletes, whereas ladder drill and hurdle drill exercises have an equally good effect on increasing VO_2max; (2) there is a significant difference in effect of badminton athletes' high and low leg muscle endurance on agility and VO_2max; (3) there is a significant interaction between ladder drill and hurdle drill exercises and high and low leg muscle endurance on agility, whereas both exercises are equally well used to provide VO_2max improvement.

Conclusions. Based on the results of the study and the results of the data analysis that was carried out, it was concluded that there is a significant difference in the effect of plyometric ladder drill and hurdle drill exercises on the agility of badminton athletes.

Keywords: ladder drill, hurdle drill, agility, VO_2max, badminton.

Introduction

Badminton is a well-known sport all over the world. According to expert opinion, badminton is the most widely practiced sport in the world (Abián, Bravo, & Abián, 2021). In badminton, physical condition is very important. According to the findings of the literature review, badminton requires a combination of technique and physical fitness (Bozdoğan & Kizilet, 2017). Flexibility, strength, coordination, power, endurance, and agility are the most important physical components in badminton (Nugroho et al., 2021). According to a review of several literatures, the purpose of training is to develop team and individual competence, as well as to achieve peak performance (Yudhistira et al., 2021). According to the preceding viewpoint, the preparation of an exercise program has become the responsibility of a coach; additionally, the exercises prepared by the coach are in accordance with the characteristics of motion in badminton (Sukendro et al. 2021). According to the findings of the literature review, there are actions with a relatively short and fast duration of about 10 seconds, followed by short breaks of about 25 seconds and a duration of 40 minutes in badminton matches (Ozmen & Aydogmus, 2017). Researchers discovered that badminton athletes' movements were comprehensive, in the sense that they were complex; logically,

when the athlete lacked agility, the movements carried out could not change direction quickly. Furthermore, when action movements are performed for an extended period of time, athletes require not only agility, but also aerobic and anaerobic endurance (Nasrulloh et al., 2021).

Endurance has evolved into a necessary physical component for badminton (Ilham et al., 2021). To become a national level badminton player, the average VO_2max required is a minimum of 55 ml/minute/body weight for male athletes and 50 ml/minute/body weight for female athletes, but the field says otherwise (Lu et al., 2022). This was clearly seen when researchers observed badminton athletes based on the needs analysis with the test of badminton athletes aged 17-18 years still not entering the criteria, namely the acquisition of a VO_2max value of 40.80-47.80ml/minute/body weight for male badminton athletes (Saifu et al., 2021). Consecutive smashes cause excessive fatigue, which affects technique and concentration (Listyarini et al., 2021). Experts agree that endurance plays a significant role in winning matches (Ramírez-delaCruz, et al., 2022).

There are numerous training methods to develop aerobic agility and endurance, but developing a good training program can be difficult (Hastuti et al., 2021). It can be seen in the setting of training doses, training targets in one session, intervals, recovery, individuality principles and the principle of progressive overload which are not appropriate when the researchers made observations with 13 trainers through a questionnaire with questions related to setting exercise doses, including: intensity settings according to the target of endurance training, the trainer answered 66.7% no, 33.3% yes. The intensity setting according to the agility training target of the trainer answered 83.3% yes, 16.7% no. Setting intervals in the application of physical exercise, the trainer answered 77.8% yes, 22.2 no. Recovery settings in the application of physical exercise, the trainer answered 66.7% yes, 33.3% no. Agility is needed in badminton to perform various movements, the coach answered 77.8% yes, 22.2 no. Endurance plays an important role when badminton players make fast movements but for a long duration the coach answered 66.7% yes, 33.3% no. Ladder drill and hurdle drill are means to help improve the physical condition of agility. The trainer answered 61.1% yes, 38.9 no. Plyometrics is an ideal method to improve the physical condition of badminton. The trainers answered 77.8% yes, 22.2% no.

Based on the needs analysis, it can be explained that there are problems regarding the setting of the exercise dose, as well as the exercise method. This study is reinforced by previous research that a good exercise is one that follows guidelines such as the principle of loading, individuality and level of regularity (Gronwald et al., 2020). The study explains that the exercise setting or exercise dose is similar to a drug dose when someone consumes it, because the exercise dose here plays an important role in improving an athlete's physique (Gasim, Cengizel, & Günay, 2022). This empirical evidence can already be the basis of the problem which is immediately given a solution. As a result, it is necessary to find a solution to increase agility and endurance, one of which is to provide plyometric training methods. Plyometric exercises are distinguished by a muscle lengthening process that is quickly followed by a muscle shortening process, also known as the stretch shortening cycle (SSC) (Fernandez-Fernandez et al., 2022). The lengthening and shortening cycle significantly improves the tendons' and muscles' ability to generate maximum strength in the shortest amount of time.

The ladder drill and hurdle drill are two of the most commonly used tools and equipment for practicing plyometrics. Ladder drills and hurdle drills are training tools that can be used in gyms to improve the physical components of badminton players. The rationale for selecting the ladder drill and hurdle drill as a means of improving physical components in badminton is that the ladder and hurdle can be varied with various training models, the hurdle is jumping, when the athlete jumps quickly with almost no jump pauses, this falls under the plyometrics category, so the authors assume that ladder drills and hurdles can be used to improve physical conditions, particularly agility and endurance.

Previous studies defined that ladder drill for 8 weeks with a frequency of three times was able to increase speed, agility and quickness in badminton players (Guo et al., 2021). In addition, training with a combination of speed, agility, quickness and plyometrics hurdle box jump exercises for 3 alternative days for 8 weeks with three sets per exercise and per session 60%-80% with progressive increases showed a significant increase in physiological variables such as vital capacity to withstand breath compared to the control group (Kanagasabai, Manikandan & Lakshmanan, 2018). Furthermore, research on high leg muscle endurance with low leg muscle endurance for increasing VO_2max capacity and the result is that there is a difference and the better one is the group that has high leg muscle endurance (Chua et al., 2021). Based on the literature review that has been explained that ideally agility and endurance training that is in accordance with the characteristics of badminton is to use the plyometrics method, therefore researchers will develop a plyometrics program using ladder drills and using hurdle drills, where both of these tools are needed to practice agility and accumulation of skills. Exercise can also affect aerobic endurance.

The remainder of this paper is organized as follows. Section 2 presents the compound set method and the data analysis technique, Section 3 presents the results, Section 4 discusses the results, and finally Section 5 concludes the paper.

Materials and methods

Study participants

The research population was a badminton club in Yogyakarta City, amounting to 45 athletes. Research sampling was based on the simple random sampling technique. The division of groups was based on a ranking system using a percentage taken is the high group of 27% and the low group 27% (Wartika et al., 2014). Based on this result, 24 samples were found, then this stage would be separated or divided by match subject ordinal pairing (MSOP) which is divided into 4 high and low groups with 1 group containing 6 athletes who are given ladder drill and hurdle drill exercises.

Study organization

This research method was an experimental method with a 2×2 factorial design. An instrument for measuring leg muscle endurance or often referred to as dynamic strength was a squat jump. Procedure: (a) ready stance, stood with legs slightly wide, (b) bent your knees and lower your but-

tocks, then jumped up, continued the movement as in the beginning, did it for 30 seconds, then took the record for the test results. Aerobic endurance test used a multistage fitness test (MFT), the procedure was as follows: (a) the test size was 20 meters with a cone marked, (b) the athlete placed 1 foot above the 20 meter marking line from each turn and test, (c) waited for the sound "beep" then continued, before the signal and the sound "beep" the athlete was not allowed to perform, (d) the athlete ran as long as possible, if the athlete failed 2 times or was late to the marking line then the athlete must stop and finished the test, (e) note the level and amount. While the agility test used the T drill test. The test procedure was as follows: (a) ran to the center cone, (b) stepped to the left 5 meters, (c) then stepped to the right side 10 meters, (d) stepped left side 5 meters to the middle (e) then ran 10 meters back (f) took the records for the time.

The half squat jump test instrument was adopted from the research of Nursalam & Aziz (2020) so that the test instrument was valid and reliable, while the VO_2max test and t-test were adopted from Mackenzie's book (2005) "Performance Evaluation Test", so that the test was standard and of course it was valid and reliable. Validity and Reliability T-Test (agility) with a significance level of (α = 0.05) obtained a validity value of 0.795, while the reliability value of 0.692. The validity and reliability of the Multi Stage Fitness (endurance) test with a significance level of (α= 0.05) obtained a validity value of 0.744, while the reliability value was 0.697. The validity and reliability of the Squad jump test with a significance level of (α= 0.05) obtained a validity value of 0.97, while the reliability value was 0.98.

Statistical analysis

Data analysis technique using prerequisite test includes normality test and homogeneity test, then after the data could be said to be normal and homogeneous proceeded to the next stage or hypothesis testing. The hypothesis test was a two-way ANOVA. Hypothesis testing was assisted by using statistical product and service solutions with a significant level of =0.05(5%).

Results

The results of plyometric exercises with ladder drills and hurdle drills on agility and VO_2max in terms of high and low leg muscle endurance in badminton athletes are described in table 1.

Based on the data in table 1, the Pre-test and Post-test of Agility and VO_2max in terms of leg muscle endurance in badminton athletes can be presented in the figure 1.

This normality test uses the Kolmogrov-Simirnov analysis technique and the calculation of the normality test using SPSS 25 software. The data is said to be normally distributed if Sig > 0.05. The results of the normality test show that all research variables have a significance value greater than 0.05, so it can be concluded that all variables are normally distributed. The results of the homogeneity test in the study were carried out using the SPSS 25 application. Based on the statistical analysis of the homogeneity test, the pretest group obtained a significance value of >0.05, so this means that the data group has a homogeneous variance. Likewise, the results of the calculation on the posttest obtained a significance value of > 0.05, this means that the data group has a homogeneous variance.

The research hypothesis was tested based on the results of data analysis and the interpretation of the two-way ANOVA analysis. Based on the processed research data, the results of hypothesis testing are as follows:

Agility

The first hypothesis tested in this study was that "there is a significant difference in the effect of plyometric ladder drill and hurdle drill exercises on the agility of badminton athletes". The results of the analysis are described in table 2.

Table 1. Description for Agility Test and VO_2max

Agility Test					
Plyometric Exercise Treatment	**Level of leg muscle endurance**	**Statistics**	**Pre-test**	**Post-test**	**Improvement**
Ladder Drill	High (A1B1)	Average	12.28	12.13	0.15
		SD	0.64828	0.56709	0.08115
	Low (A1B2)	Average	12.10	10.70	1.4
		SD	0.50725	0.66211	-0,15486
Hurdle Drill	High (A2B1)	Average	12.40	10.68	1.72
		SD	0.46911	0.20926	0.25985
	Low (A2B2)	Average	12.17	11.05	1.12
		SD	0.56793	0.57424	-0.00631
VO_2max Test					
Plyometric Exercise Treatment	**Level of leg muscle endurance**	**Statistics**	**Pre-test**	**Post-test**	**Improvement**
Ladder Drill	High (A1B1)	Average	41.32	49.12	7.8
		SD	1.45522	1.67412	0.2189
	Low (A1B2)	Average	40.77	42.85	2.08
		SD	2.95138	6.54973	3.59835
Hurdle Drill	High (A2B1)	Average	42.47	49.18	6.71
		SD	1.68008	2.16002	0,47994
	Low (A2B2)	Average	42.42	45.23	2.81
		SD	2.75566	2.30362	-0.45204

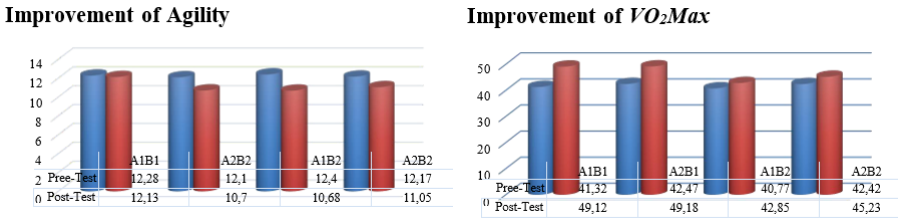

Fig. 1. Average Score of Pre-test dan Post-test in the Agility and VO_2max Improvement Based on the Ladder Drill dan Hurdle Drill

Table 2. ANOVA Result for the Difference of Plyometric Exercise with Ladder drill dan Hurdle drill on the agility

Source	Type III Sum Of Squares	df	Mean Square	F	Sig
Training Method	2.051	1	2.051	6.966	0.016

From the results of the ANOVA test, it can be seen that the significance value of p is 0.016 and the F value is 6.966. Since the significance value of p is 0.016 < 0.05, thus there is a significant difference in the effect of ladder drill plyometric exercises and hurdle drills on the agility of badminton athletes. This means that the research hypothesis is proven that there is a significant difference in the effect of plyometric ladder drill and hurdle drill exercises on the agility of badminton athletes.

The second hypothesis tested in this study was that "there is a difference in the effect between badminton athletes who have high and low leg muscle endurance on agility". The results of the study can be seen in the table 3.

Table 3. Results of ANOVA for the Difference of Athletes Having High and Low Leg Muscle Endurance on the Agility

Source	Type III Sum Of Squares	df	Mean Square	F	Sig
Leg Muscle Endurance	1.912	1	1.912	6.493	0.019

From the results of the ANOVA test in table 3, it can be seen that the significance value of p is 0.019 and the F value is 6.493. Since the significance value of p is 0.019 < 0.05, thus there is a significant difference in the effect of badminton athletes who have high and low leg muscle endurance on agility. This means that the research hypothesis proves that there is a difference in the effect of badminton athletes who have high and low leg muscle endurance on agility.

The third hypothesis tested in this study was that "there is an interaction between ladder dill and hurdle dill plyometric exercises and leg muscle endurance (high and low) on the agility of badminton athletes". The calculation results can be seen in the table 4.

Table 4. Result of ANOVA for the Interaction of Plyometric Exercise with Ladder Drill and Hurdle Drill and Leg Muscle Endurance on the Agility of Badminton Athletes

Source	Type III Sum Of Squares	df	Mean Square	F	Sig
Training Method * Leg Muscle Endurance	4.062	1	4.062	13.795	0.001

From the results of the ANOVA test in table 4, it can be seen that the significance value of p is at 0.001 and the F value is at 13.795. Since the significance value of p is 0.001 < 0.05, so based on this it means that the hypothesis is proven that there is an interaction between plyometric exercises (ladder dill and hurdle dill) and leg muscle endurance (high and low) on the agility of badminton athletes. After testing the third hypothesis, there is an interaction between plyometric exercises (ladder dill and hurdle dill) and leg muscle endurance (high and low) on the agility of badminton athletes, it is necessary to carry out further tests using the Turkey test. Further test results can be seen in the table 5.

Tabel 5. Ringkasan Uji Post Hoc

Group	Interaction	Mean Difference	Std, Error	Sig.
A1B1	A1B2	1.4300*	0.31531	0.001
	A2B1	1.4583*	0.31531	0.001
	A2B2	1.0883*	0.31531	0.013
A1B2	A1B1	-1.4300*	0.31531	0.001
	A2B1	0.0283	0.31531	1.000
	A2B2	-0.3417	0.31531	0.703
A2B1	A1B1	-1.4583*	0.31531	0.001
	A1B2	0.0283	0.31531	1.000
	A2B2	-0.3700	0.31531	0.650
A2B2	A1B1	-1.0883*	0.31531	0.013
	A1B2	0.3417	0.31531	0.703
	A2B1	0.3700	0.31531	0.650

Based on table 5 the results of the Turkey test calculation on the asterisk sign (*) show that the pairs that have interactions or pairs that are significantly different are: (1) A1B2-A1B1, (2) A2B1-A1B1, (3) A2B2 -A1B1, while the other pairs stated that there was no difference in effect were: (1) A1B2-A2B1, (2) A1B2-A2B2, (3) A2B1-A2B2. The following is a group of pairs of pairs that have interactions:

The group that was trained plyometrically with ladder drill and had lower leg muscle endurance was better than those trained plyometrically with the ladder drill method and had high leg muscle endurance on agility, with p < 0.05.

The plyometric group trained with the hurdle drill method and had high leg muscle endurance was better than the group trained with the leader drill plyometric method and had high leg muscle endurance for agility, with a p value of < 0.05.

The group that was trained with the hurdle drill method and had lower leg muscle endurance was better than the group trained with the ladder drill method and had high leg muscle endurance for agility, with a p value of < 0.05.

VO_2max

The hypothesis tested in this study was that "there is a significant difference in the effect of plyometric exercises with ladder drills and hurdle drills on the VO_2max of badminton athletes". Results of the analysis are described in table 6.

Table 6. Results of ANOVA on the Difference of Ladder Drill and Hurdle Drill Effects on VO_2max

Source	Type III Sum Of Squares	df	Mean Square	F	Sig
Training Method	0.920	1	0.920	0.210	0.652

From the results of the ANOVA test in table 6, it can be seen that the significance value of p is at 0.652 and the F value is at 0.210. Since the significance value of p is 0.652 < 0.05, it can be concluded that there is no difference between the drill and hurdle drill training methods on VO_2max, meaning that the ladder drill training method has the same effect as the hurdle drill training method on VO_2max and ladder training methods. drill and hurdle drill have the same effect on VO_2max in badminton athletes.

The next hypothesis that was tested was that "there is a difference in the effect between badminton athletes who have high and low leg muscle endurance on VO_2max". The results of the study can be seen in the table 7.

Table 7. Results of ANOVA on the Difference of Effect of Athletes Having High and Low Leg Muscle Endurance on VO_2max

Source	Type III Sum Of Squares	df	Mean Square	F	Sig
Leg Muscle Endurance	75.260	1	75.260	17.165	0.001

From the results of the ANOVA test, it can be seen that the significance value of p is at 0.001 and the F value is at 17.165. Since the significance value of p is 0.001 < 0.05, it can be concluded that there is a significant difference in the effect of badminton athletes who have high and low leg muscle endurance on VO_2max. Based on the results of the analysis, it turns out that high leg muscle endurance has a better effect than low leg muscle endurance on VO_2max in badminton athletes. This means that the research hypothesis proves that there is a difference in the effect of badminton athletes who have high and low leg muscle endurance on VO_2max.

The last hypothesis tested in this study was that "there is an interaction between plyometric ladder drill and hurdle drill exercises and leg muscle endurance (High and Low) on the VO_2max of Badminton Athletes". The calculation results can be seen in the table 8.

Table 8. Results of ANOVA Tes ton the Interaction between Plyometric Ladder Drill and Hurdle Drill and Leg Muscle Endurance on VO_2max of the Badminton Athletes

Source	Type III Sum Of Squares	df	Mean Square	F	Sig
Training Method* Leg Muscle Endurance	1.000	1	1.000	0.228	0.638

From the results of the ANOVA test in the table above, it can be seen that the significance value of p is 0.638 and the F value is 0.228. Since the significance value of p is 0.638 > 0.05, it can be concluded that there is no interaction between the plyometric ladder drill and hurdle drill training methods with muscle endurance on badminton athletes' VO_2max.

Discussion

Based on the hypothesis testing, it is known that the ladder drill and hurdle drill exercises have a significant different effect on the agility of badminton athletes, accepted. This means that the hurdle drill and ladder drill training methods have a significant difference in influence on the agility of badminton athletes. Ladder drill and hurdle drill are forms of plyometric exercise. Plyometric exercises can improve agility in athletes (Kayantaş & Söyler, 2020; Padrón-Cabo et al., 2021).

Plyometrics is a type of physical exercise that emphasizes the formation of lower body power (Moran et al., 2021; Nasrulloh et al., 2022; Pratama et al., 2022). This type of exercise is effective when practiced in sports that require foot support (Almeida et al., 2021; Chen et al., 2017; Nopembri et al., 2022). Most researchers and practitioners have the same view that plyometric training is one approach in every field of sport that is often used by athletes, especially those who have Short-Shortening Cycle (SSC) (Shamshuddin et al., 2020; Adji et al., 2022; Sutapa et al., 2021). Previous studies have shown that plyometric training in every sport can improve athlete performance (Ramirez-Campillo et al., 2021; Jufrianis et al., 2021). The selection of hurdle drill and ladder drill exercises was carried out based on the relevance of previous research which stated that there was an increase in agility in athletes who were given hurdle drill exercises (Ramirez-Campillo et al., 2021). This is in line with this study that based on data analysis on the calculation of the average value of the hurdle drill exercise is higher (good) compared to the ladder drill exercise on the agility of badminton athletes.

Ladder drill and hurdle drill exercises did not have a significant difference in the VO_2max of badminton athletes. Based on the results of the research data analysis, it is stated that the average calculation for ladder drill exercises is 45.98 and hurdle drill is 47.20 for the increase in VO_2max with a difference of 1.22. Because the results of the difference between the ladder drill and the hurdle drill are small, it means that the two exercises have the same effect on increasing the VO_2max capacity of badminton athletes. In this study, there was no significant difference between the two groups of ladder drill and hurdle drill exercises because both exercises were aimed at increasing the VO_2max of badminton athletes. The factor that distinguishes these two training methods is the stage of implementation. So, to train to increase VO_2max, you can choose these two training methods, on the basis of research that these two methods have the same effect on increasing VO_2max.

The results of the analysis show that badminton athletes who have high leg muscles are better than badminton athletes who have low leg muscles on agility and VO_2max. It is relevant to previous research that athletes who have high leg muscle endurance will have excellent agility and VO_2max capacity compared to athletes who have low leg muscle endurance, so their physical condition of agility and VO_2max is sufficient (Raymundo et al., 2018).

One of the important elements of physical fitness is endurance or leg muscle endurance (Junker & Stöggl, 2019). There-

fore, badminton requires a physical component of agility and an increase in VO_2max (Cinthuja et al., 2015). Athletes who have good endurance, the athlete's performance will remain optimal from time to time leading to long-term fatigue (Handaru et al, 2020). Physical endurance produces physiological and biochemical changes in muscles, so that endurance generally manifests through muscle endurance (Wee et al., 2016).

Conclusions

Based on the results of the research and the results of data analysis that has been carried out, it is concluded that there is a significant difference in the effect of plyometric ladder drill and hurdle drill exercises on the agility of badminton athletes. In addition, there is a significant difference between badminton athletes who have high and low leg muscle endurance on agility and VO_2max and there is a significant interaction between the ladder drill and hurdle drill training methods on agility and there is no significant interaction between ladder drill and hurdle drill exercises on VO_2max.

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Conflict of interest

All authors know of no conflict interest associated with this publication, and there has been no significant financial support for this work that could have influenced its outcome. As corresponding author, Sigit Nugroho confirmed that the manuscript has been read and approved for submission by all the named authors.

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ВПЛИВ ПЛІОМЕТРИЧНИХ ВПРАВ І МІЦНОСТІ М'ЯЗІВ НІГ НА ПОКАЗНИКИ СПРИТНОСТІ ТА МАКСИМАЛЬНОГО СПОЖИВАННЯ КИСНЮ СПОРТСМЕНІВ-БАДМІНТОНІСТІВ

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Реферат. Стаття: 8 с., 8 табл., 1 рис., 42 джерела.

Мета дослідження. Метою цього дослідження було визначення: (1) відмінності впливу пліометричних вправ із координаційною драбиною та з координаційними бар'єрами на показники спритності та максимального споживання кисню (МСК), (2) відмінності впливу високих і низьких показників міцності м'язів ніг спортсменів-бадмінтоністів на показники спритності та МСК, (3) взаємного впливу пліометричних вправ із координаційною драбиною та з координаційними бар'єрами за високих і низьких показників міцності м'язів ніг на показники спритності та МСК.

Матеріали та методи. Це дослідження було експериментальним дослідженням із факторним планом 2×2. Досліджуваною вибіркою були спортсмени-бадмінтоністи загальною кількістю 24 особи, випадковим чином відібрані з генеральної сукупності кількістю 45 осіб. Засобом вимірювання показників спритності слугував Т-тест на спритність і координацію (різноспрямований біг між 4 конусами, розташованими у формі літери «Т» з торканням кожного та поверненням у вихідне положення), для вимірювання показників МСК використовували тест «Човниковий біг на 20 метрів». Для аналізу даних використовували метод двофакторного дисперсійного аналізу за рівня значущості 0,05.

Результати. Результати дослідження наступні: (1) існує статистично значуща відмінність впливу вправ із координаційною драбиною та з координаційними бар'єрами на показники спритності спортсменів-бадмінтоністів, при цьому вправи з координаційною драбиною та з координаційними бар'єрами однаково гарно впливають на підвищення показника МСК; (2) існує статистично значуща відмінність впливу високих і низьких показників міцності м'язів ніг спортсменів-бадмінтоністів на показники спритності та МСК; (3) існує статистично значущий взаємний вплив вправ із координаційною драбиною та з координаційними бар'єрами за високих і низьких показників міцності м'язів ніг на показники спритності, при цьому обидва види вправ однаково гарно використовують для забезпечення підвищення показників МСК.

Висновки. На підставі результатів дослідження та результатів проведеного аналізу даних було зроблено висновок про наявність статистично значущої відмінності впливу пліометричних вправ із координаційною драбиною та з координаційними бар'єрами на показники спритності спортсменів-бадмінтоністів.

Ключові слова: вправи з координаційною драбиною, вправи з координаційними бар'єрами, спритність, максимальне споживання кисню (МСК), бадмінтон.

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