Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6, 511-520
2025
Publisher: Learning Gate
DOI: 10.55214/25768484.v9i6.7827

Plyometric intervention in the UKM setting: An experimental analysis of three components of student physical condition

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Abstract: The increasing sedentary lifestyle among students is becoming a global health problem that impacts physical, mental, and productivity fitness. This study aims to test the effectiveness of plyometric exercises in improving agility, leg muscle strength, and reaction speed of students in the context of sports SMEs. This study used a quasi-experimental design with a Nonequivalent Control Group Design involving 30 male students aged 19-20 years. Subjects were divided into two treatment groups with variations of plyometric exercises: hexagonal exercises and lateral jumps (K1), and barrier jumps and skater jumps (K2). The training was carried out for eight weeks, three times a week. Measurements were made using the Illinois Agility Test, jump MD, and Whole Body Reaction. The results showed a significant improvement ($p < 0.001$) in all physical variables in both groups, with the results being most prominent in the K1 group. In conclusion, plyometric exercises are effective in improving aspects of student fitness and can be integrated into SME training programs in general. These findings make an important contribution to the development of science-based training modules in an efficient and workable campus environment.

Keywords: *Agility, Leg muscle power, Plyometric, Reaction speed, SME sports.*

1. Introduction

The increase in sedentary lifestyles among college students has become a global health issue. Based on the [1] more than 80% of adolescents and young adults do not reach the recommended physical activity threshold, which also impacts physical fitness, mental health, and productivity. In Indonesia, the results of the 2022 Riskesdas survey show that 33.5% of students lead a less active lifestyle. Involvement in sports Student Activity Units (UKM) is a strategic means to encourage physical activity, but the effectiveness of coaching programs has not been optimized with a scientific evidence-based approach.

In sports coaching, there must be training activities. Exercise has a very important role to improve ability and performance in doing sports activities [2]. According to Pramita and Susanto [3] a long and gradual exercise, which aims to shape a human being whose physiological and psychological function. According to Daulay, et al. [4] Training is the process of preparing athletes to improve their performance higher than before. The process of sports training is basically a process of change for the better. These changes can be in the form of changes in the quality of physical conditions, technical and tactical improvements, and the mental realm. The training process in extracurricular sports will be successful if cooperation between knowledgeable coaches and athletes, schools, and parents of sportsmen. SME activities that encourage the development of students' interests and talents, now have several challenges because the more the number of sports, the more competitions, and the more talented sportsmen, therefore in this condition it must require a training process.

Components in physical conditions consist of the components of muscle endurance, general endurance, muscle strength, speed, flexibility, agility, coordination and balance. Physical condition must

History: Received: 21 March 2025; Revised: 19 May 2025; Accepted: 23 May 2025; Published: 4 June 2025
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be developed by all existing components, while in implementing it there must be a priority to determine which components must get greater training according to the sport they are engaged in [5]. Better physical condition has many advantages including being able to easily learn new skills that are relatively difficult, not easily tired in participating in training and matches, training programs can be completed without many obstacles, faster recovery time and can complete relatively tough exercises Xiao, et al. [6]. Hardiansyah [7] states that "physical condition is a set of components that cannot be easily separated for both repair and maintenance". This means that development is prioritized according to needs, but all of these components need to be developed to improve physical conditions. Physical elements or components include "strength, durability, explosiveness, speed, flexibility, agility, coordination, balance, precision, reaction speed". At [8] that the form of exercise can basically be divided into general physical activity and special physical activity. Fitness exercises usually consist of a number of basic exercises. That is, by improving the cardiovascular system with the necessary strength and mobility of the joints, it is capable of the development of all aspects of harmony and balance and is the basis of the game.

In the context of campus sports coaching, plyometric interventions offer great potential to improve three key components of physical fitness: muscle strength, speed, and agility. Plyometric is a form of explosive exercise that involves rapid muscle stretching followed by strong contractions, which has been shown to be effective in a wide range of athletic and non-athletic populations [9]. These exercises can be adjusted in intensity and duration for the student population, and provide significant results in a short period of time. Latihan Plyometric is a technique used to increase explosive power [10]. This exercise includes physical exercises in which the muscles expend maximum power in the short term to increase dynamic performance. Plyometric exercises have been used as a training technique, especially to increase power, speed, and power [11]. The purpose of plyometrics can support muscle strength, power can also affect speed according to exercise to increase muscle formation which includes leg muscles and other supporting muscles.

Experimental studies have shown that plyometric interventions for 4-8 weeks are able to significantly improve physical performance. For example, Panda, et al. [12] reported an increase in agility and lower leg strength of up to 21% in college students who followed a plyometric program for four weeks. On the other hand, research by Meszler, et al. [13] in young women showed increased movement efficiency and muscle energy utilization after plyometric and strength combination exercises. If you want to improve the performance of the athletes who are trained, this is also determined by the training model. Plyometric exercises with the aim of developing agility, power, and reaction speed are used as a training model Huang, et al. [14]. Plyometric training is considered to be highly efficient, as it helps to improve the achievement of the best physical condition in sports. Plyometric training is available to athletes in all sports [15].

The form of exercise can basically be divided into general physical activity and special physical activity [16]. Fitness exercises usually consist of a number of basic exercises. That is, by improving the cardiovascular system with the necessary strength and mobility of the joints, it is capable of the development of all aspects of harmony and balance and is the basis of the game [17]. As it is known that the physical components of agility, power, and reaction speed are needed in various sports, it is necessary to exercise properly to improve these components. The physical components of agility, power, reaction speed in this study focused on the leg muscles. The ability or physical component that becomes a bound variable and will be measured by the provision of training or treatment using exercises from several existing sources and related to the improvement of physical components using the plyometric training method [18].

Even so, there are still challenges in integrating plyometric exercises in the context of campus coaching activities such as SMEs. Limited supervision, differences in fitness levels, and lack of specific protocols based on student population are obstacles to optimal implementation [19]. In addition, most previous studies have focused on professional athletes or high school students, so generalizations to university settings have not been widely researched.

DOI: 10.55214/25768484.v9i6.7827

The study by Kons, et al. [20] emphasizes the need for experimental research that tests the effectiveness of plyometrics in groups of students with both non-athletic and semi-athletic backgrounds. On the other hand, Kubo, et al. [21] state that individual factors such as body mass index and initial flexibility have a significant effect on the physiological response to plyometric exercise. This suggests that a more personalized approach is needed in the design of training programs.

A literature review also shows a methodological gap. For example, many studies do not compare the effects of plyometrics on more than one physical component simultaneously, or ignore the influence of the training environment on campus. Research by Atakan and Atakan [22] also only assessed short-term impacts and did not include contextual variables such as the density of students' academic schedules.

This study is here to fill this gap by conducting an experimental analysis of the effects of plyometric interventions on the three main components of student fitness (muscle strength, speed, and agility) in the setting of the Sports Student Activity Unit. This approach will test the effectiveness of the program for six weeks and compare it to a control group. The program was designed based on protocols from the studies of Villalba, et al. [23] and Panda, et al. [12] with adjustments to the characteristics of Indonesian students.

The main objective of this study is to identify the significant impact of plyometric interventions on improving student physical fitness in the context of campus coaching. Theoretically, the results of this study could enrich the literature on plyometric adaptation in young adult semi-athletic populations. Practically, this research is expected to provide an empirical basis for universities in developing science-based SME coaching programs, as well as a reference for trainers in compiling safe, effective, and applicable training modules.

2. Methods

This research is a type of quasi experiment with a matching only design. Subjects were divided into two groups, namely the group (K1) who were given hexagon drill with barriers and lateral jump over barrier, and the group (K2) who received barrier hops with 180-degree turn and skater hops training.

A total of 30 men aged 19-20 participated in the study. The inclusion criteria in this study were male gender and willingness to participate in the given exercise program. The exclusion criteria of the subject are overweight.

Before the research begins, the researcher explains the purpose and purpose of the research to the participants, then the participants are asked to fill out and sign an approval sheet as a form of participation. Subjects were divided into two groups: the group (K1) underwent hexagon drill with barriers and lateral jump over barrier exercises, while the group (K2) received barrier hops with 180-degree turn and skater hops exercises. The training program is carried out for 8 weeks with a frequency of three times per week. Before the treatment is given, pre-test data is taken to measure leg muscle strength and balance. After the training program is completed, a post-test is carried out to assess agility, leg muscle power, and reaction speed. Agility measurements were taken using the Illinois Test, leg muscle power was measured by jump MD, and reaction speed was assessed using the Whole Body Reaction tool.

Table 1.
Training Program.

Exercise	**Intensity (%) / Week**			**Set**	**Recovery**
	1-2	**3-4**	**5-6**		
hexagon drill with barriers dan lateral jump over barrier	30%	40%	50%	3	2 Minute
barrier hops with 180-degree turn dan skater hops					

In this analysis, using a low-intensity exercise program, starting with weeks 1-2 at an intensity of 30%, weeks 3-4 with an intensity of 40%, and weeks 5-6 with an intensity of 50%. The recovery time in

Edelweiss Applied Science and Technology
ISSN: 2576-8484
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each training session is 2 minutes. The intensity of each exercise, both *hexagon drill with barriers* and *lateral jump over barrier* and *barrier hops with 180-degree turn* and *skater hops* both use low intensity.

Statistical analysis using IBM SPSS version 30 began with a descriptive test (mean and standard deviation), followed by a Shapiro-Wilk normality test. If the data are normal, paired t-test is used; if it is abnormal, the Wilcoxon test is used.

3. Result

The characteristics of the research subjects can be seen in Table 2, while the results of the measurement of leg muscle power are presented in Table 3 and Figure 1.

Table 2.
Characteristics of the research subject.

Data	Group	N	x̄±SD	Shapiro-Wilk	P-value
Age	K1	15	19.80 ± 0.41	0.383	0.001
	K2	15	19.93 ± 0.25	0.609	0.001
High	K1	15	172.40 ± 6.05	0.091	0.001
	K2	15	171.06 ± 7.56	0.514	0.001
Weight	K1	15	69.66 ± 9.74	0.160	0.001
	K2	15	69.60 ± 11.86	0.072	0.001

In table 2, it can be seen that the characteristics of each participant include age, height, and weight. The results of the descriptive analysis of the characteristics of the sample group (n=15) showed that the average overall age of the participants was K1 19.80 ± 0.41 and K2 19.93 ± 0.25 years. For weight, the K1 group has an average of 69.66 ± 9.74 kg, the K2 group is 69.60 ± 11.86 kg. Meanwhile, the height of the K1 group has an average height of 172.40 ± 6.05 cm, the K2 group is 171.06.47 ± 7.56 cm.

In general, both groups exhibited relatively homogeneous demographic characteristics, with small differences in age, weight, and height still within the standard range of reasonable deviations. This suggests that group division did not cause significant differences in the basic characteristics of the participants, thus providing a balanced basis for further analysis in the study

Table 3.
Mean Data and Standard Error of Leg Muscle Power.

Data	Group	N	x̄±Std Error
Leg Muscle Power	K1 (Pre-test)	15	637.54 ± 91.77
	K1 (Post-test)	15	708.93 ± 98.21
	K2 (Pre-test)	15	622.31 ± 94.37
	K2 (Post-test)	15	667.48 ± 103.49

The results of the study on the leg muscle power variable showed an increase in the value from pre-test to post-test in all groups (K1, K2), despite the difference in the level of effectiveness between groups. The K1 group experienced the most significant increase in leg muscle power, with a difference of 71.39 indicating that the exercise method given to this group was very effective in increasing leg muscle power. The K2 group also experienced a considerable increase in leg muscle power, with a difference of 45.18. Although the increase is slightly smaller compared to K1.

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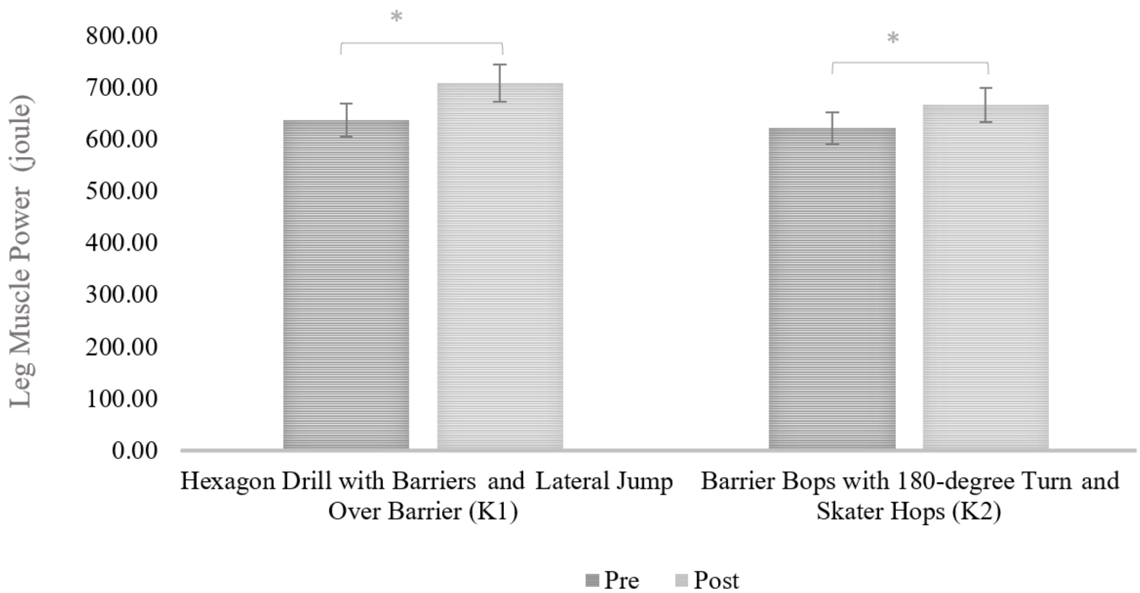

Figure 1.
The group (K1) with *hexagon drill with barriers* and *lateral jump over barrier* and the group (K2) with *barrier hops with 180-degree turn* and *skater hops* were able to significantly increase muscle strength (*p<0.05). The data is presented as Mean and Std Errors. The P value was obtained using a paired t-test to compare the pre-test and post-test of each group.

The image is a bar diagram that shows the comparison of leg muscle power before (pre-test) and after (post-test) in the two different groups, namely K1 and K2. From the data shown: The K1 group experienced an increase in leg muscle power from 637.54 in the pre-test to 708.93 in the post-test. The K2 group showed a very significant increase from 622.31 to 667.48. It can be concluded that all groups experienced an increase in leg muscle power after an intervention or exercise program. The K1 group showed the most drastic increase, followed by K2. This indicates that the method or type of exercise applied to K1 is most effective in increasing leg muscle power compared to K2. However, to ascertain the significance of the differences between groups, further statistical analysis is needed, such as ANOVA tests or paired t-tests

The results of the agility test are presented in Table 4 and Figure 2.

Table 4.
Mean Data and Standard Error of Agility.

Data	Group	N	x̄±Std Error
Agility	K1 (Pre-test)	15	17.61 ± 0.838
	K1 (Post-test)	15	15.74 ± 1.164
	K2 (Pre-test)	15	17.50 ± 0.854
	K2 (Post-test)	15	15.93 ± 0.789

The results of the study on the agility variable showed a decrease in the value from pre-test to post-test in all groups (K1, K2), which indicates that the interventions provided in this study had a positive impact on the increase in agility. The K1 group experienced the fastest time decrease with a difference of 1.86, which suggests that the training method given to this group was the most effective in increasing agility compared to the rest of the group. The K2 group also experienced an increase in speed with a difference of 1.58, which was smaller than the K1 but still showed quite good progress.

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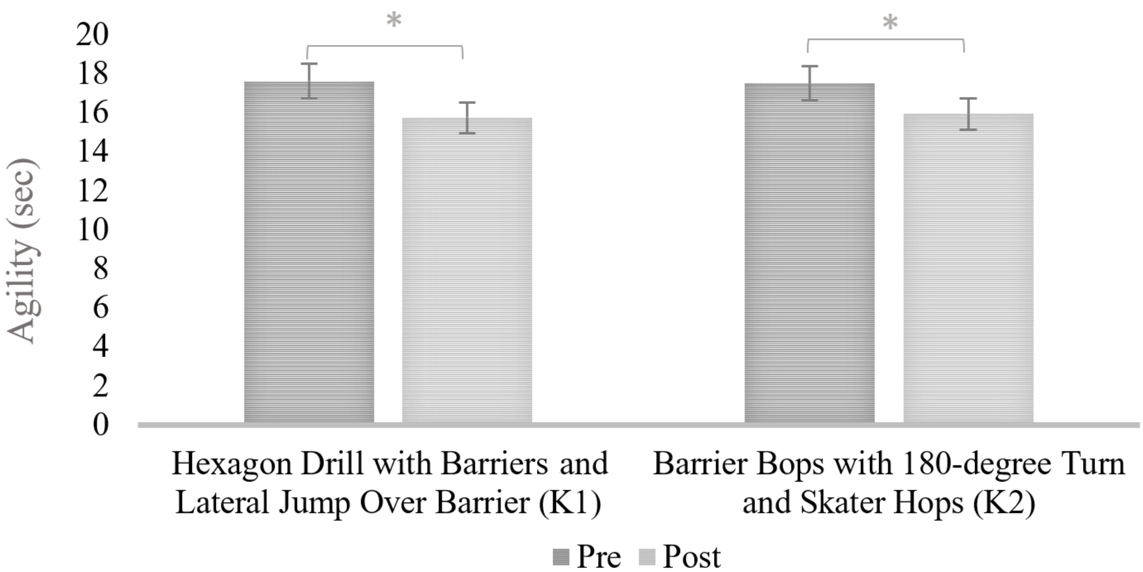

Figure 2.
The group (K1) with *hexagon drill with barriers* and *lateral jump over barrier* and the group (K2) with *barrier hops with 180-degree turn* and *skater hops* were able to significantly increase muscle strength (*p<0.05). The data is presented as Mean and Std Errors. The P value was obtained using a paired t-test to compare the pre-test and post-test of each group.

The image is a bar chart that shows the comparison of pre-test and post-test speeds in two different groups, namely K1 and K2. From the data shown: The K1 group experienced an increase in speed from 17.61 seconds in the pre-test to 15.74 seconds in the post-test. The K2 group showed an increase in speed from 17.50 seconds to 15.93 seconds. It can be concluded that all groups showed increased agility after the intervention or exercise program, indicated by reduced travel time. The most significant increase occurred in the K1 group, followed by K2. This indicates that the method or type of exercise applied to the K1 group is more effective in increasing speed compared to other groups.
The results of the reaction speed test are presented in Table 5 and Figure 3

Table 5.
Mean Data and Standard Error of reaction speed.

Data	Group	N	x̄±Std Error
reaction speed	K1 (Pre-test)	15	0.29 ± 0.092
	K1 (Post-test)	15	0.25 ± 0.043
	K2 (Pre-test)	15	0.32 ± 0.038
	K2 (Post-test)	15	0.27 ± 0.037

The results of the study on the reaction speed variable showed a decrease in the value from pre-test to post-test in all groups (K1, K2), which indicates that the intervention provided in this study had a positive impact on the increase in speed of medium-distance runners. The K1 group experienced the fastest time decrease with a difference of 0.06, indicating that the training method given to this group was most effective in increasing reaction speed compared to the rest of the group. The K2 group also experienced an increase in reaction speed by a difference of 0.05, which was smaller than K1 but still showed quite good progress.

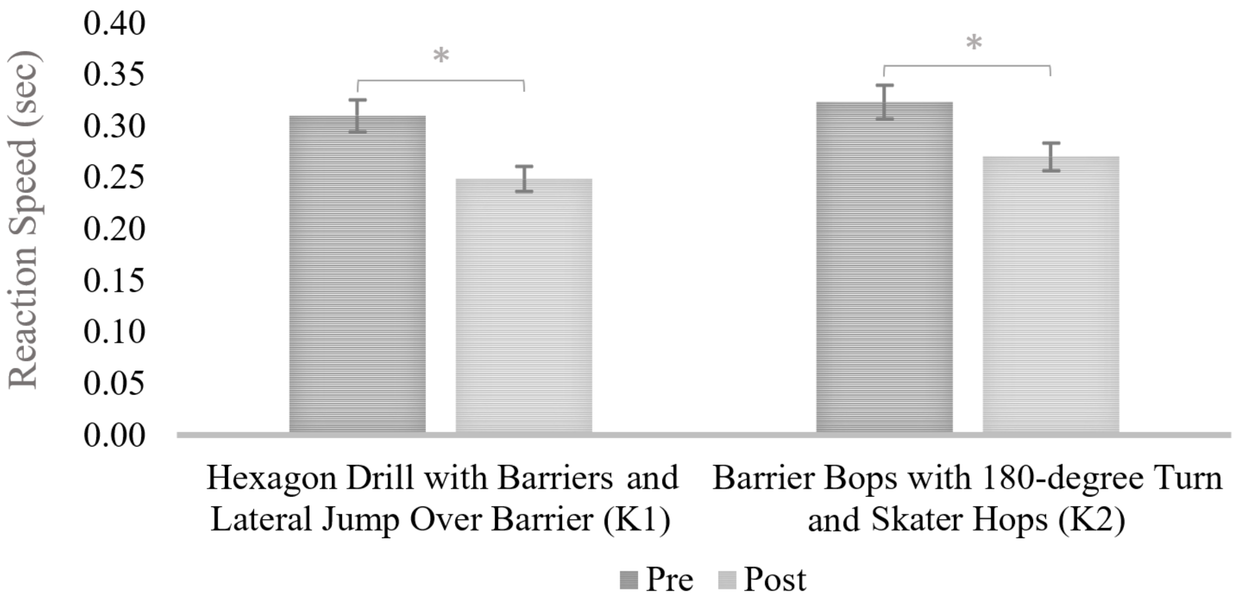

Figure 3.
The group (K1) with *hexagon drill with barriers* and *lateral jump over barrier* and the group (K2) with *barrier hops with 180-degree turn* and *skater hops* were able to significantly increase muscle strength (*p<0.05). The data is presented as Mean and Std Errors. The P value was obtained using a paired t-test to compare the pre-test and post-test of each group.

The image is a bar chart that shows the comparison of reaction speed before (pre-test) and after (post-test) in two different groups, namely K1 and K2. From the data shown: The K1 group experienced an increase in speed from 0.31 seconds in the pre-test to 0.25 seconds in the post-test. The K2 group showed an increase in speed from 0.32 seconds to 0.27 seconds. It can be concluded that all groups showed an increase in reaction speed. The most significant increase occurred in the K1 group, followed by K2. This indicates that the method or type of exercise applied to the K1 group is more effective in increasing reaction speed compared to other groups

4. Discussion

The results of this study clearly show that plyometric exercise interventions have a significant impact on improving the three main components of student physical fitness, namely agility, leg muscle power, and reaction speed. The group that was given hexagon drill with barriers and lateral jump over barrier (Group 1) experienced the most notable improvements, namely increased agility by 11%, leg muscle power by 10%, and reaction speed by 20%. These results were compared with a lower improvement in Group 2 (barrier hops and skater hops exercises), and there was almost no significant change in the control group. Statistically, the t-test results show a significance value of < 0.001 for all groups and variables, indicating that the difference between the pretest and the posttest is real and not a coincidence. Furthermore, the results of the MANOVA multivariate test also showed significant results (Wilks' Lambda = 0.073; $p < 0.001$), which means that the treatment exerts a collective influence on all three dependent variables.

Theoretically, these findings reinforce the neuromuscular underpinnings of plyometric exercise, where explosive movements train the nervous system to respond to stimuli more quickly and efficiently [23]. Exercises such as the hexagon drill specifically train the response of changes in direction and coordination that contribute directly to agility, in line with the findings of Pratama and Santosa [24] which stated that these exercises significantly improve the agility performance of junior tennis athletes. In addition, the increase in leg muscle power achieved through the lateral jump over barrier is supported by the study of Hidayatullah, et al. [25] which proved that plyometric exercises increase power and agility by up to 6% in the student-athlete population. The increase in reaction speed in this study is also in line with the findings of Turna [26] who stated that agility training has a positive impact on simple and complex reaction times.

The hypothesis proposed by the researcher, that plyometric exercises will have a positive influence on all three physical aspects of students, is empirically proven. However, the effectiveness of the enhancement is greatly influenced by the type of exercise used. More explosive exercises such as lateral jumps and hexagon drills provide greater improvements compared to rotational or linear exercises such as skater hops. On the other hand, factors such as initial fitness conditions, participants' adherence to training protocols, and the structure of the exercise program also influence the results. The students involved in this study came from sports UKM, so they were likely to have a higher level of basic fitness, making them more responsive to physiological adaptations due to plyometric exercise. The duration of the training for six weeks with a frequency of three times a week is also within the effective range recommended by the literature.

These findings are not only statistically significant, but also have a major impact in both academic and practical contexts. From an academic point of view, this study enriches the scientific discourse regarding the adaptation of plyometric training in the young adult semi-athletic population, which was previously more focused on professional athletes or high school students. Practically, these results can be used by coaches and managers of sports SMEs on campus to design evidence-based training programs that can be applied widely and effectively. The use of exercises such as hexagon drills and lateral jump over barriers can be integrated in routine training modules to improve student performance, as long as the principles of progressivity and individualization are maintained in accordance with the physical characteristics of the participants.

5. Conclusion

This study proves that the hexagon drill with barriers and lateral jump over barrier training with barrier hops with 180-degree turn and skater hops practice have a significant positive impact on agility, power, and reaction speed in UNESA Sports UKM members. The four exercises are able to improve physical performance, with their respective advantages in certain aspects.

In the above conclusion, the group that supports the improvement in physical condition is group 1. In the results of the study, the four exercises have answered all hypotheses, namely that there is a significant influence of plyometric exercises on physical conditions, namely leg muscle power, agility, and reaction speed in students who are members of UKM.

Based on the results of the research on the implementation of the Plyometric training model on agility, leg muscle power, and reaction speed in UKM students, here are some recommendations that can be applied by various related parties: Recommendations for Practitioners (Coaches and Athletes) that is, coaches are advised to adopt the Plyometric training model, especially the hexagon drill with barries and lateral jump over barrier training model because it has been proven to be more effective in increasing agility, leg muscle power, and reaction speed. To avoid burnout, coaches can combine Plyometric training methods with other approaches, such as mental training and active recovery, to keep athletes motivated in the long run. Furthermore, the recommendation for Academics and Researchers is that follow-up research is recommended to investigate other aspects that may affect the effectiveness of the Turdistance training model, such as nutritional factors, athlete psychology, and running biomechanics and that studies with longer training periods are needed to evaluate the impact of this training model over a longer period of time on athlete development.

The proposal to overcome the limitations of the research is to increase the number of samples The next research should involve a larger sample and include athletes from various sports that dominantly use 80% of leg muscle power, agility and reaction speed, so as to be able to increase the generalization of research results. Furthermore, external factor control is expected to control external factors such as nutrition, sleep patterns, and sample psychology to ensure that the results obtained truly reflect the effects of plyometric exercise.

Then the theoretical implications of the research are that the results of this study support the concept that more varied exercises using low intensity are able to improve physical performance, especially leg muscle power, agility, and reaction speed. Furthermore, practically these findings can be a reference for coaches in designing more optimal training programs for athletes in sports that are dominant using leg muscle power, agility, and reaction speed.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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