



PLYOMETRIC HURDLE JUMP TRAINING USING BEACH SAND MEDIA INCREASES POWER AND MUSCLE STRENGTH IN YOUNG ADULT MALES

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Abstract

The study purpose was to analyze the effectiveness of the different effects of knee tuck jump and hurdle jump plyometric training using beach sand on power and leg muscle strength in young adult males.

Materials and methods. A total of 30 young adult males were enrolled in this study and were given plyometric knee tuck jump training (KTJT), and plyometric hurdle jump training (HJPT). Plyometric training is carried out with an intensity of 80-100% of 1RM, three sets with 12 repetitions each set, with a frequency of three times each week for six weeks. The measurement of leg muscle power uses the Jump Meter Digital (MD) Test, while the measurement of leg muscle strength uses the Back & Leg Dynamometer. Statistical analysis used one-way ANOVA and continued with the Least Significant Difference (LSD) post hoc test.

Results. The results of the analysis are as follows: the mean Δ increase in muscle power on CTRL (12.92 ± 2.51 joule) vs. KTJT (142.88 ± 35.21 joule) vs. HJPT (269.49 ± 138.06 joule), ($p=0.000$). The mean Δ increase in muscle strength on CTRL (11.61 ± 1.49 kg) vs. KTJT (75.49 ± 18.53 kg) vs. HJPT (137.43 ± 34.13 kg), ($p=0.000$).

Conclusions. Based on the results of the study, it was concluded that both types of plyometric training improve power and strength in young adult males.

Keywords: plyometric training, power, strength, muscle strength, young adult.

Introduction

Currently, the development of sports is not only pursued by a minority group, but sports have a wide range of lives and actively contribute to physical and spiritual training (Jona & Okuo, 2013). Because sports have several goals: leisure, health, education, and competitive sports, yet, due to some of these goals, sports achievement is the most sought-after as it aims to seek achievement/champions in sports (Malm et al., 2019). Achieving optimal performance requires programmed, regular, measurable, and continuous exercises involving various disciplines of science and technology (Adams et al., 2018).

Physical condition plays a dominant role in improving the performance and outcomes of athletes and non-athletes in popular sports (Xu, 2015). Good physical condition positively contributes to mass sports athletes mastering

excellent, precise techniques and tactics (Malm et al., 2019). In addition, the good physical condition will have a positive impact on improving mental health and being able to produce effective and efficient movement patterns (Falch et al., 2022). Therefore, the physical condition needs crucial attention because it affects the athlete's motor skills. According to Bafirman & Wahyuri (2018), physical condition is an indispensable prerequisite in efforts to increase performance and can even be said to be a basic need that cannot be postponed by an athlete. In line with Bompa & Buzzichelli (2019), achieving achievement is determined by four training factors, namely physical preparation, technical preparation, tactical preparation, and mental preparation.

One of the efforts to achieve prime health conditions and optimal performance in sports is to have a good physical condition (Malm et al., 2019). This is because physical condition is the basis for achieving optimal skills (Adams et al., 2018). Without good physical condition, it is hard to achieve peak fitness and optimal performance, as completing a training program is hampered (Malm et al., 2019). Leg muscle power is an integral part of generating

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strength, so it is an important component for athletes to express high levels of strength in dynamic movements (Power = Force * Velocity) (Falch et al., 2022). Leg muscle power and strength training can induce neuromuscular adaptation in both adolescents and adults (Hammami et al., 2018). One of the training methods to increase leg muscle power and strength using self-weight is plyometric training (Davies et al., 2015). Plyometric training is very effective and efficient because it can help improve the achievement of excellent physical conditions in sports (Slimani et al., 2016). Plyometric training can be used by athletes in all sports, to improve their physical condition. To improve skills and physical conditions plyometric training has a significant impact on bio motor components, such as speed, strength, and agility (Arafat et al., 2018). This was evident by Godara (2016), who reported that plyometric training significantly increased strength by 15.44%, muscle endurance by 12.46%, speed by 11.13%, agility by 1.27%, and flexibility by 2.15%

Plyometrics is a type of strength, speed, and agility training that is widely used in team and individual sports to improve sports performance (Ramírez-Campillo et al., 2014). Plyometrics involve multi-joint movements (jumping) that utilize stretch-shortening cycles, muscles are stretched quickly (eccentric phase) and then immediately shortened (concentric phase) (Marzouki et al., 2022). Plyometric training usually involves stopping, starting, and changing direction explosively (Miller et al., 2006). Plyometric training can improve motor skills and body composition, such as optimizing bone health and reducing fat mass (Wang & Zhang, 2016). The results of the research by Silva et al. (2019) reported that plyometric training significantly increases strength and speed, regardless of gender, and age during adolescence, and neuronal, muscular, and hormonal changes occur due to growth spurts that affect adolescent abilities. However, the effects of plyometric knee tuck jump and hurdle jump on power and leg muscle strength in young adult males have not been explored clearly. This study aims to analyze the effectiveness of the different effects of knee tuck jump and hurdle jump plyometric training using beach sand on power and leg muscle strength in young adult males.

Materials and methods

Study participants

This research is a true experimental randomized controlled trial (RCT). A total of 30 young adult males,

age (20.10±1.32 years), normal body mass index (21.17±1.35 kg/m²), normal blood pressure (systolic: 115.23±5.48 mmHg; diastolic: 75.83±4.03 mmHg), resting heart normal rate (64.23±5.41 bpm), normal oxygen saturation (97.30±1.42 %) voluntarily participated in the study. Respondents were randomly divided into three experimental groups: CTRL (Control group) – n = 10; KTJT (Plyometric knee tuck jump training group) – n = 10; and HJPT (Plyometric hurdle jump training group) – n = 10. The procedures applied in the study complied with the Helsinki World Medical Association Declaration on the ethical conduct of research involving human subjects.

Study organization

The plyometric training intervention program implemented is supervised by professional officers from the Sports Science Fitness Center (SSFC), Universitas Negeri Surabaya. Plyometric training is carried out at the Out Door Sand Field, State University of Surabaya with an intensity of 80-100% 1RM, 3 sets of 12 repetitions, frequency 3x/week for 6 weeks. Warming up and cooling down were each carried out for 5 minutes with an low-intensity of 50-60% HRmax (Sugiharto et al., 2023; Pranoto et al., 2023) muscles undergo a rapid elongation followed by an immediate shortening (stretch-shortening contraction. Monitoring heart rate during plyometric training using polar (Polar H 10 Heart Rate Sensor, USA. Inc) (Susanto et al., 2023; Pranoto et al., 2023) muscles undergo a rapid elongation followed by an immediate shortening (stretch-shortening contraction).

Measuring leg muscle power uses the Digital Jump Meter (MD) Test while measuring leg muscle strength uses a Back & Leg Dynamometer (Putera et al., 2023) muscles undergo a rapid elongation followed by an immediate shortening (stretch-shortening contraction). Measurements of leg muscle power and leg muscle strength were carried out twice, namely 30 minutes pre-training and 1×24 hours after 5 weeks post-training at SSFC Universitas Negeri Surabaya.

Statistical analysis

Data analysis techniques used the Statistical Package for Social Science (SPSS) software version 21.0. The normality test was used to test the normality of the data using Shapiro-Wilk, while Levene's test was used to test whether the data came from populations with the same variance (homogeneity). The difference test was applied using a paired

Table 1. Criteria for research subjects

Variable	CTRL	KTJT	HJPT	p-value
Age (years)	20.00±1.49	20.20±1.32	20.10±1.29	0.948
Body height (m)	1.66±0.05	1.64±0.03	1.65±0.06	0.441
Body weight (kg)	58.80±7.05	57.60±5.34	57.30±3.77	0.816
Body mass index (kg/m ²)	21.19±1.44	21.51±1.72	20.82±0.76	0.538
Systolic blood pressure (mmHg)	115.80±3.71	114.80±7.98	115.10±4.33	0.921
Diastolic blood pressure (mmHg)	76.00±3.56	76.00±4.39	75.50±4.48	0.953
Resting heart rate (bpm)	63.90±5.51	64.00±4.99	64.80±6.19	0.925
Oxygen saturation (%)	97.00±1.25	97.50±1.65	97.40±1.43	0.720

Description: CTRL: Control group; KTJT: Plyometric knee tuck jump training; HJPT: Plyometric hurdle jump training. Presentation of data with Mean and standard deviation (mean±SD).

sample t-test, and one-way ANOVA, and continued with the Least Significant Difference (LSD) post hoc test. The data is declared significant if the significant value is 5%.

Results

Based on the results of the analysis, showed that the average criteria for research subjects in the three groups (CTRL, KTJT, HJPT) did not show any significant differences which can be seen in Table 1 below. The results of the analysis of power and muscle strength before and after the intervention for 5 weeks can be seen in Figure 1, while the results of the analysis of power and muscle strength between groups (CTRL vs. KTJT vs. HJPT) can be seen in Table 1.

Discussions

This study aims to analyze the effectiveness of the different effects of knee tuck jump and hurdle jump plyometric

training using beach sand on power and leg muscle strength in young adult males. The main finding of this study was the effect of plyometric training of knee tuck jump and hurdle jump using beach sand on increasing power and leg muscle strength in young adult males (Figure 1, 2, and Table 2). This is in line with research conducted by Puspodari et al. (2022) who reported that training with an intensity of 80% HRmax with a frequency of 3x/week for 8 weeks found a significant increase in muscle power. Likewise, the study conducted by Putera et al. (2023) reported that plyometric training of jumping jacks, countermovement jumps, and tuck jumps carried out for 30 minutes/session, with an intensity of 70-90% 1-RM, a frequency of 3x/week for 6 weeks was effective in increasing leg muscle power, leg muscle strength, and speed. The same results have also been observed that plyometric training also significantly increases strength, speed, and agility in the hamstring and quadriceps muscles before and after plyometric training compared to the non-plyometric training group (Elnaggar et al., 2019). Previous

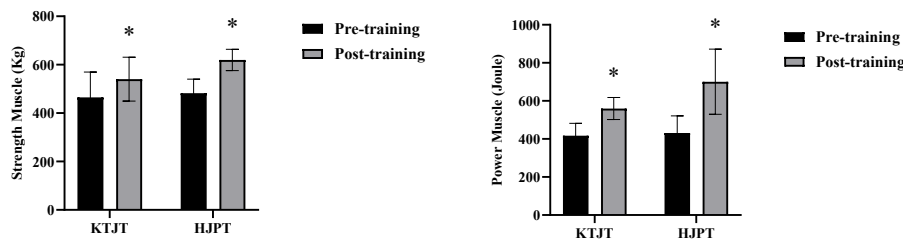


Fig. 1. The results of the analysis of the mean muscle strength between the pre- and post-training. Description: (*) Significantly different from the pretest ($p \leq 0.001$). Presentation of data with mean±SD. p-value obtained by analysis of Paired Sample T-Test

Table 2. Results of analysis of power and muscle strength between groups (CTRL vs. KTJT vs. HJPT)

Variable	CTRL	KTJT	HJPT	p-value
Pre-training Muscle Power (joule)	436.65±152.12	416.81±65.32	431.11±90.32	0.916
Post-training Muscle Power (joule)	449.57±150.89	559.69±57.84	700.61±171.36†	0.001
Δ Muscle Power (joule)	12.92±2.51	142.88±35.21*	269.49±138.06*†	0.000
Pre-training Muscle Strength (kg)	490.25±62.79	464.91±104.82	482.55±57.87	0.760
Post-training Muscle Strength (kg)	501.85±62.79	540.39±90.42	619.97±43.98*†	0.002
Δ Muscle Strength (kg)	11.61±1.49	75.49±18.53*	137.43±34.13*†	0.000

Description: CTRL: Control group; KTJT: Plyometric knee tuck jump training; HJPT: Plyometric hurdle jump training. (*)Significantly different at CTRL ($p \leq 0.05$). (†)Significantly different at KTJT ($p \leq 0.05$). Presentation of data with Mean and standard deviation (mean±SD).

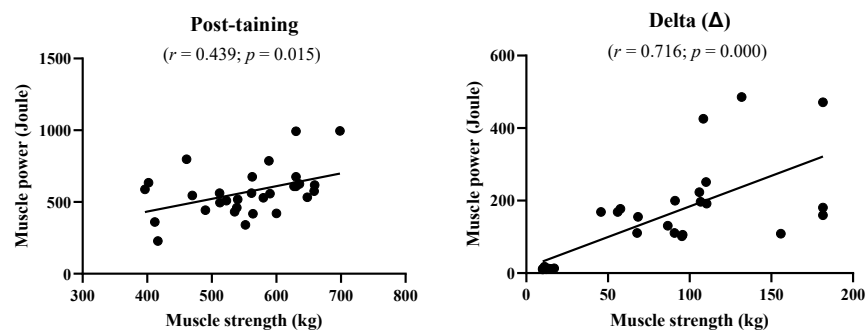


Fig. 2. Results of correlation analysis between muscle strength and muscle power. Description: p-value was obtained by Pearson's correlation coefficient test ($p \leq 0.05$).

investigations also reported that there was an increase in 10-m, 30-m, and 40-m sprint speeds after undergoing six weeks of plyometric training (Beato et al., 2018). The increase in power and leg muscle strength is most likely due to the intervention factor of plyometric knee tuck jump training with hurdle jump. During plyometric training, there are cycles of shortening and stretching muscle contractions to produce speed and strength, resulting in an adaptation to increase leg muscle power (Turgut et al., 2016; Hrženjak et al., 2016; Bin Shamshuddin et al., 2020).

Plyometric training of knee tuck jumps with hurdle jumps using a sand base can stimulate the muscles to contract more explosively, resulting in a progressive increase in power and leg muscle strength (Kumar, 2015). Constant shifting underfoot involves small stabilizer muscles which can improve balance and reduce the risk of injury (Huxel Bliven & Anderson, 2013). In addition, training using the sand platform can be an option for exercising outside the fun. Sand training is a simple form of resistance training and has a low risk of injury (Ahmadi et al., 2021). Evidence shows that the physiological and biomechanical adaptations that occur during training using sand platforms can positively affect increased physical performance (Ahmadi et al., 2021), reduce the risk of muscle damage and muscle pain, and decrease physical condition (Binnie et al., 2014). The use of sand surfaces during training can increase greater adaptation during the training period and reduce the effects of negative impacts and heavy training loads (Binnie et al., 2013).

Plyometric training is an effective method for explosively developing the lower limbs and can optimize various dependent variables such as leg muscle strength, speed, and power (Buckthorpe & Della Villa, 2021). Plyometric training can be done on one leg or two legs. Plyometric training performed on one leg has a low impact on strength and movement speed (Kariyama et al., 2011), whereas plyometric training using two legs will provide a higher output on the hips so that it will have a much higher impact on strength and speed, and leg muscle power (Makaruk et al., 2011; Bubanj et al., 2010). Donald et al. (2013) in his study emphasized that plyometric training is an effective training program for increasing leg muscle power and strength. Fischetti et al. (2018) also confirmed that the minimum duration of plyometric training to produce a significant increase in leg muscle power and speed is six weeks.

Conclusions

Based on the research results, it can be concluded that both types of plyometric training increase muscle power and muscle strength, but plyometric hurdle jump training is more effective in increasing muscle power and muscle strength than plyometric knee tuck jump training in young adult males. This study found a positive relationship between increased muscle strength and muscle power.

Conflict of Interest

The authors declare that there is no conflict of interest.

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ПЛІОМЕТРИЧНІ ТРЕНУВАННЯ ЗІ СТРИБКІВ ЧЕРЕЗ ПЕРЕШКОДУ З ВИКОРИСТАННЯМ ПЛЯЖНОГО ПІСКУ ПІДВИЩУЮТЬ ПОТУЖНІСТЬ І СИЛУ М'ЯЗІВ У МОЛОДИХ ЛЮДЕЙ ЧОЛОВІЧОЇ СТАТІ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 8 с., 4 табл., 3 рис., 58 джерел.

Метою дослідження було проаналізувати ефективність різних впливів пліометричних тренувань зі стрибків зігнувши ноги та стрибків через перешкоду з використанням пляжного піску на потужність і силу м'язів ніг у молодих людей чоловічої статі.

Матеріали та методи. До участі в цьому дослідженні було включено загалом 30 молодих людей чоловічої статі, які проходили курси пліометричних тренувань зі стрибків зігнувши ноги (ТСЗН) та пліометричних тренувань зі стрибків через перешкоду (ТСЧП). Пліометричні тренування проводять з інтенсивністю 80-100% одного повторення з максимальною вагою (1RM), три підходи по 12 повторень за підхід, із частотою три рази на тиждень протягом шести тижнів. Для вимірювання потужності м'язів ніг використовують тест на стрибок угору із цифровим вимірювачем висоти стрибка, а для вимірювання сили м'язів ніг використовують динамометр для м'язів спини та ніг. Для статистичного аналізу використовували однофакторний дисперсійний аналіз, після чого за одержаними результатами проводили апостеріорний тест на визначення найменшої значущої різниці (НЗР).

Результати. Результати аналізу є такими: середнє Δ збільшення потужності м'язів у контрольній групі ($12,92 \pm 2,51$ джоуля) порівняно з ТСЗН ($142,88 \pm 35,21$ джоуля) порівняно з ТСЧП ($269,49 \pm 138,06$ джоуля), ($p=0,000$). Середнє Δ збільшення сили м'язів у контрольній групі ($11,61 \pm 1,49$ кг) порівняно з ТСЗН ($75,49 \pm 18,53$ кг) порівняно з ТСЧП ($137,43 \pm 34,13$ кг), ($p=0,000$).

Висновки. На підставі результатів дослідження було зроблено висновок про те, що обидва типи пліометричних тренувань збільшують потужність і силу в молодих людей чоловічої статі.

Ключові слова: пліометричні тренування, потужність, сила, сила м'язів, молода людина.

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