British Journal of Multidisciplinary and Advanced Studies:
Arts, Humanities and Social Sciences 5 (3),69-95, 2024
Print ISSN: 2517-276X
Online ISSN: 2517-2778
Website: https://bjmas.org/index.php/bjmas/index
Published by European Centre for Research Training and Development UK

Effectiveness of Squat and Countermovement Jumps in Improving Vertical Jump Performance

John Paul D. Endab
Lourdes College, Cagayan de Oro City, Philippines
jpendab1980@gmail.com

doi: https://doi.org/10.37745/bjmas.2022.04101 Published May 31, 2024

Citation: Endab J.P. D (2024) Effectiveness of Squat and Countermovement Jumps in Improving Vertical Jump Performance, *British Journal of Multidisciplinary and Advanced Studies*: Arts, Humanities and Social Sciences 5 (3),69-95

ABSTRACT: *Vertical jump is an essential component for success in sports and athletic performance. This study determined the effectiveness of squat and countermovement jumps in improving vertical jump performance of Tertiary Athletes in one of the Universities in Cagayan de Oro City for School Year 2018-2019. This study utilized quasi-experimental design (pretest and posttest) where two treatment groups were involved. There were seventy-four (74) athletes who participated and they were distributed into two groups with specific exercise routines such as squat jump and countermovement jump. Findings reveal that there was a significant increase in the vertical jump performance of the athletes after exposure to the two exercise routines. This study concluded that both half squat jump and countermovement jump enhanced the vertical jump performance of the tertiary athletes. The study further established that both squat jump and countermovement jump was comparably effective in improving the vertical jump performance of the participants. It is recommended that the two exercise routines will be integrated in the varsity training program as well as in the physical education classes to improve the vertical jump performance of both athletes and the students.*

KEYWORDS: Exercise routines, Incremental vertical jump performance, Squat jump, Countermovement jump

INTRODUCTION

Sports coaches in basketball, volleyball and athletics are aware that having a good leaping ability is a great advantage for their players. Vertical jump is one of the most explosive physical movements in sports. In a number of sports, the higher the athlete jumps, the greater the possibilities to excel in that discipline. The jumping ability of an athlete is also a sign of over-all athletic ability as there is a clear relationship between the ability to jump and the running speed that the athlete will develop over short distances (Gale, 2017).

Success in many sports depends heavily upon the athlete's explosive leg power and muscular strength. In jumping, throwing, and track and field events and other activities, the athlete must be able to use strength as quickly and forcefully as possible. This display comes in the form of speed-strength or power (Yessis & Hatfield, 1986). According to Sharma, et al. (2017), vertical jump (VJ) is a good measure of athletic performance and occupational activities. Explosive power should be considered to improve sport-specific performance like in basketball (Castagna, et al., 2009).

Leg power is one of the most important factors influencing sport performance. Despite the variety of training methods used in the training, more individualized, varied and enjoyable methods are needed to enhance muscle peak power in sports (Nebil, et al., 2014).

The researcher in his workplace observed that some of the student-athletes need improvements on their vertical jumping ability. This ability is much needed especially the sports they are involve with are team sports that requires more on jumping. The researcher also observed that there were crucial instances that the games were won by teams having the jumping ability advantage.

The effectiveness between the two exercise routines, squat jump (half) and countermovement jump in tertiary athletes' vertical jump performance in team sports, has not been clarified. It is, therefore, the purpose of this study is to determine the effectiveness of both exercises in improving tertiary athletes' vertical jump performance.

Conceptual Framework

Vertical jump is an essential component for success in sports and athletic performance. It will help the athletes, coaches, athletic trainers, and rehabilitation specialists in selecting, treating, and training athletes for a specific sport. Thus, the researcher is motivated to study the effectiveness of squat and countermovement jumps in improving vertical jump performance of tertiary student-athletes of in of the Universities in Cagayan de Oro City for the School Year 2018-2019. This study argues that squat jump (half) and countermovement jump exercises can improve the vertical jump performance among tertiary athletes. This assumption is anchored on one of the principles of exercise, which is the principle of regularity. The principle of regularity states that benefits of exercise only last when one exercises regularly. This makes one's body to adapt to muscle stimulation. To maintain effective results, one must exercise regularly.

The vertical jump is one of the most explosive physical movements executed in sport. In a number of sports, the higher the athlete is able to jump, the greater is the chance of success

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in that discipline. The jumping ability of an athlete is also an indicator of overall athletic ability as there is a clear relationship between the ability to jump and the running speed that the athlete will develop over short distances. The jump height is defined as the highest point that the athlete can touch from a standing jump, less the height that the athlete can touch from a standing position. The measurement of the jump is flawed if the athlete is permitted to take one or more steps before jumping, as the athlete will convert some of the energy developed in the step taken into the force of propulsion that generates upward lift (Sierer, S., Battaglini, C., & Mihalik, J., 2008).

Furthermore, Markovic (2007) explained that leg muscle in general, and vertical jump performance in particular are considered as critical elements for successful athletic performance as well as for carrying out daily activities and occupational tasks. The author further pushed that a number of research has been focused on the development of the vertical jump performance. Various training methods, including heavy-resistance training, explosive-type resistance training, electrostimulation training and vibration training have been effectively used for the enhancement of vertical jump performance where most coaches and researchers seem to agree that plyometric training (PT) is a method of choice when aiming to improve vertical jump ability and leg muscle power.

Bedoya, et al. (2015) added that plyometric exercises are used to improve power output and to increase explosiveness by training the muscles to do more work in a shorter amount of time. Conceptually, Plyometric Training (PT) is characterized by the operation of the stretch-shortening cycle (SSC) that develops during the transition from a rapid eccentric muscle contraction (deceleration or a negative phase) to a rapid concentric muscle contraction (acceleration or a positive phase).

Plyometric exercise is a highly effective form of power training designed to significantly improve sports performance. Used by athletes to reach peak physical condition, plyometric exercises manipulate the elasticity and strength of muscles by increasing the speed and force of their contractions. This gives plyometric workouts the ability to produce fast and powerful movements that provide explosive power for a variety of sports (Walker, 2003).

This study also found support through the concept of Matavulj, et al. (2001) describing how plyometric training proved its efficiency and one of the best ways to train for explosive power and strength. The physiological basis of plyometric training is dependent on the amount of stretch placed on the muscle during an exercise. Plyometric trains a specific fiber within the muscle to gain power and strength.

Kannan, et al. (2018) concluded in their study that the squat jump training significantly improved in leg strength and explosive power. Squat jump is a plyometric exercise where the jumper engages in a rapid eccentric contraction and jumps forcefully off the floor at the top of the range of motion. This squat jump variation is performed rhythmically with each jump occurring immediately after the next. In the study of Rahman (2005), athletes showed signs of improvement in the vertical jump performance, the 50-yard dash, and leg strength that was significantly greater than the improvement in the other two training groups (plyometric training and weight training). This study provides support for the use of a combination of traditional weight training and plyometric drills to improve the vertical jumping ability, explosive performance in general and leg strength.

The Squat Jump (SJ) test is typically used to measure an athlete's explosive lower-body power (i.e. speed-strength ability). It is also less commonly used to in conjunction with a Countermovement Jump (CMJ). CMJ refers to a kind of jump where the jumper starts from an upright standing position, makes a preliminary downward movement by flexing at the knees and hips, then immediately extends the knees and hips again to jump vertically up off the ground. Such movement makes use of the 'stretch-shorten cycle' where the muscles are 'pre-stretched' before shortening in the desired direction. Moreover, there are two common variations of the SJ test which are Static SJ test and Dynamic SJ test. The static SJ test requires the athlete to 'pause' in a flexed semi-squat position for several seconds before initiating the upward/concentric phase and jump. The dynamic SJ test, on the other hand, allows the athlete to descend and ascend through the counter-movement in one continuous and rapid motion without any stop or pause (Walker, 2017).

Plyometric exercises are basic drills that improve agility and power as well as help improve an athlete's vertical jump. This exercise is often used as the beginning movement to develop proficiency in the vertical jump, high jump, long jump, and box jumps. Some coaches use this drill to help improve an athlete's technique during the full squat lift. The squat jump exercise ranks near the top of the list for developing explosive power using only an athlete's body weight. It can be done as a single exercise or as a combination, which includes other movements before and/or after the jump (Squat Jumps Build Agility and Power - Plyometric Jumps Build Dynamic Power, 2018).

Other than the squat jump, this study also considered countermovement jump as an intervention exercise. According to Bobbert, et al. (1996) even when the body position at the start of push-off was the same in squat jump as in countermovement jump, jump height was on average 3.4 cm greater in countermovement jump. The possibility that non-optimal coordination in squat jump explained the difference in jump height was ruled out: there were no signs of movement disintegration in squat jump and toe-off position, which was the same in squat jump as in countermovement jump. The greater jump height in countermovement jump was attributed to the fact that the countermovement allowed the subjects to attain greater joint moments at the start of push-off.

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Published by European Centre for Research Training and Development UK

Figure 1 shows the Interplay of variables in the study such as the vertical jump height and the two interventions namely: squat jump exercise and countermov exercise.

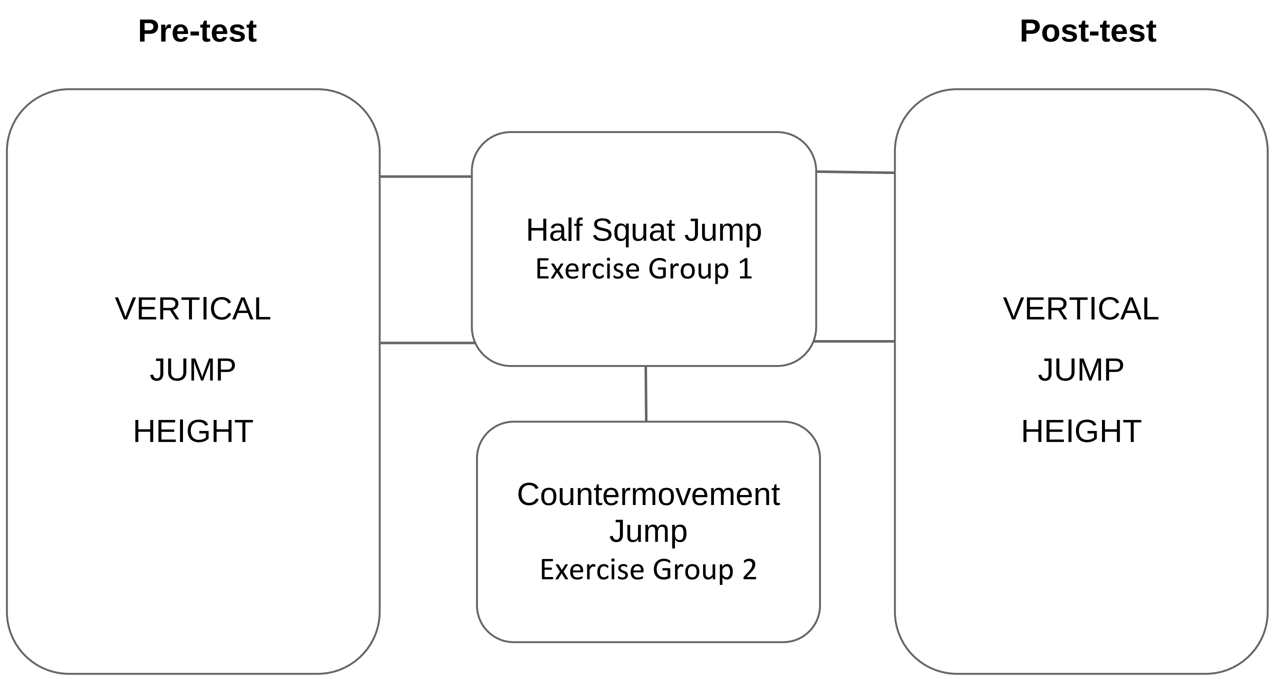

Figure 1: Schematic Presentation of the Interplay of the Variables in the Study

Statement of the Problem

This study determined the effectiveness of half squat jump and countermovement jump in improving the vertical jump performance of tertiary student-athletes of one of the Universities in Cagayan de Oro City during the second semester of School Year 2018-2019.

Specifically, the study answered the following questions:

1. What is the level of the participants' vertical jump test before and after the intervention?
2. How do the participants' vertical jump performance compare before and after the interventions?
3. Do the increments of the two groups of participants' vertical jump performance significantly differ?

Significance of the Study

The results of this study are beneficial to the following sectors:

Physical Educators. The findings will serve as basis for the Physical Education teachers in prescribing appropriate exercises for the improvement of the students' vertical jumping ability.

Students. The findings will help students recognize their physical capabilities, needs and limitations in the area of vertical jump, and utilize the prescribed intervention exercise to improve their vertical jumping ability and how this can be applied in their day-to-day activities.

Physical Education Department. The findings will provide baseline information in the formulation of needs-based development plan of the department.

School Administrators. The findings would help provide research-based data to support the Physical Education Program in implementing appropriate sports programs.

Sport Coaches. The findings would provide basis in creating effective programs and activities to help motivate the athletes and improve their performance. As such, the coaches would be able to come up with appropriate exercise program in enhancing specific skill.

Parents. The findings would help the parents in providing adequate and appropriate support in the area of training and conditioning for their children.

Future Researchers. The findings may serve as basis for future studies in terms of the intervention exercises using other components of fitness and profiling of fitness level.

Scope and Delimitation of the Study

This study determined the effectiveness of the half squat and countermovement jumps to the vertical jump performance of tertiary student-athletes. The researcher recognized that there are other exercise routines that would develop vertical jump performance. However, for the purpose of this study, only the half squat jump (no arm swing) and countermovement jump (no arm swing) were considered.

The participants of this study were the seventy-four (74) tertiary student-athletes who came from different sports events such as basketball (18 men, 14 women), volleyball (12 men, 11 women), football (4 men, 7 women), and dragon boat (4 men, 4 women) of different year levels and courses. The study was conducted for a period of eight (8) weeks from November 5, 2018 to February 8, 2019. The study was affected by some uncontrollable factors such as holidays, exam week (no varsity-related practices one week prior to exam – per school policy), in-campus and off campus competitions, rest period every after a competition, and other school-related activities that caused the discontinuation of the intervention program.

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Definition of Terms

To assist the readers, the following terms used in the study are operationally and conceptually defined:

Countermovement Jump. This refers to a kind of jump where the jumper starts from an upright standing position, makes a preliminary downward movement by flexing at the knees and hips, and then immediately extends the knees and hips again to jump vertically up off the ground.

Jump Height. This refers to the highest point that the athlete can touch from a standing jump, minus the height that the athlete can touch from a standing position.

Exercise Routines. This refers to the vertical jump exercise programs that were prescribed to the participants. In this study, squat jump and countermovement jump were included.

Plyometric exercises. This refers to exercises designed to enhance muscles, mainly using jump training.

Sargent Jump Test. This term refers to the standard test for measuring vertical jump height. In this study, the researcher used an improvised measuring tool made of used tarpaulins calibrated in inches and colored chalk for marking the wall or the measuring tool, and a rubber mat to soften the landing area.

Squat Jump. This term refers to a kind of jump used as one of the interventions of the study.

Tertiary student-athletes. Student-athletes are the participants in an organized competitive sport sponsored by the educational institution in which they are enrolled. In this study, student-athletes are full time students and athletes at the same time.

LITERATURE REVIEW

This chapter discusses the related professional literature and studies both in foreign and local setting. This constitutes the review of the related literatures and studies to support the investigation. These literatures and studies were taken from books, journals, and electronic sources.

Plyometric Exercises

Rimando, et al, (2015) cited plyometric or reactive neuromuscular training as an exercise program designed to increase muscle power and explosiveness. Though plyometric training has been shown to increase performance when combined with other managements, it has not been well- established that plyometric could decrease the risk of knee-injuries, especially among female football varsity players in the Philippine setting. However, it was suggested that plyometric in addition to conventional physical therapy training among female football players can be used as part of the ligament knee re-injury preventive program in the Philippines and for the improvement of leg power, strength, balance and agility.

The capacity to improve performance in athletes and recreationally trained individuals is the primary goal of sport performance professionals. Plyometric Training (PT) is ranked among the most frequently used methods for the development of the above-mentioned profiles in team sport games. Several research studies have confirmed that PT can enhance muscle strength and power (Markovic, et al., 2007).

Plyometric exercises that exploit the stretch-shortening cycle have been shown to enhance the performance of the concentric phase of movement (Gehri, et. al., 1998) and increase power output (Adams, et al. 1992; Paul, et. al., 2003).

Further, Stemm and Jacobson (2007) concluded in their study that aquatic and land-based plyometric training outperformed the control group in the vertical jump performance.

Plyometric training is an effective form of training to improve vertical jump performance (e.g. counter movement jump, squat jump and drop jump) among female athletes. The benefits of plyometric training on vertical jump performance are greater for interventions of longer duration (Stojanović, Ristić, McMaster, & Milanović, 2017). In sum, plyometric exercises are indeed helpful in improving athletes' vertical jump performance.

Leg power

According to Adams, et al. (1992), success in many sports depends heavily upon the athlete's explosive power. In jumping, throwing track and field events and other activities, the athlete must be able to use strength as quickly and forcefully as possible. This display comes in the form of speed-strength or power. Power represents the amount of work a muscle can produce per unit of time. An increase in power gives the athlete the possibility of improved performance in sports in which the improvement of the speed-strength relationship is sought. Power represents the amount of work a muscle can produce per unit of time. An increase in power gives the athlete the possibility of improved performance in sports in which the improvement of the speed-strength relationship is sought (Paul, et al., 2003).

Gajewski, et al. (2018) concluded in their study that the jump height of an individual is an exact indicator of their ability to produce maximum power. The presented model has a potential to be utilized under field condition for estimating the maximum power output of vertical jumps**.** Talpey, Young, & Beseler (2016) added that instructions have a meaningful influence on squat jump variables and therefore need to be taken into consideration when assessing or training athletes.

The Jump-and-Reach Test has good ecological validity in situations when reaching height during the flight phase for performance (e.g basketball and volleyball) but limited to accuracy for the assessment of vertical impulse production with different techniques and conditions (Menzel, et al., 2010).

In the study by Walsh, Waters, Bohm, & Potteiger (2007) posited that general upper body strength measures did not correlate strongly with the effect of arms on jumping, but peak power did. As in previous studies, peak power had a high correlation with jumping performance. These results show that the arm swing contributes significantly to jump performance in both men and women basketball players and that strength training for jumping should focus on power production and lifting exercises that are jump specific. Having a desirable leg power is an advantage in one's athlete sports and athletic performance.

Squat Jump

Squat Jumps are a powerful, plyometric exercise that strengthens your entire lower body and increases one's heart rate for a significant calorie burn. Squat Jumps target quads, hamstrings, glutes and calves. During squat jump one is forced to balance its body weight, which results to a stronger core from the intensified muscle stabilization. In addition, squat jumps allow for better posture. Traditional squats have been taught and highly emphasized for toning the butt and the legs, however, the incorporation of the jump allows for extra strength and muscle density and gives one the maximum heart rate for a high volume of calorie burn leading to fat loss. Squat jumps are a plyometric exercise which is a powerful move that is effective in burning calories at a faster rate. This makes squat jumps a great exercise if one is trying to focus on lower body strength and weight loss (How to Do Squat Jumps, 2015).

Loturco, et al. (2017) added that squat jump was shown to be more connected to sprinting, change of direction speed and jumping abilities and should be preferred for assessing and possibly training elite athletes needing to improve speed-power related abilities. According to a study of Mangus, et al. (2006), the examined individual responses to the exercises showed that 5 out of 10 of the subjects did increase their vertical jumps after both squat exercises (half squat and quarter squat). It may be that the influence of pre-jump exercise on jump performance may be individualized. Nevertheless, the use of a strength ratio does not appear to predict who will benefit from post tetanic potentiation in this type of exercise situation.

As concluded in previous studies, power in the squat jump is maximized at body mass (BMI), including adolescent male subjects. It was observed that peak power attained at body mass regardless of subject's baseline strength levels does not affect the load at which power output is maximized. While it may be beneficial to train at various load across the

Print ISSN: 2517-276X
Online ISSN: 2517-2778
Website: https://bjmas.org/index.php/bjmas/index
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loading spectrum, emphasis may be placed on body mass squat jump when training to optimize power (Dayne, et al., 2010).

Blache & Monteil (2014) added that vertical jumping was decreased if this muscle (erector spinae) was not taken into consideration in the model. They concluded that the erector spinae should be considered as trunk extensor, which enables to enhance total muscle work and consequently vertical jump height.

However, the study made by Coelho, Figueiredo, Moreira, & Malina (2008) established that functional capacities and basketball skills appeared to be largely independent of pubertal status especially after controlling for variation in the body size. Results also showed multiple linear regressions indicating chronological age as a significant predictor for four items, while maturity status was a significant predictor for only one item. The influence of body mass (BMI) was negative for two functional indicators (jumping, multi-stage shuttle run) and two basketball skills (dribbling, defensive movements), but positive for two functional tests for upper body strength (hand grip, ball throw). Height was positively correlated with two specific skills (passing, defensive movements), while a combination of tallness and heaviness was associated with a disadvantage on three functional capacities and two sport-specific skills.

Squat jump exercise is more associated with jumping and sprinting abilities than the Olympic Push Press and suggested that more studies are needed to confirm if these relationships imply superior training effects in favor of the squat jump exercise (Loturco, et al., 2017). Further, squat jump and countermovement jump can significantly enhanced from pre-to-mid training and it appeared that using squat jumps with loads that allow repetitions to be performed at maximum average power output can simultaneously improve several different athletic performance tasks in the short-term (Vanderka, et al., 2016).

In the study of Gheller, et al., 2015, they found that jumping from a position with knees more flexed seemed to be the best strategy to achieve the best performance. Intersegmental coordination and jump performance (CMJ and SJ) were affected by different knee starting angles.

However, another study (Squat Deep**,** Jump High?, 2007) posited that deeper squats will not reduce jump height but can be improved through practice. Furthermore, another study by La Torre, et al. (2010) stated that static knee stretching reduces power and force development during squat jump especially at lower knee starting angles.

Biomechanical analysis of squat jump and countermovement jump and the profiles of electromyogram (EMG) activity of selected muscles showed some differences between squat jump and countermovement jump (Mackala, Stodolka, Siemienski, & Coh, 2013).

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With these researches, they are enough evidence that this kind of exercise can significantly improve athletes' vertical jump.

Countermovement Jump

Santos, et al. (2016) concluded in their study that there was a significant increase of the athletic performance among junior male soccer players at a critical phase during the competitive season. Performance on a countermovement jump test significantly improved in the group which is described as large effects of slackline training on the postural control system and jump performance of athletes (Hammami, M., Negra, Y., Shephard, R. J., & Chelly, M. S., 2017).

The study of Bobbert, et al. (1996), found out that even when the body position at the start of push-off was the same in squat jump as in countermovement jump. Further, jump height was on average 3.4 cm greater in countermovement jump. The possibility that non-optimal coordination in squat jump explained the difference in jump height was ruled out. There were no signs of movement disintegration in squat jump and toe-off position was the same in squat jump as in countermovement jump. The greater jump height in countermovement jump was attributed to the fact that the countermovement allowed the subjects to attain greater joint moments at the start of push-off.

The Countermovement Jump (CMJ) has been shown to be the most reliable measure of lower-body power compared to other jump tests. Furthermore, the CMJ has been shown to have relationships with sprint performances, 1RM maximal strength, and explosive-strength tests. This suggests that performances in the CMJ are linked with maximal speed, maximal strength, and explosive strength. When the CMJ is performed using the arm-swing, performances are ≥10% higher than when they include no arm-swing. Contact mats, force platforms, accelerometers, high-speed cameras, and infrared platforms have all been shown to provide a valid and reliable measure of CMJ performance – though force platforms are considered as the 'gold-standard' (How to Do Squat Jumps, 2015).

Salles, S., Baltzopoulos, V., & Rittweger, J. (2011) concluded that there was a significant differential effects of countermovement magnitude and volitional effort on vertical jump performance of the participants. In addition, a standard warm-up protocol followed by 3 maximal bouts of shot put and either 3 consecutive countermovement jumps or a bout of 20-meter sprinting induce an acute increase in shot put performance in experienced shot putters (Terzis, et al., 2012).

Deutsch, M., & Lloyd, R. (2008) found in their study that peak force during squatting was significantly greater in both cross-over treatments (loaded parallel squats-countermovement jumps and countermovement jumps-loaded parallel squats) compared with the control. A control session of three CMJs repeated for 10 sets increased the mean

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jump height performance and was enhanced compared to performing CMJs only irrespective of which intensity was used (Poulos et al., 2018).

Hammami, M., Negra, Y., Shephard, R. J., & Chelly, M. S. (2017) revealed in their study that during the competitive season, some measures of athletic performance in male soccer players were increased more by 8 weeks of contrast strength training or CST (countermovement jump) than by strength training.

In the study conducted by Floría, P., & Harrison, A. (2013), results showed that the group achieved a higher jump height by increasing the effectiveness of the countermovement jump and achieving a more advantageous position at takeoff. The Countermovement Jump (CMJ) has been shown to be the most reliable measure of lower-body power compared to other jump tests. Further, the CMJ has been shown to have relationships with sprint performances, 1RM maximal strength, and explosive-strength tests. This suggests that performances in the CMJ are linked with maximal speed, maximal strength, and explosive strength. When the CMJ is performed using the arm-swing, performances are ≥10% higher than when they include no arm-swing. Contact mats, force platforms, accelerometers, high-speed cameras, and infrared platforms have all shown to provide a valid and reliable measure of CMJ performance – though force platforms are considered as the 'gold-standard' (How to Do Squat Jumps, 2015). Through these studies, countermovement jump proved to be one of the most reliable exercises in improving vertical jump.

Sargent Jump Test

This procedure describes the method used for directly measuring the vertical jump height jumped. There are also timing systems that measure the time of the jump and from that calculate the vertical jump height (Wood, 2008). In the study conducted by De Salles, et al. (2012), they concluded that Sargent Jump Test was a valid and reproducible instrument for measuring the explosive strength. Adequate research and studies supported that Sargent jump test can really be considered as one of the most reliable test in measuring athletes' vertical jump height.

Vertical Jump Height

The jump height is defined as the highest point that the athlete can touch from a standing jump, less the height that the athlete can touch from a standing position. The measurement of the jump is flawed if the athlete is permitted to take one or more steps before jumping, as the athlete will convert some of the energy developed in the step taken into the force of propulsion that generates upward lift (Sierer, S., Battaglini, C., & Mihalik, J., 2008).

Athletes' vertical jump height is a key factor in both sports and athletic performance because athletes with this ability will have the advantage most especially in game situations where vertical jump height plays a crucial part.

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These valuable sources and researches are very much helpful in supporting this study with its relevant concepts that enabled the researcher to understand some technical teri as to enrich the interpretation of the data.

RESEARCH METHODOLOGY

This chapter deals with the strategies and approaches used to answer the research problem. This section consists of research design, participants of the study, selection procedure, data gathering, instrumentation, scoring procedure, intervention administration, and statistical treatment of data.

Research Design

This study utilized the quasi-experimental design. Quasi-experimental is defined by Cook, Campbell, & Shadish (2002) as the process of conducting an initial observation (pre-test) to the group of participants, and then administering a treatment (intervention) and finally conducting the second observation (post-test). In this study, two (2) groups of participants had undergone pre-testing and post-testing of the exercise routines to determine the performance increment after exposure to the intervention exercises; hence, this research design was deemed appropriate for the study.

Participants of the Study

The participants of this study were the seventy-four (74) enrolled tertiary student-athletes of one of the Universities in Cagayan de Oro City, for the second semester of School Year 2018-2019. All student-athletes who were members of the different team sports, namely: basketball, volleyball, football and dragon boat were included in the study. The participants were organized and equally distributed to two (2) exercise groups. One group composed of thirty-seven (37) athletes was exposed to half squat jumping drill and another thirty-seven (37) athletes were introduced to countermovement jumping drill.

Selection Procedure

This study utilized purposive sampling, which requires the deliberate choice of an informant due to the qualities the informant possesses. The participants were selected based on their being a member of the varsity teams. This study was composed of seventy-four (74) student-athletes who came from different sports events such as basketball (18 men, 14 women), volleyball (12 men, 11 women), football (4 men, 7 women), and dragon boat (4 men, 4 women) of different year levels and courses. The study was conducted for a period of eight (8) weeks from November 5, 2018 to February 8, 2019 and was held at gymnasium for basketball, covered courts for volleyball, and soccer field for football and dragon boat.

Data Gathering

Before the study was administered, a letter was sent to the Director of the University Athletics Office to ask permission to conduct the study to the basketball, volleyball, football, and dragon boat athletes since the athletes are under the University Athletics Program (*See Appendix A*). Upon approval, the Athletics Director notified all the concerned coaches of the different sports of the said study and they were given a letter of consent as well (*See Appendix B*). The researcher invited all the coaches for a conference to tackle the purpose and decide on the procedures and schedules of the study to be conducted (*See Appendix C*). After the decision was made, the coaches were requested to distribute to the members of the team the parents' consent form indicating the nature of the study (*See Appendix D*). The athletes were also requested to fill out the Personal Data Information Sheet and the Health Appraisal Record (*See Appendices E & F*). After permission was granted and all forms were filled out, the researcher conducted an orientation for all tertiary student-athletes (*See Appendix G*). After the orientation, the pretest was administered (*See Appendix H*). During the pretest, the researcher was assisted by the team captain of each sport events, who served as research-assistant.

The participants were instructed to avoid any strenuous physical activity over the whole duration of the study to avoid external threats to ensure no factor will influence their performance. Participants were required to wear appropriate sports attire before participating in the test.

Each testing session (pretest and posttest) started with the standard 15-minute combination of static and dynamic stretching procedures (*See Appendix I*). The participants were taught the importance of proper way of landing prior to the conduct of the tests and the intervention exercises.

The two exercise routines were administered on the agreed schedule. The scheduled practices for basketball men was every Monday and Wednesday at 5:00 in the morning in the gymnasium; volleyball men and women every Tuesday and Thursday at 5:00 in the morning in the covered courts; football men and women every Monday and Wednesday at 6:00 in the morning in the soccer field; dragon boat every Tuesday and Thursday at 6:00 in the morning either soccer field or covered courts; and basketball women every Monday and Wednesday at 7:00 in the evening either gym or covered courts. Closed supervision and monitoring of participants' performance were recorded.

Ethical Considerations

For ethical considerations, the identity of the respondents will not be disclosed and their scores will not affect their academic ratings in this study. Consent forms from the parents of the respondents and assent forms to the respondents themselves will also be furnished. The procedures will also be explained thoroughly to the respondents. Furthermore, no government or private fund will be utilized in the gathering of data nor should any fee be collected from the respondents.

Instrumentation

The researcher used the Sargent Jump Test, which is a standard test for measuring vertical jump height. The researcher used an improvised measuring tool made of used tarpaulins calibrated in inches (*See Appendix J*). Colored chalk was used for marking the wall or the measuring tool, and a rubber mat to soften the landing area (*See Appendix K*). The landing mats ensure that the participants will have a soft landing to avoid or minimize injury. The participants dip their middle finger into the powdered colored chalk and then stand facing the wall and reaches up with the hand closest to the wall. Keeping the feet flat on the ground, the point of the fingertips is marked or recorded. This is called the standing reach height (*See Appendix L*). The athlete stood away from the wall (side view depending on the dominant hand), and leapt vertically as high as possible using both arms and legs to assist in projecting the body upwards. The athlete performed three jumps where the highest jump was considered. The difference in distance between the standing reach height and the jump height is the score (*See Appendix M*).

Scoring Procedure

The table below shows the target performance and rating scale in Sargent Jump Test. There were five (5) categories to determine the target performance and the level of the participants' vertical leaping ability level with the use of the rating scales.

Rating Scale of Vertical Jump for Men and Women

(Interpretation)	(in inches)
Very High	26.76 – 29
High	22.26 – 26.75
Moderately High	17.76 – 22.25
Low	13.26 – 17.75
Very Low	11 – 13.25

The rating scale was calculated based on the difference between the highest and the lowest scores to describe the interval or ratio level of data.

Intervention Administration

The participants were divided into two (2) exercise groups with one specific exercise routine to perform. The researcher assigned half of the members of each team to the two intervention exercises.

Exercise Group 1 was assigned to be exposed to half squat jump where the participants performed the following procedures: standing straight with feet shoulder-width apart; shoulders rolled back, abs tight; and belly button sucked into the spine; hands on the hips; knees bend in half squat making sure knees are above the ankles, and hips pushed out; applying force with the legs; push self upward into a jump straightening body; and land softly into a squat position. (This is one rep). Athletes rest for five seconds in between the jump (Static Jump) is done. Executed for two sets of ten repetitions. For safety purposes, the drill was done on a rubber mat.

Exercise Group 2 was assigned to do the countermovement jump where the following were executed: the jumper starts from an upright standing position, hands on the hips, make a preliminary downward movement by flexing the knees, then extend immediately the knees and hips to jump vertically up off the ground. Such a movement made use of the 'stretch-shorten cycle', where the muscles was 'pre-stretched' before shortening in the desired direction. The execution is done for two sets of ten repetitions. For safety purposes, the drill was done on a rubber mat.

Statistical Treatment

Descriptive statistics such as frequency, percentage, and mean were used to describe the variables of the study. T-test for paired samples was used to determine if there were significant differences in the participants' vertical jump performance before and after the use of the two (2) exercise routines and t-test for independent samples was u compare the increments of the performance of the two groups of participants.

RESULTS

This chapter presents, analyzes and interprets the data gathered form the participants of the study. It also provides answers to the questions stipulated in Chapter 1. The presentation, analysis and interpretation of the data are reinforced with tables that were arranged by problems and hypothesis.

Problem 1. What is the level of the tertiary student-athletes' vertical jump before and after the interventions?

Table 1 presents the frequency, percentage and mean distributions of the participants' vertical jump performance before and after the interventions.

British Journal of Multidisciplinary and Advanced Studies:
Arts, Humanities and Social Sciences 5 (3),69-95, 2024
Print ISSN: 2517-276X
Online ISSN: 2517-2778
Website: https://bjmas.org/index.php/bjmas/index
Published by European Centre for Research Training and Development UK

Table 1. Frequency, Percentage and Mean Distributions of the Participants' Vertical Jump Performance before and after the Interventions

Range	**Interpreta-tion**	**Half Squat Jump Group**				**Counter Movement Jump Group**			
		Pretest		Posttest		Pretest		Posttest	
		f	%	*f*	**%**	*f*	**%**	*f*	**%**
26.76 – 31	Very High	1	2.70	2	5.41	1	2.70	1	2.70
22.26 – 26.75	High	6	16.22	8	21.62	5	13.51	4	10.81
17.76 – 22.25	Moderately High	10	27.03	7	18.92	13	35.14	13	35.14
13.26 – 17.75	Low	17	45.95	19	51.35	12	32.43	15	40.54
11 – 13.25	Very Low	3	8.11	1	2.70	6	16.22	4	10.81
Total		**37**	**100.0**	**37**	**100.0**	**37**	**100.0**	**37**	**100.0**
Overall Mean		**18.35**		**18.97**		**17.59**		**17.96**	
Description		**Moderately High**		**Moderately High**		**Low**		**Moderately High**	
Standard Deviation		**4.01**		**4.12**		**3.97**		**3.94**	

The table explains that out of thirty-seven (37) participants of half squat jump group, there were ten (10) participants who jumped "moderately high" and seventeen (17) who jumped "low" in their pretest results. Meanwhile, on the countermovement jump group, out of thirty-seven participants, there were thirteen (13) who jumped "moderately high" and there were twelve (12) who jumped "low". After exposure to the assigned intervention exercise, 51.25% or majority of the half squat jump group was still categorized as "low" and 40.54% of the countermovement jump group increased from "low" to "moderately high" category.

Overall, the group exposed to half squat jump remained moderately high in their vertical jump performance even after the intervention. However, an increase in the numerical value can be gleaned on the table and that is from the overall mean of 18.35 in the pretest to an overall mean of 18.97 in the posttest.

On the other hand, this was not the same for the group exposed to countermovement jump. There was two heads of increase that was seen after the exposure to countermovement jump, which is from overall mean of 17.59 which was low to an overall mean of 17.96 interpreted as moderately high.

Problem 2. How do the participants' vertical jump performance compare before and after the interventions?
Ho1. The participants' vertical jump performance does not significantly differ before and after the interventions.

Table 2. Result of the Test of Difference in the Participants' Performance Before and After the Interventions

Vertical Jump Performance	Half Squat Jump Group				Counter Movement Jump Group			
	Pre Test	Post Test	t	p	Pre Test	Post Test	t	p
Means	18.35	18.97	**4.71****	**.000**	17.59	17.96	**2.17***	**.036**
SD	4.01	4.12			3.97	3.94		
Description	**Moderately High**	**Moderately High**			**Low**	**Moderately High**		

**significant at 0.01 level
*significant at 0.05 level

Table 2 shows the result of the test in the participants' performance before and after the interventions. Results reveal that there were significant improvements in the participants' vertical jump performance from the pretest to the posttest (t=4.71, p=.000) after they were exposed to half squat jump although such performance belongs to the moderately high category. The performance of the group exposed to countermovement jump significantly increased from low to moderately high (t=2.17, p=.036). Thus, the null hypothesis can be rejected. There is sufficient evidence to say that half squat jump and countermovement jump are helpful in improving the vertical jump performance of the tertiary athletes.

There could be more significant improvements in the participants' performances if not because of the uncontrollable factors that have had affected the intervention program. Factors such as in-campus tournament (St. Ignatius de Loyola Cup for Basketball men & women), off-campus games such as Mindanao Peace Games or MPG and the Catholic Educational Association of the Philippines or CEAP for Basketball, Volleyball, and Football for both men & women), and other Barangay or City-wide Invitational Tournaments, Christmas break, exam week, and retreats and recollections.

These findings are supported with one of the principles of exercise, which is the principle of reversibility. The principle of reversibility states that an athlete can lose the effects of training when they stop, and can gain the effects when they begin to train again. Detraining occurs within a relatively short period after an athlete ceases to train. Performance reductions may occur in as little as two weeks or sooner.

Problem 3. Do the increments of the two groups of participants' vertical jump performance significantly differ?
Ho_2. The increments of the two groups of participants' vertical jump performance do not significantly differ.

Table 3. Result of the Test of Difference in the Participants' Performance Increments in the Two Groups

	Half Squat Jump Group		**Counter Movement Jump Group**		**t**	**p**
Vertical Jump Performance	**M**	**SD**	**M**	**SD**		
	0.618	0.80	0.376	1.05	1.12	.268

Table 3 presents the result of the test difference in the participants' performance increments in the two groups. As shown in the table, the increments of the two groups do not comparably differ. Earlier, it has been established that both squat and countermovement jump exercise groups showed significant increase and that both exercises are comparably effective in enhancing respondents' vertical jump performance.

This finding is supported by Kannan, et al. (2018) that athletes exposed to squat jump training had significant improvement in leg strength and explosive power. In addition, this finding also found support in the study of Hammami, M., Negra, Y., Shephard, R. J., & Chelly, M. S. (2017) which revealed that the countermovement jump significantly improved the jump performance of the athletes. Further, Loturco, et al. (2017) added that squat jump was shown to be more connected to sprinting, change of direction speed and jumping abilities and should be preferred for assessing and possibly training elite athletes needing to improve speed-power related abilities. According to a study of Mangus, et al. (2006), the examined individual responses to the exercises showed that 5 out of 10 of the subjects did increase their vertical jumps after both squat exercises (half squat and quarter squat). It may be that the influence of pre-jump exercise on jump performance may be individualized. Nevertheless, the use of a strength ratio does not appear to predict who will benefit from post tetanic potentiation in this type of exercise situation.

The Countermovement Jump (CMJ) has been shown to be the most reliable measure of lower-body power compared to other jump tests. Furthermore, the CMJ has been shown to have relationships with sprint performances, 1RM maximal strength, and explosive-strength tests. This suggests that performances in the CMJ are linked with maximal speed, maximal strength, and explosive strength. When the CMJ is performed using the arm-swing, performances are ≥10% higher than when they include no arm-swing. Contact mats, force platforms, accelerometers, high-speed cameras, and infrared platforms have shown to provide a valid and reliable measure of CMJ performance – thou platforms are considered as the 'gold-standard' (How to Do Squat Jumps, 2015).

DISCUSSION

This chapter deals with the summary, conclusion, recommendations as well as the findings and implications generated from the study. Problems and queries raised in the statement of the problem were answered.

SUMMARY

The Problem. This study determined the effectiveness of squat and countermovement jumps exercises in improving vertical jump performance of the tertiary athletes in one of the Universities in Cagayan de Oro City for School Year 2018-2019. Specifically, the study sought to answer the following questions: 1. What is the level of the tertiary student-athletes in the vertical jump test before and after the intervention? 2. How do the participants' vertical jump performance compare before and after the interventions? 3. Do the increments of the two groups of participants' vertical jump performance significantly differ?

Method. This study used the quasi-experimental design by Campbell (2002). In this study, there were two (2) exercise groups of participants who had undergone the pretest and posttest to determine the vertical jump performance before and after the exposure to the exercise routines.

This study utilized purposive sampling. The chosen participants were the tertiary athletes of in of the Universities of Cagayan de Oro City for School Year 2018-2019. The participants came from the following sports/events such as basketball, volleyball, football, and dragon boat both men and women of different year levels and courses. The two (2) exercise routines included were squat jump and countermovement jump as the intervention exercises. There were seventy-four (74) participants in the study. The exercise routine 1 (squat jump) had thirty-seven (37) participants and the exercise routine 2 (countermovement jump) had thirty-seven (37) participants.

British Journal of Multidisciplinary and Advanced Studies:
Arts, Humanities and Social Sciences 5 (3),69-95, 2024
Print ISSN: 2517-276X
Online ISSN: 2517-2778
Website: https://bjmas.org/index.php/bjmas/index
Published by European Centre for Research Training and Development UK

The descriptive statistics such as mean, percentages, frequency distributions and standard deviations were used to describe the variables of the study. T-test for paired samples was used to determine if there were significant differences in the participants' vertical jump performance before and after the use of two (2) exercise routines. T-test for independent samples was utilized to compare the increments of the participants' vertical jump performance in the two groups.

FINDINGS

Based on the data gathered, the following are the salient findings of the study:
1. The group exposed to half squat jump remained moderately high in their vertical jump performance even after the intervention. Meanwhile, the group exposed to countermovement jump had a "low" performance in the pretest and enhanced to a "moderately high" performance after the intervention.

2. There was a significant difference on the participants' vertical jump performance before and after the intervention exercises with the posttest having a higher mean than the pretest.

3. The increments of the two groups did not significantly differ implying that both exercises were comparably effective in improving the participants' vertical jump performance.

CONCLUSION

Both squat jump and countermovement jump groups have significantly improved the vertical jump performance of the participants. The result confirmed the principle of regularity, which states that the benefits of exercise only last when one exercises regularly, to adapt to muscle stimulation.

The study confirms the principle advanced by Bobbert, et al. (1996) that greater joint moments at the start of the push-off enables the athletes to do higher vertical jumps in countermovement jump exercise. It also confirms the principle advanced by Gheller, et al. (2015) that squat jump exercise, when knees are more flexed it produces rapid eccentric contraction that helps improve athletes' vertical jump performance.

Therefore, if the athlete starts a training program and trains regularly, one will achieve the best possible increase in vertical jumping. Regularity is synonymous with consistency where the training schedule should be consistent in terms of the nature of the training exercise undertaken.

RECOMMENDATIONS

On the basis of the findings and conclusions, the following recommendations are endorsed by the researcher:

1. For the Physical Educators
1.1 To ensure a continuous and appropriate implementation and administration of the exercise program.

2. For the Tertiary Physical Educators
2.1 Since the Second Year Physical Education Curriculum will be more on team sports, it may be best to integrate the exercise routines in sports that involve vertical jumping that will help enhance the vertical jump performance of the students.

3. For the Tertiary Varsity Coaches
3.1 Since most of the sports involve vertical jumping, it may be best to include in their Varsity Training Program exercise routines that will help improve athletes' vertical jump performance.

4. For the Tertiary Athletes
4.1 To engage in simple vertical jump exercises and develop a positive outlook towards healthy and active lifestyle and the concept of fitness through active participation in physical activities.

5. For Future Researchers
5.1 That they may conduct an experimental research that aims to measure other skill related components of fitness such as balance, coordination, reaction time, and speed with its prescriptive exercise programs.
5.2 That they control the extraneous factors that could delay the effectivity of the intervention program.

REFERENCES

Adams, K., O'Shea, J. P., O'Shea, K. L., & Climstein, M. (1992). The effect of six weeks of squat, plyometric and squat-plyometric training on power production. *Journal of applied sport science research*, *6*(1), 36-41. (1)

Amasay, T. (2008). Static block jump techniques in volleyball: Upright versus squat starting positions. *The Journal of Strength & Conditioning Research*, *22*(4), 1242-1248. (2)

Blakey, J. B., & Southard, D. (1987). The combined effects of weight training and plyometrics on dynamic leg strength and leg power. *J Appl Sport Sci Res*, *1*(1), 14-6. (3)

Cagas, J. Y., Manalastas, E. J., Torre, B., & Sánchez-Pituk, C. H. E. S. S. A. (2015). Comparison of exercise versus sport participation motives among Filipino university students. *Asia Life Sciences*, *24*(2), 703-713. (4)

Cagas, J. Y., Torre, B., Manalastas, E. J., & City, Q. (2010, May). Why do Filipinos exercise? Exploring motives from the perspective of Filipinos youth. In *Proceedings of the III International Conference of Physical Education and Sports Science. Singapore: National Institute of Education* (pp. 243-8). (5)

Castagna, C., Chaouachi, A., Rampinini, E., Chamari, K., & Impellizzeri, F. (2009). Aerobic and explosive power performance of elite Italian regional-level basketball players. *The Journal of Strength & Conditioning Research*, *23*(7), 1982-1987. (6)

Chimera, N. J., Swanik, K. A., Swanik, C. B., & Straub, S. J. (2004). Effects of plyometric training on muscle-activation strategies and performance in female athletes. *Journal of athletic training*, *39*(1), 24. (7)

Coelho E Silva, M. J., Figueiredo, A. J., Moreira Carvalho, H., & Malina, R. M. (2008). Functional capacities and sport-specific skills of 14-to 15-year-old male basketball players: Size and maturity effects. *European Journal of Sport Science*, *8*(5), 277-285. (8)

Dayne, A., Dayne, A. M., Nuzzo, J. L., Mcbride, J. M., Burr, A., & Triplett, N. T. (2010). Power output in the jump squat in adolescent male athletes. *The Journal of Strength & Conditioning Research*, *24*, 1. (9)

Endab, J. P. (2024). Effectiveness of Squat and Countermovement Jumps in Improving Vertical Jump Performance [Zenodo]. https://doi.org/10.5281/zenodo.11003141 (10)

Deutsch, M., & Lloyd, R. (2008). Effect of order of exercise on performance during a complex training session in rugby players. *Journal of Sports Sciences*, *26*(8), 803-809. (11)

Floría, P., & Harrison, A. J. (2013). Ground reaction force differences in the countermovement jump in girls with different levels of performance. *Research quarterly for exercise and sport*, *84*(3), 329-335. (12)

Gajewski, J., Michalski, R., Buśko, K., Mazur-Różycka, J., & Staniak, Z. (2018). Countermovement depth—a variable which clarifies the relationship between the maximum power output and height of a vertical jump. *Acta Bioengineering and Biomechanics*, *20*(1). (13)

Gheller, R. G., Dal Pupo, J., Ache-Dias, J., Detanico, D., Padulo, J., & dos Santos, S. G. (2015). Effect of different knee starting angles on intersegmental coordination and performance in vertical jumps. *Human movement science*, *42*, 71-80. (14)

Gonzalez-Suarez, C. B., & Grimmer-Somers, K. (2009). Physical activity pattern of prepubescent Filipino school children during school days. *Journal of School Health*, *79*(7), 304-311. (15)

Guthold, R., Cowan, M. J., Autenrieth, C. S., Kann, L., & Riley, L. M. (2010). Physical activity and sedentary behavior among schoolchildren: a 34-country comparison. *The Journal of pediatrics*, *157*(1), 43-49. (16)

Hammami, M., Negra, Y., Shephard, R. J., & Chelly, M. S. (2017). The effect of standard strength vs. contrast strength training on the Development of sprint, agility, repeated change of direction, and jump in junior male soccer players. *Journal of strength and conditioning research*, *31*(4), 901-912. (17)

Hellberg, P., Hartman, M. J., & Winchester, J. B. (2010). The Effects Of External Load On Vertical Jump Peak Power And Eccentric Utilization Ratio. *The Journal of Strength & Conditioning Research*, *24*, 1. (18)

"How to Do Squat Jumps." Retrieved from https://gethealthyu.com/exercise/squat jumps/ (19)

Kotzamanidis, C. (2006). Effect of plyometric training on running performance and vertical jumping in prepubertal boys. *Journal of strength and conditioning research*, *20*(2), 441. (20)

La Torre, A., Castagna, C., Gervasoni, E., Cè, E., Rampichini, S., Ferrarin, M., & Merati, G. (2010). Acute effects of static stretching on squat jump performance at different knee starting angles. *The Journal of Strength & Conditioning Research*, *24*(3), 687-694. (21)

Loturco, I., Kobal, R., Maldonado, T., Piazzi, A. F., Bottino, A., Kitamura, K., ... & Nakamura, F. Y. (2017). Jump squat is more related to sprinting and jumping abilities than Olympic push press. *International journal of sports medicine*, *38*(08), 604-612. (22)

Loturco, I., Pereira, L. A., Moraes, J. E., Kitamura, K., Abad, C. C. C., Kobal, R., & Nakamura, F. Y. (2017). Jump-Squat and Half-Squat Exercises: Selective Influences on Speed-Power Performance of Elite Rugby Sevens Players. *PloS one*, *12*(1), e0170627. (23)

Mackala, K., Stodólka, J., Siemienski, A., & Coh, M. (2013). Biomechanical analysis of squat jump and countermovement jump from varying starting positions. *The Journal of Strength & Conditioning Research*, *27*(10), 2650-2661. (24)

Mangus, B. C., Takahashi, M., Mercer, J. A., & Holcomb, W. R. (2006). Investigation of vertical jump performance after completing heavy squat exercises. *Journal of Strength and Conditioning Research*, *20*(3), 597. (25)

Marián, V., Katarína, L., Dávid, O., Matúš, K., & Simon, W. (2016). Improved maximum strength, vertical jump and sprint performance after 8 weeks of jump squat training with individualized loads. *Journal of sports science & medicine*, *15*(3), 492. (26)

Menzel, H. J., Chagas, M. H., Szmuchrowski, L. A., Araujo, S. R., Campos, C. E., & Giannetti, M. R. (2010). Usefulness of the jump-and-reach test in assessment of vertical jump performance. *Perceptual and motor skills*, *110*(1), 150-158. (27)

Nebil, G., Zouhair, F., Hatem, B., Hamza, M., Zouhair, T., Roy, S., & Ezdine, B. (2014). Effect of optimal cycling repeated-sprint combined with classical training on peak leg power in female soccer players. *Isokinetics and Exercise Science*, *22*(1), 69-76. (28)

Poulos, N., Buchheit, M., Chaouachi, A., Haff, G. G., & Newton, R. U. (2018). Complex training and countermovement jump performance across multiple sets: Effect of back squat intensity. *Kinesiology*, *50*(1). (29)

Riggs, M. P., & Sheppard, J. M. (2009). The relative importance of strength and power qualities to vertical jump height of elite beach volleyball players during the counter-movement and squat jump. *Journal of human sport and exercise*, *4*(III). (30)

Rimando, C. R., Devora, K., Viray, B., Canlas, J., Eugenio, E., Ferrer, F. D., ... & Refuerzo, J. C. (2015). Effectiveness of plyometrics in addition to conventional training of female soccer varsity players with ligament knee injuries in re-injury prevention. *Physiotherapy*, *101*, e1284. (31)

Robert Wood, "Vertical Jump Test." Topend Sports Website, 2008, https://www.topendsports.com/testing/tests/vertjump.htm, Accessed 3/3/2019 (32)

Santos, L., Fernández-Río, J., Fernández-García, B., Jakobsen, M. D., González-Gómez, L., & Suman, O. E. (2016). Effects of slackline training on postural control, jump performance, and myoelectrical activity in female basketball players. *The Journal of Strength & Conditioning Research*, *30*(3), 653-664. (33)

Salles, A. S., Baltzopoulos, V., & Rittweger, J. (2011). Differential effects of countermovement magnitude and volitional effort on vertical jumping. *European journal of applied physiology*, *111*(3), 441-448. (34)

Sharma, H. B., Gandhi, S., Meitei, K. K., Dvivedi, J., & Dvivedi, S. (2017). Anthropometric Basis of Vertical Jump Performance: A Study in Young Indian National Players. *Journal of clinical and diagnostic research: JCDR*, *11*(2), CC01. (35)

Sierer, S., Battaglini, C., & Mihalik, J. (2008). The National Football League Combine: performance differences between drafted and nondrafted players. (36)

Squat Deep, Jump High? (2007). *Journal of Pure Power*, *2*(2), 14–16. Retrieved from https://bit.ly/2QWih0b (37)

Squat Jumps Build Agility and Power - Plyometric Jumps Build Dynamic Power. Elizabeth Quinn, 2018 (38)

"Squat Jump." Owen Walker. Published 15th October 2017. (39)

Stemm, J. D., & Jacobson, B. H. (2007). Comparison of land-and aquatic-based plyometric training on vertical jump performance. *Journal of strength and conditioning research*, *21*(2), 568. (40)

Stojanović, E., Ristić, V., McMaster, D. T., & Milanović, Z. (2017). Effect of plyometric training on vertical jump performance in female athletes: a systematic review and meta-analysis. *Sports Medicine*, *47*(5), 975-986. (41)

Talpey, S. W., Young, W. B., & Beseler, B. (2016). Effect of instructions on selected jump squat variables. *Journal of strength and conditioning research*, *30*(9), 2508-2513. (42)

Terzis, G., Karampatsos, G., Kyriazis, T., Kavouras, S. A., & Georgiadis, G. (2012). Acute effects of countermovement jumping and sprinting on shot put performance. *The Journal of Strength & Conditioning Research*, *26*(3), 684-690.(43)

"Vertical Jump." World of Sports Science..Encyclopedia.com. 28 Oct. 2018 Retrieved from https://www.encyclopedia.com. (44)

Walsh, M. S., Waters, J. A., BÖhm, H., & Potteiger, J. A. (2007). Gender bias in jumping kinetics in national collegiate athletic association division I basketball players. *Journal of strength and conditioning research*, *21*(3), 958. (45)

URLs

1. https://tinyurl.com/bd9kjhx2
2. https://tinyurl.com/2khud4za
3. https://tinyurl.com/w5euu9z9
4. https://tinyurl.com/mv7n427c
5. https://tinyurl.com/4kr4u77t
6. https://tinyurl.com/4nze4pyc
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18. https://tinyurl.com/mr36e9ua
19. https://tinyurl.com/yj5vx42e
20. https://tinyurl.com/4d5z38hs
21. https://tinyurl.com/4kaz239r
22. https://tinyurl.com/3kmhfep5
23. https://tinyurl.com/28fn59cc
24. https://tinyurl.com/3m6y477v
25. https://tinyurl.com/2dcfwcu8

British Journal of Multidisciplinary and Advanced Studies:
Arts, Humanities and Social Sciences 5 (3),69-95, 2024
Print ISSN: 2517-276X
Online ISSN: 2517-2778
Website: https://bjmas.org/index.php/bjmas/index
Published by European Centre for Research Training and Development UK

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27. https://tinyurl.com/2rwhrcnv
28. https://tinyurl.com/zvspn3rs
29. https://tinyurl.com/3a8utw92
30. https://tinyurl.com/4w7u7d2x
31. https://tinyurl.com/ka9v85r8
32. https://tinyurl.com/mu6fkaw7
33. https://tinyurl.com/ye228axf
34. https://tinyurl.com/5axvkb95
35. https://tinyurl.com/4u2rwmvb
36. https://tinyurl.com/mwp9xa4k
37. https://bit.ly/2QWih0b
38. https://tinyurl.com/2etw4vm5
39. https://tinyurl.com/2pr5224v
40. https://tinyurl.com/2s4yu8av
41. https://tinyurl.com/3tcu6e3f
42. https://tinyurl.com/yntutbj9
43. https://tinyurl.com/ycyek2uj
44. https://tinyurl.com/d8xnryzv
45. https://tinyurl.com/bdhn96xk