Journal of Novel Physiotherapies

Lehecka et al., J Nov Physiother 2017, 7:3
DOI: 10.4172/2165-7025.1000352

Research Article OMICS International

Correlations of Gluteal Strength, Power, and Endurance in Healthy Adults

Bryan Jason Lehecka*, **John ED Bab, Madison L Bertrand, Adam J Goltra, MaKayla L McPhail, Danielle R Stevenson and Barbara S Smith**

Wichita State University, Wichita, KS, United States

***Corresponding author:** Bryan Jason Lehecka, Assistant Professor, Department of Physical Therapy, Wichita State University, 1845 Fairmount, Box 210, Wichita, KS 67208, United States, Tel: 3169786156; E-mail: bryan.lehecka@wichita.edu

Received date: April 18, 2017; **Accepted date:** June 26, 2017; **Published date:** June 29, 2017

Abstract

Gluteal muscles have a unique composition of fast- and slow-twitch fibers that may require specific training. The purpose of this study was to determine correlations between measures of gluteal strength, power, and endurance in healthy adults. Moderate correlations existed between gluteal strength and endurance (r=0.454-0.466), as well as gluteal strength and vertical jump height (r=0.477-0.558). Low correlations were found between vertical jump height and endurance (r=0.278). These results suggest gluteal endurance training in addition to power and strength training may provide a more comprehensive training strategy than any one type of training alone to maximize gluteal muscle function.

Keywords: Hip; Dynamometry; Vertical Jump; Bridging

Introduction

The gluteus medius and gluteus maximus comprise about 33% of the musculature around the hip (10% and 23%, respectively) [1]. Their mass may contribute to the common thought that their primary functions are for power and strength. An examination of the gluteal muscle's fiber composition, however, reveals they have a larger percentage of Type I fibers than Type II fibers [2,3]. They have been shown to have a higher percentage of Type I fibers than several other primary lower limb muscles including the iliopsoas, rectus femoris, vastus lateralis, and gastrocnemius [2,3]. This morphology should encourage clinicians and athletes to train the gluteal muscles with endurance exercises in addition to strength and power exercises. Yet strength and power exercises for the gluteal muscles prevail over endurance exercises in discussions and training regimens. Some clinicians and trainers may assume challenging the gluteal muscles with power and strength exercises will simultaneously optimize their function for endurance tasks. The purpose of this study, therefore, was to determine correlations between measures of gluteal strength, power, and endurance in healthy adults.

Methods

Participants

Forty males and females 18 to 35 years of age with no history of surgery in the last year, no history of lower extremity or back pathology, and who were not pregnant were recruited from a local university.

Instrumentation

A Lafayette hand-held dynamometer was used to measure hip abduction and hip extension strength. Hand-held dynamometry has proven reliable for hip strength measurements (ICC=0.895-0.932) [4]. The Vertec Jump System was used to record quantitative data for participants' maximal vertical jump, a measure of power. The Vertec has demonstrated similarly high reliability (ICC=0.87-0.89) [5]. During the endurance measure of repetitive single-leg bridging, a stadiometer was used to provide proprioceptive input to participants when their hips reached the appropriate height, and a standard stopwatch was used to measure the time to task failure.

Tasks and Procedures

All participants were tested on the same day at a local university. Participants signed a consent form and completed a demographics questionnaire prior to a two-minute warm-up on an exercise bike at a self-selected speed and resistance.

Following the warm-up, a maximal vertical jump was determined using the Vertec Jump System to assess power. Participants were instructed to perform a stationary jump and were given one practice trial. Participants were asked to stand flush against the wall and reach with the arm of their choice to touch the highest marker possible. The height of the highest marker reached was added to the starting position of the Vertec and recorded. The Vertec was set at 84 inches for females or moved up to 96 inches for males. If participants were able to reach the top vane of their original starting position during the practice jump, the vanes were moved up six inches. For the jump, participants lined up directly beneath the vanes of the Vertec with feet shoulder width apart. Participants were asked to drop to a comfortable depth at which they felt was optimal to allow a maximal vertical jump. The highest vane reached was recorded and the difference between jump height and standing height was determined to be the maximal vertical jump height. Three jumps were recorded for each participant. This procedure was similar to that performed in previous research [5].

Maximal hip abduction and hip extension strength were measured next using hand-held dynamometry. Hip abduction was tested first, followed by hip extension. Hip abduction was tested in supine, using a belt to stabilize the pelvis to the testing surface. The handheld dynamometer was attached and stabilized by a separate belt that was positioned five centimeters proximal to the lateral femoral condyle. Participants were asked to abduct the dominant lower extremity into the dynamometer and hold a maximal voluntary contraction for four seconds. After at least two minutes of rest, hip extension was tested with the participant prone with a belt used to secure the pelvis to the testing surface. The knee of the participants' lower extremities being tested was flexed to 90 degrees. The handheld dynamometer was attached to a separate belt positioned five centimeters from the knee joint line on the distal femur. Participants were asked to raise their thigh off the plinth into the dynamometer and hold a maximal voluntary contraction for four seconds. Three measurements of maximal hip abduction and extension strength were taken and averaged. These methods are similar to those performed in previous research for hip abduction and extension [6].

The gluteal endurance measure consisted of repeated single-leg bridging on the dominant leg until task failure. Participants were positioned in supine with feet flat on the plinth. The knee was measured with a goniometer to 120 degrees, placing the hip in 60 degrees of flexion. Participant's hands were placed across their chest. The dominant foot was strapped to the plinth to maintain correct foot placement and prevent the foot from sliding. Participants performed single-leg bridging to a metronome at 60 beats per minute until task failure. Maximal bridge height was determined when the hips were in neutral in the sagittal plane. A stadiometer was placed at maximal bridge height to give participants sensory feedback when the dominant anterior superior iliac spine came into contact with it at the peak of the bridge. Verbal instructions were, "keep hips level, raise your hips to the bar on the first beat and touch the plinth on the second beat and repeat until fatigue." Participants were given three verbal cues to maintain proper technique. When a third verbal cue was needed, if the participant was no longer able to contact the stadiometer, or fatigue limited participants' ability to complete another bridge, testing was concluded and the time to task failure was recorded. These methods were based on those used in previous research for similar functional measures of the hip [7]. Power, strength, and endurance measurements were taken by separate researchers, and all researchers were blinded to participants' scores on other measures.

Statistical Analysis

The variables analyzed in this study were gluteal strength (measured via dynamometry for hip extension and hip abduction), lower extremity power (measured via the Vertec Jump System), and gluteal endurance (measured via repeated single-leg bridging to task failure). Three dynamometer measurements for both hip extension and hip extension, and three vertical jumps were measured and averaged for use in the final analysis. SPSS Version 23 was used to determine the correlation coefficients between each of the three main variables. Descriptive statistics for each variable and participant demographics were also calculated.

Results

Forty healthy adults (16 males, 24 females) between 18 and 35 years of age were tested (average age=24.8 years; average height=68.59 inches). Results of the correlation analysis are presented in Table 1. There was a high correlation between gluteus maximus (GMax) strength and gluteus medius (GMed) strength as expected (r=0.822). There were moderate correlations between gluteal strength and endurance (GMax: r=0.466; GMed: r=0.454), as well as gluteal strength and vertical jump height (GMax: r=0.477; GMed: r=0.558). There were low correlations between vertical jump height and bridging endurance (r=0.278).

	Overall (n=40)	Males (n=16)	Females (n=24)
GMax Strength and GMed Strength	0.822	0.71	0.848
GMax Strength and Bridging Endurance	0.466	0.462	0.399
GMed Strength and Bridging Endurance	0.454	0.592	0.299
GMax Strength and Vertical Jump	0.477	0.254	0.501
GMed Strength and Vertical Jump	0.558	0.465	0.445
Vertical Jump and Bridging Endurance	0.278	0.057	0.26
GMax=gluteus maximus (hip extension); GMed=gluteus medius (hip abduction)			

Table 1: Correlations between measures of gluteal strength, power, and endurance.

Discussion

Previous studies have examined gluteal strength in relation to therapeutic exercise, testing positions, and return to prior level of function [8-13]. Currently, there is little research about gluteal endurance as an indicator for return to function. A study by Schmitz et al. [14] is one of the few studies examining the importance of hip muscle endurance [14]. The study found a decrease in trunk side-plank endurance, which is a measure of gluteus medius endurance, was associated with an increased peak hip internal rotation angle during running. Future research is necessary to explore the role of endurance training in the clinical setting to develop a more comprehensive approach to hip muscle rehabilitation.

Limitations

This study was conducted on a young healthy population with no history of injury. The results of the present study may not be applicable to different populations. The prone position has been shown less than ideal to test hip extensor strength [9]. However, in the clinical setting, the prone position is considered standard, which is the reason it was chosen for this study. The Vertec Jump System was used in the present study due to its availability and inexpensiveness; however, it is less reliable than other tools for measuring vertical jump height. Lastly, the results of the study were dependent on participant effort, which could not be controlled by test administrators.

Clinical Implications

The present study revealed a high correlation between GMax and GMed strength, which is intuitive in a healthy population of young adults. Moderate correlations were found between gluteal strength and endurance, as well as gluteal strength and power. Due to the moderate correlation between gluteal strength and endurance, clinicians must not assume a one-time strength measure (e.g. manual muscle testing) is an accurate representation of the patient's readiness to return to prior level of function. Moderate correlation between power and gluteal strength suggests the need for power training in addition to tradition strength training in appropriate populations. Low correlation appears to exist between measures of lower extremity power (i.e. the scores on the Vertex Jump System) and gluteal endurance, indicating power is not strongly related to endurance and should not be used alone by clinicians within comprehensive rehabilitation programs.

References

1. Ito J, Moriyama H, Inokuchi S, Goto N (2003) Human lower limb muscles: an evaluation of weight and fiber size. Okajimas Folia Anat Jpn 80: 47-56.
2. SÄrca A, Susec-Michieli M (1980) Selective type II fibre muscular atrophy in patients with osteoarthritis of the hip. J Neurol Sci 44: 149-159.
3. Johnson MA, Polgar J, Weightman D, Appleton D (1973) Data on the distribution of fibre types in thirty-six human muscles. An autopsy study. J Neurol Sci 18: 111-129.
4. Click Fenter P, Bellew JW, Pitts TA, Kay RE (2003) Reliability of stabilised commercial dynamometers for measuring hip abduction strength: a pilot study. Br J Sports Med 37: 331-334.
5. Nuzzo JL, Anning JH, Scharfenberg JM (2011) The reliability of three devices used for measuring vertical jump height. J Strength Cond Res 25: 2580-2590.
6. Rowe J, Shafer L, Kelley K, West N, Dunning T, et al. (2007) Hip strength and knee pain in females. N Am J Sports Phys Ther 2: 164-169.
7. Lubahn AJ, Kernozek TW, Tyson TL, Merkitch KW, Reutemann P, et al. (2011) Hip muscle activation and knee frontal plane motion during weight bearing therapeutic exercises. Int J Sports Phys Ther 6: 92-103.
8. Hamstra-Wright KL, Huxel Bliven K (2012) Effective exercises for targeting the gluteus medius. J Sport Rehabil 21: 296-300.
9. Lue YJ, Hsieh CL, Liu MF, Hsiao SF, Chenet SM, et al. (2009) Influence of testing position on the reliability of hip extensor strength measured by a handheld dynamometer. Kaohsiung J Med Sci. 25: 126-132.
10. Presswood L, Cronin J, Keogh JWL, Whatman C (2008) Gluteus medius: Applied anatomy, dysfunction, assessment, and progressive strengthening. J Streng and Cond 30: 41-53.
11. McBeth JM, Earl-boehm JE, Cobb SC, Huddleston WE (2012) Hip muscle activity during 3 side-lying hip-strengthening exercises in distance runners. J Athl Train 47: 15-23.
12. Boudreau SN, Dwyer MK, Mattacola CG, Lattermann C, Uhl TL, et al. (2009) Hip-muscle activation during the lunge, single-leg squat, and step-up-and-over exercises. J Sport Rehabil 18: 91-103.
13. Ekstrom RA, Donatelli RA, Carp KC (2007) Electromyographic analysis of core trunk, hip, and thigh muscles during 9 rehabilitation exercises. J Orthop Sports Phys Ther 37: 754-762.
14. Schmitz A, Russo K, Edwards L, Noehren B (2014) Do novice runners have weak hips and bad running form? Gait Posture 40: 82-86.