# CORRELATIONS BETWEEN HIP ABDUCTOR'S PERFORMANCE WITH HIP BONE MINERAL DENSITY IN ELDERLY WOMEN

**Rwahita Satyawati, Imam Subadi, Damayanti Tinduh Utama, Bayu Santoso**
Department of Physical Medicine and Rehabilitation
Faculty of Medicine Airlangga University, Dr. Soetomo General Hospital, Surabaya

## ABSTRACT

*The purpose of this study was to find correlation between hip abductor's performance (muscle strength and endurance) with hip bone mineral density (BMD) on menopausal osteoporotic women in Surabaya. This cross sectional study was done on 39 menopausal osteoporotic women 50-80 years old, which met the inclusion criterias (perform activity daily living independently, agreed join this research with signed the informed consent and cooperative) and exclusive criteria (have neuromusculoskeletal problems on both lower extremities and cardiopulmonary problems). Every woman underwent assessment for non dominant hip abductor performance with EN Tree machine and non dominant total hip bone density with bone densitometer Hologic QDR 4500. Pearson and Spearman Correlation was used to measure the correlation between hip abductor performance and total hip bone density. This study showed that age has weak negative correlation with average power concentric (r=-.360), average power eccentric (r=-.344), average peak power concentric (r=-.328), peak power concentric (r=-.319) and total hip bone density (r=-.353). Total hip bone density has moderate possitive correlation with concentric contraction on peak power (r=.509), average power (r=.485), peak force (r=.476), average power eccentric (r=.460), average peak power (r=.452) and average peak force (r=.450), with eccentric contraction on average power (r=.416) and peak power (r=.412). This study showed that total hip bone density (reflect the static bone strength) had no correlation to 1 RM (reflect the muscle strength). Total hip bone density has stronger correlation with concentric than eccentric contraction activity. Endurance exercise for maintain bone density must give rhythmic eccentric and concentric contraction As long as there are enough force and power performed by exercise (within the intensity range 40-60% of 1 RM), endurance exercise will help (included non trained person) to maintain bone density. In conclusion, the older, the weaker hip abductor and hip bone.*

***Keywords:*** *elderly women, total hip bone density, hip abductor*

**Correspondence:**
Rwahita Satyawati, Department of Physical Medicine and Rehabilitation, Faculty of Medicine Airlangga University, Dr. Soetomo General Hospital, Surabaya

## INTRODUCTION

There is increased incidence of osteoporosis on post menopausal women in Surabaya from 1996 (26%) (Roeshadi 1997) to 2003 (28%)(Tinduh 2004). And as consequences, there is increased incidence of osteoporotic fractures including neck femur fractures. On the other hand, the weaker hip abductor muscles have contribution to increased incidence of fall (especially fall on lateral side) and will cause increased incidence of neck femur fracture too. Because of its function to stabilize hip joint, we can say that gluteus medius is a predictor of fall risk. There is no research that explains correlation between strength and endurance of gluteus medius muscle with BMD on menopausal osteoporotic women.

With EN-Tree Machine we have various advantages to measure performance of muscles including its strength and endurance. With this research we try to measure correlation between bone mass density with strength and endurance of gluteus medius muscle on menopausal osteoporotic women. We suggested in this study that that there was correlation between reduced bone mass density with reduced gluteus medius muscle strength on menopausal osteoporotic and there was correlation between reduced bone mass density with reduced gluteus medius muscle endurance on menopausal osteoporotic. women

## MATERIALS & METHODS

This study was point prevalence quantitative correlation test, included 39 post menopausal – osteoporotic women which met inclusive criteria (perform activity daily living independently, agreed join this research with signed the informed consent and cooperative) and

exclusive criteria (have neuromusculoskeletal problems on both lower extremities and cardiopulmonary problems). All subjects underwent measurement of hip bone mineral density with bone densitometer Hologic QDR 4500 and hip abductor muscle performance with ENTree machine. Both hip BMD and hip abductor muscle performance were done on non dominant side and the results were taken for the data analysis. All data has been compiled and analyzed with descriptive statistic and normality test with one sample Kolmogorov Smirnov. We used pearson correlation for parametric data and spearman correlation for non parametric data.

## RESULTS

Thirty nine subjects were measured, mean of age 63.41 + 6.282 (51-77) years old with menopausal period 15.23 + 7.467 (3-32) years (see table 1). On left hip abductor performance, we found 4 variables that included in non parametric data (1 RM, repetition concentric, repetition eccentric and time endurance) and the rests were parametric data (see Table 2).

Table 1. Subject Characteristics

| | N | Min | Max | Mean | Std. Deviation | 1S-KS |
|---|---|---|---|---|---|---|
| Age | 39 | 51 | 77 | 63.41 | 6.282 | .893 |
| Menopausal age | 39 | 31 | 58 | 48.18 | 5.558 | .049 |
| Menopausal period | 39 | 3 | 32 | 15.23 | 7.467 | .842 |
| Body height (BH) | 39 | 1.38 | 1.63 | 1.5228 | .05530 | .741 |
| Body weight (BW) | 39 | 32.00 | 71.50 | 53.5308 | 9.39286 | .932 |
| Body Mass Index (BMI) | 39 | 16.80 | 32.21 | 23.0425 | 3.74806 | .882 |

Table 2. Left Hip Abductor Performance

| | N | Min | Max | Mean | Std. Deviation | 1S-KS |
|---|---|---|---|---|---|---|
| 1 RM (kg) | 39 | 7.10 | 8.60 | 7.7821 | .35531 | .002 |
| Repetition Concentric | 39 | 17.00 | 204.00 | 57.9487 | 45.21466 | .005 |
| Repetition Eccentric | 39 | 17.00 | 204.00 | 58.1538 | 45.47847 | .005 |
| Peak Power Concentric (W) | 39 | 22.00 | 55.60 | 40.2308 | 8.53297 | .978 |
| Peak Power Eccentric (W) | 39 | 22.90 | 70.90 | 44.2846 | 11.38729 | .536 |
| Average Peak Power Concentric (W) | 39 | 16.60 | 49.60 | 33.5154 | 7.55254 | .922 |
| Average Peak Power Eccentric (W) | 39 | 17.50 | 54.40 | 35.2231 | 8.82513 | .554 |
| Average Power Concentric (W) | 39 | 8.41 | 27.70 | 17.5967 | 4.13013 | .945 |
| Average Power Eccentric (W) | 39 | 10.70 | 29.70 | 19.1128 | 4.10655 | .911 |
| Peak Force Concentric (N) | 39 | 26.90 | 39.60 | 31.5000 | 2.70856 | .824 |
| Peak Force Eccentric (N) | 39 | 26.20 | 46.20 | 34.2103 | 3.96164 | .940 |
| Average Peak Force Concentric (N) | 39 | 25.60 | 33.70 | 29.1308 | 1.98430 | .847 |
| Average Peak Force Eccentric (N) | 39 | 26.40 | 40.70 | 30.6154 | 2.95221 | .627 |
| Fatigue index | 39 | -.41 | .20 | -.0779 | .15855 | .948 |
| Time endurance (s) | 39 | 28.00 | 224.00 | 77.1026 | 46.08276 | .009 |
| Total Hip | 39 | -4.30 | -.80 | -2.1667 | .69787 | .705 |

Age has weak negative correlation with average power concentric (r=-.360), average power eccentric (r=-.344), average peak power concentric (r=-.328), peak power concentric (r=-.319) and total hip bone density (r=-.353) (see table 3). Total hip bone density has moderate possitive correlation with concentric contraction on peak power (r=.509), average power (r=.485), peak force (r=.476), average power eccentric (r=.460), average peak power (r=.452) and average peak force

(r=.450), with eccentric contraction on average power (r=.416) and peak power (r=.412) (see table 3).

Table 3. Correlation between variables

| | N | Age | | Total Hip | |
|---|---|---|---|---|---|
| | | Pearson's correlation | Sig (2-tailed) | Pearson's correlation | Sig (2-tailed) |
| Age | 39 | | | -.353* | .027 |
| Menopause | 39 | .686 | .000 | -.119 | .469 |
| 1 RM (kg) | 39 | -.040 | .808 | -.174 | .289 |
| Repetition Concentric | 39 | -.120 | .467 | -.011 | .945 |
| Repetition Eccentric | 39 | -.118 | .474 | -.010 | .953 |
| Peak Power Concentric (W) | 39 | -.319 | .048 | .509** | .001 |
| Peak Power Eccentric (W) | 39 | -.154 | .350 | .412** | .009 |
| Average Peak Power Concentric (W) | 39 | -.328* | .042 | .452** | .004 |
| Average Peak Power Eccentric (W) | 39 | -.173 | .294 | .416** | .008 |
| Average Power Concentric (W) | 39 | -.360* | .024 | .485** | .002 |
| Average Power Eccentric (W) | 39 | -.344* | .032 | .460** | .003 |
| Peak Force Concentric (N) | 39 | -.089 | .590 | .476** | .002 |
| Peak Force Eccentric (N) | 39 | .049 | .766 | .306 | .058 |
| Average Peak Force Concentric (N) | 39 | -.151 | .360 | .450** | .004 |
| Average Peak Force Eccentric (N) | 39 | .051 | .759 | .242 | .138 |
| Fatigue Index | 39 | -.090 | .584 | .047 | .777 |
| Time Endurance (sec) | 39 | -.162 | .324 | .011 | .946 |

Correlation is significant at the .05 level (2-tailed).
** Correlation is significant at the .01 level (2-tailed).

## DISCUSSION

The interior of femoral neck is composed of cancellous bone with trabeculae which are organized into medial and lateral trabecular systems. The fact that the joint reaction force on the femoral head parallels the trabeculae of medial system indicates the importance of the system for supporting this force. The epiphyseal plates are the right angles to the trabeculae of the medial system and are thought to be perpendicular to the joint reaction force on the femoral head. It is likely that the lateral trabecular system resist the compressive force on the femoral head produced by contraction of the abductor muscles – included the gluteus medius. With ageing the femoral neck gradually undergoes degenerative changes: the cortical bone is thinned and cancellated and trabeculae are gradually resorbed. These changes may predispose the femoral neck to fracture (Nordin & Frankle 1980). This fact was supported by our result, age has negative correlation to total hip bone density.

The gluteus medius is a largest hip abductor muscle, occupying about 60% of the total abductor cross-sectional area, and has role on dynamic and static hip stabilization. During the stance phase, the hip abductor has a main role as dynamic stabilisator to control the pelvic movement in the frontal and horizontal planes (See diagram on figure 1).

Muscle strength is defined as the maximal force that a muscle can produce. Muscle endurance must be defined operationally for such situation, because it may refer to the holding time for static action, the number of repetition of brief static action or the number of repetition of dynamic action (concentric, eccentric or

isokinetic) (5). When we discuss about hip stability during walking, we talk about dynamic muscle endurance. At least there are four important components of muscle endurance: power, force, time and fatigue index. Power (P) can be defined as the work done (U) is divided by the amount of time (Δt) it took to perform the work, or as the product of average force (F) and velocity (v)(6) : $P = U/\Delta t$ or $P = F.v$

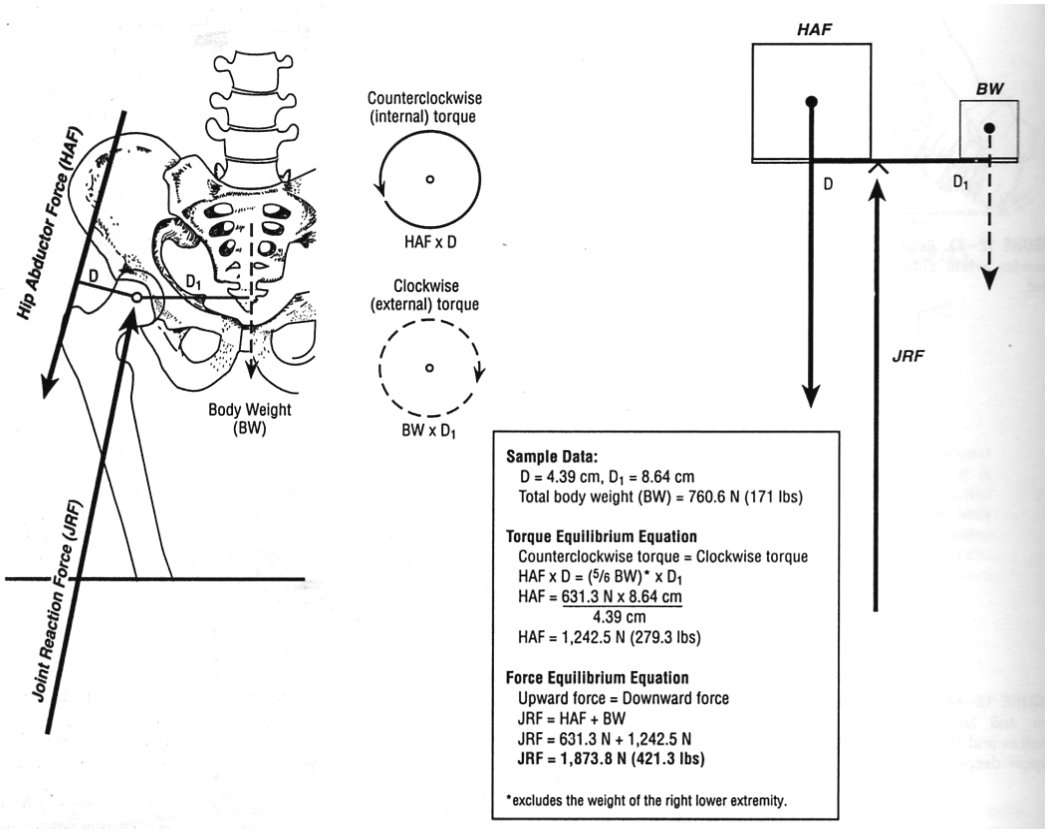


Figure 1. A frontal plane diagram of the right hip abductor muscles function(4)

Work is a scalar quantity that is calculated as the product of the displacement experienced by the object and component of the force acting in the direction of the displacement. In this study muscle strength condition could be seen on 1 RM (kg) and muscle endurance condition could be seen on all the other measurements. This study showed that total hip bone density (reflect the static bone strength) had no correlation to 1 RM (reflect the muscle strength), but had significant positive correlation to power (of concentric and eccentric contractions) and force of concentric contraction. It reflects that just muscle strength is not enough to maintain bone strength, but the muscle endurance (which reflects the strength on the activity although it is submaximal) more important for maintain bone strength.

Mechanical loading mechanism in bone remodeling process is initiated by dynamic force leading to intermittent compressive and tensile stress and strain(7). Strain transduction in achieving cells depends on strain amplitude and frequency (8). Compression force make polarity difference and squeeze the intracanalicular fluid which initiate piezoelectric effect leading to negative strain gradient difference , intraluminair polarity and fluid shift. This shift signals the transduction via gap junction to osteocyte with alter its membrane. And then osteocyte signals osteoblast lining cells to initiate bone remodeling process (7,8,9,10,11,12,13). Forces which work on neck femur from gluteus medius muscle contraction (eccentric and concentric) give rhythmic compressive and tensile forces (14). These forces lead

to femoral bone remodeling process running well, and as an end result will maintain the bone density. It is supporting our study which shows there is correlation between gluteus medius contraction (concentric and eccentric) with total hip density. Even though correlation between concentric contraction with total hip density stronger than eccentric contraction, it is possible because we done the measurement on the abduction amplitude only.

This study revealed no correlation between total hip density and time endurance or fatigue index. Fatigue index is defined as percent decline in specified amount of time such as 15 or 30 seconds of repeated muscle actions (5). So although muscle endurance can trained by using relatively low loads with high number of repetitions to the point of fatigue (5) . but time endurance and fatigue index are not to important to maintain hip bone density. As long as there are enough force and power performed by exercise (within the intensity range 40-60% of 1 RM (5)), endurance exercise will help (included non trained person) to maintain bone density.

Further research is still needed to reveal the form of endurance exercise which can maintain bone density maximally (in determination of load magnitude and direction of hip abductor contraction). And because our study is a point prevalence research, which reflects a cross section condition of muscle performance, we suggest to make advanced research which observed effects of hip abductor muscle endurance exercises on hip bone density.

## CONCLUSION

This study showed that total hip bone density (reflect the static bone strength) had no correlation to 1 RM (reflect the muscle strength). Total hip bone density has stronger correlation with concentric than eccentric contraction activity. Endurance exercise for maintain bone density must give rhythmic eccentric and concentric contraction. As long as there are enough force and power performed by exercise (within the intensity range 40-60% of 1 RM), endurance exercise will help (included non trained person) to maintain bone density. The older, the weaker hip abductor and hip bone.

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