Symbiosis

www.symbiosisonline.org
www.symbiosisonlinepublishing.com
ISSN Online : 2374-6904

Research Article Journal of Exercise, Sports & Orthopedics Open Access

Establishing Norms for Weight-Bearing Hip Rotation Range of Motion

Heather Gulgin, Lindsey Remski, Brittany Sugg, Alexis VanDusen, Dalton Payton, Josie Freybler, Jake Sommers

Movement Science Department , Grand Valley State University, Allendale, MI 49401, United States

Received: December 15,2018; Accepted: January 03, 2019; Published: January 09, 2019

***Corresponding author:** *Dr. Heather Gulgin, Grand Valley State University, Movement Science Department, Allendale, MI 49401,Tel: 616-331-8871, E-mail: gulginh@gvsu.edu*

Abstract

Introduction: Range of motion is typically measured in a non-weight-bearing status, however we participate in sport activities when in weight-bearing condition. The purpose of the study was to establish normative values for weight-bearing hip rotation.

Methods: 135 participants were separated into two different age categories: 18-35 (20.7 ± 3.3 yrs., 173.4 ± 9.7 cm, 74.3 ± 18.4 kg, 24.2 ± 3.9 BMI) and 36-55 (45.2 ± 6.0 yrs., 173.0 ± 9.7, 76.8 ± 19.9 kg, 25.4 ± 4.8 BMI) and had bilateral hip internal and external rotation measured on the Functional Footprint® device. A One-way ANOVA tested for significance ($p < 0.05$) between the two age categories for internal and external rotation. Separate paired t-tests tested for significance between right and left sides.

Results: There was no significant difference between the groups for hip internal rotation (R Int Rot $p = 0.444$, L Int Rot $p = 0.997$) or external rotation (R Ext Rot $p = 0.933$, L Ext Rot $p = 0.443$). There was a small but significant side-to-side difference for the older group internal rotation (2.9^0) and both the younger and older groups external rotation (2.8^0 and 4.3^0) respectively.

Conclusion: Normative values for two age groups were established and may be used to compare to other active range of motion values for hip rotation.

Keywords: Hip; Range of Motion; Weight-Bearing; Norms; Movement System

Introduction

Several studies have reported varying values for hip rotation range of motion (ROM). Part of the reason for this is that there has been different methodology regarding the type of motion measured (active vs. passive), and the position (prone, supine, or seated) used during the measurement [1-8].

Interestingly, most activities of daily living as well as sports occur with a majority of the time spent in a weight-bearing (WB) status, but often when assessing available joint ROM, the measurement is performed in a non-weight-bearing (NWB) status. For example, when a clinician measures available NWB joint ROM with a goniometer or inclinometer, the assessment is often completed bilaterally and a comparison is made between the two sides. The goal is to have a patient or athlete not only within a published normal range of values, but also to have side-to-side symmetry. Since the hip, spine, and pelvis function as a unit in the overall kinetic chain, lack of motion in one segment is typically compensated for by another segment in this unit. However, the resulting imbalance in joint mobility may lead to injury. For example, several investigators have demonstrated an association with hip rotation ROM asymmetry and low-back pain or sacroiliac dysfunction [9-13]. Other researchers have found that asymmetrical hip rotation ROM may be associated with sports hernias, and anterior cruciate ligament injury[14-16].

One recent study did examine a novel approach to measure loaded hip rotation [17]. They placed the participant in a kneeling position, allowing for the lower leg of loaded side to rotate. However, this position also required the participant to flex the hip and knee of opposite limb 90^0 to place the foot forward. This created frontal plane tilting of the pelvis, which could alter surrounding hip musculature. More importantly, this position still does not represent how an athlete would be loaded during activity. For the athlete, a more functional assessment in the WB position may be required to determine if there is an adequate amount of hip rotation ROM necessary for a particular sport skill or motion.

If an athlete goes through a particular amount of motion during a particular sport skill or task and they do not have that amount of WB ROM available at the hip, then there may be an increased risk of injury. For example: Does a golfer have the necessary WB hip rotation ROM available in the lead hip required to make a full golf swing? Does a tennis player have enough WB hip rotation ROM to turn through a forehand? Or a baseball player has enough WB hip rotation ROM to turn through the impact zone while hitting? If an athlete does not have adequate ROM, then over time, the body may adapt to the demand and allow for more ROM at the hip, or the soft-tissues about the joint (joint capsule, ligaments, labrum, etc.) become stressed, fail, and result in pathology or injury.

Three-dimensional motion capture studies that have examined athlete's lower extremity hip rotation range of motion used during various sport skills are sparse. McLean utilized a 3D motion capture system to measure lower extremity kinematics in three different sport tasks: sidestep, jump-landing, and shuttle run [18]. He reported actual values for hip internal/external ROM among males and females, ranging from $17-24^0$, depending on the task. Another study examined the amount of lower extremity ROM in all three planes while sprinting on straight away and sprinting on a curve [19]. They reported very small hip internal rotational values ranging from 1.5-4.6 degrees, and hip external rotational values ranging from 12.9-21.6 degrees, which fall within normal hip rotation ROM. While the motion utilized in these studies appear to fall within the normal hip rotation ROM limits, these tasks are somewhat non-rotational by nature, and thus more studies should expand on other rotational sport movements and the actual ROM utilized. One particular study in the past has reported on golfer's hip rotation ROM utilized during a full golf swing [18-19]. Gulgin20 measured elite female golfers WB hip rotation ROM and compared this to the amount of rotation used by the lead hip during the full golf swing and found that golfers exceed their available lead hip WB internal rotation during the golf swing [20]. Another study by Milewski et al. , analyzed adolescent baseball pitcher's lower extremity kinematics with a 3D motion capture system and reported that both the lead and trail hip internal and external rotation values recorded during the pitching motion are within normal passive ROM limits [21].

In summary, while a few studies have examined lower extremity range of motion of a particular sport skill, there has only been one study to compare these movements to an athlete's measured available WB hip rotation ROM. In order to determine if an athlete's hip movement requirements for a sport skill are putting them at risk for soft-tissue injury, there first should be a normative database of WB hip rotation ROM for which to compare to. Thus, the purpose of this study is to measure WB hip rotation ROM on healthy adults. The hypotheses are that there will be no significant difference in hip rotation range of motion between the various age categories, nor side-to-side differences. These data would provide normative values for which future studies could compare to various athletic populations, as well as make comparisons to studies that measure actual WB ROM used during specific sport skills to determine if athletes are using extreme range of motion that may put them at risk for injury.

Methods

One hundred thirty-five participants reported to the Exercise Science laboratory on one occasion and were separated into two different age categories: 18-35 and 36-55. Bilateral hip internal rotation and external rotation were measured on the Functional Footprint® device (Figure 1). Prior to data collection all participants were given instructions of the procedures, allowed the opportunity to ask questions, and signed a written consent approved by the Institute's Human Research Review Board.

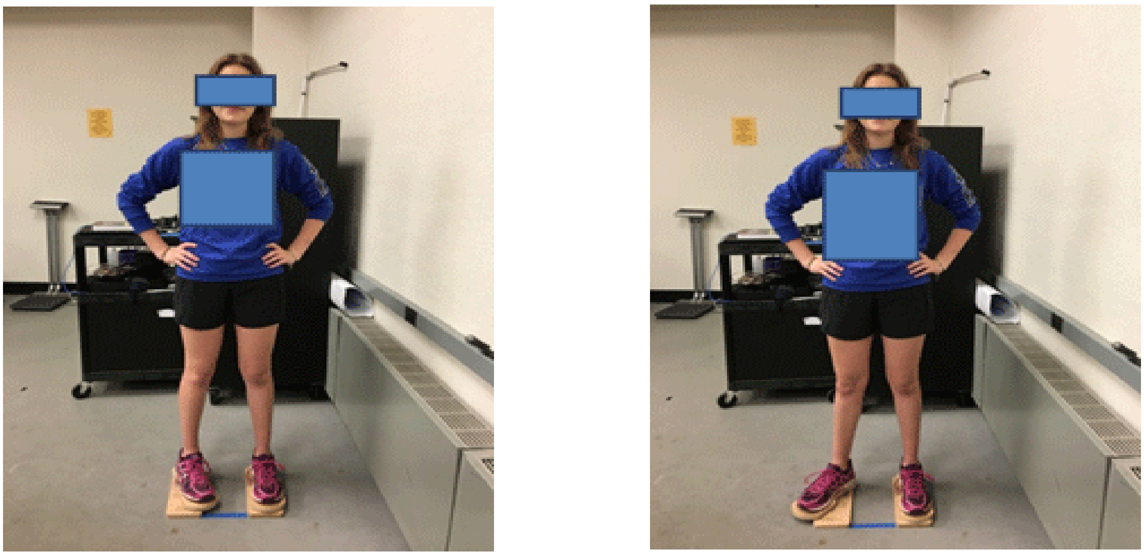

Figure 1: Participant set-up

Participant anthropometrics (height and weight), age, hand & foot dominance, and ethnicity were recorded. Additionally, participants were questioned about their typical physical activity per week and past sport participation to report about the type of sample population being collected. Following the questions, participants warmed up on a stationary bike for five minutes at their own pace. Immediately following the warm-up, the primary investigator demonstrated how to perform the hip rotation (and gave verbal instructions) while standing on the Functional Footprint⍰ device. The participants were instructed to keep their leg straight, foot flat (not lift up toes or roll arch), hands on hips, keep pelvis and shoulders facing forward and remain still, and

Citation: Gulgin H, Remski L, Sugg B, et al. (2019) Establishing Norms for Weight-Bearing Hip Rotation Range of Motion. J Exerc Sports Orthop 6(1): 1-5. DOI: http://dx.doi.org/10.15226/2374-6904/6/1/00177

to look straight ahead. Participants were asked to try internal and external rotation on each side in order for the investigator to look to correct form before collecting three trials in each direction on each side. The investigators also watched for any transverse plane movement as well as any sagittal tilting of pelvis. If a participant performed the hip rotation motion with any one of the above compensations, the trial was not counted.

Statistical analysis was completed using SPSS version 24 (IBM Corp, Raleigh, NC). The average of three trials for each measure were entered for data analysis. A One-way ANOVA tested for significant differences ($p < 0.05$) between the two groups for internal and external rotation. Additionally, separate paired t-tests tested for side-to-side differences. Cronbach's Alpha test was run on pilot data to test for reliability of measures on the Functional Footprint® device [22].

Results

Previous pilot testing on 15 participants revealed ICC for right internal rotation (.817), right external rotation (.897), left internal rotation (.918), and left external rotation (.840).

Participant demographics are reported in Table 1. Additionally, of the 135 participants, 85.2% were Caucasian, 4.4% Latino, 5.9% African-American, 3.0% Asian, and 1.5% other. Right hand and leg dominance were 91.9% and 92.6% respectively. Regular physical activity was determined by ACSM Guidelines of recommended 150 min/week, regular yoga was determined to be two or more times/week, and rotational sport participation (dance, golf, tennis, baseball, softball, hockey, field hockey, figure skating) of five or more years counted as history of rotation sport. Overall, 77.8% of the sample population were considered physically active, 11.9% performed yoga on regular basis, and 48.1% had history of a rotational sport.

Peak internal and external WB ROM for right and left sides are reported by group in Table 2. There was no significant difference between the groups for internal or external hip rotation (Table 2). There was a small, but significant side-to-side difference for the older group internal rotation (2.9^0), and both the younger and older groups external rotation (2.8^0 and 4.3^0) respectively.

Table 1: Participant Demographics

Group (n)	Age (yrs)	Ht (cm)	Wt (kg)	BMI
Age 18-35 (91)	20.7 (3.3)	173.4 (9.7)	74.3 (18.4)	24.2 (3.9)
Age 36-55 (44)	45.2 (6.0)	173.0 (9.7)	76.8 (19.9)	25.4 (4.8)

Table 2: Weight-bearing Hip Rotation Range of Motion Means and Standard Deviations

Group (n)	R Int Rot°	L Int Rot°	Diff	R Ext Rot°	L Ext Rot°	Diff
Ages 18-35 (91)	21.2 (10.1)	22.6 (9.6)	1.4°	41.5 (9.9)	38.7 (9.3)*	2.8°
Ages 36-55 (44)	19.8 (9.4)	22.7 (10.6)*	2.9°	41.5 (9.9)	37.2 (12.1)*	4.3°

*Significant difference (p<0.05) between right and left side
+Significant difference (p<0.05) between the groups

Discussion

Most of the existing literature on hip rotation range of motion has been measured actively or passively but measured in a non-weight bearing condition. However, sports occur with athletes in load-bearing or weight-bearing condition. Thus, it is important to determine normative values for weight-bearing hip rotation range of motion. One study17 recently examined a load bearing condition of hip rotation. For internal hip rotation, they found average values of 22.6^0 ± 2.7 and 21.1^0 ± 2.1 for right and left limbs respectively. For external hip rotation, they found average values of 27.8^0 ± 2.1 and 25.8^0 ± 1.7 for right and left limbs respectively. In the current study, our internal hip rotation values ranged from 19.8-21.2^0 (right) and 22.6-22.7^0 (left) depending on age category. Thus, our findings are very similar despite slightly different measuring technique. Regarding external hip rotation, the current study found values ranging from 41.5^0 (right) and 37.2-38.7^0 (left). Thus, it appears our values for external rotation were quite higher than Aefsky.[17] This could be due to the difference in position of the pelvis that was slightly tilted in frontal plane for Aefsky[17] measurements.

In comparison to other literature on active ROM hip rotation measures, our study aligns with the general findings, in that external rotation ROM is more than internal rotation ROM,[2-3, 7, 23-24] and that there are typically no side-to-side differences[1,4,8,23] in hip rotation range of motion in healthy population.

In particular, of the studies that measured active hip rotation, most of them did so in seated position[1,4, 6, 25] and would not be ideal for comparison, as previous studies[3, 7,17] found that there is an effect for position of measurement. Thus, our study results would best be compared to those that measured prone, active hip rotation, as our standing test position places the hip in neutral position, the same as when measured prone. Of those that measured active, prone hip rotation,[7,11, 23-24, 26-27] Mosler[26] did not report whether the measurement was active or passive and will not be compared. In comparison with Ellenbecker [23], our internal hip rotation values (19.8-22.7^0) were similar to theirs for internal hip rotation in baseball players (22-23^0), but we showed lower values in comparison to male tennis players (26-27^0) and female tennis players (35-37^0). For external hip rotation, our findings (37.2-41.5^0) were similar or slightly higher than their baseball players (34-35^0), male tennis players (36-37^0), and female tennis players (35-36^0). In comparison to Moreno-Perez et al. [24], our values for internal hip rotation were approximately 9-10^0 lower than their findings for internal hip rotation that ranged from 28.5-30.6^0 (male) to 34.2-36.9^0 (female). Interestingly, their study [18] found external hip rotation values of 51.9-52.7^0 (male) to 48.1-49.1^0(female). Thus, their[24] external hip rotation values were higher than most who have measured active, prone hip rotation ROM. In comparison to Simoneau et al. [7] our values are 13-16^0 lower for internal hip rotation, as their findings ranged from 32-38^0 and our findings ranged from approximately 20-23^0. Similarly, our values were 7-9^0 lower for external hip rotation, as their findings ranged from 44-46^0 and our findings ranged from approximately 37-41$^{0.}$

The Academy of Orthopedic Surgeons 1965 normative data[28] report 45^0 for hip internal and external rotation ROM. However, little is known about make-up of population (males, females, age, etc.) And how the measurements were taken. More recently the American Medical Association (1990) reported normal internal hip rotation values of 40^0 and external hip rotation values of 50^0. [28] Again, little information was provided on population demographics or type of measurement. Thus, comparisons of hip rotation range of motion should only be made when the mode of measurement (active vs passive) and the position of the measurement (prone, seated, supine) are known. The current study values for internal hip rotation are much lower than the previously established standards ($40\text{-}45^0$), but those may have been measured passively. Since our weight-bearing ROM findings do show that internal hip rotation is much less (approximately 20^0) in a weight-bearing condition, clinicians and fitness coaches need to be aware that the athlete may be at risk for hip injury if their sporting task requires more transverse plane motion.

One of the limitations of the study was that femoral-ace tabular torsion (ante version or retroversion angle) was not accounted for. However, most studies that measure hip rotation range of motion do not account for this. Another limitation was that the primary investigator was not blinded to the measures. Ideas for future studies would be to measure actual hip rotation ROM used during specific sports and compare this to participants WB ROM values.

Conclusion

With knowledge of normative weight-bearing hip rotation range of motion values, further examination can be done on specific sub-populations of athletes. Ideally, clinicians or coaches could measure the more functional weight-bearing range of motion, to determine if an athlete has existing asymmetry or values of concern (relative to normal population).

References

1. Hallaceli H, Uruc V, Uysal HH, Ozden R, Hallaçeli C, Soyuer F, et al. Normal hip, knee, and ankle range of motion in Turkish population. Acta Orthop Traumatol Turc. 2014;48(1):37-42. Doi: 10.3944/AOTT.2014.3113
2. Kouyoumdjian P, Coulomb R, Sanchez T, Asencio G. Clinical evaluation of hip joint rotation range of motion in adults. Orthop Traumatol Surg Res. 2012;98(1):17-23. Doi: 10.1016/j.otsr.2011.08.015
3. Kumar S, Sharma R, Gulati D, Dhammi IK, Aggarwal AN. Normal range of motion of hip and ankle in Indian population. Acta Orthop Traumatol Turc. 2011;45(6):421-424. Doi: 10.3944/AOTT.2011.2612
4. Macedo LG, Magee DJ. Differences in range of motion between dominant and non-dominant sides of upper and lower extremities. J Manipulative Physiol Ther. *2008;31(8):577-582. Doi: 10.1016/j.jmpt.2008.09.003*
5. *Roaas A, Andersson G. Normal range of motion of the hip, knee and ankle joints in male subjects, 30-40 years of age. Acta Orthop Scand. 1982;53(2):205-208.*
6. *Roach KE, Miles TP. Normal hip and knee active range of motion: the relationship to age. Phys Ther. 1991;71(9):656-665.*
7. *Simoneau GG, Hoenig KJ, Lepley JE, Papanek PE. Influence of hip position and gender on active hip internal and external rotation. J Orthop Sport Phys. 1998;28:158-164. Doi:* 10.2519/jospt.1998.28.3.158
8. Svenningsen S, Terjesen T, Auflem M, Berg V. Hip motion related to age and sex. *Acta Orthop Scand. 1989;60(1):97-100.*
9. Barbee-Ellison J, Rose S, Sahrmann SA. Patterns of hip rotation range of motion: a comparison between healthy subjects and patients with low back pain. Phys Ther. 1990;70(9):537-541.
10. Cibulka MT, Sinacore D, Cromer GS, Delitto A. Unilateral hip rotation range of motion asymmetry in patients with sacroiliac joint regional pain. Spine. 1998;23(9):1009-1015.
11. Chesworth BM, Padfield BJ, Helewa et al. A comparison of hip mobility in patients with low back pain and matched healthy subjects. Physiother Can. 1994;46:267-274.
12. Harris-Hayes M, Sahrmann SA, VanDillen LR. Relationship between the hip and low back pain in athletes who participate in rotation-related sports. J Sport Rehabil. 2009;18(1):60-74.
13. VanDillen LR, Bloom NJ, Gombatto SP, Susco TM. Hip rotation range of motion in people with and without low back pain who participate in rotation-related sports. Phys Ther Sport. 2008;9(2):72-81. Doi: 10.1016/j.ptsp.2008.01.002
14. Rambini R, Hackney R. Loss of range of motion of the hip joint: a hypothesis for etiology of sports hernia. Muscles Ligaments Tendons J. 2015;5(1):29-32.
15. Bedi A, Warren RF, Wojtys EM, Oh YK, Ashton-Miller JA, Oltean H, et al. Restriction in hip internal rotation is associated with an increased risk of ACL injury. Knee Surg Sports Traumatol Arthrosc. 2016;24(6):2024-2031. Doi: 10.1007/s00167-014-3299-4
16. Tainaka K, Takizawa T, Kobayashi H, Umimura M. Limited hip rotation and non-contact anterior cruciate ligament injury: a case-control study. The Knee. 2014;21(1):86-90. Doi: 10.1016/j.knee.2013.07.006
17. Aefsky B, Fleet N, Myers H et al. Reliability and validity of a novel approach to measure hip rotation. J Sport Rehabil. 2016;25(4):330-337. Doi: 10.1123/jsr.2015-0013
18. McLean S, Walker K, Van den Bogert A. Effect of gender on lower extremity kinematics during rapid direction changes: an integrated analysis of three sports movements. J Sci Med Sport. 2005;8(4):411-422.
19. Alt T, Heinrich K, Funken J, Potthast W. Lower extremity kinematics of athletics curve sprinting. J Sports Sci. 2014; 33(6):552-560. Doi: 10.1080/02640414.2014.960881
20. Gulgin H, Armstrong C, Gribble P. Female golfers weight-bearing hip rotation range of motion. N Am J Sports Phys Ther. 2010;5(2):55-62.
21. Milewski M, Ounpuu S, Westwell M, Nissen CW. Adolescent baseball pitching technique: Lower extremity biomechanical analysis. J Appl Biomech. 2012;28(5):491-501.
22. Tavakol M, Dennick R. Making sense of Cronbach's alpha. *Int J Med Educ. 2011;2:53-55. Doi: 10.5116/ijme.4dfb.8dfd*

23. *Ellenbecker TS, Ellenbecker GA, Roetert EP,* Silva RT, Keuter G, Sperling F. Descriptive profile of hip rotation range of motion in elite tennis players and professional baseball pitchers. Am J Sport Med. *2007;35(8):1371-1376. Doi: 10.1177/0363546507300260*
24. *Moreno-Perez V, Ayala F, Fernandez-Fernandez J,* Vera-Garcia FJ. Descriptive profile of hip range of motion in elite tennis players. Phys Ther Sport. 2016;19:43-48. Doi: 10.1016/j.ptsp.2015.10.005
25. Tippett SR. Lower extremity strength and active range of motion in college baseball pitchers: a comparison between stance and kick leg. JOSPT. 1986;8(1):11-14. Doi: 10.2519/jospt.1986.8.1.10
26. Mosler AB, Crossley KM, Thorborg K et al. Hip strength and range of motion: Normal values from a professional football league. J Sci Med Sport. 2017;20(4):339-343. Doi: 10.1016/j.jsams.2016.05.010
27. Peixoto Leao Almedia G, Lima de Souza V, Sadao Sano S, Saccol MF, Cohen M. Comparison of hip rotation range of motion in judo athletes with and without history of low back pain. Man Ther. 2012;17(3):231-235. Doi: 10.1016/j.math.2012.01.004
28. Norkin C, White D. Measurement of joint motion. A guide to goniometry 3rd Ed. Philadelphia; FA Davis Company: 2003.