



## Screening the Ability to Squat in the Middle aged Population: An Observational Study

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### Abstract

**Background:** *The biomechanical analysis of squatting in individuals from the kinematic prospective would reveal numerous errors in the performance of these movements. These errors essentially arise when the functional integrity of human body is hampered. Individual in the middle aged population are more susceptible to injuries due to incorrect biomechanics during this movements.*

**Objective:** *To screen the ability to squat in the middle aged population.*

**Methods:** *The observational study included open ended participation between the age of 35-50 years to screen the squatting ability in general population. The outcome measure was squatting assessment and strength of hamstrings and quadriceps muscle by hand held dynamometer.*

**Result:** *Significant difference found in deep squat performance and biomechanical movement errors [ $p < 0.05$ ]. Also significant difference found between right and left hamstring and quadriceps with normal and inaccurate squat [ $p < 0.05$ ].*

**Conclusion:** *Ability to squat in middle age population is hampered.*

**Keywords:** *Squatting, hand-held dynamometer, muscle strength.*

### Introduction

Squatting is a posture where the weight of the body is on the feet (as with standing) but the knees and hip are bent. Squatting may be either full squat, deep squat or partial, half, semi, parallel, shallow, intermediate, incomplete or monkey squat.<sup>1</sup>

Squatting performance benefits not only to athletic population, but it also benefits common individuals in many of their daily activities. In daily activities various number of muscle groups

are stimulated and squatting is counted to be one of the best exercise to improve quality of life as squatting too recruits various muscle groups in single task. Squatting is seen to be closely related to most of the regular activities namely lifting objects and other daily tasks.<sup>2</sup> The significant isometric activity is required by a wide range of supporting muscles to facilitate postural stabilization of the trunk. In all, it is estimated that over 200 muscles are activated during squat performance<sup>3</sup>.

The biomechanical analysis of squatting in individuals from the functional movement perspective would focus on numerous errors in performance of movement. These errors essentially arise when functional integrity of body is hampered. The analysis of biomechanics of body segments involved in squatting would help to identify these errors which could further be suggested to corrections, thus aiding in improving functional integrity of body and reducing the long term risk of injuries in middle age population. Hence, the aim of the study is to screen the ability to squat in the middle-aged population.

## **Materials and methodology**

### **Study design and setting**

The observational study conducted into tertiary care hospital Belagavi city, Karnataka, India.

### **Participants**

In this observational study both male and female subjects between age group of 35-50 years were included. Exclusion criteria comprised of restricted physical activity due to any recent fracture of the limb, pre-existing disease or medical condition that made their participation inadvisable.

### **Outcome measures**

#### **Hamstrings muscle strength**

The participant was told to lie in prone position. The hand-held dynamometer was placed at the calcaneum by therapist. Participant was then instructed to bend the knee while the resistance was applied by the therapist through the hand-held dynamometer. After knee flexion complete resistance was applied till the knee was completely extended and the reading was recorded.

#### **Quadriceps muscle strength**

Participants was in high sitting position, hand-held dynamometer was placed at the anterior aspect of distal tibia. Participant was asked to extend knee while the resistance was offered through dynamometer by the therapist. When knee was extended resistance was applied till the knee was flexed and the reading was recorded.

### **Functional movement screen (FMS)**

Functional movement screening was done using deep squat test. The participant was asked to stand with feet shoulder width apart with wand held in both the hand overhead with 90-degree angle of elbows. Participant is asked to press the wand overhead with shoulders flexed and abducted and elbows extended while squatting slowly with heels on floor, head and chest facing forward. The participants were explained the procedure by therapist and asked to practice under supervision before analyzing the squat.

### **Procedure**

Ethical clearance was obtained from institutional ethical committee. A written informed consent was taken from subjects before including them into study. Subjects were screened for inclusion and exclusion criteria. Subjects were made to sit and procedure was explained to them. Quadriceps and hamstring muscle strength were measured by hand-held dynamometer. Then subject made to perform deep squat. The performance assessed on the basis of functional movement screening of squat performance.

The scores range from zero to three, three being the best possible score. If participant complains of pain anywhere while performing test individual is scored zero and painful area is noted. If participant is unable to complete movement or assume position score 2 was given. If participant performed movement without compensation participant was scored 3.

### **Statistical analysis**

All statistical analysis was done by using SPSS version 21 for windows. Distribution of individuals with type of squat normal or abnormal was done. Type of squat was compared to right and left hamstring scores and quadriceps scores using independent t test. The correlation between right and left quadriceps and hamstrings score was analyzed using Karl Pearson's correlation coefficient method. Probability values less than 0.05 were considered statistically significant.

**Results**

The participants were classified in normal and abnormal squat, there were 31%(31) people performed normal squat off 100 participants and rest 69%(69) participants performed abnormal squat.(figure 1)

In the present study when mean age was compared among normal squat and abnormal squat, the mean age obtained for normal squat was 41.59±5.39. Similarly, in abnormal squat the mean age was 41.76±5.57, which is not statistically significant (p = 0.8853). When BMI was compared among normal squat and abnormal squat, the mean BMI obtained for normal squat was and in 24.47±3.07 abnormal squat the mean BMI was 24.67±2.75, Which is statistically not significant (p = 0.7465)(table no 1).

When squatting was compared to right and left side with respect to quadriceps score, the mean

obtained for right side normal squat was 26.91±3.83 and for abnormal squat the mean score was 26.29±3.77 which is statistically not significant (p = 0.4529). Similarly for left side the mean obtained for normal squat was 26.91±3.83 And for abnormal squat was 26.28±3.78 ..... which is statistically not significant(p = 0.4427 ) (table 2).

When squatting was compared to right and left side with respect to hamstring score the mean obtained for right side normal squat was 24.63±3.48 and for abnormal squat the mean score was 23.93±3.36 Which is statistically not significant (p = 0.3405). Similarly, for left side the mean obtained for normal squat was 24.63±3.48 and for abnormal squat was 23.94±3.38 Which is statistically not significant (p = 0.3518) (table 3).

**Table 1:** Comparisons of types of squat (normal and abnormal) with respect to age and BMI scores by t tests

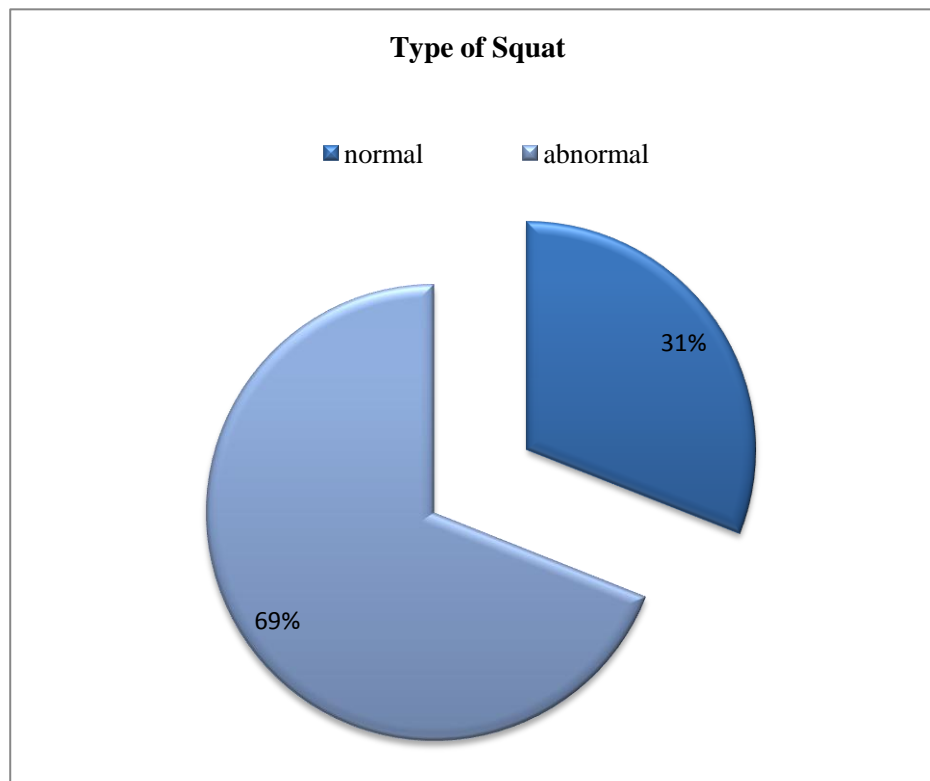
Variable	Types of squat	Mean±SD	SE	t-value	P-value
Age in yrs	Normal	41.59±5.39	0.95	-0.1446	0.8853
	Abnormal	41.76±5.57	0.68		
BMI	Normal	24.47±3.07	0.54	-0.3242	0.7465
	Abnormal	24.67±2.75	0.33		

**Table 2:** Comparisons of types of squat (normal and abnormal) with respect to mean quadriceps scores at right and left sides by t tests

Sides	Types of squat	Mean±SD	SE	t-value	p-value
Right side	Normal	26.91±3.83	0.68	0.7536	0.4529
	Abnormal	26.29±3.77	0.46		
Left side	Normal	26.91±3.83	0.68	0.7708	0.4427
	Abnormal	26.28±3.78	0.46		

**Table 3:** Comparisons of types of squat (normal and Abnormal) with respect to mean hamstring scores at right and left sides by t tests

Sides	Types of squat	Mean±SD	SE	t-value	P-value
Right side	Normal	24.63±3.48	0.62	0.9578	0.3405
	Abnormal	23.93±3.36	0.41		
Left side	Normal	24.63±3.48	0.62	0.9356	0.3518
	Abnormal	23.94±3.38	0.41		

**Figure 1:** Distribution of participants with type of squat

### Discussion

Squatting comprises of the combined kinetic and kinematic movements of ankle, knee, hip and spine. The ankle complex contributes significant support and aids in power generation during squat performance<sup>4</sup>. The peak ankle movements of 50 to 300 Nm have been reported during squat<sup>5</sup>. The gastrocnemius has been the primary ankle joint muscles studied in a squat performance. It is believed that the medial head of gastrocnemius acts as dynamic knee stabilizer during squatting, helping to offset knee valgus movements as well as limiting posterior tibial translation<sup>6,7</sup>. The gastrocnemius shows only moderate levels of activation during squatting, which tends to progressively increase as the knee flexes and decrease as the knee extends<sup>8,5</sup>.

Knee joint consists of tibiofemoral, which carries out movement throughout range of motion of 0 to approximately 160 degrees of flexion<sup>9,10,11</sup>. The hip joint is freely mobile in planes of movement, carrying out flexion and extension in saggital plan, adduction and abduction in frontal plane and internal/ external-rotation and horizontal

adduction/abduction in transverse plane<sup>10,11</sup>. In the spine synergistic lumbar-pelvic relationship, absolute spine angle generally increase as an individual flexes at the hips. Therefore, the vertebral column and its supporting muscles are subjected to significant internal forces during performance of the deeper squats<sup>12</sup>.

Bell et al. found that a lack of strength in the medial gastricnemius, tibialis anterior or tibialis posterior may decrease an individual's ability to control knee valgus and foot pronation motions, as well as contributing to excessive medial knee displacement [MKD] and dynamic valgus. Weakness of the ankle musculature has been implicated in the genesis of faulty movement patterns during the squat. The current study focus on the error in squatting movement because of long term adaptation of inaccurate biomechanical movement pattern.<sup>6</sup>

Furthermore the study conducted by caterisano et al. reported that although average muscle activity of gluteus maximus was not significantly different in the partial squat and parallel squat, it increase significantly during the full squat, although there

were some methodological differences. They presented only peak values, which displayed significantly greater activity during performance of full squat as compared with lesser squat depth, no strength values provided for bilateral hamstring and quadriceps muscle during full squat.<sup>13</sup> If the FMS™, or any similarly developed test, can identify at risk individuals, then prevention strategies can be instituted based on their scores.<sup>14</sup>

### Conclusion

The present study concluded that ability to squat in middle aged population is hampered.

### Limitations

Limitation to the present study include homogeneous group of participation which limits the study only for population of middle age people. There was suboptimal standardization used for deciding stance width for deep squat.

### Future scope

The screening of deep squat as functional movement emphasize on at risk population for musculoskeletal disorders. By clinically implicating the exercise intervention for corrections of the functional movement would prevent or reduce the risk of musculoskeletal disorders.

### Reference

- Gordon W. Hewes, World Distribution of Certain Postural Habits. *American Anthropologist*. 1955;57:231-243.
- Dahlkvist NJ, Mayo P, Seedhom BB. Forces during squatting and rising from a deep squat. *Engineering in medicine*. 1982 Apr;11(2):69-76.
- Solomonow, M, Baratta, R, Zhou, BH, Shoji, H, Bose, W, Beck, C, and D'Ambrosia, R. The synergistic action of the anterior cruciate ligament and thigh muscles in maintaining joint stability. *Am J Sports Med*.1987; 15: 207–213,
- Hung, YJ and Gross, MT. Effect of foot position on electromyographic activity of the vastus medialis oblique and vastus lateralis during lower-extremity weight-bearing activities. *J Orthop Sports Phys Ther*.1999;29: 93–102.
- Escamilla, RF, Fleisig, GS, Lowry, TM, Barrentine, SW, and Andrews, JR. A three-dimensional biomechanical analysis of the squat during varying stance widths. *Med Sci Sports Exerc*.2001; 33: 984–998.
- Bell, DR, Padua, DA, and Clark, MA. Muscle strength and flexibility characteristics of people displaying excessive medial knee displacement. *Arch Phys Med Rehabil*.2008; 89: 1323–1328.
- Rasch, PJ and Burke, RK. *Kinesiology and Applied Anatomy* (5th ed.) 1974. Philadelphia, PA: Lea and Febiger,.
- Donnelly, DV, Berg, WP, and Fiske, DM. The effect of the direction of gaze on the kinematics of the squat exercise. *J Strength Cond Res*. 2006 20: 145–150.
- Li, G, Most, E, DeFrate, LE, Suggs, JF, Gill, TJ, and Rubash, HE. Effect of the posterior cruciate ligament on posterior stability of the knee in high flexion. *J Biomech*. 2004;37: 779–783.
- Signorile, JF, Kwiatkowski, K, Caruso, JF, and Robertson, B. Effect of foot position on the electromyographical activity of the superficial quadriceps muscles during the parallel squat and knee extension. *J Strength Cond Res*. 1995; 9: 182–187.4
- van Eijden, TM, Weijts, WA, Kouwenhoven, E, and Verburg, J. Forces acting on the patella during maximal voluntary contraction of the quadriceps femoris muscle at different knee flexion/extension angles. *Acta Anat*.1987;129: 310–314,
- Schoenfeld BJ. Squatting kinematics and kinetics and their application to exercise performance. *The Journal of Strength &*

Conditioning Research. 2010 Dec 1;24(12):3497-506.

13. Caterisano A, Moss RE, Pellingier TK, Woodruff K, Lewis VC, Booth W, Khadra T. The effect of back squat depth on the EMG activity of 4 superficial hip and thigh muscles. The Journal of Strength & Conditioning Research. 2002 Aug 1;16(3):428-32.
14. Cook G, Burton L, Hoogenboom B. Pre-participation screening: The use of fundamental movements as an assessment of function—Part 2. North American journal of sports physical therapy: NAJSPT. 2006 Aug;1(3):132.