

How to Cite:

Soni, J., & Aghara, K. (2022). Association of quadriceps angle with gender, anthropometric measurements and quadriceps muscle strength in middle age group: A systemic review. *International Journal of Health Sciences*, 6(S8), 1113–1122.
<https://doi.org/10.53730/ijhs.v6nS8.10254>

Association of quadriceps angle with gender, anthropometric measurements and quadriceps muscle strength in middle age group: A systemic review

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Abstract---This study aims to determine the relationship between quadriceps angle, anthropometric measurements and quadriceps muscle strength. The quadriceps angle (Q angle) consider clinically as a very important parameter which displays the biomechanical effect of the quadriceps muscle on the knee and it is also a crucial factor for the proper posture and movement of the knee. Quadriceps angle is routinely and regularly used as an assessment parameter during the diagnosis of many knee-related problems. This study shows the inverse relation between quadriceps angle and height and quadriceps muscle strength. Also it provides information of the proportional relation between quadriceps angle and weight.

Keywords---quadriceps angle, anthropometric measurements, quadriceps muscle strength.

Introduction

Quadriceps angle is defined as the angle formed between the Quadriceps muscle and the patellar tendon, which also known as Q angle.¹ Quadriceps angle is measured between a line connecting the anterior superior iliac spine to the mid point of patella and the line connecting the tibial tuberosity to the mid point of patella.² The net effect of the pull of the quadriceps muscle and the patellar tendon can be assessed clinically. The quadriceps angle is considered clinically as a very important parameter which displays the biomedical effect of the quadriceps

muscle on the knee and it is also regarded as a crucial factor for the proper posture and movement of the knee.¹ The quadriceps angle is routinely used as an assessment parameter during the diagnosis of many knee related problems including the anterior knee pain, osteoarthritis, degenerative knee disorders etc.¹ Normal value of quadriceps angle is between 13 to 18 degrees. Normal value of Q angle in male is 13 degree and in female it is 18 degree.³ An increased quadriceps angle is indicative of pathological lateral forces on the patella.² Thus it is considered as an important index of patello femoral function and dysfunction. It is a risk factor for patella femoral pain, patella subluxation and dislocation.⁴

Muscle strength is an important indicator of muscle performance.⁵ It is the quantity of force, a muscle can generate with one largest exertion. The quadriceps muscle group is a hip flexors and knee extensors. It consists of four individual muscles (Rectus Femoris, Vastus Medialis, Vastus Lateralis and Vastus Intermedius). In everyday life, it is an extraordinary important muscle. But due to the stress it receives, it is often subject to trauma. The quadriceps muscle is essential for daily activities like climbing stairs, getting up from chair etc.⁵

Many studies have highlighted a inverse correlation between the quadriceps angle and the quadriceps muscle strength.⁶ This negative relationship has been reported to depend on the developmental differences in force production ability in terms of increased muscle tone in the quadriceps muscle and a drop in the quadriceps angle.⁶ Factors that affect the quadriceps muscle strength includes age, body mass index, physical activity level and nutritional factors.⁶ According to gender, women have higher values of the quadriceps angle than men, this difference is seen due to women's broader pelvis, shorter femur lengthened more inward twist of the femur.⁷ Quadriceps angle has negative correlation with height. As height increases, the quadriceps angle decreases.⁸ There is a positive correlation between weight and quadriceps angle. Female have greater quadriceps angle when compared with male, with respect of their body weight.⁴ Positive correlation is present between body mass index and the quadriceps angle.⁸ There is a negative correlation seen between waist hip ratio and quadriceps angle.⁷ Quadriceps angle has become accepted as an important factor in assessing knee joint function and determining knee health in individuals. Quadriceps angle measurement gives useful information concerning the alignment of the pelvis, leg and foot. Misalignment will cause problems to the knee function.¹

Method

The Database used were- pub med, Scopus, Web of Science and the other search engine/databases used: Cochrane database / SCIRE / PEDro / CINAHL/ EMBASE, ERIC. The University library and research center were also approached for e-copy and possible hand search of articles. The criteria for inclusion of articles were all research designs like Systematic review, Meta-analysis, Randomized Control trials, Cohort studies, Case Report, Case Series, Narrative Reviews and editor's notes published in English language and full articles providing data on quadriceps angle, anthropometric measurements, quadriceps muscle strength.

Inclusion Criteria

- Studies with quadriceps angle, anthropometric parameters and quadriceps muscle strength
- Clinical Trials,
- Case Control Studies
- Full text articles available
- The criteria for inclusion of articles were all research designs like Systematic review, Meta-analysis, Randomized Control trials, Cohort studies, Case Report, Case Series, Narrative Reviews and editor's notes published in English language and full articles providing data on sports related overuse injuries and physiotherapy and/or physical rehabilitation as the primary management
- The articles included in the study were then appraised and reviewed

Exclusion Criteria

- Studies not specifying the methodology for measuring quadriceps angle
- Only abstract

Results

S.N.	Year/Author	Study Title	Method used	Conclusion
1	Madhu GR and Dr. Keshavamurthy T April, 2021	An analysis of Q angle with respect to various body parameters in athletes	50 male and female athletes were selected for the study. Q angle and other various body parameters were measured, statistical analysis was done.	There was significance deference between male and female athletes in all selected parameters.
2	Maha H. El Gharib, MD , Amira M. El Tohamy, PhD and Nanees E. Mohamed, PhD Oct, 2020	Determining the relationship between the quadriceps and tibiofemoral angles among adolescents	150 adolescents were taken as subjects between 12 to 18 years and classified them into two groups. That was an observational cross-sectional design research. In which measurement of Q-angle and TF-angle were done.	The study showed a strong relationship between the Q-angle and the TF-angle. The Q-angle and the TF-angle should be measured bilaterally and the nature of sports should also be considered.
3	Aprajita Raizada, Shruthy	Changes in	148 subjects (80	No significant

	K.M, Ramnath Takiar, S.Bhuvanesh May, 2019	quadriceps angle (Q – angle) with regard to gender and different anthropometric parameters	girls and 68 boys)were studied. This was observational study and in that study various body parameters and Q angle were measured properly.	differences in both gender was noted, No significant bilateral differences were seen. According to our study Q-angle does not vary with the age. Higher Q-angle was seen with those having high BMI, increased waist and hip-circumference
4	Ramada R. Khasawneh ¹ , Mohammed Z. Allouh ² , Ejlal Abu-El-Rub May, 2019	Measurement of the quadriceps (Q) angle with respect to various body parameters in young Arab population	500 volunteers (267 females and 233 males) were taken, age ranging from 19 to 25 years. Study design was observational study. All data were recorded include their age, gender, weight, height, and dominant side on a specific investigation paper sheet. After that statistical analysis was done.	There was statistically significant deference found between Q angle, gender, height, weight, BMI and condylar distance.
5	Ogochukwu C Onuorah, Maximus M Agha,Emeka U Mong, Davidson O John, Peter A Dim,OdirachukwuAhanonu, Jeneiv N John August, 2019	Relationship of quadriceps femoris muscle strength and endurance with selected anthropometric indices	This was descriptive observational study involved 103 undergraduate students (81 males and 22 females) recruited by convenience sampling method. Body weight, height and body mass index (BMI)	Sports medicine experts and team coaches should put into consideration individual's body weight, height and BMI during pre-participatory

			<p>were measured using standardized procedures. QFM strength was measured using an adapted cable tensiometer. QFM endurance was measured in seconds using a handheld stop watch as the maximum time to maintain the maximum contraction of quadriceps femoris. Descriptive statistics was used to explore demographic data</p>	<p>screening in placing prospective athletes to sports or sporting positions requiring repetitive use of QFM where they have a higher likelihood to excel.</p>
6	<p>Ajlan Saç, Mehmet Yalçın Taşmektepliği August, 2018</p>	<p>Correlation between the Q angle and the isokinetic knee strength and muscle activity</p>	<p>Total 50 healthy and right-leg dominant men (age range, 18 to 27 years) with a Q angle between 5° and 20° and active in sports were included. An isokinetic strength test of the knee joint extensor and flexor muscles was tested who had a Q angle of 5 to 20° and were active in sports. Surface electromyography (sEMG) was used to determine these muscles' activity levels.</p>	<p>In this study, they conclude that a higher Q angle is associated with decreased isokinetic knee strength</p>
7	<p>Ved Prakash , Pallavi Sahay , Ananya Satapathy June, 2017</p>	<p>Correlation between Body Mass Index, Waist Hip Ratio & Quadriceps</p>	<p>Total 185 subjects with age more than 38 years (male & female) were assessed. The measurement</p>	<p>The study provided evidence to support that the BMI & Q-angle together</p>

		Angle in Subjects with Primary Osteoarthritic Knee	includes body mass index, Waist-hip ratio & Quadriceps angle. This was observational study.	are a risk factors for primary OA knee. Therefore, the study concludes that BMI, WHR & Q-angle being a independent risk factors for primary OA knee.
8	Gulunjkar Pooja , Godbole Anushree , Tambekar Neha , Wani Surendra , SanchetiParag , Shyam Ashok June, 2017	Comparison of the effect of Delorme and Macqueen strengthening protocol for improving quadriceps muscle strength in normal female individuals	Total of 34 subjects were randomly allotted in Delorme and Macqueen strengthening groups, each group consisting of 17 subjects. This was the interventional study of 4 week duration.	Both the progressive resistance exercises were found to be equally effective in improving quadriceps muscle strength in healthy female individuals post 4 weeks of intervention.
9	Islam Tarawneh BSC , Omar AL-Ajoulin MD, Abdullah Alkhwaldah MD, Heba Kalbouneh DDS, Amjad Shatarat MD, Darwish Badran MD, Maher Hadidi MD June, 2016	Normal values of Quadriceps angle and its correlation with anthropometric measures in a group of Jordanians	This was a double-centered observational study, including 419 individuals (219 males and 200 females). Q angle and other various body parameters were measured with help of goniometer and other tools.	The higher Q angles in females could also be attributed to wider pelvic width measurements and lower body obesity pattern. This study represents a good reference for clinicians to improve the clinical diagnosis and assessment of the malalignment

				of patellofemoral joint.
10	Veeramani Raveendranath, Shankar Nachiket, Narayanan Sujatha, Ranganath Priya, Devi Rema My, 2015	The Quadriceps angle (Q angle) in Indian men and women	This was observational study, 100 subjects consisting of 50 males and 50 females) were studied. Males and females of 18 years of age and above were included in the study. All measurements were taken by a single investigator. 20 measurements (bilaterally in ten subjects) were performed independently by another observer after one week to assess inter-observer variability.	There was significant difference was found between both gender.
11	Adam K. Russell, Megan C. Zerr, Todd G. Rinehart, Brandon M. Norris, Nicole K. Perkuhn Faculty: Bryan J. Lehecka 2014	The Relationship between Lower Extremity Musculature Strength, Q-angle, and Single-Leg Balance	31 healthy subjects (mean age = 24 + 1.83) participated in the study. Bilateral measurement of Q-angle and leg length, Star Excursion Balance Testing (SEBT), and hip abduction (HABD), flexion(HFLEX), extension (HEXT), external rotation (HER), and knee extension (KEXT) strength testing were done in this observational study.	The findings of this study suggest there is a relationship between Q-angle and certain LE muscle strength in males, and that LE FLEX strength relates to at least one direction of the SEBT in females.
12	Veeramani Raveendranath, Shankar Nachiket,	Bilateral Variability of	100 subjects consisting of 50	The present study shows

Narayanan Sujatha, Ranganath Priya, Devi Rema May, 2011	the Quadriceps Angle (Q angle) in an Adult Indian Population	males and 50 females were studied. Males and females of the age of 18 years and above were included in the study. Measurement of Q angle was done with the help of universal goniometer in supine position.	that bilateral variability in the Q angle could be attributed to an alteration of the relative placement of the tibial tuberosity with respect to the centre of the patella.
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Discussion

As per all the studies, there were difference showed between quadriceps angle and anthropometric measurements, also difference found between quadriceps angle and quadriceps muscle strength. The Q-angle is a very important tool in assessing the knee joint function and describing the biomechanical alignment and function of the lower limbs. Abnormal values may lead to subsequent articular problems, and in certain cases may lead to subluxation of the patella or an increase in the risk of development of anterior cruciate ligament ACL injuries by influencing the quadriceps reflex time. A Q-angle value of 20° to 22° or more is considered one of the predisposing factors for patellar dislocation and anterior knee pain. The Q-angle shows an inverse relationship with quadricep strength. Thus, the smaller the angle, the greater is the quadricep's power, which suggests that individuals with above normal Q-angle have lower quadriceps strength and are more prone to the diseases of joint patellofemoral. The Q angle (The quadriceps femoris angle) is one of the most clinically used parameter in evaluating the quadriceps forces and factors acting on the patellofemoral joint which is considered to be as an indicator for sports performance as well as in the diagnosis of several patellofemoral painful disorders and diseases. Knee alignment indicators such as Q angle are highly correlated with the quadriceps femoris muscularity.

Decrease in quadriceps angles and anterior knee laxity were greater in males compared to females, and females were observed to have a more inwardly rotated hip and valgus knee posture, compared to males. No significant differences were found in right and left Q-angles of both male and females. To further investigate the reason behind the higher Q angle values in our study, the mean values were correlated with anthropometric measures (body height, weight, BMI, pelvic width, and waist to hip ratio). The body height and weight might show variations in different ethnic origins. In addition, variations in the body fat for the same BMI might also be caused by variations of physical activity, diet and ethnicity. So the variations of body parameters could attribute in part to different Q angle measurements in different areas. Our results are in line with previous data suggesting the body height and pelvic width as the main determinants of Q angle.

Acknowledgments

I acknowledge PG students and other colleagues for guiding and helping in drafting this manuscript. In addition to this, i also thank to reviewers for their valuable comments on the earlier version of this paper.

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