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Systematic Review of Quadricep Angle and Knee Injury Occurrence

Kalana Pinnagodage[1*], Richard Clarke[2]
[1]Researcher, Department of Life Science and Education, University of South Wales, South Wales, United Kingdom
[2]Senior Lecturer, Department of Life Science and Education, University of South Wales, South Wales, United Kingdom

***Abstract*: This electronic document is a "live" template and already the quadriceps angle, which is a very critical factor in determining knee alignment, biomechanics, and injury susceptibility, has received a considerable amount of attention in the scientific literature. Nevertheless, due to the fact that different studies have produced contradictory results, a thorough knowledge of its influence on knee injuries continues to elude researchers. By utilizing the PRISMA methodology, the purpose of this systematic review is to shed light on the connection between the quadriceps angle and the occurrence of knee injuries, with a particular emphasis on the gender differences that exist in this regard. Eight English-language journal papers that met severe requirements were accepted for examination after being subjected to a thorough screening process from the PubMed database, which covered publications from the years 2010 to 2013. According to the findings of our investigation, there is a favorable connection between increased quadriceps angles and a variety of knee problems, such as patellofemoral pain syndrome and patella dislocation. It is important to note that ladies have a higher tendency to knee injuries than males do. This can be related to the fact that girls have naturally bigger quadriceps angles than males do. In addition, our findings provide credence to the arguments made in the past that the quadriceps angle is directly related to the quadriceps muscle power. The findings of this analysis highlight the vital significance of doing more systematic research into the quadriceps angle as a major factor of knee malalignment and injury risk.**

***Keywords*: biomechanics, PRISMA, quadriceps, knee injuries, PubMed.**

1. Introduction

Athletes frequently have lower extremity injuries, which frequently result from changed joint biomechanics, small deviations in alignment, and imbalances between ligamentous and muscular stresses. These ailments are a common cause of worry for athletes. Among the myriad of elements that contribute to these kinds of accidents, the alignment of the lower extremities stands out as a significant driver [1]. It has been established that malalignment in the lower extremities is a substantial risk factor for a wide range of chronic and acute injuries to the lower limbs. These ailments include patellofemoral syndrome, medial tibial stress syndrome, anterior cruciate ligament injuries, plantar fasciitis, and stress fractures. There are a number of causes that contribute to this malalignment, including unequal load on the knee joint, mechanical impairments in lower body muscles, reduced proprioception, and aberrant neuromuscular activity [2]. These variables, when combined, result in greater compressive stress on particular joint surfaces.

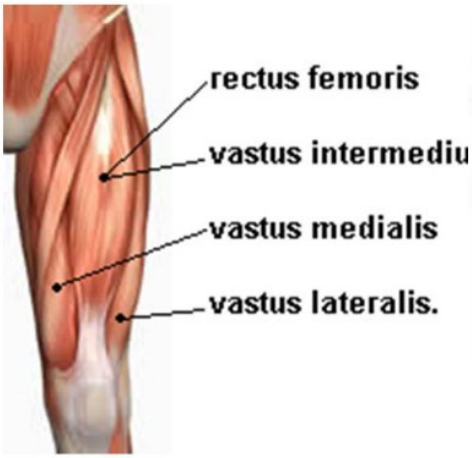

Fig. 1. Quadriceps muscles

According to the figure 1, shows that the group of quadriceps muscles [3]. Basically, this quadricep muscles helps human to perform the muscle movement of extension as the agonist muscle and supporting to the muscle movement of flexion as antagonist muscle. The quadriceps muscle group, which is located anteriorly in the thigh, plays a crucial role in the process of preserving the alignment of the lower extremities. Vastus medialis, Vastus intermedius, Vastus lateralis, and Rectus femoris are the four primary muscles that make up the quadriceps femoris, which is widely recognized as the biggest and most powerful muscle in the human body [4]. It contributes significantly to the mobility of the knee and hip joints, allowing for both intra and extra rotation of the patella joint. It encompasses roughly 29% of the thigh and plays a crucial part in these motions. Notably, the Rectus Femoris, which originates from the anterior inferior iliac spine, helps to knee stability and movement initiation. Additionally, the Vastus Lateralis and Vastus Medialis muscles work together to guarantee knee stability, particularly when the knee is bent at a 90-degree angle [5].

When it comes to clinical evaluations of patellofemoral

*Corresponding author: vimukthikalana6@gmail.com

mechanics, the quadriceps angle, also known as the Q-angle, is the most important factor to consider. In 1964, Brattstrom was the first person to define the Q-angle, which is the angle that exists between the patellar tendon and the quadriceps muscles. This angle reflects the mechanism of knee quadriceps, the impact of thigh muscles on knee movement, and the tracking of the patellar tendon inside the knee groove [6]. Supine position with pelvis extension and standing upright are the two primary methods that are typically used to evaluate the Q-angle. The Q-angle is an important indicator of knee health and function because it evaluates the relative positions of the anterior superior iliac spine, the center of the patella, and the tibial tuberosity [7].

Quadriceps muscles are essential for a broad variety of sports, including running, leaping, and cycling, as well as fundamental daily movements such as walking and ascending stairs. They are also essential for a wide range of other activities. As an additional point of interest, the Q-angle emerges as a fundamental measure of biomechanical activity and lower extremity alignment, providing vital insights into a variety of patellofemoral illnesses and diseases [8].

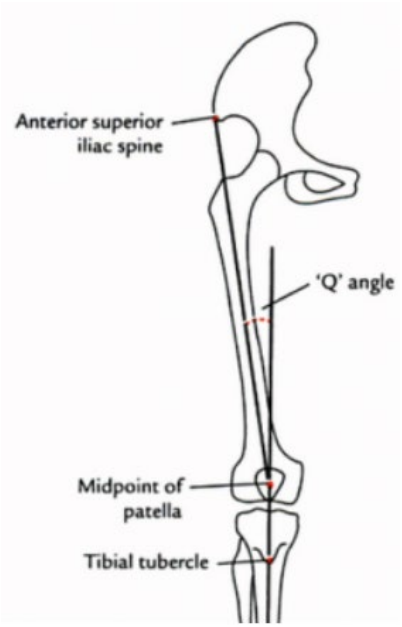

Fig. 2. Q-angle

Considering the high incidence of injuries to the lower extremities among athletes, it is of the utmost importance to have a solid awareness of the inherent risk variables, such as the Q-angle. Despite the fact that the normal range for Q-angle values is normally between 120 and 200, with males typically displaying lower values than females, greater Q-angle values are related with abnormalities and may exacerbate patellofemoral illnesses.

There is a lack of a comprehensive synthesis of the current literature, despite the fact that decades of study have shed light on the connection between Q-angle alignment and the prevalence of knee injuries. The purpose of this study is to address this gap by exploring the impact of Q-angle on knee injury incidence and its link with gender differences. This will be accomplished by conducting a complete examination of past scientific results [9].

2. Literature Review

For the purpose of gaining an understanding of the complexities of lower limb biomechanics and the underlying processes of injury, the quadriceps angle, also known as the Q-angle, is an essential measure that serves as a cornerstone in both clinical evaluations and biomechanical analysis [10]. The research that is devoted to investigating the Q-angle has launched on a variety of investigations, which have traversed through a variety of dimensions. These dimensions include its association with body weight, lower limb kinematics, muscle function, and susceptibility to injury, particularly in athletic cohorts [11].

In the process of investigating the connection between body weight and Q-angle, researchers have discovered some fascinating discoveries that create a vivid picture of the ways in which weight dynamics impact the biomechanics of the lower limbs. A considerable rise in Q-angle has been found to be associated with increased body weight, with obesity serving as a key contributing factor [12]. These findings have been consistent across a number of scholarly investigations. These studies highlight the substantial influence that changes in body composition have on the biomechanics of the lower limbs. They also imply that there may be a connection between increasing body weight and an increased vulnerability to ailments such as patellofemoral pain syndrome and anterior cruciate ligament injuries [13].

Additionally, research that has been conducted on the correlation between body weight and Q-angle has shed light on the complex relationship that exists between adiposity and the dynamics of the musculoskeletal component. It seems that increases in body weight, particularly in obese persons, may lead to variations in lower limb alignment and biomechanics, which in turn predisposes individuals to a variety of lower limb injuries [14]. This is especially true in obese individuals. These discoveries not only enhance our comprehension of the intricate connection that exists between body weight and Q-angle, but they also highlight the significance of holistic approaches to injury prevention and management, particularly in populations where weight dynamics play a significant role in the susceptibility to injury [15].

The investigation of the connection between body weight and Q-angle has yielded significant insights into the intricate relationship that exists between adiposity, lower limb biomechanics, and the likelihood of experiencing an injury. Researchers and clinicians alike are better equipped to devise targeted interventions aimed at mitigating injury risk and optimizing musculoskeletal health, particularly among individuals where weight dynamics exert a significant influence on lower limb biomechanics. This is because uncovering these intricate relationships allows them to better understand the complex relationships that exist between these factors [16].

Numerous research attempts have focused a substantial amount of emphasis on the Q-angle, which is a factor that influences the alignment of the lower limbs. The link between

Q-angle and kinematic variations has been rigorously investigated in a number of studies, which have revealed complex correlations between Q-angle, hip-knee alignment, and lower limb functioning [15]. When it comes to the creation of tailored therapies that are aimed at enhancing lower limb alignment and decreasing injury risk, the grasp of these relationships is of the utmost significance [17].

In addition, the methodological issues that are associated with the measurement of the Q-angle have been the primary focus of researchers' attention. For the purpose of precisely determining the Q-angle, researchers have utilized a wide variety of methods, ranging from the time-honored manual goniometry to the cutting-edge digital photogrammetry [18]. Furthermore, developments in imaging techniques, including as magnetic resonance imaging (MRI) and three-dimensional motion analysis, have provided insights into the dynamic nature of Q-angle during functional motions that have never been seen before. Not only do these methodological developments improve the precision of Q-angle measurements, but they also make it easier to gain an all-encompassing comprehension of the variations that occur throughout a wide range of movement patterns and activities [19].

Taking everything into consideration, the comprehensive study of lower limb alignment and Q-angle, in conjunction with the developments in measuring techniques and imaging modalities, highlights the multifaceted character of Q-angle evaluation. Not only do these kinds of initiatives increase our understanding of lower limb biomechanics, but they also pave the way for tailored therapies that attempt to optimize alignment and minimize injury risk in a variety of groups and activity scenarios [20].

There has been a significant amount of research and documentation done on the subject of gender differences in Q-angle, and the findings have consistently shown that females have greater Q-angle values than males. Variations in pelvic shape and lower limb alignment between the sexes are frequently cited as the cause of these discrepancies [21]. These gender-specific differences in Q-angle are thought to be a contributing factor in the unique injury patterns that have been seen among male and female athletes. This highlights the need of incorporating sex-specific considerations into injury prevention techniques [22].

Additionally, in addition to having consequences for anatomy, the Q-angle is an extremely important factor in determining how well muscles operate and how well athletes perform. Numerous studies have been conducted to investigate the complex link that exists between the Q-angle and the quadriceps muscle strength [23]. These studies have uncovered correlations between changes in the Q-angle and patterns of muscular activation that occur during dynamic movements. The ramifications of these discoveries are substantial for improving athletic performance across a wide range of sporting activities and maximizing the function of muscles [24].

Q-angle evaluations are essential components of injury risk management procedures for athletic populations, such as volleyball players and soccer players. Sports like these are examples of athletic populations. Studies have repeatedly revealed substantial relationships between Q-angle and a variety of knee ailments, most notably patellofemoral pain syndrome and anterior cruciate ligament injuries. These findings underscore the crucial role that Q-angle measurement plays in injury prevention measures [25].

In a nutshell, the corpus of research that surrounds the Q-angle emphasizes its complex character and its significance to several elements of lower limb biomechanics, injury susceptibility, and athletic performance at the same time. It is imperative that research efforts be continued in order to unravel the complex interplay that exists between Q-angle, musculoskeletal health, and functional outcomes. This interplay has profound implications for the development of comprehensive injury prevention, rehabilitation, and performance enhancement strategies that are tailored to the specific requirements of athletes competing in a variety of sports and genders [26].

3. Methodology

In accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) criteria, the purpose of this systematic review was to explore the influence of Q-angle on the occurrence of knee injuries in both males and females.

A. Eligibility Criteria

Define abbreviations and acronyms the first time they are the publications that were considered in this systematic review were published in English-language journals and investigated the connection between Q-angle and the formation of knee injuries. There were studies that were qualified for inclusion that investigated Q-angle measurements or knee injuries that were ascribed to Q-angle positions. Only publications that were published between the years 2013 and 2023 were eligible for inclusion in the scope of the study. As a requirement for consideration, the availability of the whole text was required.

1) The Criteria for Inclusion

- Research is being conducted to investigate the correlation between knee injuries and Q-angle readings.
- Knee problems that are directly connected to the Q-angle, such as patellofemoral pain syndrome, patellar dislocation, or anterior cruciate ligament injuries, are the subject of investigations.
- Scholarly articles written in English and published during the years 2013 and 2023.
- The availability of the whole text facilitates in-depth examination and analysis.

2) Requirements for Exclusion

- The only way to access these articles is through a paywall or in an abstract form.
- A variety of publications, including books and web sites.
- The only studies that addressed knee injuries were those that did not specifically mention the Q-angle.
- Items that were published prior to 2013 or after the

year 2023.

- The purpose of the review was to gather relevant and up-to-date literature discussing the influence of Q-angle on knee injury incidence. This was accomplished by following to these qualifying criteria.

B. Information Sources, Search Strategy, and Selection Process

In order to guarantee exhaustive coverage and stringent selection criteria, the technique that was used to discover relevant literature on the association between Q-angle and knee injury incidence was rigorously constructed. Detailed information on the information sources, search method, and selection procedure that were utilized in this systematic review is provided in this section.

For this particular systematic review, the major source of information that was utilized was PubMed, which is a database that is generally acknowledged and considered to be authoritative for biological literature. PubMed is an effective platform for doing comprehensive searches since it provides wide coverage of journal papers that have been evaluated by peers in the fields of medicine, health sciences, and other relevant subjects. The PubMed database was searched using a sophisticated search method in order to obtain papers that were pertinent to the topic.

Combining key phrases that were associated with Q-angle and knee injuries was accomplished through the use of Boolean operators (AND) in the search method. The selection of keywords such as "Q-angle AND Knee injuries" and "Quadriceps angle AND Knee injury occurrence" was done in order to guarantee the retrieval of papers that explicitly addressed the connection between Q-angle measurements and the occurrence of knee injuries. In accordance with the standards established by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), the selection procedure was carried out using a methodical methodology. Independent screening of titles, abstracts, and keywords was performed by the author in order to find papers that could be related to the topic at hand. The first classification of articles was determined by the presence of keywords in the names of the articles. Through the use of this classification, the subsequent abstract screening procedure was made easier.

During the screening of abstracts, publications were evaluated to see whether or not they adhered to the inclusion criteria and whether or not they were relevant to the study subject. The articles that were eligible were then subjected to full-text screening in order to guarantee that they were in accordance with the goals of the study and to conduct a thorough evaluation of their content. Within the research team, any disagreements or uncertainties regarding the admissibility of the article were handled by debate and reaching a consensus among the members of the team.

C. Data Collection Process

The method of collecting data for this systematic review was carried out in accordance with stringent standards in order to guarantee the extraction of pertinent and reliable information from studies that were eligible for inclusion. Continuous consistency and dependability were maintained throughout the procedure, which was directed by a single reviewer named Thilakabandu P.K.V. A unique data extraction criterion that was matched with the Cochrane Handbook for Systematic Reviews of Interventions was used in order to obtain crucial data items from each research in a systematic manner.

The initial step in the process of data extraction consisted of gathering information on the structure of the research. As part of this process, studies were classified according to their technique, which encompassed various approaches such as experimental, observational, cross-sectional, cohort, case-control, and qualitative methods. The interpretation of the findings and the evaluation of the strength of the evidence that was presented required a crucial context, which was provided by an understanding of the research design.

Documentation of population characteristics was carried out with great care in order to characterize the individuals who participated in each research. Details such as age range, gender distribution, athletic history (if available), and any demographic variables that were pertinent were included in this. Having a better understanding of the demographics of the study group made it easier to conduct a detailed analysis of the findings of the research.

An information extraction process was carried out in order to get data concerning interventions or exposures that were associated with Q-angle measurement or modification. This entailed recording the technique that was utilized for the evaluation of the Q-angle as well as any actions that were intended to affect the Q-angle. The procedure for collecting data was successful in gaining essential insights into the elements that influence Q-angle and the possible consequences it may have. This was accomplished by outlining the experimental settings or exposures that were being investigated.

Identification and documentation of the major outcomes of interest, particularly those associated with Q-angle and the consequences it has on the occurrence of knee injuries, were carried out with great attentiveness. Measures of knee injuries, such as incidence rates, prevalence, severity, or related risk factors, were included in this category of injuries. A full investigation of the link between Q-angle and knee injury susceptibility was made possible by the thorough documenting of the outcomes.

It was decided to create a thorough quality assurance procedure in order to guarantee the correctness and dependability of the data that was extracted. During the review, the reviewer demonstrated a high level of thoroughness and attention to detail by comparing the data that was retrieved with the data that was obtained from the original sources. For the purpose of ensuring consistency and dependability, any inconsistencies or doubts that arose throughout the process of data extraction were resolved through interaction with the study team.

4. Research Findings

There were twenty-four papers found in the PubMed database after a search was conducted for English-language

articles that focused on Q-angle and knee injury incidence between the years 2013 and 2023. After conducting a preliminary screening of titles and abstracts, a total of eight papers were chosen for full-text evaluation based on the eligibility criteria. Among the reasons for exclusion were the use of a language other than English, the absence of explicit topic numbers, and the availability of complete texts that were not free.

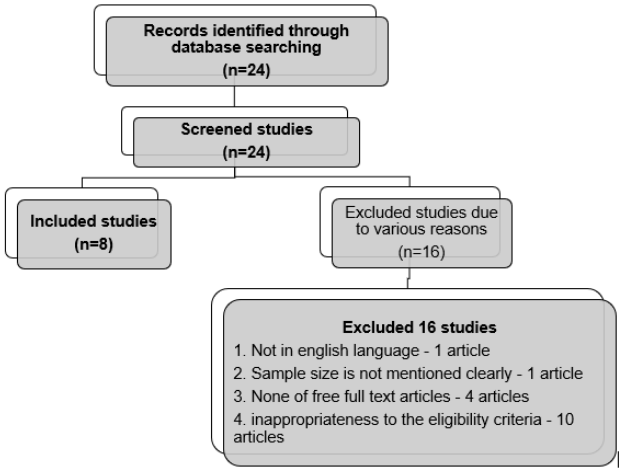

Fig. 3. Search strategy of articles

Eight of the twenty-four papers that were initially found were selected for inclusion in the final evaluation. Specifically, knee injuries and the influence of gender on Q-angle were the subjects of investigation in these papers. Across all of these research, the total number of participants included in the sample size was 1040. The studies included participants of varying ages and genders, and they offered insights that were extremely helpful in understanding the connection between Q-angle and knee-related outcomes.

In order to highlight the most important findings from the studies that were chosen, a summary table was prepared. This table included information about the authors, the publication year, the number of subjects, the age ranges, and the significant outcomes. The following table offered a succinct summary of the emphasis of the research as well as their contributions to the knowledge of the relationship between Q-angle and knee injury incidence.

In the discussion part, the data from the chosen studies were examined, and relevant insights regarding the association between Q-angle and knee-related outcomes were highlighted. Studies investigated a variety of variables, such as the alignment of the lower extremities, patellofemoral pain syndrome, patellar dislocation, muscular strength, and the thickness of the articular cartilage. It was also stated that there are gender disparities in Q-angle, as well as the consequences these variances have for knee health, and that there are variables that contribute to variations in Q-angle.

The summary of the findings highlighted the significance of the quadriceps muscles and the Q-angle in relation to knee function and the likelihood of sustain an injury. In this discussion, we covered a variety of approaches of measuring the Q-angle, as well as its connection to body anthropometrics and knee biomechanics. Studies have repeatedly demonstrated that females have higher Q-angles than males do, and these studies have also brought attention to the significance that Q-angle plays in characterizing the anatomy and physiology of the knee. The therapeutic importance of Q-angle evaluation was highlighted by the fact that abnormal Q-angle readings were associated with malalignment and an increased risk of knee diseases.

In addition to contributing to a better knowledge of lower limb biomechanics and injury causes, this in-depth examination of the data offers useful insights into the association between Q-angle and the occurrence of knee injuries. It would be beneficial to do further study in this field in order to have a better understanding of the intricate relationship that exists between Q-angle, musculoskeletal health, and functional results. This would have implications for injury prevention and rehabilitation efforts.

5. Conclusion

The systematic analysis of research that investigated the association between Q-angle and the occurrence of knee injuries gives valuable insights into the biomechanics of the lower limbs and the processes that cause injuries. The most important findings include gender differences in Q-angle, with females often displaying greater values compared to males, as well as the link between Q-angle and a variety of knee-related events, such as patellofemoral pain syndrome and patellar dislocation. In addition, the Q-angle has been associated with the strength of the muscles, the thickness of the articular cartilage, and the general alignment of the knee.

The findings highlight the significance of taking into account the Q-angle in clinical evaluations and biomechanical analysis, particularly in the context of injury risk management among athletic populations. In order to design targeted therapies that seek to reduce the risk of injury and improve athletic performance, it is essential to have a solid understanding of the influence that the Q-angle has on the alignment of the lower limbs and the function of the muscles. Given that there are gender differences in Q-angle and the consequences that these differences have for knee health, the findings further highlight the need of taking into account gender-specific factors when developing injury prevention measures.

It is necessary to do further study in order to investigate the intricate relationship that exists between Q-angle, musculoskeletal health, and functional results in a comprehensive manner. For the purpose of informing evidence-based strategies for injury prevention and rehabilitation, longitudinal studies that evaluate the impact of therapies aiming at improving Q-angle and lower limb alignment are required. We will be able to design more effective techniques for promoting musculoskeletal health and improving sports performance across a wide range of groups if we make progress in our knowledge of the Q-angle and its function in knee biomechanics.

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