TAY YU XIN

KNOWLEDGE OF QUADRICEPS ANGLE AMONG PHYSIOTHERAPY STUDENTS

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KNOWLEDGE OF QUADRICEPS ANGLE (Q-ANGLE) AMONG PHYSIOTHERAPY STUDENTS

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By

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A Research project submitted to the Department of Physiotherapy,

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KNOWLEDGE OF QUADRICEPS ANGLE (Q-ANGLE) AMONG PHYSIOTHERAPY STUDENTS

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ABSTRACT

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Background A foundational understanding of musculoskeletal parameters, including the Quadriceps angle (Q-angle) is required in physiotherapy education for optimal clinical practice, as it plays a crucial role in assessing lower-limb alignment and biomechanics. Despite its clinical value, there is a significant gap in the existing literature regarding physiotherapy students' knowledge of the Q-angle and their ability to apply it in clinical settings. This study aims to address this gap by investigating the knowledge level of the Q-angle among physiotherapy students at Universiti Tunku Abdul Rahman (UTAR). By identifying students' obstacles, this research intends to provide insights that may be used to improve educational practices, ensuring future physiotherapists in Malaysia have the essential abilities to thrive in musculoskeletal rehabilitation.

Objective This study investigates the knowledge level of the Q-angle among physiotherapy students.

Methods A total of 100 participants were recruited, including physiotherapy students from Years 2 to 4 with foundational biomechanics knowledge. Participants provided informed consent and completed a demographic information form before answering a tailor-made Q-angle knowledge questionnaire validated by experts. The questionnaire included objective and subjective sections, with results analysed using descriptive statistics, Chi-square tests, Kruskal-Wallis H tests, and Mann-Whitney U tests with Bonferroni correction.

Results The findings showed significant variations in Q-angle knowledge, awareness, and practical experience across academic years. Year 4 students demonstrated higher knowledge levels and practical experience, while Year 2 students had limited exposure. The results revealed significant associations

between academic year and knowledge level ($p = 0.005$), awareness ($p = 0.002$), and practical experience ($p = 0.000$).

Conclusion This study emphasizes the importance of the Q-angle in physiotherapy education for enhancing curricular content and addressing gaps in knowledge and hands-on skills. Furthermore, physiotherapy students must take an active role in enhancing their understanding and application of this critical concept.

Keywords: Q-angle, physiotherapy education, biomechanics, student knowledge, musculoskeletal rehabilitation, curricular improvement.

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APPROVAL SHEET

This Research project entitled "**KNOWLEDGE OF QUADRICEPS ANGLE (Q-ANGLE) AMONG PHYSIOTHERAPY STUDENTS**" was prepared by TAY YU XIN and submitted as partial fulfilment of the requirements for the degree of Bachelor of Physiotherapy (HONOURS) at Universiti Tunku Abdul Rahman.

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PERMISSION SHEET

It is hereby certified that **TAY YU XIN** (ID No: **22UMB07143**) has completed this Research project entitled "KNOWLEDGE OF QUADRICEPS ANGLE (Q-ANGLE) AMONG PHYSIOTHERAPY STUDENTS" under the supervision of Mr. Avanianban Chakkarapani (Supervisor) from the Department of Physiotherapy, M Kandiah Faculty of Medical and Health sciences.

Yours truly,

_____

(TAY YU XIN)

DECLARATION

I hereby declare that the Research project is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UTAR or other institutions.

Name: TAY YU XIN

Date: 19/12/2024

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LIST OF ABBREVIATIONS

Adj. Sig.	Adjusted Significant Value
ASIS	Anterior Superior Iliac Spine
df	Degree of Freedom
H	Kruskal-Wallis H Test Value
n	Numbers
PF	Patellofemoral
Q-angle	Quadriceps Angle
S	Semester
sig. (p)	Significant Value
SOLO	Structure of Observed Learning Outcome
UTAR	Universiti Tunku Abdul Rahman
X^2	Chi-Square Value
Y	Year

CHAPTER 1

1.0 INTRODUCTION

1.1 Chapter Overview

This chapter establishes the foundation of the study by introducing the fundamental concepts about the Quadriceps angle (Q-angle), including its definition, significance, measurement methods, and clinical relevance in physiotherapy. It highlights the study's importance by addressing educational gaps in Q-angle knowledge among physiotherapy students. The research questions, problem statement, objectives, and operational definitions are detailed, followed by an overview of the structure of the research project.

1.2 Background of the Study

1.2.1 Introduction to the Quadriceps Muscle and Patellofemoral Joint

The quadriceps muscle plays an important role in the proper function of the patellofemoral joint. As well as the resultant force vector or line of action is in the right direction, it will actively pull the patella in an upward and outward direction. (Lin et al., 2010) A more laterally oriented quadriceps line of action has been proposed to correct malalignments of lower extremities, such as valgus knees, lateralized tibial tubercle, femoral anteversion, and subtalar pronation, which can pull the patella more to the lateral side of the femoral condyles and change the alignment, thus increasing the risk of knee joint injury (Livingston, 1998).

1.2.2 Definition and Importance of the Q-Angle

Brattström (1964) proposed the term “Q-angle” in his pioneering study. The quadriceps angle (Q-angle) is the angle constructed between the patellar tendon and the extensor mechanism of the quadriceps muscle (Umunnah et al., 2020). It is used to determine the disorientation of the quadricep muscle (Tsakoniti et al., 2011). This is because the Q-angle represents the total line of force of the quadriceps on the knee. The angle can reveal the reasons for abnormal patellofemoral joint kinematics, which is usually called tracking. (Mansfield & Neumann, 2019) Considering that the Q-angle indicates the alignment of the osseous, it can only be altered by surgical operations to rearrange the bones. Although clinicians generally believe that an excessive Q-angle serves as a contributing factor to the onset of patellofemoral (PF) pain, it has not been established as a predictive factor in the rehabilitation process for individuals suffering from PF pain. (Malone & Pfeifle, 2017)

1.2.3 Measurement of the Q-Angle

The measurement of the Q-angle needs an extension of a line from the centre of the patella to the anterior superior iliac spine, in addition to another line from the tibial tubercle to the centre of the patella. The intersection points of these two lines result in the determination of the Q-angle. The typical values for this angle range from 13 degrees to 18 degrees. (Malone & Pfeifle, 2017) The Q-angle of women is slightly larger than that of men. Due to the correspondingly larger Q-angle and related genu valgus, a correspondingly larger lateral directed

"bow-stringing force" is applied to the patella. (Mansfield & Neumann, 2019) The normal range of the Q angle in males is 10° to 14°, and in females it is 14.5° to 17° (Austin, 2003). Women tend to have a larger Q angle than men do, and they are more likely to experience patellofemoral joint problems because of the wider pelvis, shorter femur, femoral neck anteversion, and weaker quadriceps muscles (Nguyen et al., 2009).

1.2.3 Clinical Relevance of the Q-Angle

Anterior knee pain is often related to patellar malalignment and dislocation in the patellofemoral joint. During knee flexion, the lateral orientation of the quadriceps muscle produces a lateral force on the patella. This lateral displacement increases the contact pressure between the lateral trochlear ridge and the patella and increases the risk of subluxation or dislocation of the patella. Even in the absence of obvious instability, increased pressure can cause patellofemoral pain and articular cartilage degeneration. The Q-angle measures the direction of the quadriceps muscle strength and represents the resultant force vector of the quadriceps group acting on the patella. The research has shown that the larger Q-angle increases the lateral patellofemoral contact pressure, while the smaller Q-angle increases the medial patellofemoral contact pressure. (Mizuno et al., 2001)

Patients with knee pain or arthropathy caused by an unusually large Q-angle are frequently treated with surgical treatments, such as proximal patellar rearrangement, lateral retinaculum release, and tibial tubercle reduction, in order

to correct patellar dislocation by centring the patella. However, although these operations are aimed at solving abnormal patellar tracking, the precise influence of the Q-angle on knee kinematics is still not fully understood. In addition, excessive medial patellofemoral contact pressure increases during these interventions, which highlights the necessity of careful evaluation and balance of surgical strategies. (Mizuno et al., 2001)

1.2.5 Importance and Relevance of Study

Physiotherapy is critical in musculoskeletal health, and thorough evaluations are required for appropriate diagnosis and treatment planning. The Quadriceps angle (Q-angle) is an important statistic in lower limb examinations because it informs clinical decisions about knee joint biomechanics. Despite its importance, there is a significant gap in the literature surrounding Q-angle knowledge among physiotherapy students. The success of future physiotherapists is dependent on a solid understanding of musculoskeletal characteristics such as the Q-angle, but the level of knowledge among students is unknown. This study attempts to close this gap by systematically analyzing the knowledge levels among physiotherapy students to address gaps in student knowledge, support evidence-based practice, enhance clinical training, and eventually increase physiotherapy graduates' competency in providing excellent patient care by identifying and correcting knowledge gaps.

1.2.6 Concluding Remark

The Quadriceps angle plays an important role in the lower extremity biomechanics, balance, and injury risk. Despite the crucial role of the Q-angle in evaluating knee joint biomechanics and informing clinical decisions, there is a significant gap in the knowledge of this measurement among physiotherapy students in Malaysia. Therefore, the current study aims to examine the knowledge of the Q-angle among physiotherapy students at Universiti Tunku Abdul Rahman (UTAR) to enhance student learning approaches and improve the quality of training in Q-angle assessments and also abnormal Q-angle interventions within physiotherapy programs, thereby increasing the competency of future physiotherapists in patient care and rehabilitation.

1.3 Research Questions

1. What is the level of knowledge regarding the concept of the Quadriceps angle among physiotherapy students at UTAR?
2. How does the knowledge of the Quadriceps angle vary among different academic years and batches of physiotherapy students at UTAR?

1.4 Problem Statements

In Malaysia, although the Quadriceps Angle (Q-angle) is of great significance in assessing the biomechanical factors related to knee joint health, there is still a gap in the knowledge of Q-angle among physiotherapy students. This lack of understanding may hinder their ability to accurately evaluate and treat knee joint problems, potentially affecting the quality of patient care and

rehabilitation outcomes. Because of the fundamental role of Q-angle assessment in the diagnosis of patellofemoral pain syndrome and other diseases, it is very important to understand this parameter for effective clinical practice. Studies have shown that the gap between anatomy and biomechanics knowledge can significantly affect clinical decision-making and patient outcomes. Addressing this gap is very important for enhancing the proficiency of physiotherapy students and ensuring that they are fully prepared to provide high-quality care. Therefore, it is very critical to explore the level of knowledge gap of physiotherapy students in Malaysia and identify the potential factors that cause this gap, so as to make up for this deficiency and enhance their ability in clinical practice. (Willy et al., 2019)

1.5 Research Objectives

1. **Primary objective**
    - To determine the level of knowledge of the Quadriceps angle (Q-Angle) among physiotherapy students at Universiti Tunku Abdul Rahman (UTAR).
2. **Secondary objective**
    - To determine the overall knowledge level of physiotherapy students at UTAR regarding the concept of Quadriceps angle.
    - To compare the knowledge of the Quadriceps angle among different academic years and batches of physiotherapy students at UTAR.

1.6 Hypothesis

Null Hypothesis (H_0)

i. There is no significant difference in the knowledge levels of the Quadriceps angle among different academic years and batches of physiotherapy students at UTAR.

Alternate Hypothesis (H_A)

i. There is a significant difference in the knowledge levels of the Quadriceps angle among different academic years and batches of physiotherapy students at UTAR.

1.7 Operational Definition

1. **Quadriceps:**

   Both the quadriceps femoris muscle and sartorius muscle belong to the group of muscles of the front of the thigh. This group includes the rectus femoris, vastus medialis, vastus intermedius, and vastus lateralis. (Bordoni & Varacallo, 2023)

2. **Quadriceps angle:**

   Q-angle is characterized by an angle formed by the intersection of an imaginary line connecting the anterior superior iliac spine (ASIS) of the pelvis to the midpoint of the patella and a proximal projection of the line extending from the tibial tubercle to the center of the patella (Skouras et al., 2022).

3. **Physiotherapy:**

   Physiotherapy can enhance health and well-being, as well as avoid, treat, or rehabilitate the disorders or dysfunctions of human movement (Higgs, 2001).

1.8 Structure of Research Project

This research paper first outlines the background of the study, including the research questions, problem statement, research objectives, and operational definitions, as well as the importance and relevance of the study in Chapter 1. Chapter 2 presents the literature review on relevant topics, such as the importance of the Quadriceps angle (Q-angle), methods for physiotherapy students to gain theoretical knowledge and practical skills, and gaps in their understanding of the Q-angle. The methodology is outlined in Chapter 3, detailing the research design, sampling approach, inclusion and exclusion criteria, research instrument, recruitment process, data collection procedures, and data analysis strategies. Chapter 4 presents the results of the study, including descriptive and inferential analyses of the collected data, with findings from both objective and subjective questions. Finally, the discussion of findings is made in Chapter 5, which provides an in-depth discussion of the findings, addresses the reliability and validity of the questionnaire, highlights the study's strengths, significance and limitations, and offers recommendations for future research, concluding with the implications of the study for physiotherapy education.

CHAPTER 2

2.0 REVIEW OF LITERATURE

2.1 Chapter Overview

This chapter provides a critical review of existing literature related to the Q-angle. It addresses its importance in physiotherapy practice, explores strategies for students to gain theoretical knowledge and practice measuring the Q-angle, and identifies gaps in the knowledge and practical skills of physiotherapy students. The literature review sets the framework for understanding the importance of this research and its potential contribution to addressing these gaps.

2.2 Importance of Quadriceps Angle

Between the quadriceps muscles and the patella tendon, the intersection of two lines is defined as a Quadriceps angle (Q-angle), in which one line runs from the anterior superior iliac spine (ASIS) to the centre of the patella, and the other line runs from the anterior tibial tubercle of the tibia to the centre of the patella (Brattström, 1964). It is a recognised medical fact that the Q-angle measurement is a highly reliable indicator of the biomechanical function of the lower extremities because it not only shows how the quadriceps mechanism affects the knee but also how the thigh muscles work to push the knee and how the patella tracks in the groove of the knee joint (Loudon, 2016). In addition, the Q-angle is now widely recognized as a key factor in evaluating the functionality

of the knee joint and determining the health status of the knee in individuals who have experienced anterior knee pain. When accurately measured, it provides highly valuable information about the alignment of the pelvis, legs, and feet. It is indisputable that misalignment will lead to issues with knee joint function such as osteoarthritis, degenerative knee joint diseases, and anterior knee pain. (Almeida et al., 2016; Daneshmandi et al., 2011; Khasawneh et al., 2019; A.-D. Nguyen et al., 2009)

A Q-angle exceeding 15°-20° is usually recognized as an anatomical risk factor for the pathological development of the patellofemoral joint. However, the Q-angle values associated with patellofemoral disorder symptoms often fall below this critical threshold. It has been proposed by some researchers that the current pathological thresholds exhibit a considerable degree of leniency and advocate for a narrower range of 15-17˚. (Sharma et al., 2023) Clinical uses the measurement of Q-angle to suggest exercises that strengthen the muscles around the knee, thus reducing the pain and enhancing function (MARK S. JUHN, 1999). It is generally believed that the extensor mechanism has encountered issues related to an abnormal Q angle. Although this assertion lacks sufficient scientific support, it is assumed that it will lead to knee extensor dysfunction and discomfort because the abnormal Q-angle will exert extra pressure on the structures around the knee joint, especially on the kneecap and the knee extensor muscles. Despite the lack of empirical support, it seems that individuals with chondromalacia patella are more likely to have an increase in Q-angle, which is related to the abnormality of the knee joint. The relationship between patellofemoral pain, recurrent patellar subluxation or dislocation, and other knee

and lower leg injuries with such angular measurement is still uncertain. (Sharma et al., 2023) For instance, the retro patellar pressure between the lateral facet of the patella and the lateral femoral condyle increases with the increase of Q-angle because it increases the lateral force on the patella. (Almeida et al., 2016; Daneshmandi et al., 2011; U.-S. D. T. Nguyen et al., 2014) Therefore, the evaluation of the Q-angle is particularly important for patients who are physically active, especially those who participate in sports activities. (Almeida et al., 2016; Daneshmandi et al., 2011; Nguyen et al., 2009)

Anatomical alignment of the lower extremity has been identified as a risk factor for abnormal Q-angle, particularly for lower extremity injuries, including knee joint injuries. The abnormal change of the Q-angle will lead to neuromuscular control disorder, dislocation of the knee joint motion plane and joint overload. As a result, due to the excessive force that the quadriceps muscle applies to the knee joint, abnormal alterations in the Q-angle may lead to personal injuries. Moreover, activation of the quadriceps muscles is a crucial component of balance. Compared with the vastus lateralis, the disorder in the lower extremity alignment caused by the Q-angle may be the reason for the delay of activation and start-up time of the vastus medialis muscle and may also be the reason for the balance change between the two. An overview of the biomechanics of the lower extremities can be obtained from the Q-angle. (Merve et al., 2023) Changes in Q-angle will affect the kinematics of knee joints in both dynamic and static postural scenarios. Studies have shown that weakness of the quadriceps muscles and postural sway issues impair the balance of the lower extremities. According to Nguyen et al., biomechanical problems with the knee

joint and muscle weakness make it difficult to maintain balance when doing daily tasks. (Nguyen et al., 2014)

In short, Q-angle is very important for physiotherapists to determine the biomechanics of the lower extremities and evaluate knee joint-related diseases. Therefore, physiotherapy students should learn to have a high understanding of Q-angle so that they can use it precisely in future clinical practice.

2.3 Methods for Physiotherapy Students to Gain Knowledge of Quadriceps Angle

To correctly apply abstract concepts to actual situations and utilize their hands as tools for diagnosis and treatment, physiotherapy students must acquire both theoretical and practical knowledge in the clinic (Thornquist, 2006). It is a complicated process for physiotherapy students to gain knowledge of the Quadriceps angle (Q-angle), which is impacted by a variety of instructional resources. Traditional lectures, textbooks, practical demonstrations, internet resources, and clinical experience can help students learn the knowledge of the Q-angle (Thornquist, 2006). Knowing the multiple sources of Q-angle information is critical for improving the physiotherapy students' knowledge about the importance of the Q-angle, the measurement techniques used to assess the Q-angle and the intervention measures that can be used to treat the abnormal Q-angle.

Physiotherapy students should acquire the knowledge of Q-angle, including how it varies between genders and age groups to provide accurate clinical assessments and appropriate patient treatment in the future. The research shows that the average Q-angle of young adult women is larger than that of men, and the difference is ranging from 2.7˚ to 5.8˚ in the supine position and 3.4˚ to 4.9˚ in standing posture. Women with patellofemoral dysfunction show bigger Q-angles than males, ranging from 2.0˚ to 8.5˚. Among teenagers, the Q-angle exhibits an obvious tendency. Few but significant data indicate that boys and girls have similar Q-angle values, which fluctuate with age. Students should use various techniques to ensure that they understand these critical differences. (Sharma et al., 2023)

After measuring the Q-angle, physiotherapy students need to know the appropriate interventions to treat abnormal Q-angle. There is a study that found that targeted strengthening exercises, such as TheraBand exercises, can effectively treat muscle imbalances, improve the alignment of lower limbs and reduce the likelihood of deformity. In the study, 8 weeks of training resulted in decreased Q-angle and improved lower limb alignment in those with genu valgum deformity. The Q-angle is influenced by factors such as the arrangement of the femur and tibia, as well as the strength of pelvic muscles. The weakness in the hip external rotators will lead to internal femoral rotation, which will increase knee valgus and Q-angle. Strengthening the abductor and external rotator muscles, particularly the quadriceps, can correct these imbalances and lower the Q-angle, to stabilize the patella. With this knowledge about interventions to treat abnormal Q-angle, they can apply effective treatment

strategies to improve patients' outcomes, tailor rehabilitation programs, and contribute to better management of lower limb deformities in their clinical practice. (Bahadori et al., 2020)

According to one of the articles, the evaluation of the acquisition of knowledge regarding the Q-angle among students studying physiotherapy was conducted through the utilization of the Structure of Observed Learning Outcome (SOLO) framework. SOLO was selected due to its capacity for qualitative assessment, allowing for assessing students' learning across various stages of cognitive development. The framework consists of five hierarchical levels, which range from structural to extended abstract, thereby reflecting the progression from incompetence to expertise. For the students who are at the undergraduate level, like those who were examined in this study, the anticipation is for a higher-order abstraction of information processing, which would enable a profound comprehension of intricate topics, as well as the ability to hypothesize about alternative conceptualizations of the world. SOLO, which has been proven to be effective across different educational levels, has been successfully utilized in the evaluation of cognitive complexity, with evidence indicating its connection to factors such as motivation, language, learning strategies, year of study, and prior academic abilities. As students advance, the structural complexity of their understanding and thinking develops both quantitatively and qualitatively, encompassing a more comprehensive organization of knowledge, a greater depth of declarative knowledge, an understanding of the relationships between concepts, and advanced skills such as critique, recognition of limitations, and extrapolation to different contexts or

applications that have not been explicitly covered in the teaching. Through this approach, physiotherapy students have acquired the knowledge of Q-angle and deepened their understanding of this knowledge. (M. Jones et al., 2014)

Physiotherapy students can learn the knowledge about the measurement methods of Q-angle through research papers. For example, the Q-angle can be measured by using both invasive and non-invasive methods. Invasive methods like radiography and x-rays, are known for accuracy but limited by invasiveness, cost, and availability. Non-invasive methods, such as goniometer use, offer cost-effectiveness but vary in reliability and may pose challenges in repeated measures research due to the Rezontal effect. Despite being widely used in clinical therapies, the goniometer's limitations include potential boredom and time consumption, especially in repeated angle calculations. (Alizadeh et al., 2012) The other study found that the goniometric measurement of the Q-angle is as effective and accurate as the radiographic measurement of the Q-angle without exposing patients to radiation. However, this study only included male patients aged 20 to 40 since the results of females with somewhat higher Q-angle than males and the elderly with degenerative joint diseases are very variable. (Chevidikunnan et al., 2017) Physiotherapy students should read more research papers on the comparative study of Q-angle measurement methods and improve their knowledge by knowing which measurement method is the most accurate and least harmful.

Physiotherapy students can enhance their understanding of the Q-angle through Problem-Based Learning (PBL) and Case-Based Learning (CBL) methods. In PBL, students work in small groups to investigate and solve clinical problems, promoting individual learning and teamwork with minimal guidance from facilitators. This technique encourages students to deal with issues and develop problem-solving skills, which may lead to better outcomes in real-world clinical circumstances compared to traditional lecture-based methods. In CBL, students work in small groups but with more organized guidance from facilitators, who help concentrate the discussion on key learning objectives. Both methods allow students to actively participate in clinical cases, making them valuable tools for learning complicated concepts such as the Q-angle and its clinical implications, while also helping them develop the skills needed to make informed decisions on appropriate interventions for treating abnormal Q-angle. (Srinivasan et al., 2007) However, an article states that PBL and CBL also have their disadvantages. The shift from traditional teaching to a facilitator-led style may reduce the students' opportunities to learn directly from expert professors. Additionally, knowledge gained through PBL and CBL might be less structured, making it challenging for students to systematically understand complicated subjects, such as Q-angle assessment and intervention. Training effective facilitators and the time-consuming nature of PBL and CBL can potentially be obstacles in an already crowded curriculum. Despite these challenges, PBL and CBL are promising approaches for educating physiotherapy students about the Q-angle and its clinical implications due to their focus on real-world applications. (R. W. Jones, 2006) Physiotherapy students should actively participate in

Problem-Based Learning (PBL) and Cased-Based Learning (CBL) to enhance their knowledge of the Q-angle and its relevance in clinical practice.

2.4 Methods for Physiotherapy Students to Practice Measuring Quadriceps Angle

A major part of physiotherapy education is the practical application of Quadriceps angle (Q-angle) measurement. Hands-on experiences, clinical simulations, and supervised patient interactions are common ways for students to practice measuring the Q-angle. This kind of hands-on experience is critical for transforming theoretical knowledge into clinical ability and ensuring that students can use Q-angle measurement confidently and accurately in practical scenarios.

Physiotherapy students must understand that the measurement of the Q-angle can vary significantly based on the position of the individual being assessed. The standard goniometric method typically involves placing the patient in a supine position with the knee fully extended and the quadriceps in a relaxed state, which is a prevalent practice among medical practitioners. However, research suggests that assessing the Q-angle in positions that reflect the functional status of the lower limb, such as standing, with knees flexed, or during movement, can offer more accurate and reliable measurements. It has been noted that the Q-angle tends to increase slightly when moving from a supine to a standing position and to decrease when the quadriceps contract, moving the patella superiorly and laterally. Furthermore, the use of various instruments,

from universal goniometers to advanced tomography and computer-based video measurements, highlights the need for methodological proficiency. Given these variations, students need to practice Q-angle measurements in multiple positions and with different tools to enhance their clinical competency and ensure accurate assessments in diverse clinical scenarios. (Sharma et al., 2023)

It is emphasized that accurate palpation of bony landmarks is important for reliable Q-angle measurement. Errors of palpation can have a significant impact on the accuracy of measurements used to assess disabilities, asymmetries, and impairments, potentially leading to inaccurate clinical decisions. The skills and techniques of the therapist will influence the reliability of palpation. Therefore, physiotherapy students should develop accurate palpation techniques to achieve high inter-rater reliability while measuring Q-angle. (Moriguchi et al., 2009) To achieve high inter-rater reliability, physiotherapy students can also learn to measure the Q-angle using smartphone goniometer applications, which are reliable and valid tools in clinical practice. Studies comparing measurements from smartphone applications to those taken with electronic goniometers, which are considered the gold standard, have shown that these applications offer excellent consistency and precision. Electronic goniometers, known for their accuracy within one-tenth of a degree, have proven to be statistically equivalent to traditional universal goniometers, with the added benefit of reducing examiner reading errors. Smartphone goniometer applications' reliability and validity make them a practical alternative to traditional tools, especially for clinicians in diverse settings such as skilled physiotherapy, home health, skilled nursing, or mission trips in underdeveloped regions. Although there are minor challenges in

securing devices and some application-specific issues, the study recommends using these applications as a convenient and efficient method for measuring Q-angle and range of motion, emphasizing their potential for widespread clinical use. (Braden, 2019) Therefore, physiotherapy students can try more high-technology applications that are valid and reliable, such as smartphone goniometer applications, to practice measuring the Q-angle and improve the hands-on experience.

Traditionally, in the field of physiotherapy education, the process of acquiring clinical skills is typically based on informative classroom lectures that convey theoretical knowledge. This is followed by hands-on training sessions where students receive in-person guidance. The goal of this approach is to adequately prepare students for their clinical rotations. Since physiotherapists' primary areas of expertise are practical clinical skills, there is particular interest in the instruction and training of necessary psychomotor skills as well as how they are used in clinical settings. Initially, students are introduced to psychomotor skills, which they then practice in a supervised skills laboratory. In this laboratory, a faculty member oversees the students and determines the sequence of practical competencies that they need to learn. The skills laboratory consists of specially equipped practice rooms that function as training facilities. These rooms provide a safe and lenient environment for students to practice their clinical skills in measuring the Q-angle and how to treat the abnormal Q-angle before applying them to real patients. (Bugaj & Nikendei, 2016; McLean & Gibbs, 2010) Physiotherapy students should attend all hands-on sessions outlined in the syllabus to ensure they gain essential knowledge and have

adequate practice with each technique in their physiotherapy education such as the Q-angle measurement technique.

Physiotherapy students can practice the measurement of Q-angle through clinical simulation education. Exploration of the fundamental learning theories that undergird clinical education in physiotherapy is crucial for informing and enriching students' learning experiences. There is an article that aims to equip clinical educators with a robust theoretical foundation, drawing on insights from influential educational thinkers spanning the last century. By engaging critically with established learning theories, educators can gain valuable perspectives that prompt a reassessment of their current educational practices. The ultimate objective is to guide educators towards potential transformative shifts in their pedagogical approaches, aligning them with the presented learning theories. It is expected that this alignment will facilitate the development of physiotherapists who possess critical reflection skills and are capable of navigating and contributing to a constantly evolving healthcare landscape with sagacity and ethical discernment. The incorporation of sound learning theories into clinical education practices has the potential to cultivate a cohort of physiotherapy professionals who can adeptly adapt to the challenges posed by a dynamic healthcare system. With clinical simulation education, physiotherapy students can engage in realistic scenarios that mirror clinical practice, providing a controlled environment where they can practice and refine their skills, including accurately measuring the Q-angle and making appropriate decisions on selecting treatment based on the measuring. (Patton et al., 2013) While clinical simulation

is useful for physiotherapy students practicing Q-angle measurement, it has limitations such as concerns over clinical validity, cost constraints, and availability of trained personnel and simulation space. Clinical simulation may not always fully replicate real scenarios, and its impact on skill acquisition can be limited by factors such as learner inexperience and insufficient repetition. Additionally, some educators may prefer bedside learning over clinical simulation. Despite these challenges, clinical simulation remains a beneficial tool for practice. Solutions like employing low-cost simulators and sharing resources can help overcome these limitations and ensure students still gain valuable experience in practicing Q-angle measurement and interventions. (Sven P. Oman et al., 2024) Therefore, physiotherapy students should cherish the clinical stimulation opportunity of measuring the Q-angle to improve their practical skills.

The establishment of professional knowledge in the field of physiotherapy is intricately linked to the reflective practices that arise from patient experiences and outcomes. When physiotherapy students participate in clinical posting, direct interaction with patients becomes the most important aspect of their educational journey. Reflecting on these patient interactions is crucial for promoting a subtle understanding of the importance of interpersonal dynamics in inpatient treatment. In addition to theoretical knowledge, practical experiences in measuring the Q-angle during patient interactions enable students to integrate their learning in a tangible background. Through this direct application, students not only enhance their technical skills in Q-angle

measurement but also cultivate a deeper understanding of how accurate assessments guide the selection of appropriate interventions to address abnormal Q-angle and improve the prognosis of patients. The process of reflection serves as a powerful tool, which empowers the students to identify mistakes and learn from errors, thereby continuously enhancing their proficiency in Q-angle measurement. This cycle of repeated practice, reflection, and refinement contributes significantly to the development of well-rounded and skilled physiotherapy professionals. (Gyllensten et al., 1999) Clinical experience is crucial for physiotherapy students, as it allows them to practice on real patients and gain a clear understanding of the importance of measuring Q-angle accurately.

Physiotherapy students should improve their range of knowledge, skills, and clinical reasoning skills, not just mastering the measuring skill of Q-angle. Physiotherapists must adopt a holistic approach, considering not only physical factors but also the environmental and psychosocial influences on a patient's health. This requires a comprehensive understanding of health, disability, assessment, and management, including the ability to identify relevant contributing factors and make appropriate clinical judgments. Clinical reasoning is very important for recognizing how a patient’s condition impacts their physical status, functional activities, and ability to participate in daily roles. Understanding this process involves considering the perspectives and shared decision-making of therapist and patient. Therefore, physiotherapy students should develop strong clinical reasoning skills to accurately relate Q-angle

measurements with diagnosis and treatment and ultimately contribute to the best patient care. (Joy Higgs et al., 2008)

2.5 Understanding Gaps in Physiotherapy Students' Knowledge of the Quadriceps Angle

It is very important to understand the Quadriceps angle (Q-angle) as it can be used to evaluate and treat knee joint-related diseases. Physiotherapy students should have a deep understanding of Q-angle so that they can apply it properly in clinical practice. However, there is a significant gap in the understanding of this key parameter among physiotherapy students. The existing literature does not sufficiently address the difficulties faced by physiotherapy students in learning Q-angle measurements and their clinical implications. (Almeida et al., 2016; Khasawneh et al., 2019) For example, a published study revealed that the Q-angle measurement may be affected by factors such as the position of the subject during measurement and the type of goniometer used, which may potentially lead to inaccuracies in assessment, which is a problem that an inexperienced student might struggle with (Roush et al., 2008). Physiotherapy students should be aware that measurement accuracy will change depending on the patient's position. Furthermore, physiotherapy students who are inexperienced in measuring Q-angle using a goniometer would make mistakes in palpating the appropriate center of the landmarks, which will result in significant errors in the calculation of Q-angle (Roush et al., 2008). As the Q-angle holds paramount importance in diagnosing and treating various musculoskeletal disorders, addressing this gap in student knowledge becomes

imperative to ensure that future physiotherapy professionals are well-prepared and proficient in incorporating Q-angle assessments into their clinical practice. (Almeida et al., 2016; Khasawneh et al., 2019)

If the study identifies that there is a gap in the knowledge of Q-angle among physiotherapy students, it is recommended that students participate in targeted interventions, such as workshops and practical sessions, which focus on the measurement of Q-angle, clinical significance, and appropriate intervention measures to effectively manage abnormal Q-angle, so that physiotherapy students can fully develop a more comprehensive understanding and improve their skills in measuring and applying Q-angle.

CHAPTER 3

3.0 METHODS

3.1 Chapter Overview

The methodology chapter describes the research design, including ethical approval processes and a sampling design with inclusion and exclusion criteria. It explains the research instrument used, including the questionnaire and its development. The procedure section explains the recruiting process and data collection methods, while the data analysis strategies section specifies the methods used for analysing the collected data.

3.2 Research Design

The study design used is a cross-sectional study as it is simple to carry out, inexpensive, and does not require follow-up. (Wang & Cheng, 2020)

3.3 Ethical Approval

This study is subjected to ethical approval by the Scientific and Ethical Review Committee (SERC) of Universiti Tunku Abdul Rahman (UTAR) (refer to Appendix A). Informed consent will be obtained from every eligible participant before participation. At the beginning of the questionnaire, participants will be presented with an informed consent form that outlines comprehensive information about the study, including its purpose, duration, procedures, potential benefits, and measures to ensure data confidentiality.

Participants must read the consent form and provide their electronic signature such as entering their full name in all capital letters. Only participants who provide consent will proceed to complete the questionnaire.

3.4 Sampling Design

The study population are Year 2 and above physiotherapy students at Universiti Tunku Abdul Rahman (UTAR), Sungai Long Campus aged between 18 to 35 years old. The sample size was calculated using the OpenEpi software (https://www.openepi.com/SampleSize/SSPropor.htm). The estimated population size of year 2 and above physiotherapy students at Universiti Tunku Abdul Rahman (UTAR) is (n = 117). Based on the OpenEpi software, the sample size is 100 to reach a 99% confidence level. (refer to Appendix G)

In this study, a convenience sampling method was used to recruit participants from the accessible population of physiotherapy students at UTAR Sungai Long Campus. Convenience sampling was chosen because it is time-efficient, cost-effective, and allows for easy participant access. This method does not need a lot of planning or resource allocation, making it suitable for studies with tight timelines. However, this approach has its drawbacks, including selection bias, as participants are chosen based on availability rather than being representative of the population. This can limit the generalizability of the research findings. Despite these limitations, convenience sampling was used for this study due to its efficiency and feasibility. (Golzar et al., 2022)

3.5 Inclusion Criteria

Participants will be included if they meet the following conditions:

a) Physiotherapy students in their second year or above, who have foundational knowledge of biomechanics (Song et al., 2015).

b) Age of 18-35 years old.

c) Both male and female.

d) Students currently enrolled in the Bachelor of Physiotherapy program at UTAR.

e) Students who have not previously participated in similar studies related to Q-angle knowledge.

3.6 Exclusion Criteria

Participants will be excluded if they meet the following conditions:

a) Year 1 physiotherapy students or students who have no basic knowledge of biomechanics (Song et al., 2015).

b) Age outside the range.

c) Incomplete or unreliable responses (Creswell, 2009).

d) Students on academic leave.

3.7 Research Instrument

The primary instrument for this study is a tailor-made questionnaire developed by the researcher to assess the knowledge of Q-angle among physiotherapy students. The questionnaire was designed with three main sections: an informed consent form (refer to Appendix B), personal data protection notice (refer to Appendix C), demographic data collection (refer to Appendix E), and a Q-angle knowledge level assessment (refer to Appendix F). The informed consent form ensures that participants are fully informed about the study's purpose, procedures, and data confidentiality before proceeding with the research.

To ensure the questionnaire's validity, it was reviewed and validated by three lecturers who are experts in the musculoskeletal field. The experts provided feedback on the clarity, relevance, and appropriateness of the questions (refer to Appendix D). Necessary adjustments were made based on their suggestions to enhance the questionnaire's content validity. This process ensures that the instrument accurately measures the intended constructs.

Components in the questionnaire:

a) Informed Consent Form (refer to Appendix B)

The first section of the questionnaire is the informed consent form, which is designed to ensure participants are fully informed about the study before agreeing to participate. The goal of this form is to provide detailed information about the research, including its purpose,

procedures, expected duration, voluntary nature, and measures to protect the confidentiality of all responses. The researcher's contact information was provided so that the participants may enquire about the study and get further information if required. Participants are required to indicate their consent by providing an electronic signature, such as entering their full name in all capital letters, to confirm their willingness to participate. This process ensures that participation is voluntary and based on a clear understanding of the study.

b) Personal Data Protection Notice (refer to Appendix C)

The Personal Data Protection Notice governs the collection, use, and retention of personal data. Participants are informed that their personal data, including name, email address, academic details, and other information provided during the study, will be collected and used solely for research purposes. Participants are required to acknowledge it by agreeing to the statement that they have been notified, understood, consented, and agreed to the notice.

c) Demographic Data (refer to Appendix E)

The demographic data collection form includes name, age, gender, academic year, prior clinical experience, and email address. This information is collected to provide context about the participants and to analyse trends or patterns in Q-angle knowledge based on these variables. Participants' names are collected for identification purposes but will be kept strictly confidential.

d) Q-angle Knowledge Level Assessment (refer to Appendix F)

The Q-angle Knowledge Level Assessment assesses the understanding level of physiotherapy students at UTAR about the clinical significance and applications of the Q-angle. This comprehensive approach combines subjective self-assessment with an objective knowledge test. Both qualitative and quantitative data are collected through this assessment, providing a valuable view of physiotherapy students' proficiency in this crucial musculoskeletal parameter. The results aim to clarify the current state of knowledge among physiotherapy students at UTAR and guide potential interventions to enhance student learning and curriculum development.

The objective section consists of nine multiple-choice questions designed to assess participants' factual knowledge regarding the Q-angle. Each question has a correct answer, and each question has one mark. The total score for this section is 9 marks. After the data collection is completed, the participant’s score will be recorded and sent to their emails. Participants will also receive the correct answers so they can know their own mistakes and learn from the results. This will also be after the data collection is completed to prevent sharing answers during the study.

The subjective section includes seven questions aimed at exploring participants' self-assessment of their knowledge and perspectives on the Q-angle. There are three “Yes, No, Maybe” questions in this section, which are used to evaluate whether the participants have heard of the Q-angle before, whether they have practical experience in measuring the Q-angle, and whether they are interested in learning more about the Q-angle from additional workshops or sessions. Participants also need to rate the importance level of understanding the Q-angle in physiotherapy practice on a qualitative scale ranging from not important at all to extremely important on a scale of 1-5. A score of 1 indicates a very low level of importance, while a score of 5 suggests a very high level of importance. In addition, participants are also required to rate the confidence level of the participants in explaining the clinical significance of the Q-angle to musculoskeletal issues on a similar scale, with 1 representing not confident at all and 5 representing extremely confident. Further subjective questions explore the ability of the participants to define the Q-angle in their own words. The section also seeks feedback on how the Q-angle could be better integrated into the physiotherapy curriculum to improve students' knowledge and application of the concept.

The questionnaire was designed without negatively worded questions to ensure that participants could understand it. Negative questions sometimes lead to misinterpretations or response biases. Instead, all questions were framed positively to encourage direct

responses, especially because the target sample included students with varying levels of exposure to the topic. Not using negative wording reduces the risk of inconsistent responses and enables direct data analysis without reverse scoring. (Colosi, 2005)

3.8 Procedure

3.8.1 Recruitment Process and Data Collection

This study uses a convenience sampling method that demands 100 participants, as determined by the sample size calculation performed with OpenEpi software. Participants must be year 2 and above physiotherapy students who study at UTAR. Participants were recruited using physical and online methods to ensure a wide reach and convenience. The researcher physically approached students during their classes to explain the study and invite them to participate. A QR code was created to make it easier to access the Google Form. Students could scan the QR code or click the shared link to open the form. For the online approach, platforms like email, WhatsApp, and Instagram were used to share the invitation and details about the study. The invitation included a brief explanation of the research and a link to the questionnaire.

The questionnaire included the informed consent form, personal data protection notice, demographic data collection, and the Q-angle Knowledge Level Assessment. Participants were required to read the information page, and only those who met the inclusion criteria and provided their electronic signature for consent were allowed to participate in the study. Providing consent and

acknowledging the personal data protection notice are mandatory steps before participants can access the questionnaire. The demographic data collection section gathered information such as the participant's name, age, gender, academic year, prior clinical experience, and email address. This section is to help the researcher understand the background of the participants and determine whether participants are eligible to take part in the study based on the inclusion criteria.

Following the demographic section, participants completed the Q-angle Knowledge Level Assessment, which consisted of two components. The objective section included nine multiple-choice questions to evaluate participants' factual knowledge about the Q-angle. Each question had one correct answer, and participants' scores were recorded. To maintain the integrity of the study, scores and correct answers were shared with participants only after the data collection period was completed. The subjective section assessed participants' perceptions and self-evaluations of their knowledge and the importance of the Q-angle in physiotherapy. Participants rated their knowledge and the significance of understanding the Q-angle on a 1-5 scale. Additionally, they provided qualitative feedback on their interest in further workshops or sessions focused on the Q-angle and shared suggestions on how it could be better integrated into their coursework.

This structured approach ensured that participants followed a clear process while completing the questionnaire, enabling the collection of both quantitative and qualitative data for the study.

3.9 Data Analysis Strategies

Descriptive analysis will be used to summarize participants' characteristics and levels of knowledge. Demographic data collection will include age, gender, academic year, and prior clinical experience to provide a general overview of the participants. The frequency, mean, mode, and standard deviation are among the measures that will be obtained to describe the data distribution in detail. These values will be tabulated and analysed using IBM Statistical Package for Social Sciences (SPSS) software version 26.0 and Microsoft Excel. The threshold for statistical significance will be set at $p < 0.05$.

Cronbach’s Alpha will be used to assess the reliability of the objective section of the questionnaire. Cronbach's Alpha is an internal consistency metric that shows how effectively a group of items assesses the same concept. In this study, the overall Cronbach’s Alpha value will be calculated, and individual questions will be examined by the Item-Total Statistics to see whether removing any items would improve the reliability. The results of this test will help identify potential areas for modification of the questionnaire.

Descriptive statistics will also be applied to analyse the total scores of knowledge level from the questionnaire. Yes, No, Maybe responses will be analysed with frequency counts and percentages, while Likert-scale responses and total scores will be summarised using measures of central tendency (mean and mode) and variability (standard deviation).

Chi-square tests will be conducted to investigate the association between academic years (batches) and categorical responses, such as Yes, No, Maybe questions. This non-parametric test is suitable for identifying relationships between the academic year and binary or ordinal data, providing insights into differences in knowledge and awareness across different batches of physiotherapy students.

To analyse the association between the academic year and numerical data, tests of normality were first conducted using the Kolmogorov-Smirnov and Shapiro-Wilk tests. These tests assessed whether the data followed a normal distribution. Since the data did not meet the assumption of normality ($p < 0.05$ for most groups), non-parametric tests were employed for further analysis.

The Kruskal-Wallis H test, which is a non-parametric test, was used to determine whether there were statistically significant differences in the total scores and responses to Likert-scale questions across batches. If substantial differences are discovered, post-hoc pairwise comparisons were conducted using Mann-Whitney U test with Bonferroni correction. The Bonferroni adjustment

was applied to control for Type I error rates during multiple comparisons, ensuring the reliability of the results. (Okoye & Hosseini, 2024)

Using these data analytical strategies, the study aims to provide a comprehensive understanding of participants' knowledge, confidence, and awareness of the Q-angle, as well as suggest possible improvements in physiotherapy education.

CHAPTER 4

4.0 RESULTS

4.1 Chapter Overview

This chapter presents the findings of the study, beginning with the demographic characteristics of the participants, including gender, age, academic year, and clinical experience, followed by a summary of the demographic data. It reports the results of the objective section of the questionnaire, including reliability analysis, descriptive statistics, and batch comparisons using Kruskal-Wallis H tests with Mann-Whitney U tests for post hoc analysis. The subjective section of the questionnaire is analysed through frequency distribution and batch comparisons using chi-square, Kruskal-Wallis H tests and Mann-Whitney U tests.

4.2 Demographic of Participants

4.2.1 Gender

The study included 100 participants, of which 18 were male and 82 were female. Figure 4.1 highlights the gender distribution, showing that males accounted for 18% of the participants, while females accounted for 82% of the participants.

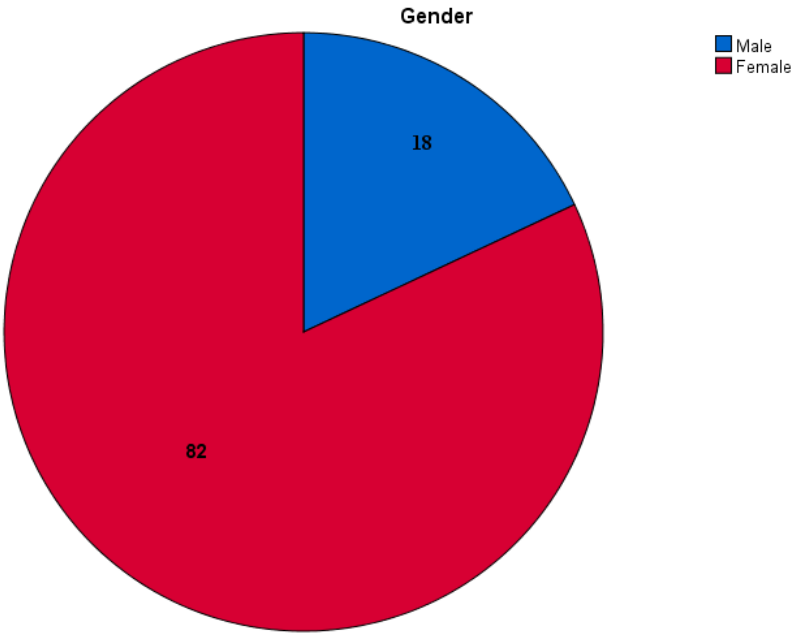

Figure 4.1: Gender Distribution Among Participants

4.2.2 Age

The participants in this study are distributed across three age groups. The largest group consists of 63 participants, representing 63%, who fall into the 18–22 age range. This is followed by 33 participants, or 33%, in the 23–27 age range, and 4 participants, or 4%, in the 28–32 age range. The mode of the data is the 18–22 age group, indicating that it is the most represented category among the participants.

As shown in the bar chart in Figure 4.2, the distribution of age groups shows a high concentration the younger individuals. Most participants are between 18 and 22 years old, and the number of participants gradually decreases with the increase of age group. This trend is consistent with the typical

demographic composition of physiotherapy students, and young students are more common than those in older age groups.

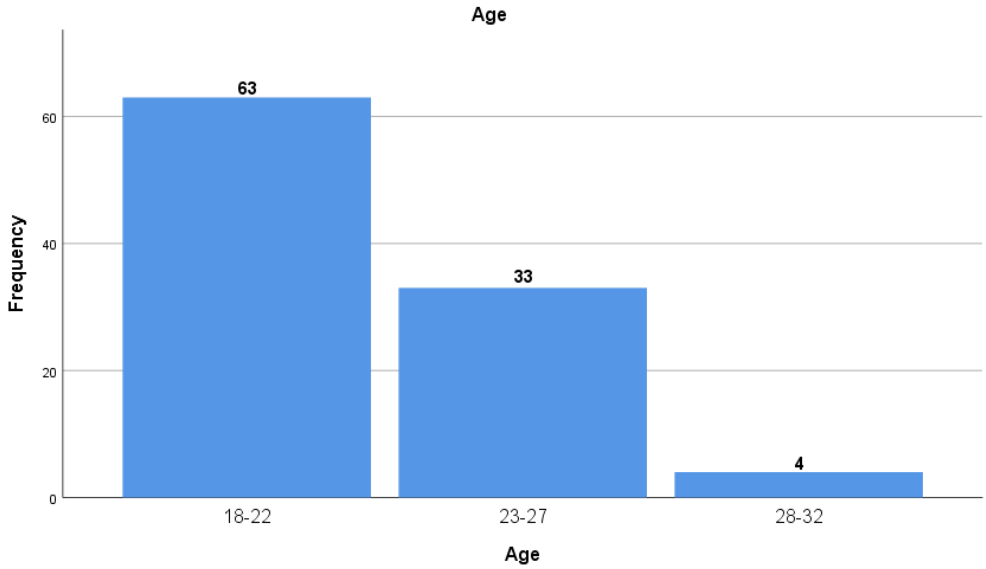

Figure 4.2: Age Distribution Among Participants

4.2.3 Academic Year

The study included participants from eight academic batches of physiotherapy students at UTAR across three academic years, ranging from the Year 2 Semester 2 (Y2S2) batch to the Year 4 Semester 3 (Y4S3) batch, as the Year 2 Semester 1 (Y2S1) batch was excluded due to a lack of foundational knowledge in biomechanics. Therefore, the participants came from various batches: Year 2 Semester 2 (Y2S2) batch, Year 2 Semester 3 (Y2S3) batch, Year 3 Semester 1 (Y3S1) batch, Year 3 Semester 2 (Y3S2) batch, Year 3 Semester 3 (Y3S3) batch, Year 4 Semester 1 (Y4S1) batch, Year 4 Semester 2 (Y4S2) batch, and Year 4 Semester 3 (Y4S3) batch. The total distribution is 25 participants

(25%) from Year 2, 40 participants (40%) from Year 3, and 35 participants (35%) from Year 4. The most represented batch is the Year 3 Semester 1 (Y3S1) batch, which has 24 participants and represents the mode of the dataset. The distribution shows a slightly higher representation in Year 3, especially in the Y3S1 batch, followed by the Y2S2 batch with 13 participants, and the Y2S3 batch with 12 participants. This data provides a balanced contribution from students at different stages of their physiotherapy education.

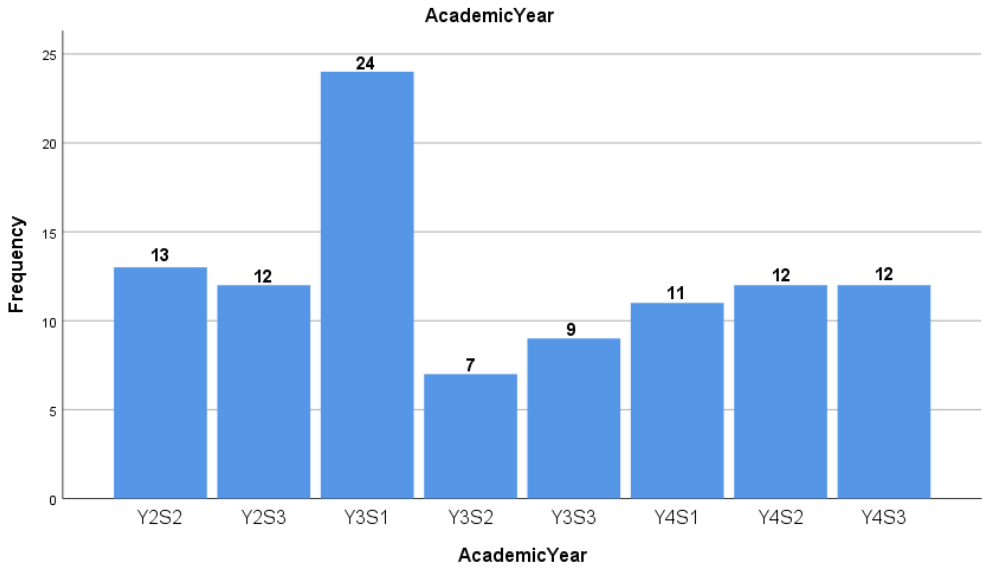

Figure 4.3: Academic Year Distribution Among Participants

4.2.4 Clinical Experience

The distribution of clinical experience among participants shows that the majority, comprising 84 participants, or 84%, have prior clinical experience, while 16 participants, or 16% have no clinical experience. As shown in the pie

chart, this distribution demonstrates a high proportion of participants who have had practical experience in clinical settings, which may influence their knowledge and understanding of the Quadriceps angle. The smaller proportion of participants without clinical experience indicates a minority group that could provide insights into the baseline knowledge acquired through academic study only.

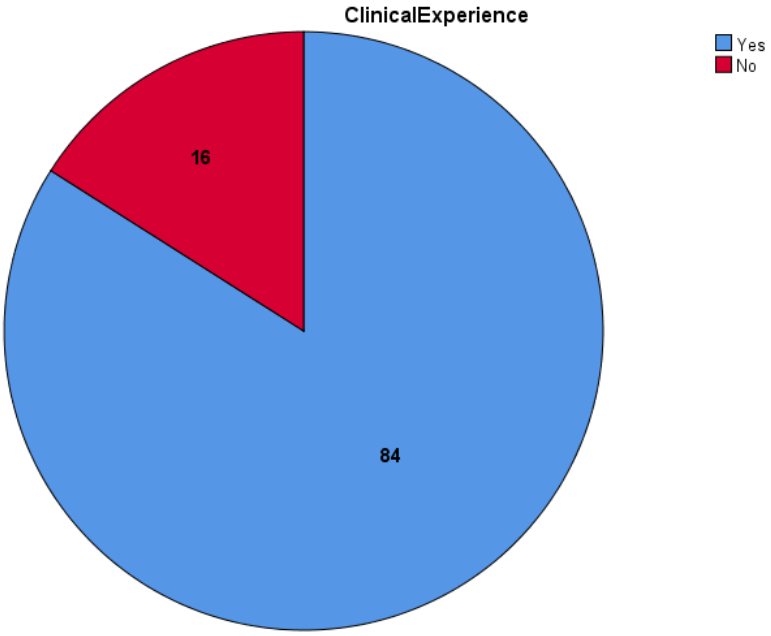

Figure 4.4: Clinical Experience Distribution Among Participants

4.2.5 Summary of the Demographic Data

In summary, the sample is 100 students, predominantly female and younger in the range of 18-22 years old, with most participants coming from Year 3, especially from the Y3S1 batch, and students having clinical experience. The summary of demographic data of the participants will be presented in the form of a descriptive table in Table 4.1.

Batch	Total No.	Male	Female	Age (18-22)	Age (23-27)	Age (28-32)	CE	Non-CE
Y2S2	13	1	12	13	0	0	0	13
Y2S3	12	3	9	12	0	0	12	0
Y3S1	24	3	21	20	4	0	21	3
Y3S2	7	1	6	6	1	0	7	0
Y3S3	9	3	6	4	5	0	9	0
Y4S1	11	1	10	2	9	0	11	0
Y4S2	12	4	8	5	7	0	12	0
Y4S3	12	2	10	1	7	4	12	0
Total	100	18	82	63	33	4	84	16

Table 4.1: Descriptive Table of Demographic Data of Participants

4.3 Validity of Questionnaire

The validity of the questionnaire was examined using content and face validity to ensure that it was suitable for measuring the Q-angle knowledge among physiotherapy students. Three lecturers specializing in the musculoskeletal field reviewed the questionnaire and rated each item according to its importance, using three categories—Very Important, Useful but not Important, and Not Important (refer to Appendix D). Most of the questions in the objective section were rated as Very Important, which shows that the reviewers strongly agreed about their relevance. However, Q6 and Q7 received mixed ratings, with one lecturer rating them as Useful but not Important and another as Not Important, suggesting areas for potential refinement.

For the subjective section, most questions were also rated as Very Important, although Q12, Q13, Q15, and Q16 received mixed ratings. Some lecturers rated these questions as Useful but not Important, reflecting the need for improvements to enhance their clarity and alignment with the research objectives. In addition to the ratings, qualitative feedback was provided. One reviewer highlighted the concerns about bias in responses from students with lower knowledge levels, such as those in earlier academic years, while another suggested minor adjustment to improve question wording and clarity.

Despite these observations, the questionnaire demonstrated acceptable content validity, since most questions were rated as Very Important and addressed key aspects of Q-angle knowledge. The mixed responses for certain

questions indicate areas for refinement in future versions of the questionnaire, but overall, it was considered appropriate for evaluating physiotherapy students' knowledge.

4.4 Objective Questions (Knowledge Assessment)

4.4.1 Reliability Analysis

Reliability analysis is an important step in evaluating the consistency of responses within a questionnaire (Chan & Idris, 2017). The objective section, consisting of 9 questions, was evaluated using Cronbach's Alpha. This section aimed to measure participants' knowledge related to the Quadriceps Angle. The initial Cronbach's Alpha for the 9 questions was 0.536, slightly below the commonly accepted threshold of 0.7. The reliability remains low even after standardisation ($\alpha = 0.573$), which suggests issues with item consistency.

An item-total statistics analysis revealed that removing the first question related to the anatomical remark of the Q-angle will increase Cronbach's Alpha to 0.547, and removing the sixth question related to the position of the Q-angle measurement will increase Cronbach's Alpha to 0.558. Although still below the optimal threshold, this small improvement suggests that certain items may affect overall reliability. The Corrected Item-Total Correlation measures how well each item correlates with the total score. Most of the questions have values below 0.3 indicating poor correlation with the rest of the items.

Item	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q1	0.054	0.547
Q2	0.336	0.500
Q3	0.202	0.518
Q4	0.275	0.498
Q5	0.440	0.455
Q6	0.186	0.558
Q7	0.350	0.468
Q8	0.177	0.529
Q9	0.309	0.484

Table 4.2: Item-Total Statistics

4.4.2 Descriptive Statistics for Total Scores

The data collected from the questionnaire was analysed using descriptive statistics (refer to Table 4.3). The total scores of the objective section in the questionnaire were calculated for each participant. A total of 100 responses were

received; the scores ranged from 4 to 9 with a range of 5. The mean score was calculated to be 7.52, the median score was 8.00 and the most frequent score (mode) was 9. The skewness coefficient was negative, so the distribution is negatively skewed. The standard deviation was computed to be 1.554, showing a moderate level of variation in the scores made by the participants with a variance of 2.414. The frequency distribution of the total scores indicated that most participants obtained 9 (35%), eight participants obtained 8, and seventeen participants obtained 7. (refer to Table 4.4)

Statistics	**Value**
Mean	7.52
Median	8.00
Mode	9
Standard Deviation	1.554
Range	5
Minimum Score	4
Maximum Score	9

Table 4.3: Descriptive Statistics for Total Scores

Total Score	Frequency (n)	Percentage (%)
4	8	8
5	5	5
6	9	9
7	18	18
8	25	25
9	35	35
Total	100	100

Table 4.4: Frequency Distribution of Total Scores

4.4.3 Frequency Analysis for Each Question

The results of the frequency analysis of the objective section indicate that most of the participants answered the questions correctly thus showing an adequate knowledge of the Q-angle. The first five questions were better understood with accuracies ranging from 87% to 95% while the sixth and seventh questions were not well understood making 68% and 69% correct responses respectively. The other options for these questions were selected more frequently than the other questions. This pattern shows the areas in which the

participants may need further understanding or information. The last two questions had 81% and 80% correct responses, demonstrating a moderate knowledge of Q-angle.

Question	Correct (-)	A (n)	B (n)	C (n)	D (n)
Q1	95	2	-	3	0
Q2	90	9	-	1	0
Q3	92	2	-	4	2
Q4	90	4	5	-	1
Q5	87	9	3	-	1
Q6	68	-	13	8	11
Q7	69	23	6	2	-
Q8	81	12	-	4	3
Q9	80	-	11	8	1

Table 4.5: Frequency Distribution of Responses for Objective Section

4.4.4 Comparison of Total Scores Across Academic Years

To analyse the data, Kolmogorov-Smirnov and Shapiro-Wilk tests were used to evaluate the normality of the total scores across different academic years. Both tests were conducted to determine whether the data followed a normal distribution. The results indicated that the p-values of several groups were less than 0.05, particularly in the Shapiro-Wilk test, which implies that the data violated the normal hypothesis. Consequently, non-parametric tests were chosen for further analysis.

Academic Year	**Kolmogorov-Smirnov (p-value)**	**Shapiro-Wilk (p-value)**	**Normality Assumption**
Y2S2	0.043	0.016	Not Normal
Y2S3	0.200	0.363	Normal
Y3S1	0.033	0.004	Not Normal
Y3S2	0.200	0.215	Normal
Y3S3	0.050	0.041	Not Normal
Y4S1	0.018	0.009	Not Normal

Y4S2	0.027	0.010	Not Normal
Y4S3	0.000	0.000	Not Normal

Table 4.6: Normality Tests Results for Total Score Across Academic Years

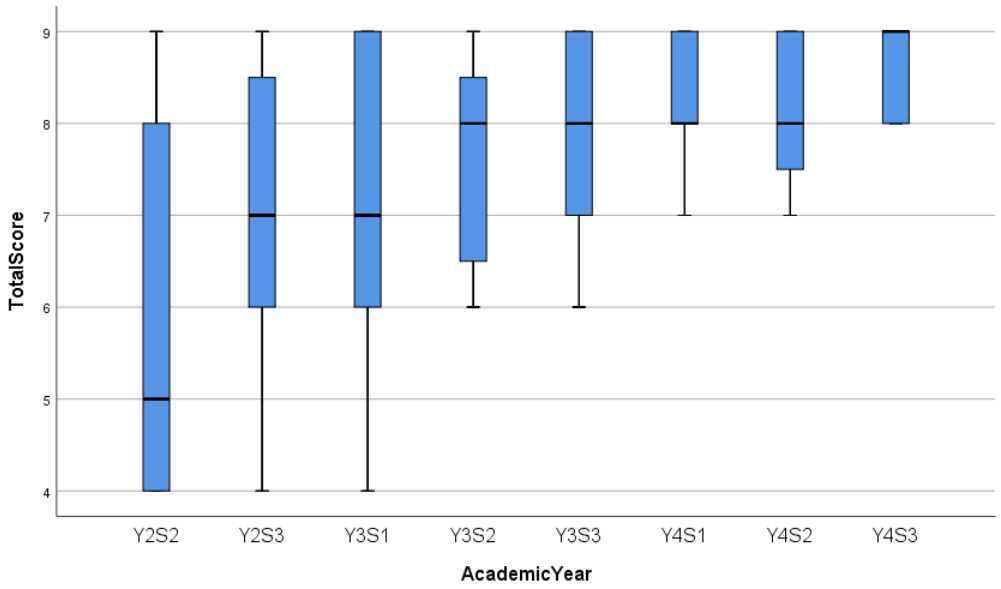

Figure 4.5: Box Plot Graph for Total Score Across Academic Years

Considering the non-normal distribution, a Kruskal-Wallis H test was carried out to determine whether there were significant differences in total scores across the academic years. The results showed a statistically significant difference (H = 20.224, p = 0.005), which rejectedad the null hypothesis, indicating that at least one group differed significantly from other groups.

Academic Year	N	Mean Rank
Y2S2	13	28.00
Y2S3	12	41.75
Y3S1	24	45.44
Y3S2	7	48.50
Y3S3	9	55.28
Y4S1	11	62.73
Y4S2	12	60.13
Y4S3	12	70.50

Table 4.7: Kruskal-Wallis H Test Results

Test	Value
Kruskal-Wallis H	20.224
df	7
Sig. (p-value)	0.005

Table 4.8: Kruskal-Wallis H Test Statistics

After that, a pairwise comparison post hoc test using the Mann-Whitney U test with Bonferroni correction was conducted to identify specific group differences. The adjusted p-values were analysed to illustrate multiple comparisons. The results showed a statistically significant difference between Y2S2 and Y4S3 (Adj. Sig. = 0.004). No other pairs showed significant differences after the Bonferroni correction. (refer to Appendix H)

4.5 Subjective Questions (Perception and Self-Assessment)

4.5.1 Frequency Analysis for Each Question

The data indicated that 83% of the participants had heard about the Q-angle, and 17% indicated that they had not. To the question on practical experience in measuring the Q-angle, 38% reported having such experience, 53% indicated no experience, and 9% were not sure. Regarding the question of whether they are interested in attending more workshops or sessions on the Q-angle, 62% were interested, 8% were not interested, and 30% selected "Maybe". The results give a background of awareness, practical experience, and interest in further learning opportunities on the Q angle among the participants.

Question	Answer Option	Frequency (n)	Percentage (%)
Q10	Yes	83	83
	No	17	17
Q14	Yes	38	38
	No	53	53
	Maybe	9	9
Q15	Yes	62	62
	No	8	8
	Maybe	30	30

Table 4.9: Frequency Distribution of Responses to "Yes, No, Maybe" Questions

The responses to Question 12 indicate that most participants perceive understanding the quadriceps angle as highly important in physiotherapy practice. A total of 87% of respondents rated the importance as either "very important" (n = 36) or "extremely important" (n = 51). The mean score of 4.37 (SD = 0.734) further reflects this strong agreement. Notably, no respondents rated the importance as "not important at all," and only one participant selected "somewhat important," indicating widespread agreement on its significance.

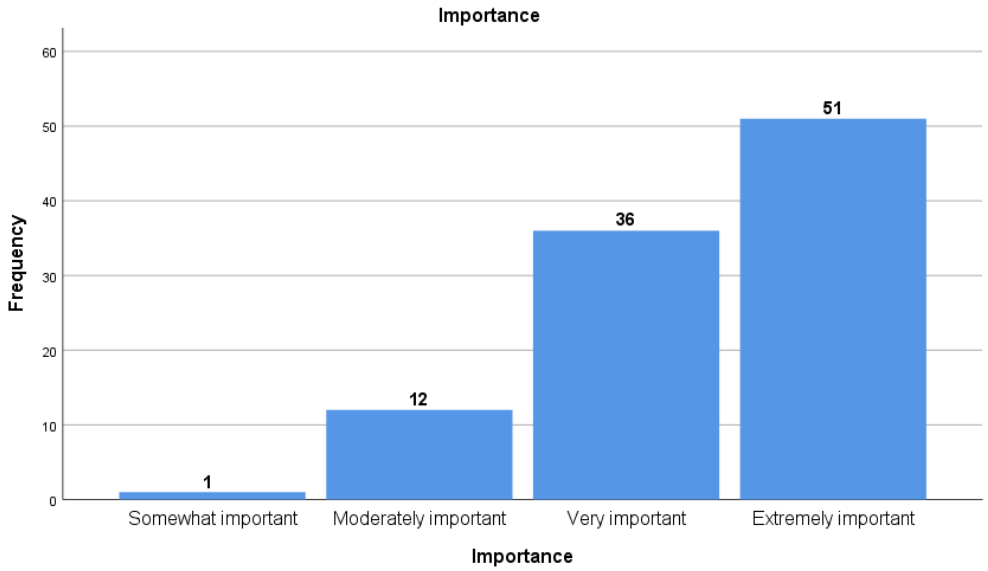

Figure 4.6: Frequency Distribution of Options in Question 12

The responses to Question 13 show a broader distribution of confidence levels. While 43% of participants evaluated their confidence as "very confident" (n = 28) or "extremely confident" (n = 15), a significant portion indicated lower levels of confidence, with 29% selecting "slightly confident" (n = 20) and 9% indicating they were "not confident at all" (n = 9). The mean score of 3.2 (SD = 1.189) indicated that participants have a moderate confidence level, but there is space for improvement in understanding or expressing the clinical relevance of the Q angle.

Figure 4.7: Frequency Distribution of Options in Question 13

In the first open-ended question (Q11), which asked the participants to describe the Quadriceps angle in their own words, responses were given by 54 participants, while 46 participants left it blank. The second open-ended question (Q16) invited participants to provide comments or suggestions on how the Quadriceps angle could be better integrated into their physiotherapy coursework; only 8 participants responded, while 92 participants left it blank.

4.5.2 Batch Comparison with Chi-Square Analysis

The Chi-Square analysis is used to check the association between the academic year and the responses to the "Yes, No, Maybe" questions. The chi-square values (X^2), degree of freedom (df), and significant values (sig.) are tabulated in Table 4.13.

Question 10 assessed whether the participants had heard about the Q-angle before. The data indicates that awareness of the Q-angle varies significantly across academic years ($p = 0.002$), as the p-value is less than 0.05. Among participants from the Year 3 Semester 3 (Y3S3) to the Year 4 Semester 3 (Y4S3) batches, none of the participants selected the "no" option. In contrast, the earlier batches, particularly the Year 2 Semester 2 (Y2S2) batch, had participants who selected the "No" option. Notably, 6 out of 13 participants in the Y2S2 batch reflected that they had not heard of the Q-angle before.

Batch	**Yes**	**No**	**Total**
Y2S2	7	6	13
Y2S3	10	2	12
Y3S1	16	8	24
Y3S2	6	1	7
Y3S3	9	0	9
Y4S1	11	0	11
Y4S2	12	0	12

Y4S3	12	0	12
Total	83	17	100

Table 4.10: Frequency of Responses to Question 10 from Each Batch

Question 14 explores whether the participants had practical experience in measuring the Q-angle. The p-value of this question is 0.000, which is less than 0.05. This result indicates that there is a statistically significant association between the academic year and responses. Among Year 2 and Year 3 participants, 12 participants selected the "Yes" option, while 39 participants selected the "No" option, and 4 were unsure. However, the majority of Year 4 participants reflected that they had the practical experience to measure the Q-angle.

Batch	**Yes**	**No**	**Maybe**	**Total**
Y2S2	1	11	1	13
Y2S3	2	8	2	12
Y3S1	7	14	3	24
Y3S2	1	6	6	7
Y3S3	1	8	8	9

Y4S1	9	1	1	11
Y4S2	8	2	2	12
Y4S3	9	3	0	12
Total	38	53	9	100

Table 4.11: Frequency of Responses to Question 14 from Each Batch

Question 15 investigates participants' interest in learning more about the Q-angle through additional workshops or sessions. The data shows no statistically significant association between academic year and responses, as the p-value is 0.516, which exceeds 0.05. The frequency distribution of responses is similar across all batches.

Batch	**Yes**	**No**	**Maybe**	**Total**
Y2S2	6	2	5	13
Y2S3	9	0	3	12
Y3S1	16	3	5	24
Y3S2	2	1	4	7

Y3S3	7	1	1	9
Y4S1	8	1	2	11
Y4S2	7	0	5	12
Y4S3	7	0	5	12
Total	62	8	30	100

Table 4.12: Frequency of Responses of Q15 from Each Batch

Question	X^2	df	Sig. (2-tailed)
Q10	18.208	N/A	0.002 ($p < 0.05$)
Q14	40.106	14	0.000 ($p < 0.05$)
Q15	13.135	14	0.516 ($p > 0.05$)

**** Due to computational limitations, Fisher's Exact Test could not be performed. Therefore, the Pearson Chi-Square test was used instead to analyse the association between variables.***

Table 4.13: Chi-Square Results of Q10, Q14, Q15

4.5.3 Comparison of Likert Scale Question Across Academic Years

4.5.3.1 Importance of Understanding Q-Angle

The normality of the Likert Scale questions like Questions 12 and 13 across academic batches was tested by the Kolmogorov-Smirnov and Shapiro-Wilk tests. Question 12 is a Likert scale question evaluating the perceived importance of understanding the Q-angle in physiotherapy practice. Most of the groups had p-values that were lesser than 0.05, indicating that the data was not normally distributed. Therefore, the Kruskal-Wallis H test was used to evaluate the significance of the importance level of understanding Q-angle across the academic years, with the results of no statistically significant difference, which the p-value was 0.244 ($p > 0.05$) and the H-value was 9.127.

Academic Year	**Kolmogorov-Smirnov (p-value)**	**Shapiro-Wilk (p-value)**	**Normality Assumption**
Y2S2	0.004	0.003	Not Normal
Y2S3	0.000	0.000	Not Normal
Y3S1	0.002	0.001	Not Normal
Y3S2	0.200	0.144	Normal
Y3S3	0.054	0.024	Not Normal

Y4S1	0.000	0.000	Not Normal
Y4S2	0.002	0.004	Not Normal
Y4S3	0.000	0.002	Not Normal

Table 4.14: Normality Test Results for Importance Level of Q-Angle Across Academic Years

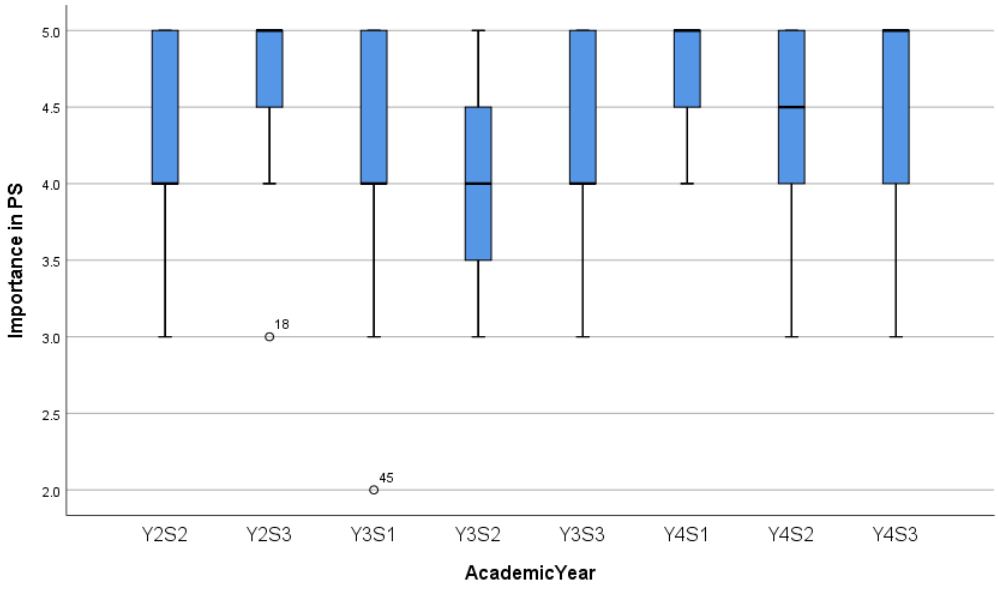

Figure 4.8: Box Plot Graph for Importance Level of Q-Angle Across Academic Years

Academic Year	N	Mean Rank
Y2S2	13	49.73
Y2S3	12	62.13
Y3S1	24	42.54
Y3S2	7	37.07
Y3S3	9	48.17
Y4S1	11	63.14
Y4S2	12	51.25
Y4S3	12	52.88

Table 4.15: Kruskal-Wallis H Test Results for Question 12

Test	Value
Kruskal-Wallis H	9.127
df	7
Sig. (p-value)	0.244

Table 4.16: Kruskal-Wallis H Test Statistics for Question 12

4.5.3.2 Confidence Level

Question 13 is another Likert scale question, which assesses participants' confidence in explaining the clinical significance of the Quadriceps angle to musculoskeletal issues. Most of the groups had p-values less than 0.05, suggesting that the data did not follow a normal distribution. Similar to Question 12, the confidence level's significance across academic batches was tested by the Kruskal-Wallis H test. The test results revealed statistically significant differences between groups, with a H-value of 21.273 and a p-value of 0.003, less than 0.05.

Academic Year	**Kolmogorov-Smirnov (p-value)**	**Shapiro-Wilk (p-value)**	**Normality Assumption**
Y2S2	0.200	0.116	Not Normal
Y2S3	0.001	0.030	Normal
Y3S1	0.024	0.057	Not Normal
Y3S2	0.039	0.006	Normal
Y3S3	0.000	0.004	Not Normal

Y4S1	0.017	0.018	Not Normal
Y4S2	0.012	0.011	Not Normal
Y4S3	0.138	0.047	Not Normal

Table 4.17: Normality Tests Results for Confidence Level Across Academic Years

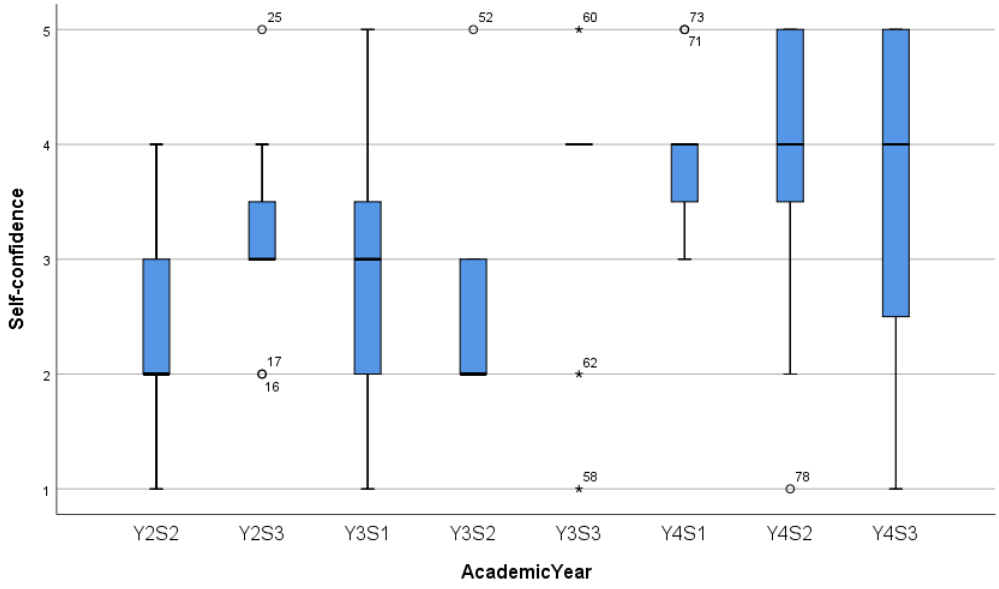

Figure 4.9: Box Plot Graph for Confidence Level Across Academic Years

Academic Year	N	Mean Rank
Y2S2	13	31.54
Y2S3	12	48.29
Y3S1	24	41.19
Y3S2	7	36.86
Y3S3	9	60.72
Y4S1	11	67.77
Y4S2	12	68.25
Y4S3	12	58.58

Table 4.18: Kruskal-Wallis H Test Results for Question 13

Test	Value
Kruskal-Wallis H	21.273
df	7
Sig. (p-value)	0.003

Table 4.19: Kruskal-Wallis H Test Statistics for Question 13

The Mann-Whitney U test with Bonferroni correction was used for the pairwise comparison post hoc test to further check for the specific group differences. The results demonstrated a significant difference between Y2S2 and Y4S1 batches (Adj. Sig. = 0.048) and between Y2S2 and Y4S2 batches (Adj. Sig. = 0.032), while the other pairs did not show significant differences after the Bonferroni correction. (refer to Appendix I)

4.5.4 Qualitative Analysis of Open-Ended Questions

4.5.4.1 Definitions of Q-Angle

In this study, 54% of the participants responded to the open-ended question that asked them to define the Q-angle in their own words. Among these responses, some participants provided a correct or partially correct definition of the Q-angle, which shows that they have a certain level of knowledge about this topic. The most common response (28%) defined the Q-angle as the angle formed by two lines: one drawn from the anterior superior iliac spine (ASIS) to the center of the patella, and the other from the center of the patella to the tibial tuberosity. These responses demonstrate an understanding of the anatomical landmarks and the biomechanical basis of the Q-angle.

Other participants (12%) defined the Q-angle as the angle formed between the quadriceps muscles and the patellar tendon, highlighting the knowledge of related structures involved in the measurement. Although these

definitions aligned with the general concept, they lacked the detail required to accurately define the Q-angle as used in clinical settings.

However, 10% of the participants showed partial understanding or confusion. For example, several responses described the Q-angle as the angle formed between the hip and knee or as a measure of hip anteversion and retroversion, which reflects a misunderstanding of its specific anatomical origin and biomechanical significance. Others (4%) incorrectly defined it as the angle between the upper and lower legs, further emphasizing the knowledge gaps.

In addition, 46% of the participants either left the question blank or gave incomplete answers, such as just mentioning the term "Q-angle" without further explanation. These patterns suggest that while some participants had general knowledge about the Q-angle, there were significant gaps in their understanding of its precise definition, clinical importance, and practical applications.

4.5.4.2 Suggestions for Teaching and Integration

Participants were also asked to provide suggestions on how to better integrate Q-angle into the curriculum to improve learning and application. A significant majority (92%) either did not respond or indicated that they had no suggestions. This lack of feedback may indicate uncertainty about how to teach the topic effectively or a lack of confidence in proposing to change the learning process.

Among the 8% of participants who did provide suggestions, the most (5%) common recommendation was to include practical sessions on Q-angle measurement. Participants emphasized the importance of hands-on learning experiences to improve their confidence and ability to measure the Q-angle under different conditions. Many advocated that these practical sessions should be included in both lectures and clinical training so that students can strengthen theoretical concepts through hands-on application.

Some participants (3%) also suggested focusing on the clinical relevance of the Q-angle, including its interpretation, implications for treatment, and management strategies. They suggested that the teaching should be more interactive and detailed to help students grasp the significance of the Q-angle in musculoskeletal assessment and intervention.

CHAPTER 5

5.0 DISCUSSION

5.1 Chapter Overview

The discussion chapter interprets the findings in detail, starting with an overview of the results. It evaluates the reliability and validity of the questionnaire while also exploring specific aspects of Q-angle knowledge, including total score comparisons across batches, perception, and confidence in Q-angle understanding. The chapter also examines practical experience, interest in further study, and participants' suggestions for improvement. It concludes with an analysis of the strengths and limitations of the research, the significance of the study, and the recommendations for future research. Finally, the chapter summarizes the key findings and their implications for physiotherapy education.

5.2 Overview of Findings

This study aimed to explore the knowledge of Quadriceps angle (Q-angle) among physiotherapy students in the second year to above in UTAR Sungai Long Campus. A structured questionnaire is used in the study to assess the participants' understanding and identify gaps in knowledge and practical exposure to the Q-angle concept. The findings give information on the present state of learning and how it varies across academic levels.

This study included 100 physiotherapy students, who were selected using a convenience sampling method. The participants are from eight different batches, representing the Year 2 Semester 2 (Y2S2) batch through the Year 4 Semester 3 (Y4S3) batch. The demographic breakdown was as follows: Y2S2 (13%), Y2S3 (12%), Y3S1 (24%), Y3S2 (7%), Y3S3 (9%), Y4S1 (11%), Y4S2 (12%), Y4S3 (12%). The Y3S1 batch has the highest number of participants, and other batches have had an average number of participants. According to the data, the majority of participants were female (82%), with male participants accounting for only 18%. Most of the participants (63%) were from the younger age group of 18 to 22. Furthermore, 84% of the participants reported having clinical experience.

To explore the variances in knowledge of the Q-angle, the total scores from the objective section of the questionnaire were compared across batches. This comparison aimed to determine whether academic advancement was connected with improved knowledge and application of Q-angle concepts. The results of these analyses are discussed in the following sections.

5.3 Reliability and Validity of Questionnaire

5.3.1 Reliability

The reliability of the objective section of the questionnaire was assessed using Cronbach's Alpha, a widely used measure of internal consistency that evaluates the extent to which a set of test items reliably measures a single concept. In general, higher values of Cronbach's Alpha indicate better reliability,

with many researchers recommending a minimum value between 0.65 and 0.8 for acceptable reliability. While some consider 0.7 as a rule-of-thumb threshold, this value is not universally applicable and depends on the nature of the instrument and the theoretical concept being measured. (Singh, 2017)

For this research, the Cronbach's Alpha for the objective section was 0.536, which falls in the moderate reliability range. Although this value is lower than the 0.7 guideline, it is not necessarily poor, especially considering the study's unique circumstances. Even after the standardization of the items, the reliability value is 0.573, which remains low. The questionnaire is newly developed and designed to assess knowledge of the Q-angle from multiple distinct aspects, which reduces the interrelation between questions. Furthermore, the relatively small sample size (n = 100) may have reduced the stability of the reliability estimate. Due to time restrictions, it was not possible to improve and revalidate the questionnaire to achieve higher reliability.

Further analysis was conducted through the Item-Total Statistics to investigate the impact of each question on overall reliability. Questions were evaluated based on their Corrected Item-Total Correlation and Cronbach's Alpha if Item Deleted values. The values of Corrected Item-Total Correlation showed that most of the questions had poor correlation and may not measure the same construct as the others, as most of them are less than 0.3. For the Cronbach's Alpha if Item Deleted values, interestingly, removing Question 1 would have increased Cronbach's Alpha slightly to 0.547, while removing Question 6 would

have increased it to 0.558. However, all questions were kept since they are necessary for completely assessing knowledge of the Q-angle. The minor increase in alpha from removing one question highlights the diversity of the structures being examined rather than a deficiency in the overall questionnaire design. Considering the multidimensional character of the questionnaire, this moderate level of internal consistency is considered acceptable. On the other hand, even with the removal of these questions, the reliability also did not reach the acceptable threshold of 0.7, suggesting that the questionnaire as a whole may require further refinement to improve consistency.

The subjective section of the questionnaire, which includes three “Yes, No, Maybe” questions, two Likert scale questions, and two open-ended questions, will not intend for a reliability test by SPSS. This section primarily aims to get the participant’s opinions, experiences, and suggestions about their exposure, awareness, and understanding of the Q-angle, as well as how interested they are in more learning opportunities. Since these questions are not designed to evaluate a single, continuous construct but rather capture individual responses, their reliability is not as critical to assessing using statistical tools like SPSS. Additionally, the “Yes, No, Maybe” questions, Likert scale items, and open-ended questions are disconnected sources, which means that they do not have the same logic that would require all responses to be checked for consistency like multi-item scales. The open-ended questions, which require participants to explain the Q-angle in their own words and provide feedback on how it should be taught or integrated into their courses, have a qualitative character and do not require reliability testing.

5.3.2 Validity

The validity of the questionnaire was established through expert review. Establishing content validity is crucial when using evaluation tools like questionnaires for research purposes. For content validation, a minimum of two experts is considered appropriate (Yusoff, 2019). In this study, three lecturers specializing in the musculoskeletal field were invited to validate the questionnaire using a form with three answer options: Very Important, Useful but not that Important, and Not Important. The results of their evaluation showed that most questions were rated as Very Important, reflecting their relevance to assessing Q-angle knowledge. However, Q6 and Q7 in the objective section and Q12, Q13, Q15, and Q16 in the subjective section received mixed ratings, indicating the need for minor revisions in future studies.

The reviewers also provided qualitative feedback and identified issues for further improvement. For example, one reviewer enquired about the scoring criteria for correct and incorrect answers, highlighting the possibility of bias in responses from lower-semester students, such as Year 1 participants, who are likely to be less knowledgeable. Another reviewer marked specific questions for modest changes, which were later updated to increase clarity and precision. However, not all reviewers provided feedback; one submitted the form with no extra comments or ideas.

Despite these suggestions, the questionnaire met the standards of content validity, as the majority of questions were rated highly. Its content was consistent with the study's objectives, making it suitable for assessing knowledge levels in musculoskeletal topics among physiotherapy students. While reliability might be improved in future iterations, the current questionnaire is considered valid and appropriate for the aim of this research.

5.4 Knowledge Assessment

The objective section of the questionnaire evaluated participants' knowledge of the Q-angle, including questions about its definition, clinical significance, associated conditions, gender differences, and interventions. The responses provided insights into the participants' knowledge levels, with trends observed in both correct and incorrect answers.

For Question 1, it focused on the participant's ability to identify the correct anatomical landmarks used to measure the Q-angle. A significant majority of participants (95%) correctly identified the landmarks as the anterior superior iliac spine and the center of the patella. However, 5% of the participants selected incorrect landmarks, such as the tibial tuberosity to the lateral malleolus (2%) or the posterior superior iliac spine to the medial malleolus (3%), indicating some confusion about the anatomical references.

Question 2 focused on conditions associated with an increased Q-angle. Most participants (90%) correctly linked the Q-angle to patellofemoral pain syndrome, while others incorrectly associated it with hamstring strains (9%) and Achilles tendonitis (1%). This suggests a need for future learning on the clinical relevance of the Q-angle.

The gender differences in the Q-angle are explored in Question 3. A high percentage of participants (92%) correctly recognized that females generally have a larger Q-angle due to wider hips. However, some participants incorrectly believed that males have a larger Q-angle (2%), no significant difference in Q-angle between different genders (4%), or that body weight primarily influences the Q-angle (2%), demonstrating misinformation regarding its determinants.

In Question 4, the importance of the Q-angle in assessing knee injuries is addressed. A majority (90%) answered correctly, identifying its role in influencing patellar tracking and joint mechanics. Incorrect responses, such as associating the Q-angle to ankle sprains (5%), claiming it is only relevant in hip assessments (4%), or Q-angle has no impact on knee function (1%), show opportunities for improvement in understanding.

For Question 5, the biomechanical effects of an abnormal Q-angle are examined. Most participants (87%) correctly identified altered patellar tracking as a potential consequence, though some incorrectly suggested increased stability (9%), enhanced shock absorption (3%), or improved muscle

coordination (1%), indicating gaps in knowledge about the biomechanical implications of Q-angle deviations.

The percentage of correct in Question 6 (68%) and Question 7 (69%) are the lowest compared to other questions. Question 6 tested participants' understanding of the lower limb position recommended for Q-angle measurement. A significant proportion (68%) correctly selected full extension, while others selected incorrect positions such as 90-degree flexion (13%), abduction (8%), or external rotation (11%). These errors suggest a need for greater emphasis on procedural accuracy during training.

Question 7 asked about the imaging method commonly used to assess the Q-angle. 69% of participants correctly identified X-ray, while the other participants incorrectly selected other imaging modalities, such as Magnetic Resonance Imaging (MRI) (23%), Computed Tomography (CT) (6%), or ultrasound (2%). This indicates some uncertainty about the preferred diagnostic tools.

Question 8 (81%) and Question 9 (80%) also have a slightly lower percentage of correct responses but still higher than Question 6 and Question 7. Question 8 focused on the relationship between Q-angle variations and patellar dislocation risk. 81% of the participants correctly recognized that increased Q-angle is associated with a higher risk of patellar dislocation. However, 12% of the participants incorrectly believed that a smaller Q-angle is associated with a

higher risk of patellar dislocation, 4% believed that there is no association between Q-angle and patellar dislocation, and 3% believed that Q-angle does not affect patellar stability, which revealed the knowledge gaps.

Lastly, Question 9 explored interventions for managing an abnormal Q-angle. 80% of the participants correctly identified quadriceps strengthening exercises as the recommended intervention, while others incorrectly suggested hamstring stretching (11%), avoidance of weight-bearing activities (8%), or no specific intervention are necessary (1%). These errors indicate a need to emphasize evidence-based approaches in learning progress.

The higher error rates observed in Q6 and Q7 may be attributed to gaps in educational exposure or the complexity of the topics covered by these questions. Q6, which assessed the proper posture for measuring the Q-angle, may have been misunderstood due to inadequate attention to this practical aspect during coursework or clinical training. Additionally, difficulties in recalling specific steps for positioning during measurements might have contributed to the high error rates in Q6. Variability in measurement techniques could also lead to confusion among students. Similarly, Q7, which focused on imaging techniques, could reflect a lack of exposure to advanced diagnostic tools, as such topics may not be prioritized in the physiotherapy curriculum at the undergraduate level. Imaging techniques are often taught briefly, as Q-angle measurements are commonly performed clinically using a goniometer rather than radiologically, despite it being more accurate. In the reliability test, Q6 and Q7 were identified

as having low Corrected Item-Total Correlation values, which were 0.186 and 0.350 respectively. These low correlations indicate that these items had weaker relationships with the overall questionnaire score. However, this may not fully explain their higher error rates, as other questions in the questionnaire also showed lower values but did not exhibit similar trends in error rates.

Overall, the research revealed variances in performance across individual questions, indicating areas of strength and aspects that required further attention in the learning process. According to the results, various aspects of Q-angle information, such as the proper posture for measurement, the optimal imaging method, clinical association, and interventions, require more understanding.

5.5 Total Score Comparison Across Batches

The results of the normality test highlighted the deviations of normal distribution, thus justifying the rationality of using the non-parametric approach for analysis. The Kruskal-Wallis H test confirmed that there were significant differences in total scores across academic years, rejecting the null hypothesis of no association and needed further investigation through post hoc analysis.

The post hoc analysis identified a significant difference between students in the Y2S2 and Y4S3 batches. This result suggests that students in the Y4S3 batch demonstrated a significantly higher level of knowledge as compared to those in the Y2S2 batch. This finding could reflect the differences in academic

exposure whereby the senior batches were expose to more coursework, practical sessions, and clinical experiences than junior batches, contributing to a deeper understanding of the Q-angle.

The other groups did not have significant differences, which may imply that, while knowledge levels generally improve with academic progression, the improvement is not constant. Curriculum structure, teaching methods, or self-directed learning strategies could be some reasons influencing the knowledge acquisition process in different batches.

Although the curriculum probably plays its role in shaping the students' fundamental knowledge, it is suggested that individual initiative, such as reading additional resources or discussing with clinical supervisors, may have an additional impact on their level of knowledge. Besides, the higher the semester, the more frequent the hands-on experiences; theoretical knowledge may be reinforced, leading to a better score on this assessment.

In summary, the significant difference in scores demonstrates the importance of academic progression along with active learning strategies in developing a comprehensive knowledge of essential topics such as the Quadriceps angle.

5.6 Perception and Confidence Regarding Quadriceps Angle Knowledge

5.6.1 Awareness of the Quadriceps Angle

When asked whether they had heard about the Quadriceps angle, the majority of participants (83%) responded affirmatively, with significant variation across batches. For instance, all the participants from Year 3 Semester 3 (Y3S1) batch to the Year 4 Semester 3 (Y4S3) batch gave “Yes” responses (n = 44), while the Year 2 Semester 2 (Y2S2) batch had the fewest, which is 7 out of 13 participants. This means that even though the Q angle is a commonly recognized term, there is still a minority of students who are not aware of it, indicating that more basic education regarding this topic is needed. The Chi-square analysis shows significant differences across the batches ($p = 0.002$), so the null hypothesis is rejected. These results indicate that awareness tends to increase with academic progression, potentially reflecting cumulative exposure to relevant concepts in coursework and clinical settings.

In this study, the Pearson Chi-square test was used to analyse the association between batches and responses to categorical variables, such as the "Yes, No, Maybe" questions in the subjective section of the questionnaire. While Fisher’s Exact Test is often used for smaller sample sizes due to its precise p-value calculation, it could not be used in this case because of the computational limitations caused by the bigger contingency tables formed by the multiple batches and response categories. As a result, the Pearson Chi-square test, which is more computationally feasible for larger datasets, was selected despite its

reliance on certain assumptions, such as the sufficiency of expected cell frequencies. (Bolboacă et al., 2011)

5.6.2 Practical Experience Measuring the Quadriceps Angle

Regarding practical experience in measuring the Quadriceps angle, 38% of participants answered "Yes," with 53% and 9% selecting "No" and "Maybe," respectively. Higher-level batches such as all three Year 4 batches (sum = 26%), had a greater proportion of participants reporting practical experience, while lower-level batches had fewer (only a total of 12% from 5 batches). However, it is important to note that not all participants in the senior batches had clinical experience with Q-angle measurement, suggesting that clinical exposure does not always guarantee hands-on practice in this specific skill. This shows a big gap regarding practical training in Q-angle measurements. This lack of exposure to practical application may prevent students from being confident in using this concept clinically; hence, more practical sessions should be integrated into the curriculum of physiotherapy. The result of the Chi-square analysis has a significance value of $p = 0.000$, this disparity rejects the null hypothesis and underscores the influence of clinical exposure in later semesters on students' hands-on familiarity with the Quadriceps angle.

5.6.3 Interest in Additional Study

A notable 62% of participants expressed interest in additional workshops or sessions to enhance their understanding of the Quadriceps angle, with 30% answering “Maybe” and only 8% responding “No”. There is no significant

association between the responses and the academic year ($p = 0.516$). However, this finding highlights the enthusiasm of students for furthering their knowledge to enhance their use of the Q-angle when working clinically and suggests the potential benefits of organizing targeted educational activities, such as workshops or hands-on training sessions, to meet this demand. These sessions could help alleviate both the lack of understanding and the limited practical experiences reported by the participants.

5.6.4 Importance of the Quadriceps Angle

The importance of the quadriceps angle in physiotherapy treatment was strongly assessed by participants, with 36% picking "Very Important" and 51% selecting "Extremely Important." The analysis of Question 12 evaluated the importance of understanding Q-angle in physiotherapy practice and revealed that the data was not normally distributed across most academic batches. This conclusion was based on the Kolmogorov-Smirnov and Shapiro-Wilk tests, where most of the p-values were less than 0.05, indicating a violation of the assumption of normality.

Given the non-normal distribution of data, the Kruskal-Wallis H test, a non-parametric method, was used to assess whether there were statistically significant differences in perceived importance levels among the academic batches.

The results of the Kruskal-Wallis H test showed that there was no statistically significant difference in the importance of understanding the Q-angle among physiotherapy students from different academic years ($H = 9.127$, $p = 0.244$). Since the p-value exceeded 0.05, the null hypothesis that there is no difference in perceptions across batches could not be rejected.

These findings show that students, regardless of their academic year, have similar views on the importance of understanding the Q-angle. This consistency may imply that the topic is considered to be equally relevant across all levels of study, which may reflect its emphasis within the physiotherapy curriculum. Alternatively, it may indicate that students' knowledge and understanding of the importance of Q-angle has not developed significantly with their academic years.

5.6.5 Confidence in Explaining the Quadriceps Angle

Confidence levels varied among participants, with the majority reporting "Very Confident" (28%) or "Moderately Confident" (28%). Higher-level batches showed slightly higher confidence, but overall confidence remained low.

The analysis of Question 13 revealed that the data did not follow a normal distribution across most academic batches. This finding was supported by the Kolmogorov-Smirnov and Shapiro-Wilk tests, where most p-values were less

than 0.05. Because of this non-normal distribution, the Kruskal-Wallis H test was utilised to determine whether there were statistically significant differences in confidence levels among the academic years. The results indicated that there were statistically significant differences across groups ($H = 21.273$, $p = 0.003$), which rejects the null hypothesis and suggests that the variability of confidence levels depends on academic progression.

To further investigate these differences, a Mann-Whitney U test with Bonferroni correction was conducted as a post hoc test to identify specific group differences. Significant differences in confidence levels were found between the Y2S2 and Y4S1 batches (Adj. Sig. = 0.048) and between the Y2S2 and Y4S2 batches (Adj. Sig. = 0.032). However, none of the other pairs showed significant differences after the Bonferroni correction, indicating that the most substantial confidence gains occurred between Year 2 Semester 2 (Y2S2) batch and Year 4 (Y4S1 and Y4S2) batch.

These findings suggest that confidence in explaining the clinical significance of the Q-angle tends to improve as students advance through their academic years. They reflect a gap in students' practical application and theoretical understanding, indicating the need for enhanced learning opportunities to build confidence. However, the absence of significant differences between the other groups may highlight the potential variations in teaching methods, learning opportunities, or curriculum design across different batches.

The results emphasize the need to enhance early-stage training to build confidence among junior students. Incorporating case-based learning, interactive tutorials, and hands-on practice sessions could help reinforce the understanding and application of the Q-angle's clinical relevance. Moreover, standardizing teaching strategies across batches may address inconsistencies and promote consistent learning outcomes.

5.6.6 Participant-Defined Description of the Quadriceps Angle

The results of this study emphasize that participants' knowledge level regarding the Q-angle is uneven. Although some participants demonstrated a correct or partially correct understanding of the Q-angle's definition and anatomical features, others revealed knowledge gaps and misunderstandings about its specific anatomical origin and clinical application.

The accurate responses determined in the study show that some participants had a foundational understanding of the Q-angle, particularly in anatomical landmarks and measurement techniques. However, the presence of partial definitions and incorrect interpretations indicates that the current teaching approaches may lack the clarity or depth needed to fully solve this problem.

The fact that 36% of participants either left the question blank or provided incomplete answers further highlighted these gaps. This pattern emphasizes the need for more targeted teaching strategies to improve knowledge retention and comprehension. Q-angle plays an important role in assessing lower limb alignment and identifying risks for musculoskeletal injuries, so it is very important to address these gaps for developing qualified physiotherapy professionals.

5.6.7 Participants' Suggestions for Improvement

When asked about ways to enhance the teaching and integration of the Q-angle into their learning, most participants (92%) failed to provide suggestions. This lack of feedback may indicate a limited awareness of effective teaching approaches or insufficient exposure to the topic during their training. It may also reflect the lack of confidence in proposing curriculum changes and emphasize that educators need to actively seek and implement strategies to improve students' participation in the topic.

Among the group who provided suggestions (8%), the demand for practical sessions is the most prominent. 5% of the participants expressed a strong desire for more practical learning opportunities to strengthen theoretical knowledge and build confidence in measuring the Q-angle. They highlighted the importance of integrating these practical sessions into lectures and clinical training to make learning more interactive and applicable.

Participants (3%) also emphasized the need for clearer explanations of the clinical significance of the Q-angle, including its role in identifying alignment issues, guiding treatment decisions, and understanding biomechanical principles. These suggestions are aligned with broader trends in physiotherapy education, which increasingly emphasizes active learning methods such as workshops, clinical simulations, and case studies.

The findings of this study support the inclusion of practical and experience-based learning strategies to address the gaps in knowledge and confidence. By combining interactive teaching methods, educators can enhance students' understanding of the Q-angle and its applications, and ultimately improve their ability to apply this knowledge in clinical practice. These recommendations also emphasize the need for a more comprehensive approach to teaching the Q-angle, a method that integrates both theoretical knowledge and practical skills to produce well-rounded physiotherapy professionals.

5.7 Strength of the Study

This study provides important insights into physiotherapy students' knowledge level of the Q-angle, which is an essential biomechanical parameter in the musculoskeletal aspect. This study's primary strength is its systematic and thorough approach to assessing many dimensions of Q-angle knowledge, including theoretical understanding, practical experience, and confidence in clinical application. The use of a validated questionnaire ensured that data

collection was systematic, and expert feedback also improved the relevance and clarity of the questions.

Another strength is the inclusion of students from multiple academic years, ranging from Year 2 to Year 4. This methodology allowed the study to examine knowledge progression over time, revealing educational gaps at different stages of the physiotherapy curriculum. Additionally, by combining both quantitative data (such as Likert scale ratings and awareness statistics) and qualitative responses (such as open-ended responses on Q-angle education), the study provided a well-rounded understanding of the subject matter. This mixed-methods approach allows for a better interpretation of the results and identifies areas that require educational improvements.

Moreover, the study emphasizes the importance of providing hands-on learning opportunities, as evidenced by the higher levels of practical experience reported among senior students. This finding highlights the impact of clinical training and actual learning in building students' confidence and competence. Collectively, these strengths highlight the research's significance in developing physiotherapy education, particularly in understanding how foundational concepts such as the Q-angle are taught and used.

While these strengths demonstrate the study's methodological reliability and broad applicability, its significance also lies in the impact it may have on

participants' learning outcomes and curriculum improvements, which will be discussed in the following section.

5.8 Study Significance to Study Population

This study is significant as it assesses the level of knowledge and awareness of Q-angle measurement among physiotherapy students, thus highlighting the potential gaps in theoretical understanding and practical application. The identification of areas where knowledge is lacking helps the participants in this research to be self-reflective in improving their understanding and clinical skills related to Q-angle assessment.

The findings provide participants with personalized feedback, including their total scores and correct answers, enabling them to learn from their mistakes and strengthen their foundation in biomechanics and musculoskeletal assessment. This can help the students prepare for clinical practice, where accurate Q-angle evaluation is essential for diagnosing lower limb alignment issues and developing rehabilitation plans.

Moreover, the findings highlight the necessity of bridging the gap between theoretical knowledge and hands-on practice, particularly for senior students who may have clinical posting experience but have limited exposure to specific techniques like Q-angle measurement. This emphasizes the importance of combining practical sessions with advanced diagnostic training in

physiotherapy education to improve the ability and confidence in performing Q-angle assessments.

From a broader perspective, the study also provides evidence-based insights for educators and curriculum developers to enhance the training programs and ensure that future physiotherapists are well-prepared for the effective application of Q-angle assessments in clinical practice.

5.9 Limitations of the Study

In contrast to these significant findings, some study limitations will have to be considered. One main limitation is that while the sample size of 100 students is sufficient to represent the physiotherapy student population in UTAR with foundational biomechanics knowledge (n = 117) and meets the confidence level of 99% as calculated via OpenEpi, it is still relatively small for calculating Cronbach's Alpha reliability. This statistical test typically requires a larger sample size to better capture variability and provide a more accurate assessment of internal consistency (Singh, 2017). This limitation may have contributed to the observed reliability scores, especially considering the questionnaire is newly developed.

The study also used convenience sampling, which selects participants based on their availability rather than random sampling methods. This presents a possible selection bias, limiting the results' applicability to the broader

population of physiotherapy students (Golzar et al., 2022). Efforts were made to achieve balance by recruiting participants across different academic years and batches. Specifically, Year 2 had 25 participants (2 batches), Year 3 had 40 participants (3 batches), and Year 4 had 35 participants (3 batches). Despite these efforts, the unequal distribution of batches between academic years may still influence the findings, and comparisons between groups should be interpreted with caution.

Moreover, the limitation of this study is that it is inability to use Fisher's Exact Test to analyse some categorical data due to computational limitations associated with the large contingency tables created by multiple batches and response options. This limitation requires the use of the Pearson Chi-square test, which may be less precise in cases where expected cell frequencies are low. Although this method is methodologically appropriate for the dataset, it may limit the robustness of the research findings when interpreting associations involving a smaller subset of samples.

Furthermore, the clinical exposure among senior students may not directly correspond to the Q-angle assessment, as the practical opportunities to measure Q-angle during clinical training might be limited or inconsistent. Lack of hands-on practice could have confounded the results, particularly when comparing knowledge and confidence levels across academic years. Therefore, the differences observed between different batches may reflect variations in

teaching methods or curriculum priorities, rather than the actual progress in practical skills, limiting the generalizability of the findings.

Apart from that, there were certain questions, such as Q6 about the position of measurement, Q7 about imaging methods, and Q14 about practical experience, which may be dependent on the academic year and clinical exposure. It is expected that senior students with more clinical training would perform better in these questions as compared to juniors, who might have had limited or no practical experience in Q-angle assessment. Specifically, Q14, which assessed hands-on measurement experience, could be irrelevant to the Year 2 students, as their curriculum may not include practical training at that stage. Similarly, although Q6 and Q7 can be theoretically taught in the early years, they might be easier for students with clinical posting experience to understand. These factors may influence the results and limit the ability to generalize findings across academic years.

The questionnaire used in this study was also limited by the absence of negative wording, which may lead to response bias due to participants selecting answers without critically analysing the content. Including negative worded questions could have enhanced the validity of responses by reducing the possibility of agreement bias.

Additionally, the scope of this research was limited to assessing the knowledge and confidence levels of participants in defining the Q-angle and recognizing its clinical significance. The study did not assess the participants' practical skills in hands-on Q-angle measurement techniques. This absence creates a gap in understanding how theoretical knowledge transfers into clinical practice. Future research should consider integrating assessments of practical competency to provide a more comprehensive evaluation of student learning outcomes related to the Q-angle.

Finally, while the questionnaire underwent content and face validation, its reliability results indicate a potential for improvement. The diversified character of the questions, which were designed to assess multiple aspects of Q-angle knowledge, may have had an impact on item interrelationships. This highlights the need for further refinement and testing to ensure the questionnaire effectively measures the targeted constructs.

5.10 Recommendation for Future Research

To address the limitations identified, several recommendations can be made to enhance future research in this field. First, efforts should be directed toward improving the reliability of the questionnaire. Conducting a pilot study before full-scale implementation would assist in identifying problematic questions and allow for necessary refinements. A pilot study can also determine the feasibility of an approach that will eventually be employed in a larger-scale investigation (Leon et al., 2011). Consulting with subject matter experts during

the questionnaire design process can also ensure that all items are clear and relevant, and effectively measure the desired constructs. Rephrasing or redesigning questions that contribute negatively to internal consistency could significantly improve the reliability of the instrument. Additionally, future studies might use advanced statistical techniques, such as factor analysis, to group related items and establish their validity.

Second, while the sample size in this study was sufficient for its objectives, future research aiming to assess reliability through Cronbach's Alpha should include a bigger and more diverse sample. A bigger sample size would help improve the robustness of the reliability findings and ensure that the statistical results are more generalizable.

Third, future studies should address convenience sampling limitations by using random or stratified sampling methods. These approaches would reduce selection bias and enhance the sample's representativeness. A random or stratified sample would provide a more accurate representation of the complete population of physiotherapy students, hence improving the validity of comparisons across academic years and batches. (Etikan, 2017) For instance, researchers could predefine equal sample sizes across academic years (e.g., 30 participants per academic year) before applying a convenience sampling method. This approach would help balance batch distributions while maintaining practical feasibility for data collection.

Future research should consider modifying the questionnaire to better reflect the academic progression and clinical exposure among participants. Developing batch-specific questions that align with students' expected levels of exposure and training can provide a more accurate evaluation of their understanding and skills related to the Q-angle.

The negatively worded questions also need to be added to the future questionnaire to reduce the response bias and encourage critical thinking when answering the questionnaire. However, researchers should be cautious when introducing such items, as research has shown that negatively worded questions may lead to confusion and inconsistent responses, potentially affecting the reliability of results. It is suggested that these items should be used sparingly and combined with other strategies to address response bias without compromising the data quality. (Roszkowski & Soven, 2010)

In addition to addressing these methodological difficulties, future research may broaden the scope of investigation. For instance, it might be beneficial to explore other dimensions such as practical competency or clinical application of Q-angle concepts. Observational methods or performance-based assessments may provide more insight into how successfully students apply their knowledge in real-world situations.

Finally, intervention-based studies should investigate the impact of focused educational strategies, such as workshops or practical training sessions, on Q-angle knowledge and measurement skills. Evaluating the effectiveness of these interventions might help to shape curriculum design and teaching methods, thereby improving student learning outcomes in physiotherapy education.

Addressing these recommendations will allow future research to expand on the findings of this study, overcoming its limitations and contributing to a more thorough understanding of Q-angle knowledge among physiotherapy students.

5.11 Conclusion

This research emphasizes the importance of the Q-angle in physiotherapy education and practice, as well as its role in understanding lower limb biomechanics and its impact on musculoskeletal health. The results show that students in different academic years at university may have varying levels of knowledge and confidence to Q-angle and identifiable gaps in theory and practice. These gaps underscore the need for focused curriculum improvements to improve the educational experience and professional preparedness of physiotherapy students.

The study was designed to test two main hypotheses. The primary hypothesis proposed that physiotherapy students at Universiti Tunku Abdul Rahman (UTAR) possess varying levels of knowledge about the Q-angle. The secondary hypothesis suggested that students in higher academic years would demonstrate higher levels of knowledge and confidence in understanding and applying the Q-angle compared to students in lower academic years. The findings of this study partially supported these hypotheses. Although higher academic years generally showed greater knowledge and experience, the gaps in practical skills and specific topics, such as imaging techniques and measurement positions, highlighted areas that require further educational reinforcement. These results emphasize the need for a more structured curriculum to address both theoretical knowledge and practical applications.

One of the important messages from this research is the need to emphasise the Q-angle in physiotherapy courses. Educational institutions can ensure that students have a full understanding of the clinical significance of the Q-angle by adding structured and detailed courses. In addition, the study shows that hands-on training is needed to supplement theoretical knowledge since practical measuring skills are very important for transforming classroom learning into efficient clinical interventions.

The research also points out the necessity of developing students' confidence in expressing and applying their knowledge of the Q-angle. Confidently defining and explaining the significance of the Q-angle in musculoskeletal disorders can enable students to make wise clinical decisions and communicate effectively with patients and colleagues. Future courses should include opportunities for students to participate in workshops, practical sessions, and peer discussions to strengthen their understanding and improve confidence levels.

Although this study mainly focused on knowledge and confidence levels, it also highlighted the possibility of future investigation. For example, determining the relationship between theoretical comprehension and practical ability would provide a more comprehensive picture of students' preparation for clinical practice. Furthermore, the findings advocate for stronger sampling procedures and higher sample sizes in future research to improve generalisability and dependability.

In conclusion, this study gives significant insights into the present state of Q-angle instruction in physiotherapy programs, as well as practical curriculum improvement recommendations. By addressing the highlighted gaps, educational institutions may better prepare future physiotherapists with the knowledge, confidence, and practical abilities required to incorporate this key idea into clinical practice. The physiotherapy students who participated in this study will also know their level of knowledge about Q-angle, so they are recommended to study more on this topic from textbooks, clinical experiences, internet resources, journal articles, or discussions with lecturers. Hopefully, the Q-angle concept will be valued by educational institutions and students, so that not only improves individual student outcomes but also helps to progress the field of physiotherapy as a whole, ensuring that practitioners are well-prepared to handle the needs of modern healthcare.

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APPENDICES

APPENDIX A - ETHICAL APPROVAL FORM

UNIVERSITI TUNKU ABDUL RAHMAN
Wholly Owned by UTAR Education Foundation (Company No. 578227-M)

Re: U/SERC/78-363/2024

23 September 2024

Mr Muhammad Noh Zulfikri bin Mohd Jamali
Head, Department of Physiotherapy
M. Kandiah Faculty of Medicine and Health Sciences
Universiti Tunku Abdul Rahman
Jalan Sungai Long
Bandar Sungai Long
43000 Kajang, Selangor

Dear Mr Muhammad Noh,

Ethical Approval For Research Project/Protocol

We refer to your application for ethical approval for your students' research project from Bachelor of Physiotherapy (Honours) programme enrolled in course UMFD3026. We are pleased to inform you that the application has been approved under Expedited Review.

The details of the research projects are as follows:

No	Research Title	Student's Name	Supervisor's Name	Approval Validity
9.	Assessment Of Diagnostic Clinical Reasoning Skills Among Undergraduate Physiotherapy Students	Jason Ho Yi Zeng	Mr Avanianban Chakkarapani	23 September 2024 – 22 September 2025
10.	Awareness, Knowledge, Attitude and Perception of Active Isolated Stretching Among Physiotherapy Academics and Students in a Private University: A Cross Sectional Study	Law Jing Tien		
11.	Knowledge Of Quadriceps Angle (Q-Angle) Among Physiotherapy Students	Tay Yu Xin		
12.	Cortical Excitability and Body Awareness in Individuals with Adolescent Idiopathic Scoliosis: An Exploratory Study	Mark Isaac Fernandez	Dr Deepak Thazhakkattu Vasu	
13.	Exercise Interventions in Primiparous Women for the Prevention and Management of Pelvic Floor Dysfunction: A Systematic Review	Jenny Peng Mei Shi		
14.	Exploring the Novel Sensor System for Detecting Postural Reactions Among Healthy Younger Adults: A Pilot Study	Ooi Xin Rou		
15.	Prevalence of Chronic Fatigue Syndrome (CFS) and Its Association on Quality of Life and Sleep Quality Among Young Adults: A Cross-sectional Study	Delphine Yeo Sze Qi	Mr Sathish Kumar Sadagobane Co-Supervisor: Mr Tarun Amalnerkar	
16.	Association Between Level of Ergonomic Knowledge and Prevalence of Neck Pain Among Part-time Postgraduate Students in Klang Valley	Ng Jia Xuan	Mr Sathish Kumar Sadagobane Co-Supervisor: Mr Edwin Gaspar	
17.	Effectiveness of Kinesiotaping with Static Stretching and Proprioceptive Neuromuscular Facilitation Stretching for Gastrocnemius Tightness Management Among Adults	Tan Jia Yin	Ms Heaw Yu Chi	
18.	Awareness, Knowledge and Perceptions of Chronic Fatigue Syndrome/ Myalgic Encephalomyelitis Between Student and Working Physiotherapists: A	Tee Yee Pei		

The conduct of this research is subject to the following:

(1) The participants' informed consent be obtained prior to the commencement of the research;

(2) Confidentiality of participants' personal data must be maintained; and

(3) Compliance with procedures set out in related policies of UTAR such as the UTAR Research Ethics and Code of Conduct, Code of Practice for Research Involving Humans and other related policies/guidelines.

(4) Written consent be obtained from the institution(s)/company(ies) in which the physical or/and online survey will be carried out, prior to the commencement of the research.

Should the students collect personal data of participants in their studies, please have the participants sign the attached Personal Data Protection Statement for records.

Thank you.

Yours sincerely,

Professor Ts Dr Faidz bin Abd Rahman
Chairman
UTAR Scientific and Ethical Review Committee

c.c Dean, M. Kandiah Faculty of Medicine and Health Sciences
Director, Institute of Postgraduate Studies and Research

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Tel: (603) 9086 0288 **Fax**: (603) 9019 8868
Website: www.utar.edu.my

APPENDIX B - INFORMED CONSENT FORM

Research Participant Information Sheet

Universiti Tunku Abdul Rahman
Faculty of Medicine and Health Sciences
Department of Physiotherapy
Bachelor of Physiotherapy (Honours)

Information Sheet to Participate in the Study
"KNOWLEDGE OF QUADRICEPS ANGLE (Q-ANGLE) AMONG PHYSIOTHERAPY STUDENTS"

Student Investigator: Tay Yu Xin
Department: Department of Physiotherapy
Course Name and Course Code: UMFD3026 Research Project
Year and Semester: Year 3 Semester 1
Research Supervisor: Mr Avanianban Chakkarapani

You are being asked to volunteer for this research study that is being conducted as part of the requirement to complete the above-mentioned course.

Please read this information sheet and contact me to ask any questions that you may have before agreeing to take part in this study.

Purpose of the Research Study
This study aims to determine the knowledge of the Quadriceps angle (Q-angle) among physiotherapy students at Universiti Tunku Abdul Rahman (UTAR). Approximately 100 physiotherapy students will participate in the study.

Procedures
If you agree to be in this study, you will be asked to fill up a questionnaire regarding a Q-angle knowledge level assessment.

Length of Participation
One-time participation only

Risks and Benefits
No risk will be involved throughout the current study.
The benefits of this study include determining the level of knowledge among physiotherapy students at UTAR regarding the concept of the Quadriceps angle. Besides that, this study can increase the knowledge of the Quadriceps angle among physiotherapy students at UTAR.

Confidentiality
No information that will make it possible to identify you, will be included in any reports to the University or in any publications.
Research records will be stored securely, and only approved researchers will have access to the records.

Voluntary Nature of the Study
Participation in this study is voluntary. If you withdraw or decline participation, you will not be penalized or lose benefits or services unrelated to the study. If you decide to participate, you may decline to answer any question and may choose to withdraw at any time.

Contacts and Questions
If you have any questions, clarifications, concerns, or complaints, about the research, the researcher conducting this study can be contacted at 011-21079123, or by email at yxtyx87288@1utar.my.

My Research Supervisor, Mr Avanianban Chakkarapani, can be contacted at 016-3749125, or by email at avanianban@utar.edu.my if there are any inquiries, concerns, or complaints about the research and there is a wish to talk to someone other than individuals on the research team.

Please keep this information sheet for your records.

Research Participant Consent Form

Universiti Tunku Abdul Rahman
Faculty of Medicine and Health Sciences
Department of Physiotherapy
Bachelor of Physiotherapy (Honours)

Consent Form to Participate in the Study
"KNOWLEDGE OF QUADRICEPS ANGLE (Q-ANGLE) AMONG PHYSIOTHERAPY STUDENTS"

Student Investigator: Tay Yu Xin
Department: Department of Physiotherapy
Course Name and Course Code: UMFD3026 Research Project
Year and Semester: Year 3 Semester 1
Research Supervisor: Mr Avanianban Chakkarapani

I have read the provided information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have, have been answered to my satisfaction. I understand that I will be given a copy of this form, and the researcher will keep another copy on file. I consent voluntarily to be a participant in this study.

Name of Participant: _____
IC No: _____ Date: _____

APPENDIX C - PERSONAL DATA PROTECTION NOTICE

PERSONAL DATA PROTECTION NOTICE

Please be informed that in accordance with Personal Data Protection Act 2010 ("PDPA") which came into force on 15 November 2013, Universiti Tunku Abdul Rahman ("UTAR") is hereby bound to make notice and require consent in relation to collection, recording, storage, usage and retention of personal information.

1. Personal data refers to any information which may directly or indirectly identify a person which could include sensitive personal data and expression of opinion. Among others it includes:

   a) Name
   b) Identity card
   c) Place of Birth
   d) Address
   e) Education History
   f) Employment History
   g) Medical History
   h) Blood type
   i) Race
   j) Religion
   k) Photo
   l) Personal Information and Associated Research Data

2. The purposes for which your personal data may be used are inclusive but not limited to:

   a) For assessment of any application to UTAR
   b) For processing any benefits and services
   c) For communication purposes
   d) For advertorial and news
   e) For general administration and record purposes
   f) For enhancing the value of education
   g) For educational and related purposes consequential to UTAR
   h) For replying any responds to complaints and enquiries
   i) For the purpose of our corporate governance
   j) For the purposes of conducting research/ collaboration

3. Your personal data may be transferred and/or disclosed to third party and/or UTAR collaborative partners including but not limited to the respective and appointed outsourcing agents for purpose of fulfilling our obligations to you in respect of the purposes and all such other purposes that are related to the purposes and also in providing integrated services, maintaining and storing records. Your data may be shared when required by laws and when disclosure is necessary to comply with applicable laws.

4. Any personal information retained by UTAR shall be destroyed and/or deleted in accordance with our retention policy applicable for us in the event such information is no longer required.

5. UTAR is committed in ensuring the confidentiality, protection, security and accuracy of your personal information made available to us and it has been our ongoing strict policy to ensure that your personal information is accurate, complete, not misleading and updated. UTAR would also ensure that your personal data shall not be used for political and commercial purposes.

Consent:

6. By submitting or providing your personal data to UTAR, you had consented and agreed for your personal data to be used in accordance to the terms and conditions in the Notice and our relevant policy.

7. If you do not consent or subsequently withdraw your consent to the processing and disclosure of your personal data, UTAR will not be able to fulfill our obligations or to contact you or to assist you in respect of the purposes and/or for any other purposes related to the purpose.

8. You may access and update your personal data by writing to us at_____.

Acknowledgment of Notice

[ ] I have been notified and that I hereby understood, consented and agreed per UTAR above notice.

[ ] I disagree, my personal data will not be processed.

.....
Name:
Date:

APPENDIX D - VALIDATION OF THE QUESTIONNAIRE

SECTION A: EXPERTS PROFILE

Please fill up your information.

1. Name: Siti Hazirah binti Samsuri

2. Years of experience: 10 years

3. Name of working institution: UTAR

4. Experts specialty: MSK/Sports/Women's Health

Will there be scores for the correct/incorrect answer? Won't the result be really biased to the lower semesters (especially Y1) students being less knowledgeable?

Appendix D i: Expert's Profile and Feedback

SECTION A: EXPERTS PROFILE

Please fill up your information.

1. Name: NIZAR ABDUL MAJEED KUTTY

2. Years of experience: 20 years

3. Name of working institution: UTAR

4. Experts specialty: Musculoskeletal Physiotherapy

Suggestion to improve the item listed above.
Please go through the highlighted text and make corrections.

Appendix D ii: Expert's Profile and Feedback

SECTION A: EXPERTS PROFILE

Please fill up your information.

1. Name: Ms Surenthini A/P Tangamani

2. Years of experience: 9 Years

3. Name of working institution: Utar

4. Experts specialty: Musculoskeletal and Cardiopulmonary

Appendix D iii: Expert's Profile with No Feedback

Question	Very Important	Useful but not Important	Not Important
Objective			
Q1	3		
Q2	3		
Q3	3		
Q4	3		
Q5	3		
Q6	2	1	
Q7	2		1
Q8	3		
Q9	3		
Subjective			
Q10	3		
Q11	3		
Q12	1	2	
Q13	2	1	
Q14	3		
Q15	2	1	
Q16	2	1	

Appendix D iv: Experts' Ratings of Questionnaire Items

APPENDIX E – DEMOGRAPHIC DATA

DEMOGRAPHIC DATA

1. What is your name?

   _____

2. What is your age?
   ( ) Under 18 (Not eligible to participate)
   ( ) 18-22
   ( ) 23-27
   ( ) 28-32
   ( ) 33-35
   ( ) Over 35 (Not eligible to participate)

3. Gender.
   ( ) Male
   ( ) Female
   ( ) Other: _____

4. Academic Year. (e.g. Y2S1)

   _____

5. Have you had any prior clinical experience? (e.g. clinical placements, internships)
   ( ) Yes
   ( ) No

APPENDIX F – Q-ANGLE KNOWLEDGE LEVEL ASSESSMENT

Objective Questions (Knowledge Assessment):

1. What is Quadriceps angle, and which anatomical landmarks are used to measure it?
   ( ) Tibial tuberosity to the lateral malleolus.
   ( ) Anterior superior iliac spine to the center of the patella.
   ( ) Ischial tuberosity to the medial malleolus.
   ( ) Posterior superior iliac spine to the medial malleolus.

2. Which conditions or injuries are often associated with an increased Quadriceps angle?
   ( ) Hamstring strains.
   ( ) Patellofemoral pain syndrome.
   ( ) Achilles tendonitis.
   ( ) Plantar fasciitis.

3. How does Quadriceps angle differ in males and females, and what factors contribute to these differences?
   ( ) Males have a larger Quadriceps angle due to wider hips.
   ( ) Females have a larger Quadriceps angle due to wider hips.
   ( ) There is no significant difference in Quadriceps angle between males and females.
   ( ) Quadriceps angle is primarily influenced by body weight.

4. In a clinical context, why is it important to consider the Quadriceps angle in the assessment of knee injuries?
   ( ) Quadriceps angle is only relevant in hip assessments.
   ( ) It helps in determining the severity of ankle sprains.
   ( ) Quadriceps angle influences patellar tracking and joint mechanics.
   ( ) Quadriceps angle has no impact on knee function.

5. What are the potential effects of an abnormal Quadriceps angle on knee joint biomechanics?
   ( ) Increased stability.
   ( ) Enhanced shock absorption.
   ( ) Altered patellar tracking.
   ( ) Improved muscle coordination.

6. During Quadriceps angle measurement, which position of the lower limb is typically recommended?
   ( ) Full extension.
   ( ) Flexion at 90 degrees.
   ( ) Abduction.
   ( ) External rotation.

7. Which imaging method is commonly used to visualize and assess the Q-angle?
   ( ) Magnetic Resonance Imaging (MRI).
   ( ) Computed tomography (CT).
   ( ) Ultrasound.
   ( ) X-ray.

8. How might variations in Q-angle influence the risk of patellar dislocation?
   ( ) Increased risk with decreased Quadriceps angle.
   ( ) Increased risk with increased Quadriceps angle.
   ( ) No association between Quadriceps angle and patellar dislocation.
   ( ) Quadriceps angle does not affect patellar stability.

9. What interventions or exercises are commonly recommended for individuals with an abnormal Quadriceps angle?
   ( ) Quadriceps strengthening exercises.
   ( ) Hamstring stretching only.
   ( ) Avoidance of weight-bearing activities.
   ( ) No specific interventions are necessary.

Subjective Questions (Perception and Self-Assessment):

10. Have you heard about the Quadriceps angle before?
    ( ) Yes
    ( ) No

11. If yes, how would you define the Quadriceps angle in your own words? (If not, please put a -)

    _____

12. How important do you think understanding the Quadriceps angle is in physiotherapy practice?
    ( ) 1- Not important at all
    ( ) 2- Somewhat important
    ( ) 3- Moderately important
    ( ) 4- Very important
    ( ) 5- Extremely important

13. How confident are you in explaining the clinical significance of the Quadriceps angle in relation to musculoskeletal issues?
    ( ) 1- Not confident at all
    ( ) 2- Slightly confident
    ( ) 3- Moderately confident
    ( ) 4- Very confident
    ( ) 5- Extremely confident

14. Have you had practical experience measuring the Quadriceps angle?
    ( ) Yes
    ( ) No
    ( ) Maybe

15. Would you be interested in additional workshops or sessions specifically focused on the Quadriceps angle to enhance your understanding?
    ( ) Yes
    ( ) No
    ( ) Maybe

16. Do you have any comments or suggestions on how the Quadriceps angle should be taught or integrated into your physiotherapy coursework to improve your understanding and application of this concept?

    _____

APPENDIX G - OPEN EPI SAMPLE SIZE CALCULATION

Sample Size for Frequency in a Population

Population size(for finite population correction factor or fpc)(*N*):	117
Hypothesized % frequency of outcome factor in the population (*p*):	50%+/-5
Confidence limits as % of 100(absolute +/- %)(*d*):	5%
Design effect (for cluster surveys-*DEFF*):	1

Sample Size(*n*) for Various Confidence Levels

ConfidenceLevel(%)	Sample Size
95%	90
80%	69
90%	82
97%	94
99%	100
99.9%	106
99.99%	109

Equation

Sample size $n = [DEFF*Np(1-p)]/ [(d^2/Z^2_{1-\alpha/2}*(N-1)+p*(1-p)]$

Results from OpenEpi, Version 3, open source calculator--SSPropor
Print from the browser with ctrl-P
or select text to copy and paste to other programs.

APPENDIX H - TABLE OF POST HOC PAIRWISE COMPARISONS FOR TOTAL SCORE

Group 1	Group 2	Adjusted Sig. (p-value)	Significant
Y2S2	Y2S3	1.000	No
	Y3S1	1.000	No
	Y3S2	1.000	No
	Y3S3	0.697	No
	Y4S1	0.070	No
	Y4S2	0.118	No
	Y4S3	0.004	Yes
Y2S3	Y3S1	1.000	No
	Y3S2	1.000	No
	Y3S3	1.000	No
	Y4S1	1.000	No
	Y4S2	1.000	No
	Y4S3	0.337	No
Y3S1	Y3S2	1.000	No
	Y3S3	1.000	No
	Y4S1	1.000	No
	Y4S2	1.000	No
	Y4S3	0.321	No

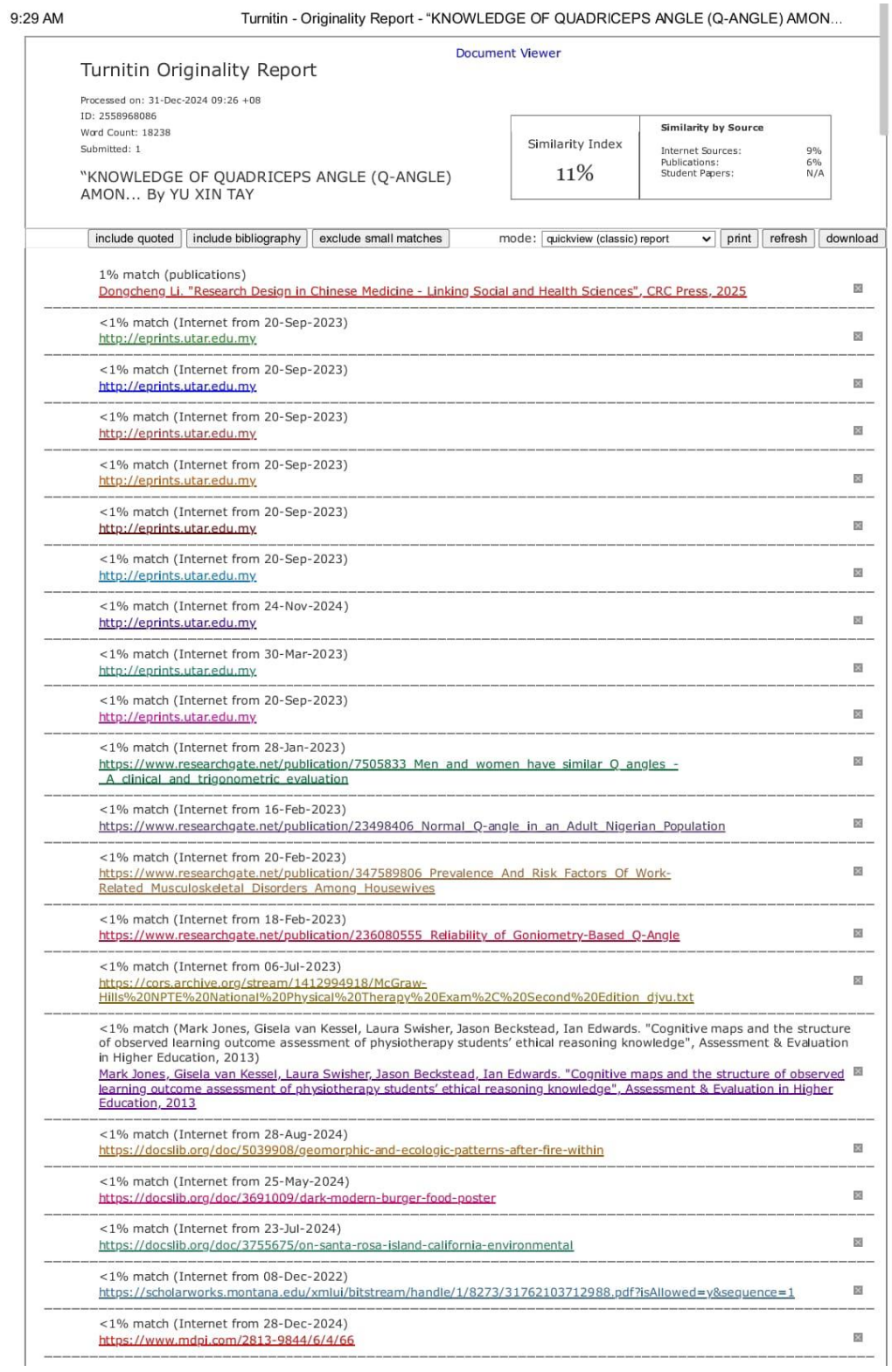
Y3S2	Y3S3	1.000	No
	Y4S1	1.000	No
	Y4S2	1.000	No
	Y4S3	1.000	No
Y3S3	Y4S1	1.000	No
	Y4S2	1.000	No
	Y4S3	1.000	No
Y4S1	Y4S3	1.000	No
Y4S2	Y4S1	1.000	No
	Y4S3	1.000	No

APPENDIX I - TABLE OF POST HOC PAIRWISE COMPARISONS FOR QUESTION 13

Group 1	Group 2	Adjusted Sig. (p-value)	Significant
Y2S2	Y2S3	1.000	No
	Y3S1	1.000	No
	Y3S2	1.000	No
	Y3S3	0.475	No
	Y4S1	0.048	Yes
	Y4S2	0.032	Yes
	Y4S3	0.463	No
Y2S3	Y3S3	1.000	No
	Y4S1	1.000	No
	Y4S2	1.000	No
	Y4S3	1.000	No
Y3S1	Y2S3	1.000	No
	Y3S3	1.000	No
	Y4S1	0.269	No
	Y4S2	0.185	No
	Y4S3	1.000	No
Y3S2	Y2S3	1.000	No

	Y3S1	1.000	No
	Y3S3	1.000	No
	Y4S1	0.653	No
	Y4S2	0.538	No
	Y4S3	1.000	No
Y3S3	Y4S1	1.000	No
	Y4S2	1.000	No
Y4S1	Y4S2	1.000	No
Y4S3	Y3S3	1.000	No
	Y4S1	1.000	No
	Y4S2	1.000	No

APPENDIX J - TURNITIN REPORT



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APPENDIX K - TABLE ON CORRECTION AFTER EXAMINER'S FEEDBACK

Examiner's Feedback	Amendment After Correction	Page & Paragraph
1. The second objective needs to be added to the hypothesis.	Added a null and alternate hypothesis. The results were included in the Conclusion section.	Pg 7 (1.6) Pg 98 (paragraph 2)
2. Mention more about the validity of the questionnaire.	Validity analysis was added to the Data Analysis chapter. The results were also discussed in the Discussion chapter.	Pg 44 (4.3) Pg 74 (5.3.2)
3. Open-ended questions can be analysed qualitatively.	A qualitative analysis of open-ended questions was conducted and included in the Data Analysis and Discussion chapter.	Pg 67 (4.5.4) Pg 86 (5.6.6) Pg 87 (5.6.7)
4. Suggest checking the normality of the data and deciding again on the analysis method.	A normality test was conducted, and the non-parametric analysis method was used. Changes were made in the Data Analysis and Discussion chapters. The Data Analysis Strategies section in the Methodology chapter was also updated.	Pg 35 (paragraph 3 & 4) Pg 50 (4.4.4) Pg 61 (4.5.3) Pg 79 (5.5) Pg 83 (5.6.4) Pg 84 (5.6.5)
5. Do item analysis to calculate the reliability.	Item analysis was conducted and incorporated into the Data Analysis chapter. The results were also discussed in the Discussion chapter.	Pg 45 (4.4.1) Pg 71 (5.3.1)
6. Why did Q6 and Q7 have lower accuracy rates?	Possible explanations for the lower accuracy rates in Q6 and Q7 were added to the Discussion chapter.	Pg 78 (paragraph 3)
7. How to reduce selection bias	Suggestions to reduce bias were added to the	Pg 91 (5.9's paragraph 2)

caused by the convenience sampling method?	Limitation and Recommendation sections in the Discussion chapter.	Pg 95 (paragraph 3)
8. Add study significance before conclusion.	The Study Significance section was added to the Discussion chapter.	Pg 90 (5.8)
9. What if not all senior students had clinical experience in measuring Q-angle, then will have a bias in data analysis?	This concern was addressed in the Limitation and Recommendation sections in the Discussion chapter.	Pg 92 (paragraph 3)
10. Are there any questions in the questionnaire dependent on the academic year?	Addressed in the Limitation and Recommendation sections in the Discussion chapter.	Pg 93 (paragraph 2) Pg 96 (paragraph 1)
11. Are there any negative wording questions in the questionnaire?	Discussed in the Methodology chapter. Additional points were added to the Limitation and Recommendation sections in the Discussion chapter.	Pg 31 (paragraph 2) Pg 93 (paragraph 3) Pg 96 (paragraph 2)

Checked by supervisor,

s/d avani

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Name: Mr. AVANIANBAN CHAKKARAPANI

Date: 31/12/2024

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