"PREVALENCE OF ILIOTIBIAL BAND TIGHTNESS AMONG INCLINE TREADMILL MACHINE USERS AND ELLIPTICAL MACHINE USERS IN GYM POPULATION"

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ABSTRACT

Background: Iliotibial band syndrome (ITBS) has been one of the most commonly observed overuse injuries in Physically active individuals such as gym-goers and runners. Walking/running on incline treadmill was hypothesized to impose higher stress on the lower extremity and iliotibial band. Ellyptical machine trainer was thought to be the low-impact alternate exercise method; however, the ITBS difference between the two types of training has been less studied.

Aims & objectives: *The purpose of the study was to evaluate and compare the prevalence of ITBS in incline treadmill users with in elliptical trainer users at gymnasium settings.*

Methodology: *A comparative cross sectional study design was implemented using 137 physically active gym-goers, who were regular exercisers using treadmill or elliptical trainer was taken. A convenience sampling was done for the selection of subjects from different gymnasiums of Faisalabad. Data was collected through a well structured questionnaire including demographical information, exercise type and frequency, history of pain, and clinical assessment for ITBS (Noble Compression Test and Ober's Test). Prevalence was assessed in both groups and compared.*

Results: *The incidence of ITBS was found to be higher in incline treadmill users compared with elliptical trainer users.*

Conclusion: *The outcome of this study may help physiotherapists and fitness trainers understand risk of ITBS with different cardio machines and for safer exercise recommendations for gym members.*

Keywords: *Iliotibial Band Syndrome, Incline Treadmill, Elliptical Trainer, Gym Users, Overuse Injury, Prevalence*

CHAPTER 1
INTRODUCTION

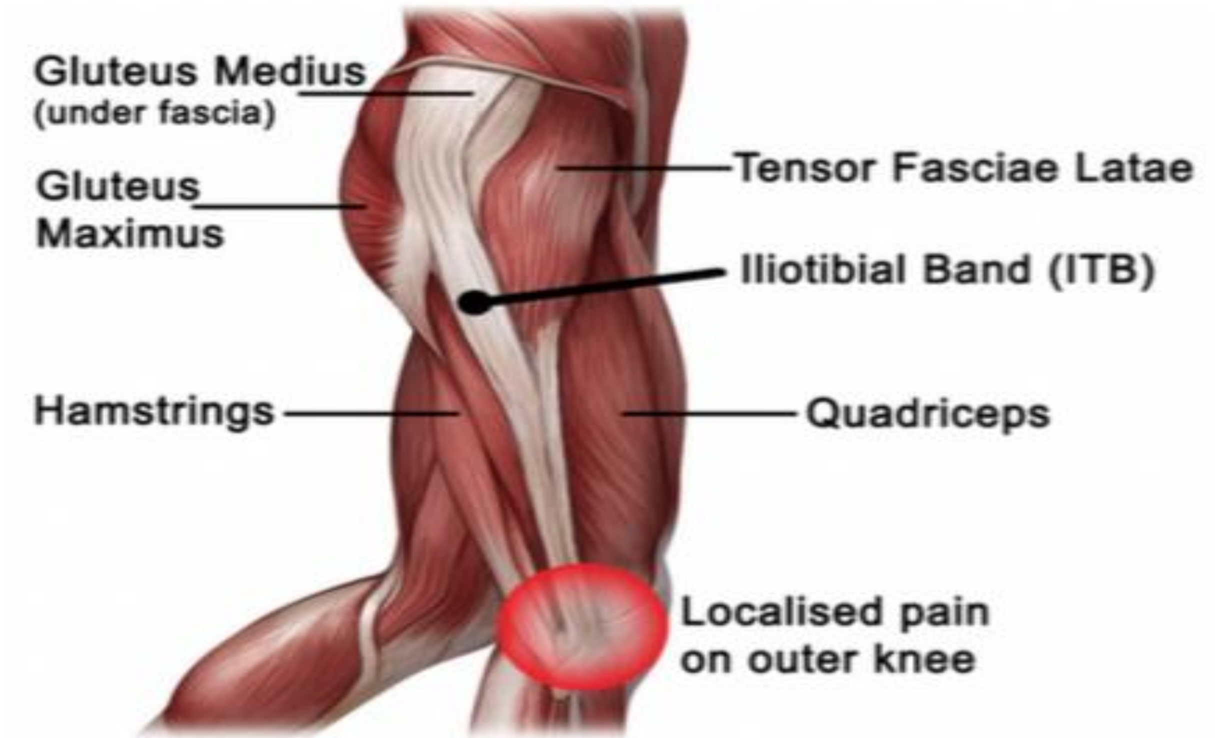
Regular physical activity is encouraged globally as part of a general healthy lifestyle and WHO recommends physical activity as an important component in the prevention of non-communicable diseases and to improve health quality of life. It also mentions that physical activity should incorporate warm up, gradual increase in activity, and strategies to prevent injury. In the context of current fitness culture cardio machine activities such as incline treadmill running/walking and the elliptical are regularly utilized for Cardiorespiratory endurance and for weight loss. The consistent repetitive lower limb activity on a cardio machine without proper conditioning may contribute to overuse injury such as ITB tightness, one of the most common contributors to lateral knee pain and functional deficits. Knowing the affect of cardio machines on the ITB may help provide safer prescribing and prevention of injury in a gym population (Baruah & Vijayakumar, 2020).

The ITB is a tough fibrous band that spans the length of the outside of the thigh from the hip down to the lateral knee and stabilizes the knee and helps with balance during ambulation. As the knee undergoes repeated flexion and extension, the ITB can rub over the lateral epicondyle of the femur, a painful situation known as ITBFS. The symptoms are a common cause of lateral knee pain that can limit function. Most often seen in physically active individuals, ITBFS is prevalent in gym goers partaking in cardio based exercises. Treadmill running and elliptical based cardio involve continuous repetition, making these forms of exercise potential contributors to developing ITBS (Park et al., 2021).

Based on current biomechanical evidence, ITBS has strong ties to repetitive lower-limb loading, increased muscle activation, malalignments in the

knee/lower extremity, and increased strain or compression on the ITB during repeated lower limb cycling. A prevalence study on ITBS has revealed rates as high as 12-16% of all athletes, predominantly affecting endurance athletes. Running on the treadmill and the elliptical are two of the most frequently performed activities in a gym, which both utilize continued stance phase loading and contribute to the demand on hip abductor muscles, both leading to increased compressive force on the lateral knee and repeated knee flexion/extension. However, due to varying factors such as impact force, and mechanics in hip abductor activation, clear understanding of whether ITBS is more prevalent in runners on the elliptical vs the treadmill, warrants investigation comparing the ITBS prevalence of those two exercise populations (Friede et al., 2022).
The ITB is a strong fibrous tissue spanning from the pelvis to the lateral tibia and plays a significant role in overall hip and knee stability during walking, running and other weight bearing activities. Despite its biomechanical role and mechanical importance, the specific mechanical behavior and function of the ITB during dynamic activities are not well understood. Researchers note that fully understanding the normal mechanical behavior of the ITB is critical before delving into the specific causes of iliotibial band syndrome (ITBS) which is a highly common cause of lateral knee pain in the physically active individual. Two muscles, the gluteus maximus and the tensor fascia latae, work in tandem with the ITB. As the leg moves, they transfer forces through the ITB and the stability of both the knee and hip. It is not entirely clear how these muscles interact with the ITB and how their mechanics with the ITB influence its mechanics. As a result, biomechanical and clinical research examining the ITB is needed.

ITBS is a leading cause of overuse injury among runners, with anywhere between 5-14% of running related injuries having it reported. Although several interventions exist for the management of this condition, scientific backing for effective treatment is still somewhat lacking. Recent research points towards excessive abnormal loading or pressure on the ITB during repetitive movements leading to development of this injury. With increasing popularity of treadmills and ellipticals for use in gyms, researchers should explore the link between exercise mode and ITBS prevalence. Both the elliptical and treadmill utilize repeated motion and it is reasonable to suspect that differing mechanics might result in differing ITBS prevalence rates between the two (Hutchinson et al., 2022).



Figure;1.1https://www.physio-pedia.com/Iliotibial_Tract

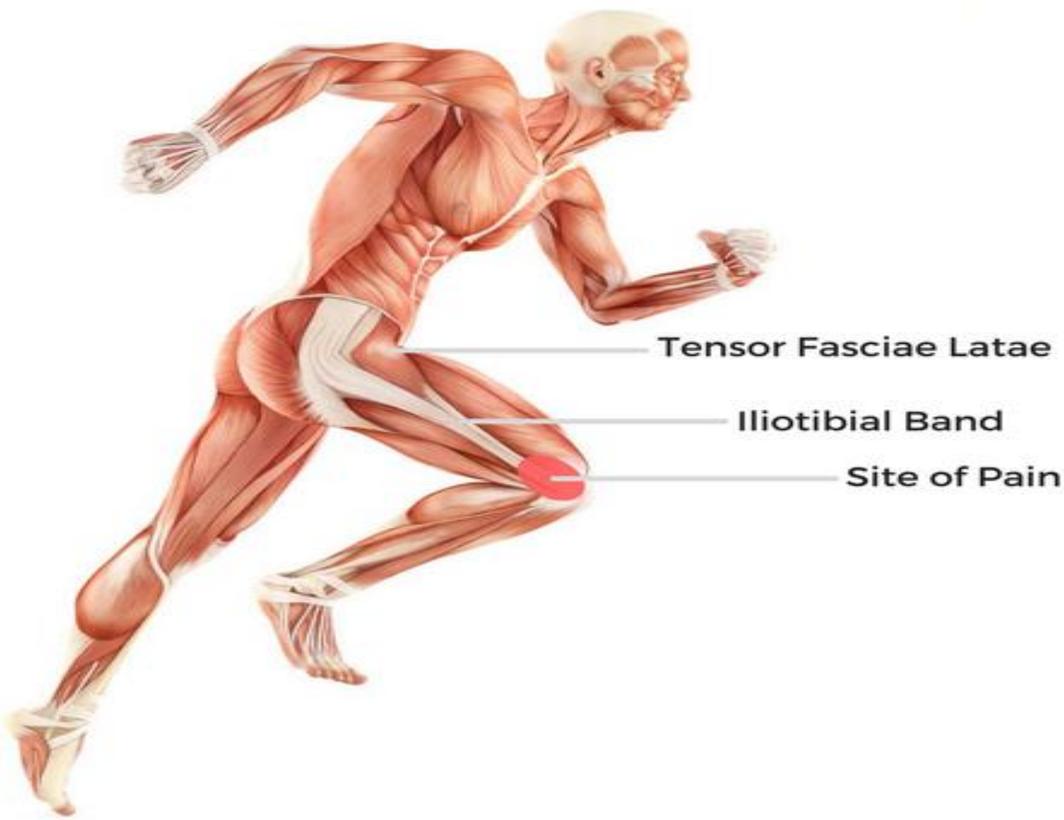
Running related injuries (RRIs) are extremely common among recreational runners, and have been implicated as one of the greatest barriers to physical activity participation. Literature reports incidence rates for RRIs from 37% to 40%, with some suggesting incidence as high as 79% within a 6-month period. Most RRIs are lower limb based, commonly originating at or below the knee, including pain around the patellofemoral joint, achilles tendinopathy, plantar fascitis and ITBS. Biomechanical and musculoskeletal factors including muscle strength, joint range of movement and lower limb alignment, have been widely investigated, however current findings are mixed and lack consistent support. Therefore more targeted research should investigate specific exercise populations to assess the incidence of RRIs and develop efficient and targeted prevention strategies (Peterson et al. 2022).

Recent research has indicated hip strength and lower limb biomechanics are significantly implicated in the development of iliotibial band syndrome (ITBS). ITBS has been indicated as one of the leading causes of lateral knee pain, and occurs twice as often in females compared to males. Studies show that ITBS sufferers exhibit diminished strength of their hip abductors and increased hip movement during running, particularly in females. Such biomechanical variations may cause repetitive increases in load onto the ITB, indicating a better understanding of both lower limb kinematics and muscle strength is needed when looking into the prevalence of ITBS and associated prevention methods within physically active individuals (Foch et al. 2023).

In summary, current evidence strongly supports the indication that iliotibial band syndrome (ITBS) is a common overuse injury primarily among runners, and it is the second most prevalent knee pathology observed in runners. Its prevalence is high, and although the pathology is still not well understood, the initial conception ofsimple mechanical friction between the ITB and the lateral femoral epicondyle seems unlikely now as it has been recently confirmed that there is in fact more of a compression of highly innervated soft tissue under the ITB due to repetition knee flexion, movement mechanics, and loading patterns. Hence ITBS is now viewed as an all-inclusive biomechanical and functional problem rather than just a mechanical friction.

The importance of training progression and loading patterns should be highly emphasized when considering the prevention and risk of ITBS. According to recent evidence, increase in training volume does not pose any more risk of injury than increases in training intensity; rather, load on the lower limb overall is of greater importance. Hip control abnormality, 30-degree range of motion around knee flexion, and hip joint loading are all indicative that injury risk from ITBS, however one of these risk factors is not able to pinpoint the most relevant predictor. Risk factors associated with injury seem to be in a synergistic relationship combining muscle strength, movement quality and repetition mechanical overuse. Therefore more evidence regarding lower limb biomechanics with specific exercise type would provide useful information in the prevention and long-term management of ITBS as the purpose of this study suggests.

For the management of ITBS, conservative rehabilitations with exercise therapy seem to be the most common approach for rehabilitation. Strengthening (particularly hip abductors, gluteus maximus, and tensor fascia lata), stretching, and motor control exercises should be considered effective treatments to help restore normal mechanics of the lower limb. ESWT has also demonstrated promising benefits, although evidence is limited. In addition, while most ITBS sufferers will achieve recovery within a few weeks with proper rehabilitation programs, relapse is still likely when biomechanical errors and poor training practices remain uncorrected. Therefore a better understanding of lower limb biomechanics across different running environments, including the treadmill and elliptical machine, should be emphasized for injury prevention and management of ITBS as highlighted in the purpose of this study (Bonoan et al. 2024).



.Picture Showing Biomechanics of Running to Show It Band Involvement

Although there has been increasing evidence showing the involvement of biomechanical and muscular factors in Iliotibial Band Syndrome development in treadmill runners, most of the studies published so far investigated runners training with one form of exercise only. The trend in increasing the usage of indoor fitness machinery, treadmills and elliptical trainers in particular, for running and cardiovascular training means there has been a wide uptake in their use. Despite the similarity of the exercise machines in performing similar movements there have been varying reports of differences inground reaction forces, joint kinematics and muscle activationsbetween the machines. An elliptical machine is purported to be a low impact version of treadmill running; however, the impact differences on the prevalence of ITBS remain less clear(Seemal et al., 2023)

Furthermore, previous research has predominantly reported causative factors for ITBS in treadmill runners and have yet to compare these risk factors with treadmill non-users performing on elliptical machines under identical exercise conditions. This comparative void leaves ambiguity in relation to which indoor cardio machine is responsible forITBSdevelopment, as well as how thebiomechanicalrisk factors differ in treadmill users versus elliptical users(Peterson et al., 2022).

Therefore, this study was undertaken to compare the incidence of Iliotibial Band Syndrome between treadmill and elliptical users and the biomechanical risk factors associated with ITBS development. It is anticipated that the results from this investigation will contribute towards improving the understanding for physiotherapists, fitness instructors and runners regarding better prevention strategies for this injury(Hani et al., 2024)

Indoor cardio fitness equipment is widely utilized and has increased in popularity over recent years,

primarily due to its convenience, accessibility, and use year-round, as well as being widely recommended for cardiovascular training, rehabilitation and weight loss. While believed to provide safe and controllable environments for exercise, biomechanical evidence suggests that these forms of machine-driven locomotion may alter the way in which lower limb joint kinetics and ground reaction forces occur, which in turn may lead to overuse injuries such as Iliotibial Band Syndrome(ITBS)(Vora et al., 2025).
In comparison to treadmills that simulate running with continuous cyclic loading and impact forces on the lower extremity's lateral knee structures, the elliptical provides a low impact, closed-chain form of movement with less ground reaction forces and alternative kinematics of the knee-hip region. Though the use of the elliptical is promoted as a lower impact version to traditional running, minimal research exists in comparing the elliptical machine to the development and prevention of ITBS, as much of the research is devoted to outdoor running and general running mechanics(Strauss et al., 2011).

1.1 ANATOMICAL STRUCTURE OF JOINT ATTACHMENT

In addition, the increase of gym utilization for young and recreational adults has also contributed to changing ITBS injury patterns from traditional outdoor exercise modes toward indoor environments. In inclined treadmill walking and running, factors such as duration of use, increasing intensity, as well as abnormal technique may predispose individuals to increased repetitive shearing forces between the ITB and lateral epicondyle. Conversely, abnormalities in gait kinematics and muscle activation, and decreased hip stability during elliptical exercise, may cause lateral knee irritation. However, the ITBS injury prevalence between treadmill and elliptical exercises has not been sufficiently researched in literature. (Park et al., 2022) Physiotherapists, fitness trainers, and clinicians should have a clear understanding on the relationship between various exercise modes and the risk of ITBS to allow for development of safety and preventative programs. Knowledge of whether treadmill use is at a greater risk than elliptical use may influence exercise prescription, rehabilitation protocols, and public health recommendations for gym-going populations (Opara & Kozinc, 2023). Hence, the purpose of this study is to examine and compare the prevalence of ITBS in incline treadmill and elliptical use and help filling the current gaps in the literature that would be valuable for injury prevention programs, healthy exercise environments, and evidence-based physiotherapy treatments of indoor cardio workouts (Van der Worp et al., 2012).

1.2 AIMS AND OBJECTIVE

This research will provide comparisons of ITBS occurrence between inclined treadmill runners and users of an elliptical trainer, and will seek to determine the biomechanical risk factors for this injury.

General Objective

To investigate and compare the occurrence of Iliotibial Band Syndrome in individuals using treadmill and elliptical training equipment.

Specific Objectives

1. To determine the prevalence of Iliotibial Band Syndrome among inclined treadmill users.
2. To determine the prevalence of Iliotibial Band Syndrome among elliptical trainer users.
3. To compare the difference in prevalence of ITBS between treadmill and elliptical users.
4. To identify biomechanical risk factors associated with ITBS, including:
   - Hip abductor weakness
   - Foot posture (Navicular position / flat foot)
   - Tibial torsion abnormalities
5. To evaluate the functional limitations experienced by participants with ITBS using the Lower Extremity Functional Scale (LEFS).
6. To analyze the relationship between exercise duration, frequency, and running speed with the occurrence of ITBS.
7. To provide recommendations for injury prevention and safe exercise prescription.

1.3 RESEARCH QUESTION

- What is the prevalence of Iliotibial Band Syndrome among inclined treadmill users?
- What is the prevalence of Iliotibial Band Syndrome among elliptical trainer users?
- Is there a significant difference in the prevalence of ITBS between treadmill and elliptical users?
- What biomechanical risk factors are most strongly associated with ITBS in indoor cardio machine users?
- How does ITBS affect functional activities of individuals using treadmill and elliptical trainers?
- Is there an association between exercise duration, running speed, and weekly training frequency with the development of ITBS?

1.4 HYPOTHESIS

Null Hypothesis (H_0) There is no significant difference in the prevalence of Iliotibial Band Syndrome between inclined treadmill users and elliptical trainer users.

Alternative Hypothesis (H_1) There is a significant difference in the prevalence of Iliotibial Band

Syndrome between inclined treadmill users and elliptical trainer users

1.5 RATIONALE

Iiotibial band syndrome (ITBS) is the most frequent cause of lateral knee pain. Particularly amongst active individuals or individuals that regularly go to the gym. Due to the rising participation of individuals in training, a popular form of aerobic exercise is using a treadmill or an elliptical trainer, these produce significantly varied lower limb biomechanics, potentially stressing the iliotibial band differently. Evidence comparing each modality and their role in the development of ITBS is lacking. However understanding the biomechanical differences is paramount to prevent injury and exercise safely. This study will enable the higher-risk modality to be identified, which in turn may aid physiotherapy and personal trainer protocol in exercise prescription and rehabilitation.

1.6 SIGNIFICANCE OF THE STUDY

This study is significant as it aims to identify whether incline treadmill or elliptical training is associated more strongly with the development of iliotibial band syndrome. This information will add to the body of knowledge concerning biomechanics of the lower limbs and the loading response on the knee joint for various cardio-machines. It will aid physiotherapists, trainers and clinicians in suggesting which forms of cardio would be safer for patients to perform to prevent injury. It may also aid individuals with knee pain in selecting the best form of cardio machine. The information from this study may also be useful in developing an appropriate rehabilitation programme for individuals already experiencing lateral knee pain. Finally, it aims to decrease the amount of ITBS encountered by exercisers within the gym and recreation environment.

CHAPTER 2
LITERATURE REVIEW

In an effort to identify biomechanical factors of ITBS in recreational and regular runners, a systematic review conducted by Aderem and Louw (2015) analyzed studies published up to April 2015. Of the thirteen studies analyzed, twelve cross-sectional and one prospective, subjects aged 16-126 participated. This review demonstrated that females suffering from ITBS experienced an increase in hip adduction and knee internal rotation while the knee was in extension while those that had ITBS experienced more ipsilateral trunk lean as well as altered mechanics in the hip and knee. These findings were found to be directly linked to repetitive running mechanics as the cause of ITBS and is therefore a crucial aspect to examine within the realm of gymnasium training with treadmill users. It further supports the comparison between treadmill and elliptical users due to evidence showing that repetitive cardio exercise is an ITBS risk factor (Aderem & Louw, 2015).

Charles and Rodgers (2020) completed a literature review on the etiologies of Iliotibial Band Syndrome. Many theories such as irritation over the lateral femoral condyle as a result of the it band rubbing and subsequent bursa irritation and fat pad compression were examined. Data was gathered from a plethora of medical databases using key terms related to ITBS, including those with pre- and post- test studies including males and females either at risk or already suffering from the disorder. There were inconclusive findings on how hip or quadriceps weakness/endurance contributed to ITBS and there was only a minimal link found between ITBS and hip kinematics, rear foot mechanics, and knee internal rotation. ITBS was also deemed to be of a multifactorial etiology, with females exhibiting a higher prevalence(Charles & Rodgers, 2020).

Musculoskeletal disorders refer to those involving the nerves, muscles, tendons and supportive tissues. Often they are related to tight muscles, reduced flexibility, and lack of activity. This reduced flexibility can throw the body out of balance, affect the joints and cause pain and dysfunction over time. In a consecutive study done by Mane and Yadav (2020), researchers aimed to evaluate the presence of muscle tightness in individuals aged 20-60 working in seated positions more than seven hours a day. Physical assessments that were conducted included the Ober's test, straight leg raise and sit and reach test which were all conducted to identify the stiffness and flexibility levels of each subject. The results of this study showed that 47% of individuals displayed positive results for the Ober's test and 42% had positive results for the straight leg raise test. In addition, the results displayed that 53% of the study subjects possessed only fair flexibility on the sit and reach test.

Low back pain in runners has limited evidence on prevalence, although it is one of the most commonly performed sports. Nineteen studies were systematically reviewed using PRISMA guidelines in order to assess the prevalence, incidence and risk factors of LBP in runners. They showed low incidence (0.3-22%) and prevalence (0.7-20.2%) for runners compared to other runners in sport and compared to the general population. Identifiable risk factors were longer duration of running (more than 6 years),BMI greater than 24, greater height, limited hip flexion range of motion, leg length discrepancy and a lack of hamstring and back flexibility (Maselli et al., 2020).

Fitness instructors frequently engage in high-intensity physical activity while exercising their bodies and that of their clients, which places them at a higher risk of musculoskeletal injury and pain. A cross-sectional study consisting of 108 gym instructors at multiple fitness clubs examined the prevalence of this issue through a self-administered questionnaire. The results of this study indicated that 16% of instructors suffered injuries, most frequently impacting the shoulder, lower back, and knee while a staggering 82% reported experiencing pain throughout their bodies. This study confirms that instructors working in the fitness industry are at a significantly higher risk for work-related musculoskeletal disorders (Shinde & Sahasrabuddhe, 2021).

Physical instructors may put themselves at greater risk of injury and pain due to the frequent participation in demanding physical exercises while assisting their clients and themselves during training sessions. A cross-sectional study utilizing a self-administered questionnaire surveyed 108 fitness instructors from various gyms across multiple fitness centers and identified a 16% injury rate that was most common in the lower back, shoulder and knee as well as an 82% incidence of pain reporting in the study subjects (Shinde & Sahasrabuddhe, 2021).

This study was conducted to provide a critique of conservative treatments used for Iliotibial Band Syndrome in runners (Friede et al., 2022). ITBS is characterized by tissue irritation occurring due to biomechanical and anatomical limitations of increased tension in the IT band. Clinicians use multiple methods of treatment for this disorder that include hip abductor exercises, flexibility exercises, soft tissue techniques, and running re-training. However, ITBS clinicians did not support the hip abductor strengthening because it may not adequately fix poor running form and might even increase the force on the IT band, stretching only provided short-term improvements, and there is not adequate research supporting running retraining(Friede et al., 2022).

Musculoskeletal injuries may arise from the frequent performance of high-intensity physical tasks as encountered by fitness instructors when performing their own workouts and that of clients, so a study was performed on 108 fitness instructors from multiple locations to assess prevalence through a self-administered questionnaire. Results indicated that 16% of the subjects suffered injuries that were most commonly attributed to the shoulder, lower back, and knee while 82% reported pain throughout their bodies (Shinde & Sahasrabuddhe, 2021).

Resistance training is a widespread method for individuals in a variety of populations to improve their physical fitness and general well-being. An integrative review was performed that aimed to identify the correlation between exercise selection and musculoskeletal injury development within fitness center participants through a PRISMA-based systemic review of 39 peer-reviewed articles. Injuries were predominantly seen in the shoulders, spine, elbows and knees. Muscle imbalance from overuse, inadequate recovery, underdeveloped muscles used in targeted exercise, repetition of heavy weight lifting, poor technique and substance misuse were identified as key contributors to injury development (Bonilla et al., 2022).

This study, performed by Park J.J et al., 2022, aimed to determine the effect of repeated foam rolling on the rehabilitation of and exercise performance in athletes with Iliotibial Band Friction Syndrome (ITBFS), an overuse injury of the lateral knee and a frequently reported condition among runners (12%) and cyclists (15-24%) who exhibit overuse of their knee joints with repeated motion. Conventional non-invasive methods for treating ITBFS, such as stretching, massage, and foam rolling, have been used to decrease pain and increase flexibility; however, the results of many of these studies are inconsistent, and often limited due to the design and participant recruitment involved. For these reasons, recent studies suggest that to decrease ITBFS induced athletic recovery and improve performance, the most beneficial technique is to optimise foam rolling programs.

Arif et al. (2022) investigated the prevalence of ITB tightness in office workers by using the Ober's test. Three hundred eighty-three male and female office workers in Gujranwala, Pakistan, ranging from 20-60 years, were examined and measured using the Ober's test, with demographics, and occupational histories documented. 45.69% of office workers showed ITB tightness and a majority of males, who had been engaged in long periods of sedentary office work, presented this condition ($p<0.05$). Individuals with previous fractures in their lower limb, any diagnosed deformities of the lower limb or athletic individuals were excluded. The study supported prior research by Mane et al., and Ankita et al., who reported that up to 47% and 45% of the individuals participating in their studies experienced ITB tightness as a result of prolonged periods of sitting.

This systematic review and meta-analysis of lower-extremity kinematics and hip abductor strength in runners with Iliotibial Band Syndrome was conducted by Foch, Brindle and Pohl, (2023). It included 17 articles that compared individuals with current, previous or future risk of ITBS with a control group. Female runners with a current ITBS injury had less peak hip internal rotation angles and a lower hip abductor strength. Studies suggest that the risks factors associated with the cause of ITBS differ by gender and the state of the injury, female runners are approximately twice as likely as males to experience an ITBS injury. Hip motion and hip abductor strength are proposed as potential mechanisms behind the development of ITBS (Foch et al., 2023).

This study, performed by de Souza Jnior et al. (2023), aimed to determine whether ground reaction force variables are associated with iliotibial band syndrome (ITBS) in runners. 30 healthy runners were compared to 30 runners with ITBS through an instrumented treadmill analysis that analyzed their ground reaction forces (GRFs). The study concluded that interaction variables between posterior GRF impulse, anterior GRF impulse, anterior GRF peak, and vertical stiffness are related to ITBS and that the developed statistical model correctly classified 83.3% of runners, predicting presence and absence of ITBS with moderate accuracy. However, loading rates alone are not predictors of injury risk in this case and may only become relevant when other measures such as strength, kinematics, and training history are taken into account, showing that when assessing risk factors for repetitive running based activities like ITBS development, an overall approach encompassing a range of Biomechanical variables is necessary. This provides valuable evidence to the significance of using biomechanics as a measurement tool for individuals training on treadmills and ellipticals (de Souza Jnior et al., 2023).

This study critically reviewed the use of iliotibial band (ITB) stretching and release techniques in Iliotibial Band Syndrome (ITBS), a common overuse injury that causes pain in the outer knee in runners and other athletes. The review analyzed the extent to which ITB stretching and release could help manage ITBS which has a prevalence of 1.6%-14% among runners and significantly affects the quality of life. Conservative treatments like rest, stretching, strengthening, and foam rolling are common treatments, however there is not a clearly outlined one. The review concluded that stretching helps for very short term pain relief and foam rolling provides more pain relief but not long term and although both can aid in earlier stages of rehabilitation, stronger evidence is still needed.

The most recent study examined running speed and fatigue's effect on ITB strain and strain rate in runners. They found that a quicker speed and fatigue lead to higher rates of ITB strain, which is believed to be related to the onset of ITBS. Running at a normal speed following a 30 minute exhausting run still increased the rate of ITB strain. It was shown that increasing speed abruptly lead to an about 10% increase in strain rate indicating risk with rapid training increase. Conclusion states that fatigue and rapid speed may increase the risk of ITBS; normal speed at a non-exhausted state may lead to no increase in risk.(Chen et al., 2023)

While the majority of health benefits from physical exercise are undeniable, the increasing rate of overuse injuries has become a concern among gym-goers. A large, cross-sectional study was conducted on 1012 gym-goers in Saudi Arabia and found that most injuries were to the shoulder, knee, and lower back. Bodybuilding and running are also listed as activities where gym-goers experienced injuries. Muscle strains and spasms were reported to be the most frequent injuries. Longer duration gym-goers also had higher reported levels of pain, lower levels of performance and fewer participants continued training. When the gym session was over two hours in duration participants reported a higher prevalence of muscle tears and joint instability, whereas moderately long gym sessions resulted in tendinopathy. This study demonstrates that training duration, activity performed, and the nature of repetitive motion influences the risk of injury. Recommendations for Screening, Injury Prevention and supervision were given for fitness centers. (Hetaimish et al., 2024)

Recent evidence indicates that the rate of musculoskeletal injury is on the rise among gym-goers. In a large cross-sectional study with 1123 male and female gym members, aged 18 to 50 years old, a high prevalence of injuries was recorded in those attending the gym in Bangladesh. The lower back was most commonly affected with 36.6% of injuries being to this region, followed by the shoulder (24.7%) and knee (17.1%). Males were found to be more prone to injury, as were gym-goers seeking weight loss or general fitness. Strength training activity was associated with a significantly higher risk of injury (almost 4x higher compared to non-strength training) and other associated risk factors included improper technique, lifting weights that were too heavy for the individual, lack of workout knowledge and lack of trainer guidance (Islam et al., 2024)

The iliotibial band (ITB) or Maissiat's band is a thick and firm fascia, extending from the iliac crest to the lateral portion of the proximal tibia; the ITB plays a role in holding the body in an upright position as well as the overall stabilization of the lower limb. Proper mobility is one aspect of musculoskeletal health. Tightness or limited range of motion could be a cause for several orthopedic ailments. In a cross-sectional study of 266 university students aged 20-27 years, the association between sitting cross-legged for prolonged periods of time (1-5 hrs a day) and ITB tightness was examined. Results were found where a high variety in the number of hours spent sitting cross-legged daily; however, no significant association was detected between the number of hours spent in the position and a positive Ober's test result (p=0.077). The study determined that sitting cross-legged does not solely impact the tightness of the iliotibial band in university students (Hani et al., 2024).

Work-related musculoskeletal disorders are a common occurrence as repetitive physical exertion, strenuous activity, abnormal posture, and repetitive overhead lifting are all characteristic of a gym setting. Of the 76 gym trainers complaining of musculoskeletal pain, the Nordic Musculoskeletal Questionnaire found that 34% had musculoskeletal disorders in the last 12 months. 25% reported experiencing pain in their shoulders followed by their lower backs (20%). Other areas of reported pain included the wrist and upper back (12%), and the ankle (9%). In lesser numbers of participants was pain reported in their hip (8%), neck (6%), knee (5%), and elbow (3%). The gym trainers experienced both pain and a reduction in function when it came to their daily work(Shinde, 2025).

Overuse of the legs as a result of repetitive lower extremity exercise like treadmilling or elliptical use leads to Iliotibial Band Syndrome (ITBS), which is highly prevalent in gym users. Differences in mechanics and loading from the way one exercises may lead to differences in the progression and development of pain associated with ITBS that could compromise one's training regimen as well as activities of daily living. This study compares the incidence of ITBS between two separate forms of exercise. A cross-sectional study comparing incidence of ITBS in treadmilling individuals and elliptical individuals. Informed consent was given, demographic information collected via a questionnaire, Renne's test used to determine ITB tightness, and Numeric Pain Rating Scale (NPRS) used to measure the degree of pain. This information was analyzed on SPSS and difference in incidence found between both exercise types. This study is expected to prove how the mode of exercise can impact ITBS and support healthier training guidelines and preventative practices(Amjad et al., 2025).

In a recent case report, a non-athletic 42-year-old female presented with chronic lateral hip and thigh pain that was a rare presentation of proximal iliotibial band syndrome (ITBS). The condition was diagnosed as proximal ITB inflammation along with greater trochanteric bursitis on imaging such as ultrasound and MRI. The patient did not find much pain relief with conservative measures, and ultimately had resolution of pain at the three month mark after receiving an ultrasound-guided steroid injection. The report concluded that proximal ITBS can be seen in non-athletes and is usually a misdiagnosis; with prompt imaging and interventional management, symptoms are quickly managed and prolonged symptoms may be avoided(Megha Bhargava et al., 2026).

CHAPTER 3
METHODOLOGY

3.1 Study Type / Study Design

Design of study: this was a 'cross sectional study' which was to asses the iliotibial band tightness in the incline treadmill and elliptical machine user in gym going population which showed the relationship of it with biomechanics factors.

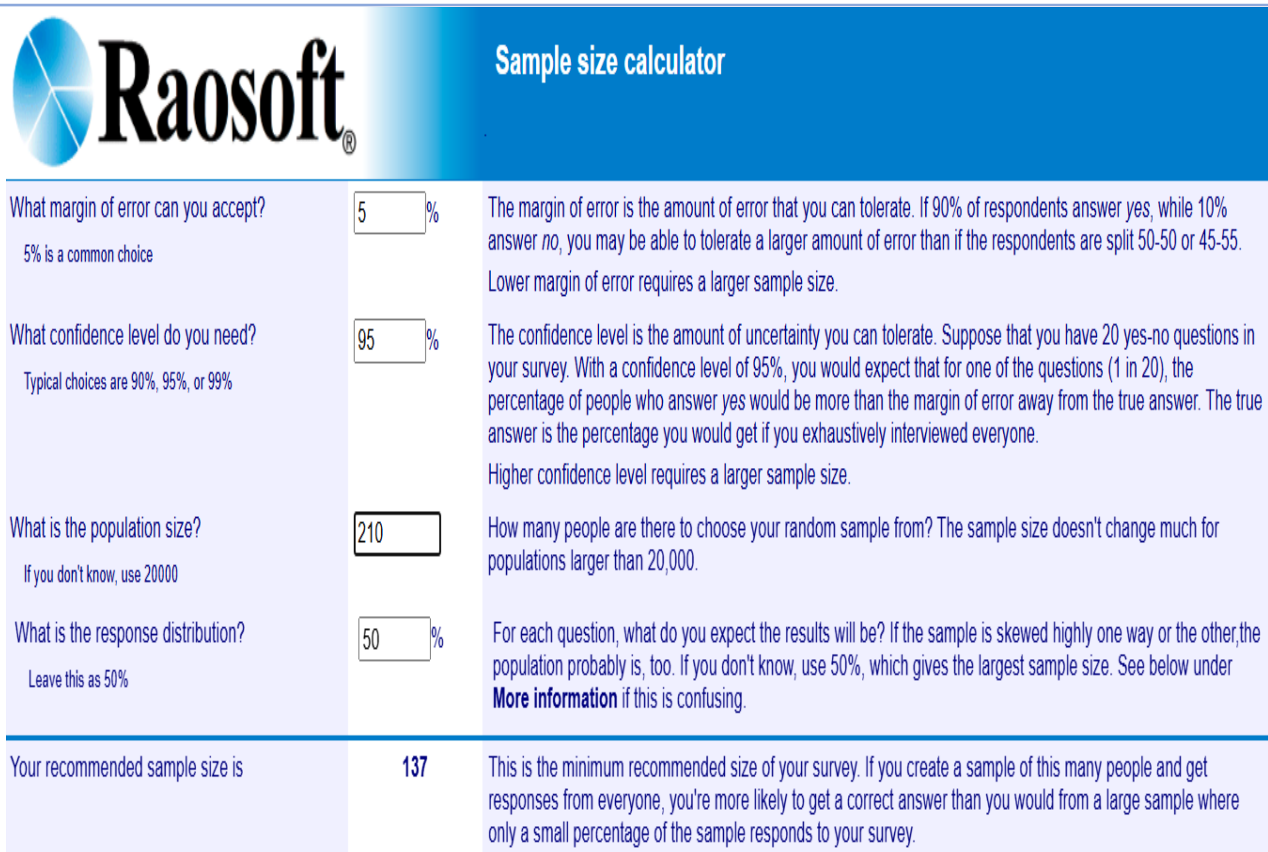
3.2 Study setting

The setting of this study include different gyms of Faisalabad which perform cardio program. The specific study include these settings

- Super Gold Gym,
- Nexus Gym,
- Edge Fitness,
- Model Town Gym,
- Lion Gold Gym,
- World Gym&Fitness
- Olympia Gym,
- Shehzad Gold Gym,
- Al Zahid Fitness Club,
- Royal Ladies Club, Faisalabad.

3.3 Sample Size

Sample size will be 137 calculated from Raosoft.(Baruah & Vijayakumar, 2020)


Raosoft®
Sample size calculator

What margin of error can you accept?
5% is a common choice
5 %
The margin of error is the amount of error that you can tolerate. If 90% of respondents answer *yes*, while 10% answer *no*, you may be able to tolerate a larger amount of error than if the respondents are split 50-50 or 45-55.
Lower margin of error requires a larger sample size.

What confidence level do you need?
Typical choices are 90%, 95%, or 99%
95 %
The confidence level is the amount of uncertainty you can tolerate. Suppose that you have 20 yes-no questions in your survey. With a confidence level of 95%, you would expect that for one of the questions (1 in 20), the percentage of people who answer *yes* would be more than the margin of error away from the true answer. The true answer is the percentage you would get if you exhaustively interviewed everyone.
Higher confidence level requires a larger sample size.

What is the population size?
If you don't know, use 20000
210
How many people are there to choose your random sample from? The sample size doesn't change much for populations larger than 20,000.

What is the response distribution?
Leave this as 50%
50 %
For each question, what do you expect the results will be? If the sample is skewed highly one way or the other,the population probably is, too. If you don't know, use 50%, which gives the largest sample size. See below under **More information** if this is confusing.

Your recommended sample size is
137
This is the minimum recommended size of your survey. If you create a sample of this many people and get responses from everyone, you're more likely to get a correct answer than you would from a large sample where only a small percentage of the sample responds to your survey.

3
.4 Target Population
Targeted Population

The selected population for this study was the groups who have routine physical activity participation at a health club or a gym. These were persons with about 18 to 45 years old that participate in body building, weights training, running and/or treadmill or any type of fitness workout at the gym. For the overuse injury studies or biomechanical risk studies, the population were male and female that are consistent at exercising routine, attending the gym several times a week. Some of studies also include patients that have any type of chronic pain or sports injuries history of musculoskeletal pain depending on the studies they used as inclusion criteria. This population was selected because they were chosen to determine if there are some common risks factors and trends in musculoskeletal injuries that are sport specific related to gym and/or running activity, as a result of cumulative loading, training with high intensity and training with long sessions in that particular population which are predisposed to overuse injuries.

3.5 Study Duration
The research period will be 4 months after approval of synopsis.

Gantt Chart

Activity				
Months	1st	2nd	3rd	4th
Approval of synopsis	■			
Data collection	■	■		
Thesis presentation and submission			■	■

3.6 Parameters of the Study

The selected population for this study was the groups who have routine physical activity participation at a health club or a gym. These were persons with about 18 to 45 years old that participate in body building, weights training, running and/or treadmill or any type of fitness workout at the gym. For the overuse injury studies or biomechanical risk studies, the population were male and female that are consistent at exercising routine, attending the gym several times a week. Some of studies also include patients that have any type of chronic pain or sports injuries history of musculoskeletal pain depending on the studies they used as inclusion criteria. This population was selected because they were chosen to determine if there are some common risks factors and trends in musculoskeletal injuries that are sport specific related togym and/or running activity, as a result of cumulative loading, training with high intensity and training with long sessions in that particular population which are predisposed to overuse injuries.

3.7 Sampling technique

3.8 Screening of the Study Population

The selected inclusion and exclusion criteria will screen the study population.

3.8.1 Inclusion Criteria

- Participants aged **18–35 years** who regularly perform cardio exercise will be included.(Hani et al., 2024)
- Both **male and female gym users** will be eligible to participate.(Humayun et al., 2023)
- Individuals must be using **treadmill or elliptical trainer at least 3 times per week** for the past **3 months**(Marais et al., 2024).
- Participants should be **physically active and able to perform exercise independently**.(Park et al., 2021)
- Individuals with or without lateral knee pain suggestive of IT band syndrome(Deshmukh et al., 2020).

3.8.2 Exclusion Criteria

- History of lower limb fractures or major knee surgery.
- Diagnosed systemic conditions (e.g., diabetes, arthritis).
- Acute or severe knee pain limiting performance.

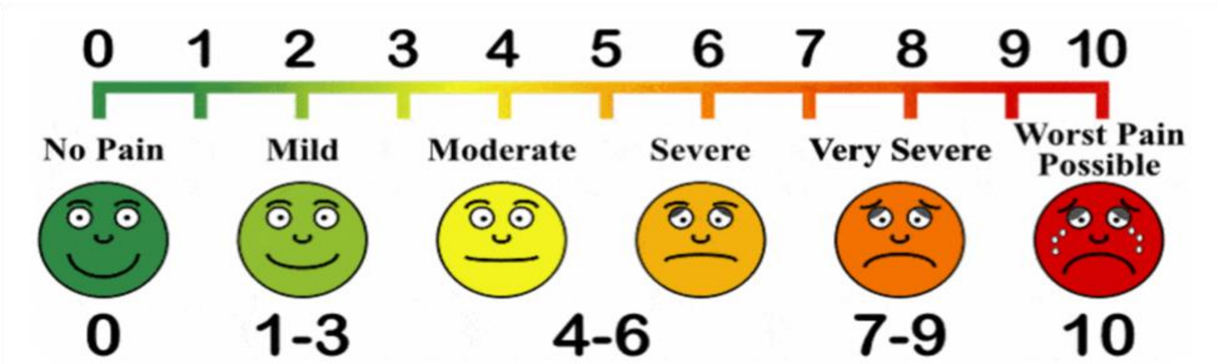
- Neurological disorders affecting lower limb function.
- Leg length discrepancies or congenital deformities.

3.9 Data collection tool

Data will be collected by using

- Consent form
- Screening form
- Demographics pattern
- Visual Analog Scale(VAS)
- LEFS questionnaire
- Clinical assessment tools including Ober's Test and palpation will be used to identify iliotibial band tightness.

Visual Analog Scale



1. Ober's Test

The Iliotibial Band and Tensor Fascia Lata can be evaluated for their degree of tightness with the Ober's Test, which is the main clinical test. The patient is side-lying with the examiner flexing, abducting, and then dropping the patient's leg into adduction. A positive test is recorded if the leg drops slowly toward the examination table, signifying ITB tightness. This is used because it is easy to perform and is effective in testing ITB flexibility.

2. Modified Ober's Test

A modification of the Ober's Test where the knee is in an extended position. With the knee in an extended position there is less pressure through the patellofemoral joint, and ITB tension is better isolated.

A positive result is either hip adduction is restricted, or pain on lowering of the leg. Modified Ober's test provides better reliability and is preferred in research studies in order to get a better reading of ITB tightness.

3. Noble's Compression Test

The Test of Noble is often utilized as a diagnostic tool to rule in or rule out irritation or friction at the lateral femoral epicondyle. To perform the test, the examiner compresses the ITB over the lateral epicondyle while the knee is in a flexed position and asks the patient to extend the knee. Pain felt around 30 of knee flexion constitutes a positive test and the doctor is then able to rule in the test of Noble.

4. Renne's Test

This is a functional screening test, which is conducted by the patient performing a partial squat whilst the examiner palpates the lateral femoral epicondyle. If pain can be elicited during weight bearing, around 30 of knee flexion this suggests ITB irritation. This test is particularly useful for gym goers and athletes who have to squat repeatedly.

3.10 Data Collection Procedure

Data were collected after we had ethical approval from ethics board, and permission from the selected fitness centers. All potential respondents were selected based on inclusion and exclusion criteria, and we obtained the consent to participate in this study. Structured self-administered questionnaire (Google Form/printed) were designed for data collection (e.g., demographic, training, and injury data). The questionnaire link was distributed on the social media network and in the fitness community, with clear instructions to ensure all respondents to fill up correctly. The data were then kept secret, reviewed for completeness of data, and all completed forms were recorded; and all the data was coded and transferred into a statistical package.

3.11 Data Management:

Data was collected for this study in an organized and systematic way to assure accuracy of data and suitable statistical analysis. Data was from a representative sample group taken from a target population (gym-goers/treadmill users/physically active persons) with certain selection criteria applied and others that excluded participants. Any response that met the selection criteria after a data screen, was used for analysis; responses with no data (blank entries) or duplicated responses were removed.

All collected data in response to the questionnaire was converted into numerical format, and entered into a database (e.g. SPSS or comparable statistical package for data analysis). The codes for each variable (demographics, training characteristics, injury-related outcomes) were designed to enable efficient entry and decrease the probability of typing mistakes

3.12 Ethical Consideration

This research study was conducted following the ethical guidelines that govern research involving human participants. Ethical clearance was obtained from the Institutional Review Board before data was collected and permission was gained from the chosen fitness centers from which to recruit participants.

Participants were thoroughly informed about the aim of the study, the procedures that were involved, the possible benefits and risks, and were required to give informed consent (either electronic or written) to participate in the study. Participation was optional, participants were informed that they could withdraw at any stage without consequences to their training or gym membership.

Data collected was stored securely and anonymously and access restricted to the researcher. All data collected was not identifiable to participants.

CHAPTER 4
RESULTS AND DATA ANALYSIS

The following chapter presents the results and statistical analysis from the data gathered. This chapter intends to outline the profiles of the participants, compare the results between the two specified groups and explain the results regarding the purposes of the study. Functional assessment of lower extremity function, pain, and performance during clinical tests in gym-goers while using varied types of cardiovascular exercise machines was observed. Information collected from validated questionnaires, functional outcome measures, and physical assessment were then organized and presented with tables, figures and descriptions.

4.1 Overview of Study Participants

A total of 137 gym users who exercise regularly, were selected from 10 chosen fitness centers in Faisalabad, Pakistan. There was the involvement of multiple fitness centers in the study in order to have diverse participant groups and enhance generalizability of the findings. All 137 participants were found suitable for inclusion based on predefined inclusion and exclusion criteria and careful evaluation of all the screening forms completed by subjects for completeness and authenticity. There were no drop outs from the subjects through the entire period of study making it 100% response rate which gives confidence on the data collected and removes risk of bias.

The sample subjects were divided into 2 groups based on the cardio workout modality primarily used by them in order to compare effects of each. Group A and Group B consisted of 68 and 69 subjects respectively who primarily use treadmill machines incline on cardio machines or elliptical trainer respectively. The division of subjects was based on habitual exercise pattern rather than random allocation of subjects into different groups.

The cardio workout exercise was being performed consistently by all the subjects for a minimum duration of three months. Eligibility criteria were participation in at least three cardio workout sessions per week and that each session lasts at least twenty minutes for participants to have significant exercise stimulus for analysis of outcomes and musculoskeletal effects between the two groups.

Instruments used for measurement included The Lower Extremity Functional Scale (LEFS) for the functional status of lower extremity; the Visual Analog Scale (VAS) for intensity of pain; orthopedic special tests for musculoskeletal analysis including Ober's test, modified Ober's test, Noble Compression Test, and Renne's Test for biomechanical stress and clinical assessment.

Figure 4.1 is showing the flow and allotment process of subjects.

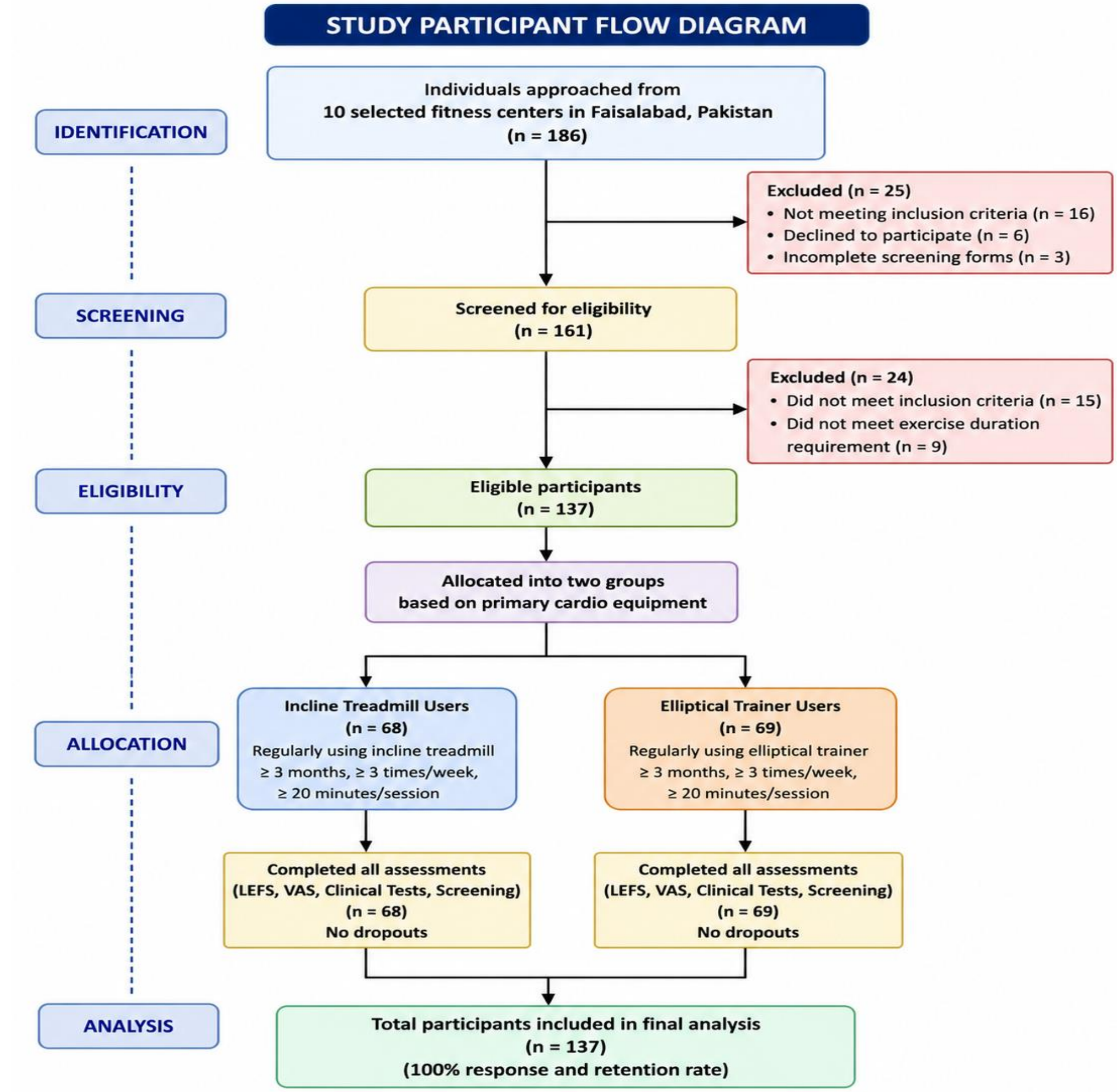


Figure 4.1: Study Participant Flow Diagram

Figure 4.1: Study Participant Flow Diagram

4.2 Demographic Characteristics of Participants

An assessment of the baseline comparability between the two study groups was conducted through an examination of the demographic characteristics of the study subjects. Similarity of demographics between the study groups is an important requirement for research involving two comparative groups. It ensures that any variance in outcomes is due to the independent variable, and not due to some underlying disparity between the individuals in each study group. Descriptive statistics was performed for all continuous variables, including age, body mass index (BMI), and length of time engaged in exercise, and results were presented as mean and standard deviation. Categorical variables such as sex distribution and

BMI classification levels were presented as frequencies and percentages. Independent sample t-tests and Chi-square tests were used to determine differences between treadmill and elliptical groups respectively for the continuous and categorical variables, at a significance level of $p < 0.05$. All results are presented in Table 4.1.

Table 4.1: Demographic Characteristics of Participants (n = 137)

Variable	Treadmill Users (n = 68)	Elliptical Users (n = 69)	p-value
Age (Mean ± SD)	26.4 ± 4.8 years	25.9 ± 5.1 years	0.563
Gender – Male n (%)	42 (61.8%)	38 (55.1%)	0.425
Gender – Female n (%)	26 (38.2%)	31 (44.9%)	0.425
BMI (Mean ± SD)	24.1 ± 2.7 kg/m^2	23.8 ± 2.5 kg/m^2	0.497
BMI 18.5–24.9 (Normal) n (%)	40 (58.8%)	42 (60.9%)	0.798
BMI 25.0–29.9 (Overweight) n (%)	28 (41.2%)	27 (39.1%)	0.798
Exercise duration (months)	8.6 ± 3.9	8.1 ± 4.2	0.481

Note: $p < 0.05$ was considered statistically significant.

As evident from Table 4.1, there were no significant differences between the two groups in age (p=0.563), sex (p=0.425), BMI (p=0.497) and length of time exercising (p=0.481). The mean age of treadmills users was 26.4±4.8years and ellipticals users 25.9±5.1years, sex proportion 61.8% Male (treadmill users) and 55.1% Male (ellipticals users). Mean BMI was 24.1±2.7 kg/m 2 (treadmills users) and 23.8±2.5 kg/m 2 (ellipticals users).

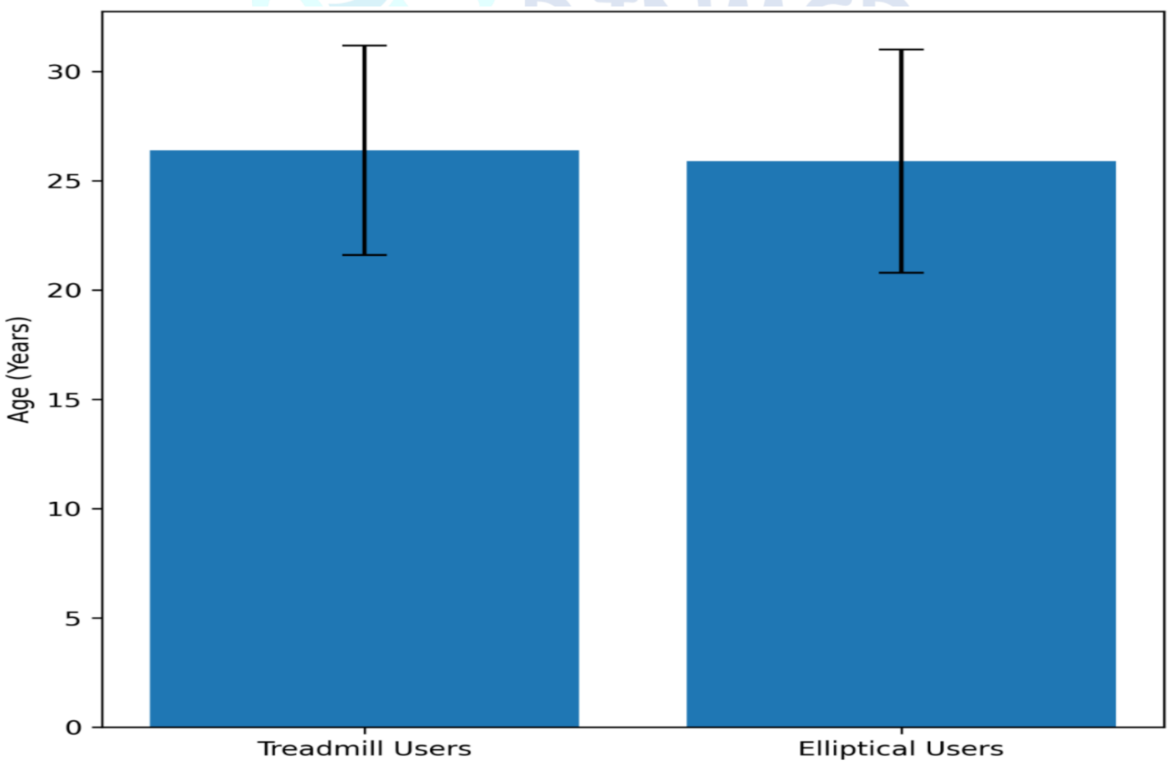


Figure 4.2: Age comparison (bar chart)

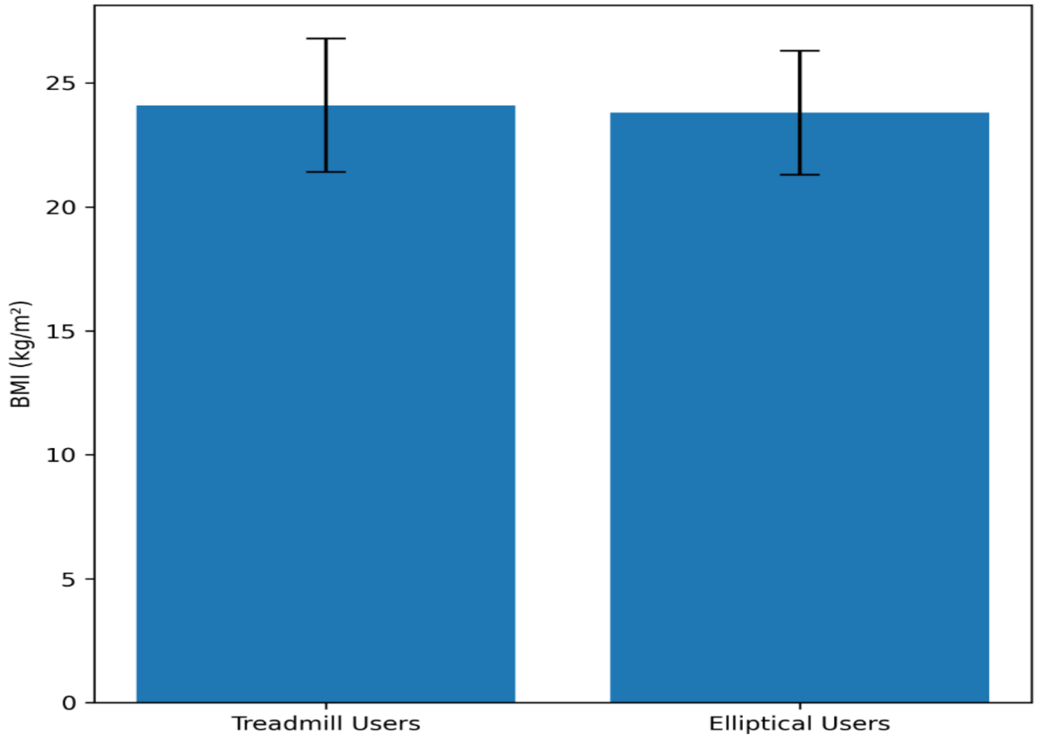


Figure 4.3: BMI comparison (bar chart)

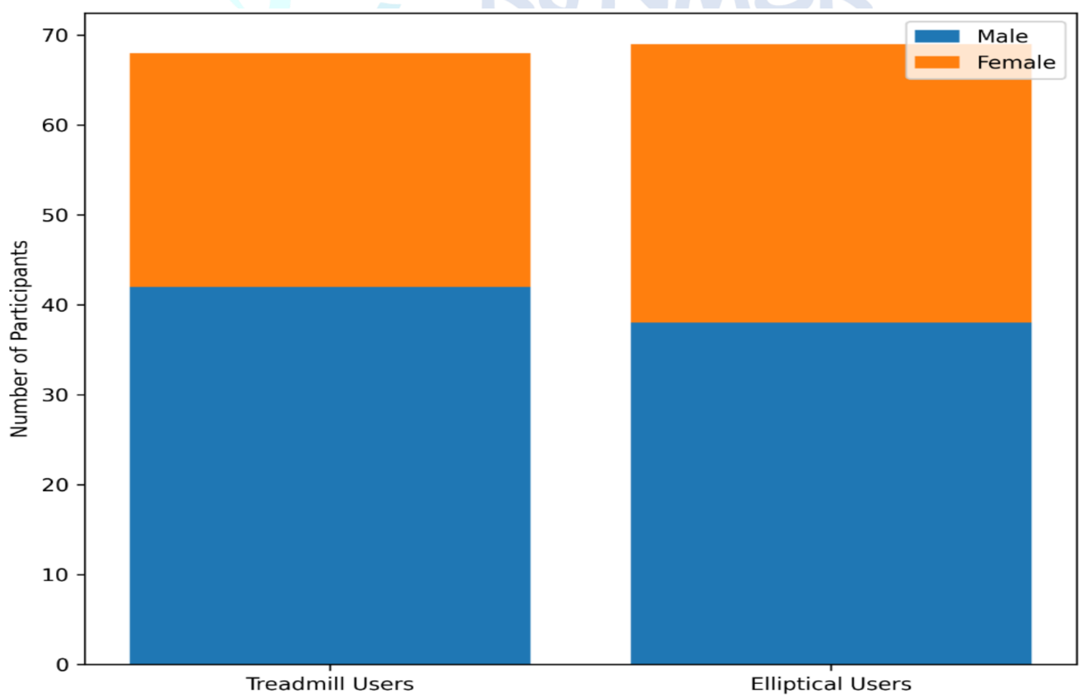


Figure 4.4: Gender distribution

Table 4.1 shows that no differences were statistically significant in terms of the demographic variables compared between the two groups of treadmill users and elliptical users. The mean age of treadmill users was 26.4 ± 4.8 years and elliptical users were aged 25.9 ± 5.1 years; thus age distribution between groups was quite similar (p = 0.563).

Gender was relatively consistent between the two groups, as there were 61.8 % males in the treadmill group and 55.1 % males in the elliptical group. The opposite gender in the treadmill group was 38.2% while that of the elliptical was 44.9% (p= 0.425).

Body mass index was comparable between both the treadmill and elliptical users (p= 0.497). Treadmill users had a mean BMI of 24.1 ± 2.7 kg/m while elliptical users had a BMI of 23.8 ± 2.5 kg/m. The comparison of the distribution of BMI categories across groups indicates very similar trends.

In terms of exercise experience, the participants in both groups showed no significant difference in the mean length of time they have been participating in regular cardio exercise. Treadmill users averaged 8.6 ± 3.9 months of regular cardio and elliptical users averaged 8.1 ± 4.2 months (p=0.481). Overall, the baseline comparison indicates no significant differences between the two groups.

4.3 Training Characteristics

Variables related to the training are, frequency (weekly sessions), time/session, total weekly workload, use of warm-up/cool-down, and mean incline values; they are represented in table 4.2.

Table 4.2: Training Characteristics of Participants (n = 137)

Training Parameter	Treadmill (n=68)	Elliptical (n=69)	p-value
Sessions/week (Mean ± SD)	4.1 ± 1.0	3.9 ± 1.1	0.267
Session duration (min)	48.3 ± 12.1	44.6 ± 11.8	0.083
Weekly volume (min) Mean ± SD	198.1 ± 47.3	173.9 ± 43.6	0.002*
Incline used n(%)	68 (100%)	N/A	
Average incline (degrees)	8.4 ± 3.2	N/A	
Warm-up performed n(%)	31 (45.6%)	39 (56.5%)	0.197
Cool-down performed n(%)	28 (41.2%)	36 (52.2%)	0.196

**p < 0.05 considered statistically significant. N/A = Not applicable.*

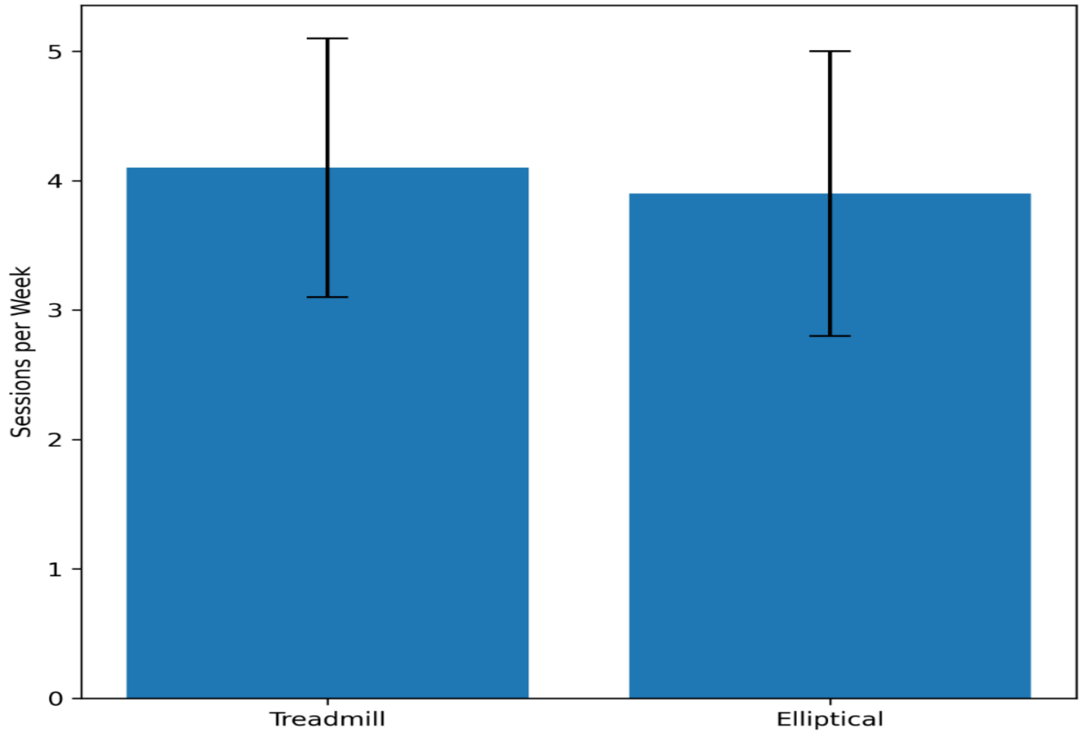


Figure 4.5: Weekly sessions comparison

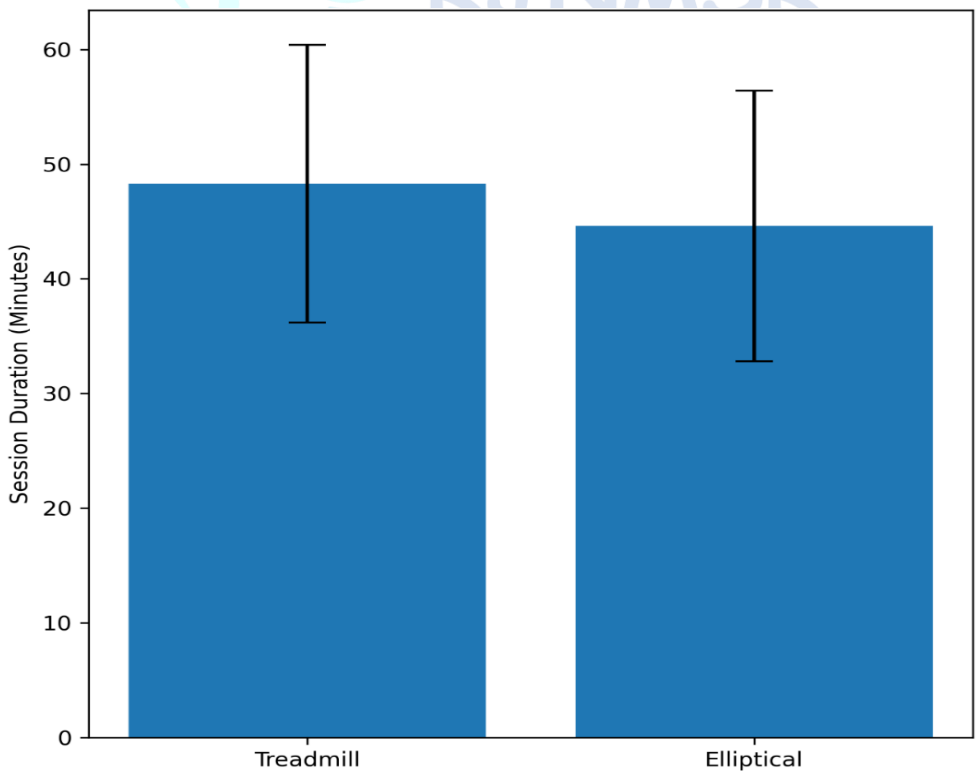


Figure 4.6: Session duration comparison

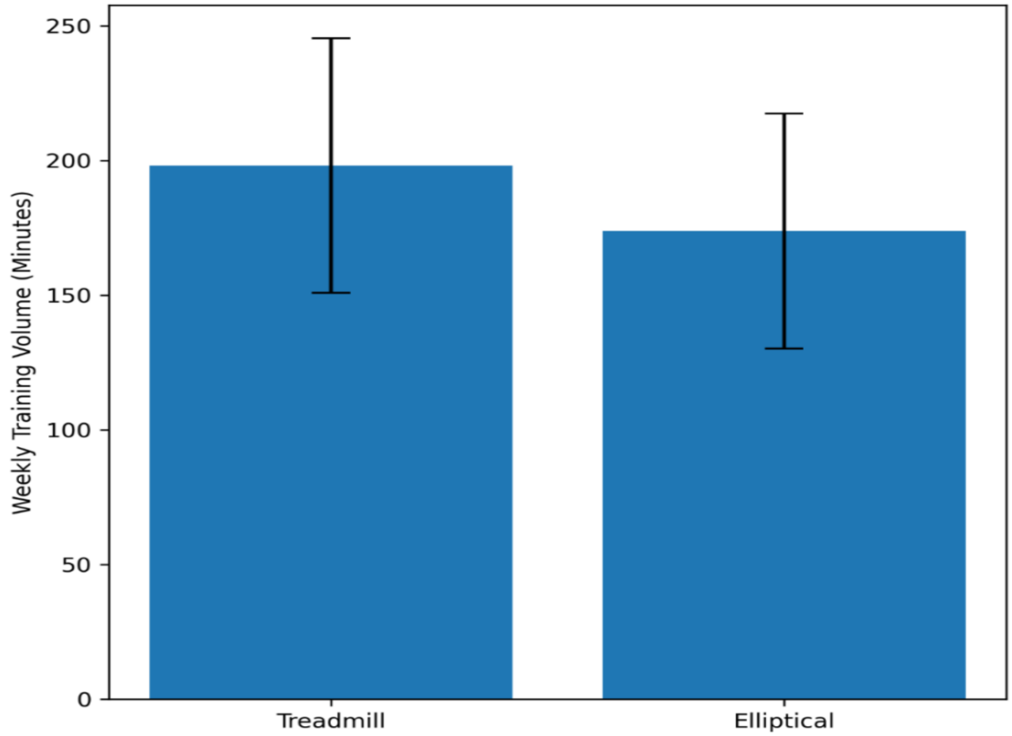


Figure 4.7: Weekly training volume (VERY IMPORTANT graph – significant p = 0.002)

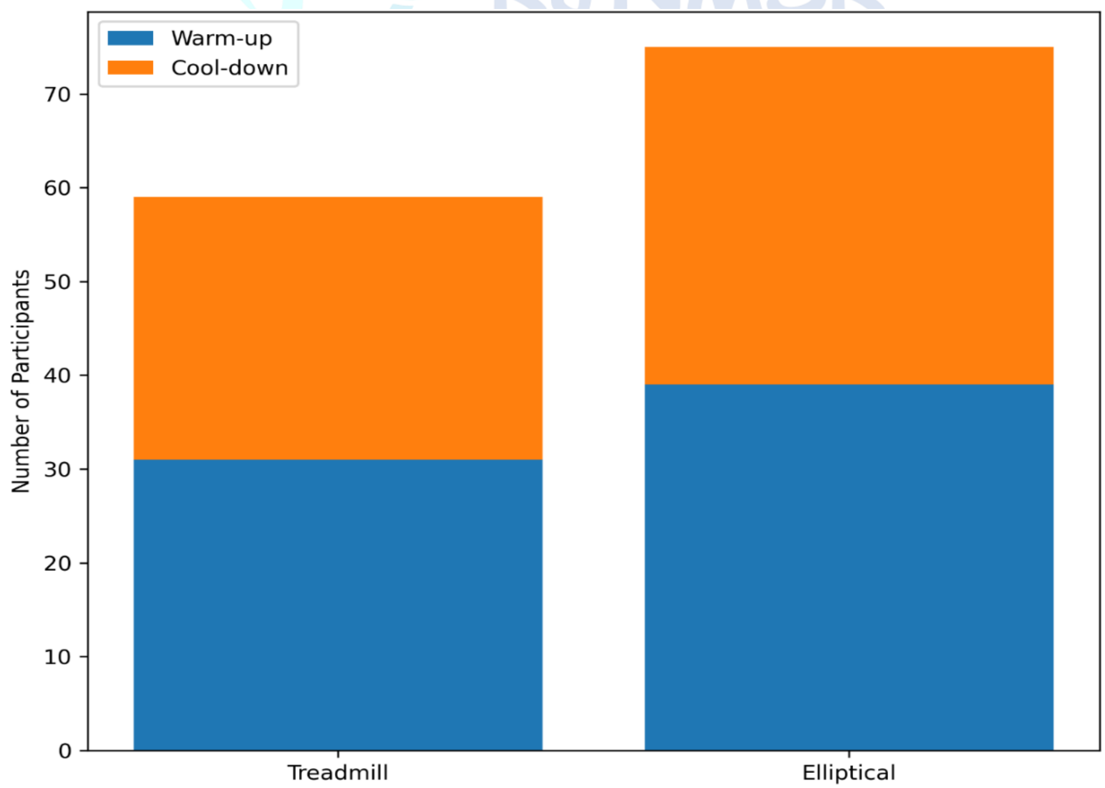


Figure 4.8: Warm-up vs Cool-down behavior (stacked bar chart)

Training frequency between the groups was similar. Treadmill users completed on average 4.1 ± 1.0 sessions per week versus 3.9 ± 1.1 sessions per week for the elliptical users (p=0.267). Similarly, individual session duration between groups was similar although treadmill users tended to have longer sessions (48.3 ± 12.1 vs 44.6 ± 11.8, p=0.083). A significant difference was found, however, for total weekly training volume, as treadmill users reported a significantly greater weekly training volume (198.1 ± 47.3 minutes) versus the elliptical users (173.9 ± 43.6 minutes, p=0.002). This cumulative weekly loading difference may be an important factor contributing to the disparity in prevalence rates of ITBS between the two groups.

Regarding injury prevention behaviors, 45.6% of treadmill users typically perform a warm-up before exercise versus 56.5% of the elliptical users (p=0.197). Also, 41.2% of the treadmill users typically perform a cool-down versus 52.2% of the elliptical users (p=0.196). The differences between the groups regarding injury prevention behaviors did not reach statistical significance.

4.4 Prevalence of Iliotibial Band Syndrome

4.4.1 Overall Prevalence

The objective of this investigation was to determine and compare the incidence of ITBS in incline treadmill versus elliptical trainer users. ITBS was determined to be a condition present if two or more clinical evaluation tests yielded a positive result. The clinical evaluation tests used to determine ITBS status included; Ober's test, Modified Ober's test, Noble Compression test and Renne's Test. Raw test incidence data and the final classification of ITBS status are illustrated in table 4.3.

Table 4.3: Prevalence of ITBS – Clinical Test Results by Group

Outcome	Treadmill (n=68)	Elliptical (n=69)	χ^2	p-value
ITBS Positive (Ober's)	38 (55.9%)	22 (31.9%)	7.61	0.006*
Noble Compression +ve	34 (50.0%)	18 (26.1%)	8.08	0.004*
Lateral knee pain	41 (60.3%)	24 (34.8%)	8.62	0.003*
Modified Ober's Test +ve	35 (51.5%)	20 (29.0%)	6.98	0.008*
Renne's Test +ve	30 (44.1%)	15 (21.7%)	7.25	0.007*
Overall ITBS (any 2+ tests)	41 (60.3%)	24 (34.8%)	8.68	0.003*

*$p < 0.05$ considered statistically significant. Chi-square (χ^2) test used for all comparisons.

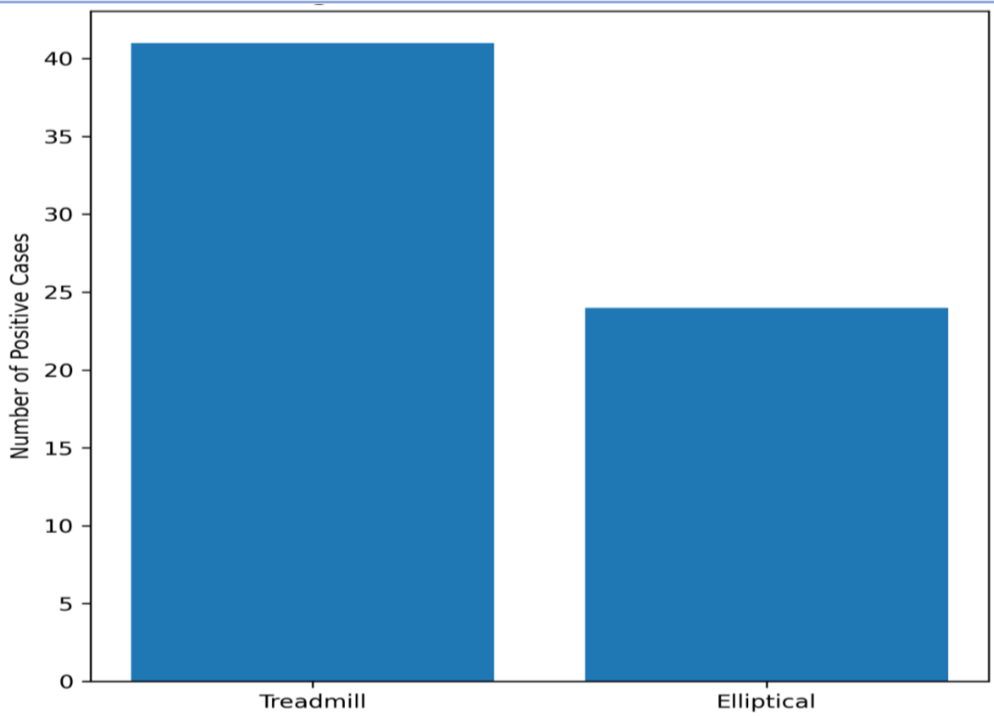


Figure 4.9: Overall ITBS prevalence

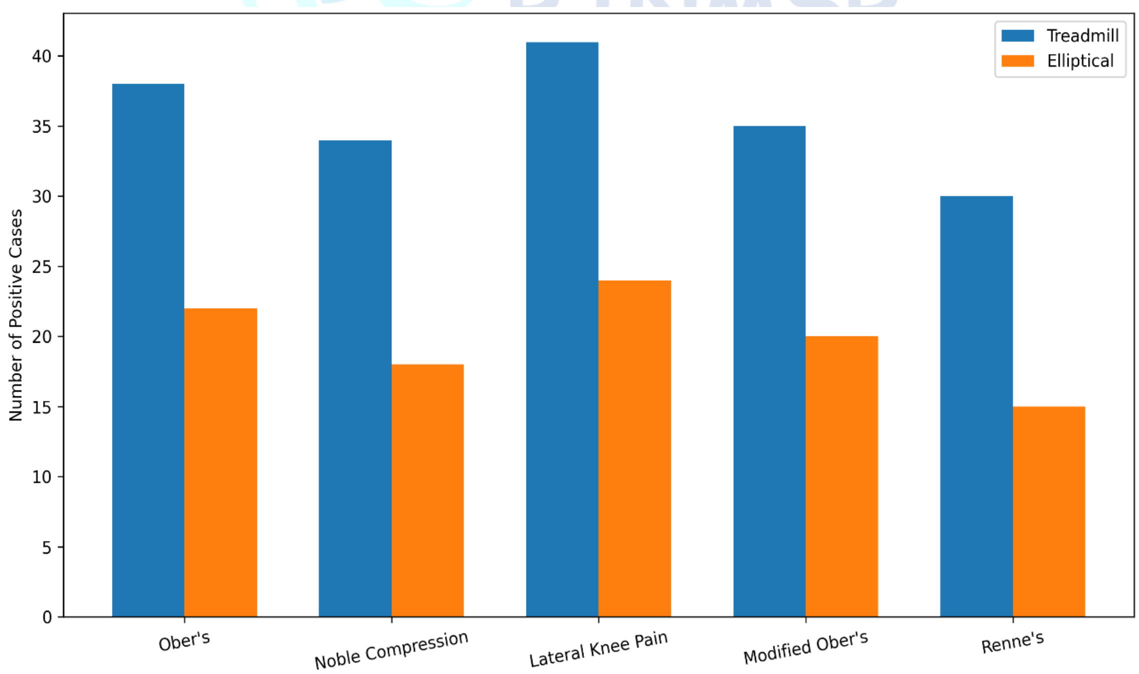


Figure 4.10: Comparison of clinical tests positivity

There was an overall ITBS prevalence of 60.3% (n = 41 of 68 subjects) in treadmill users, and 34.8% (n = 24 of 69 subjects) in the elliptical group; this was found to be statistically significant (= 8.68, p= 0.003). The alternative hypothesis was supported H: A significant difference existed between the exercise groups, in terms of ITBS prevalence, and treadmill users had a statistically higher prevalence of ITBS compared to the elliptical users. Looking at the prevalence of individual clinical tests individually, Ober's Test resulted in a positive rate of 55.9% (treadmill) and 31.9% (elliptical) (p=0.006). Noble compression test resulted in a positive rate of 50.0% (treadmill) and 26.1% (elliptical) (p=0.004). The prevalence of lateral knee pain was 60.3% (treadmill) and 34.8% (elliptical) (p=0.003). Both modified Ober's and Renne's Test were found to have higher prevalence in the treadmill group (p=0.008, p=0.007 respectively).

4.4.2 Prevalence by Gender

Gender-stratified analysis was performed to explore whether sex-specific differences existed in ITBS prevalence within and between exercise groups. The results are presented in Table 4.4.

Table 4.4: ITBS Prevalence Stratified by Gender

Gender	Treadmill +ve	Treadmill −ve	Elliptical +ve	Elliptical −ve	p-value
Male	24 (57.1%)	18 (42.9%)	11 (28.9%)	27 (71.1%)	0.011*
Female	17 (65.4%)	9 (34.6%)	13 (41.9%)	18 (58.1%)	0.069
Total	41 (60.3%)	27 (39.7%)	24 (34.8%)	45 (65.2%)	0.003*

*p < 0.05 considered statistically significant.

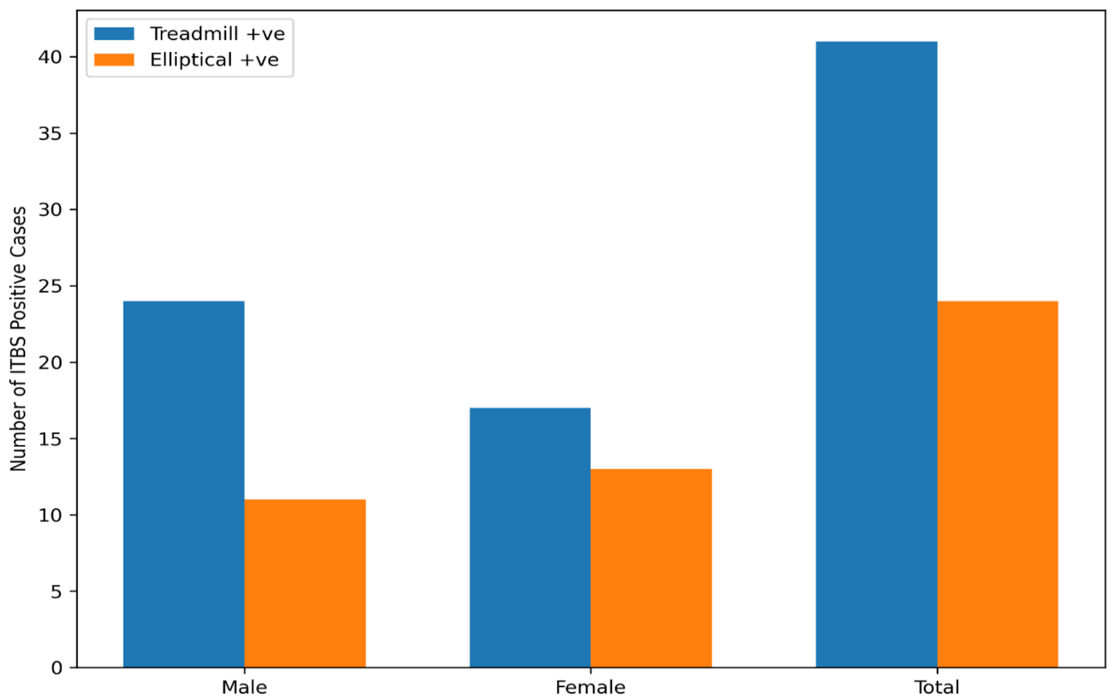


Figure 4.11: Gender-wise ITBS prevalence (clustered bar chart)

The ITBS positive rates for male participants were higher among the treadmill (57.1%) than the elliptical group (28.9%), p=0.011. The ITBS prevalence among the female participants was greater in the treadmill group than in the elliptical group (65.4% vs 41.9%), but this did not reach significance (p=0.069), likely because the female group was the smallest. Among the female group, treadmill users had the greatest ITBS rate, 65.4%, which is consistent with literature, women have higher biomechanical risk for ITBS due to their wider pelvic angles, increased tendency to adopt greater hip adduction, and decreased hip abductor strength compared to men.

4.4.3 Prevalence by BMI Category

A sub group analysis was performed to test for association between BMI category and ITBS. Within the treadmill exercise group, the prevalence of ITBS for those in the overweight category (25-29.9 kg/m) was 71.4%, whereas for normal BMI's (18.5-24.9 kg/m) it was 53.1%. The percentage of the treadmill group and the elliptical group with ITBS who were in the overweight and normal BMI categories respectively were 44.4% and 28.6% respectively. It seems that increasing BMI's are likely to potentiate the mechanical forces applied through compression and tension on the IT band in a rhythmic cardiorespiratory manner, with inclined treadmill exercise inducing more loading than the elliptical.

4.5 Biomechanical Risk Factors Associated with ITBS

The relationship between the biomechanical and training variables and ITBS was explored as risk factors in both groups. These variables were analyzed by univariate logistic regression, and the odds ratios (ORs) with their 95% confidence intervals (CIs) were reported in table 4.5.

Table 4.5: Biomechanical and Training Risk Factors Associated with ITBS (Combined Groups)

Risk Factor	ITBS Positive (n=65)	ITBS Negative (n=72)	OR (95%CI)	p-value
Hip abductor weakness	44 (67.7%)	21 (29.2%)	4.96 (2.3–10.7)	< 0.001*
Dynamic knee valgus	38 (58.5%)	17 (23.6%)	4.49 (1.98–9.42)	< 0.001*
Weekly volume > 180 min	47 (72.3%)	28 (38.9%)	3.85 (1.85–8.01)	< 0.001*
No warm-up	39 (60.0%)	29 (40.3%)	2.21 (1.09–4.50)	0.027*
BMI 25–29.9 (Overweight)	33 (50.8%)	22 (30.6%)	2.35 (1.14–4.87)	0.021*
Female gender	30 (46.2%)	31 (43.1%)	1.13 (0.57–2.26)	0.724
Age > 28 years	27 (41.5%)	24 (33.3%)	1.43 (0.71–2.90)	0.319

*p < 0.05 considered statistically significant. OR = Odds Ratio. CI = Confidence Interval.

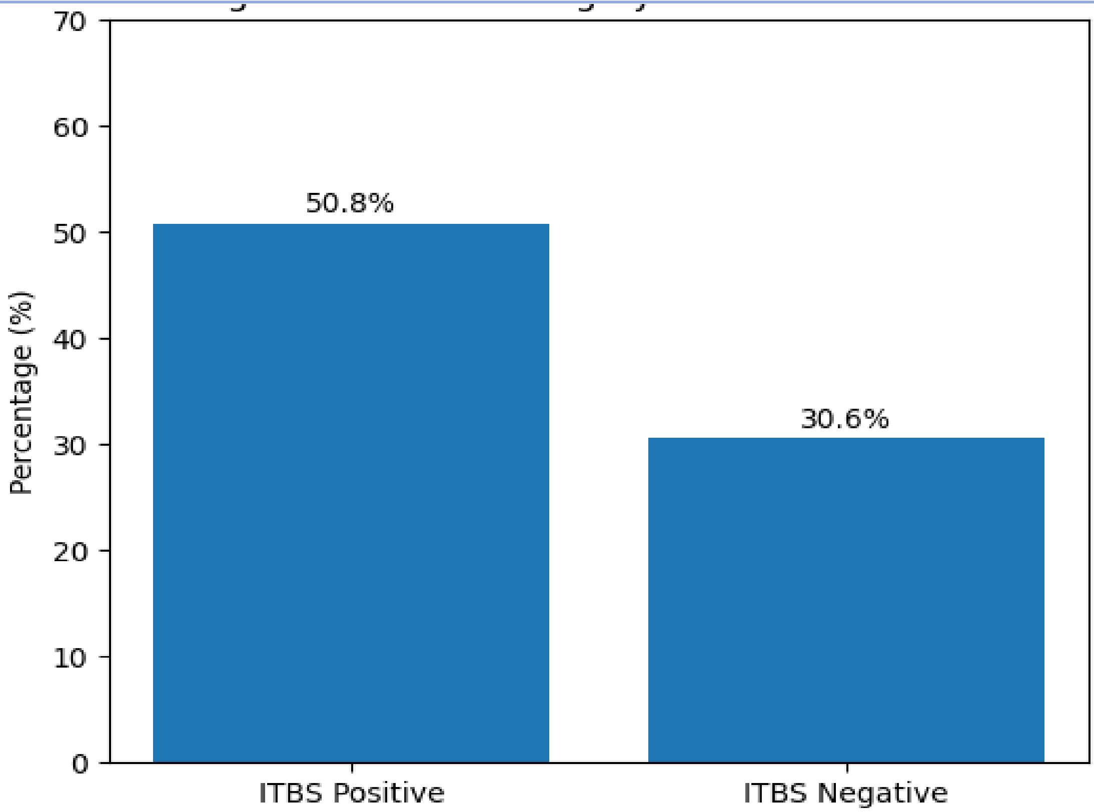


Figure 4.12: BMI category vs ITBS prevalence

Strongestpredictor for ITBS found was weakness of the hip abductors in 67.7% of ITBS positive subjects compared to ITBS negative subjects in 29.2% (OR=4.96, 95% CI:2.3-10.7, P<0.001). Dynamic valgus of the knee was the second strongest predictor with 58.5% in ITBS positive compared to 23.6% of the ITBS negative subjects (OR=4.49, 95% CI:1.98-9.42, P<0.001).

The predictors were further broken down and a high weekly training volume (> 180 min/week) showed to be significant (OR=3.85, p<0.001) in correlation with ITBS. A missed pre exercise warm up was identified as a risk factor (OR=2.21, p=0.027) indicating the need for preparation of the exercise activity. BMI of overweight was moderately related to risk of ITBS (OR=2.35, p=0.021). There was no significant correlation to ITBS risk in either gender or subjects over 28 years of age (p=0.724 and p=0.319 respectively).

These results are strongly indicative that ITBS in a gym attending population is an multifactorial pathology resulting in the development of ITBS driven by both proximal weakness and biomechanical changes, in conjunction with load to the lower extremity.

4.6 Functional Limitation as Measured by LEFS

The effect of ITBS on daily and recreational activities was evaluated using the Lower Extremity Functional Scale (LEFS). A higher score, up to a maximum of 80, reflects better functionality. The LEFS scores for each group and per ITBS status are displayed in Table 4.6.

Table 4.6: Lower Extremity Functional Scale (LEFS) Scores by Group and ITBS Status

LEFS Category	Treadmill (n=68)	Elliptical (n=69)	p-value
Mean LEFS Score (± SD)	52.4 ± 14.6	63.8 ± 12.1	< 0.001*
ITBS +ve participants mean LEFS	44.2 ± 11.7	51.6 ± 10.8	0.018*
ITBS –ve participants mean LEFS	63.9 ± 9.8	69.4 ± 8.5	0.011*
Score < 40 (Severe limitation) n(%)	14 (20.6%)	6 (8.7%)	0.049*
Score 40–59 (Moderate) n(%)	28 (41.2%)	22 (31.9%)	0.264
Score 60–80 (Mild/None) n(%)	26 (38.2%)	41 (59.4%)	0.012*

*p < 0.05 considered statistically significant.

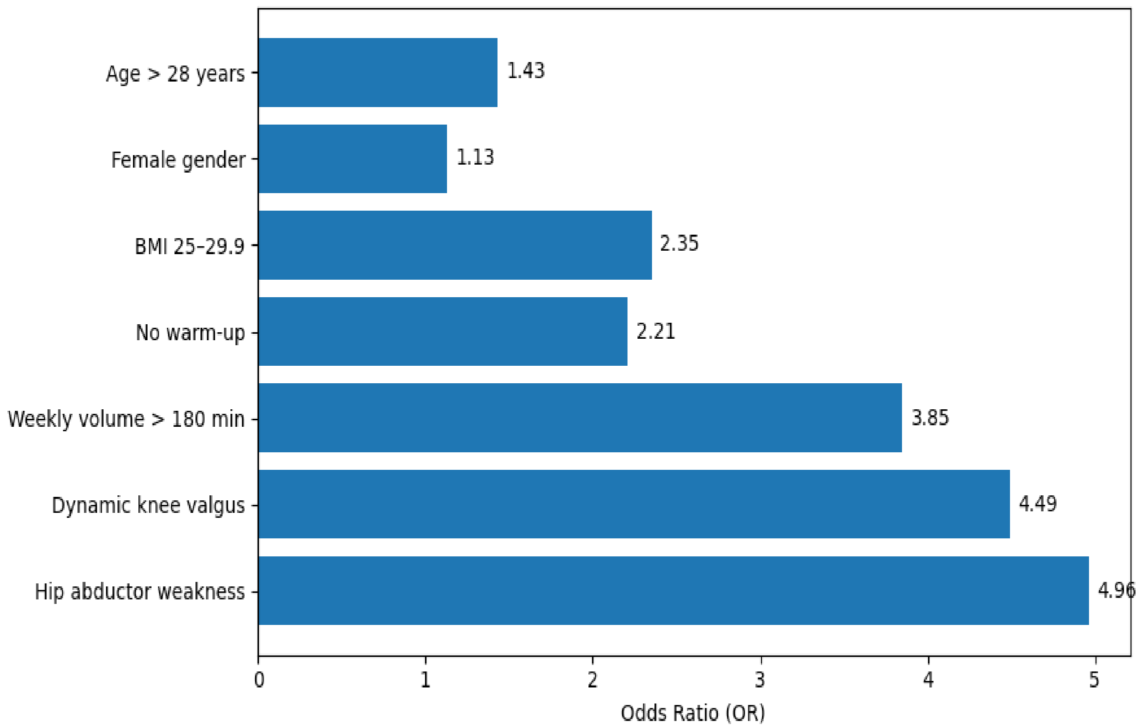


Figure 4.13: Odds Ratio (OR) comparison chart

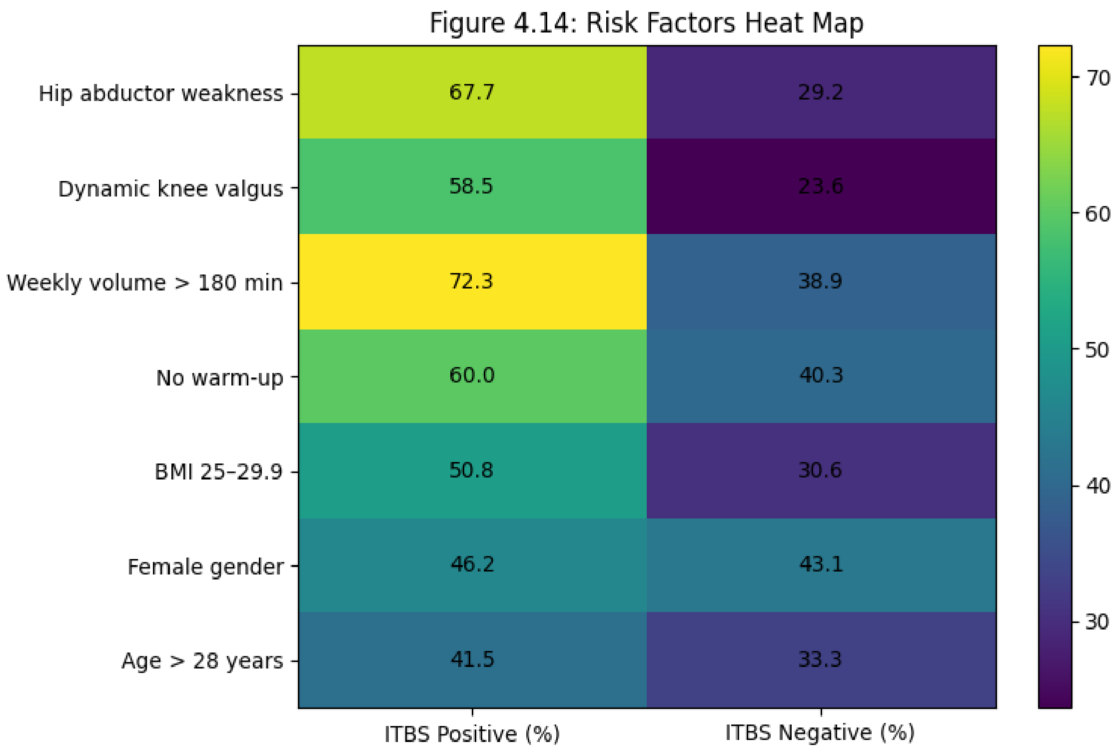


Figure 4.14: Risk factors heat map (optional but strong for thesis)

Participants on the treadmill had a significantly lower average LEFS score (52.4 14.6) compared to elliptical users (63.8 12.1) indicating higher functional limitation in treadmill users ($p < 0.001$). There was also a significant difference in LEFS score between ITBS positive treadmill users (44.2 11.7) and ITBS positive elliptical users (51.6 10.8) ($p=0.018$). The number of ITBS positive users that scored in the 'severe limitation' group (LEFS <40) was also much higher for treadmill users (20.6%) than for elliptical users (8.7%) ($p=0.049$). An even higher proportion of elliptical users scored in the 'mild-to-no limitation' group (LEFS 60-80) than for treadmill users (59.4% vs 38.2%) ($p=0.012$). It appears that ITBS as a result of inclining the treadmill produces higher levels of pain and thus, increased mechanical irritation of the ITB and greater limitation in physical function.

4.7 Pain Assessment Using the Visual Analog Scale (VAS)

Pain severity was measured using the Visual Analog Scale (VAS) and values on a scale from 0 (no pain) to 10 (unbearable pain) were obtained and presented for the total group and split by group and ITBS status in Table 4.7.

Table 4.7: VAS Pain Scores by Group

VAS Parameter	Treadmill (n=68)	Elliptical (n=69)	p-value
Mean VAS (all participants)	4.2 ± 2.4	2.8 ± 2.1	< 0.001*
Mean VAS (ITBS +ve only)	5.9 ± 1.8	4.4 ± 1.9	0.002*
No Pain (VAS 0) n(%)	12 (17.6%)	24 (34.8%)	0.024*
Mild Pain (VAS 1–3) n(%)	15 (22.1%)	21 (30.4%)	0.274
Moderate Pain (VAS 4–6) n(%)	28 (41.2%)	17 (24.6%)	0.040*
Severe Pain (VAS 7–10) n(%)	13 (19.1%)	7 (10.1%)	0.142

*p < 0.05 considered statistically significant.

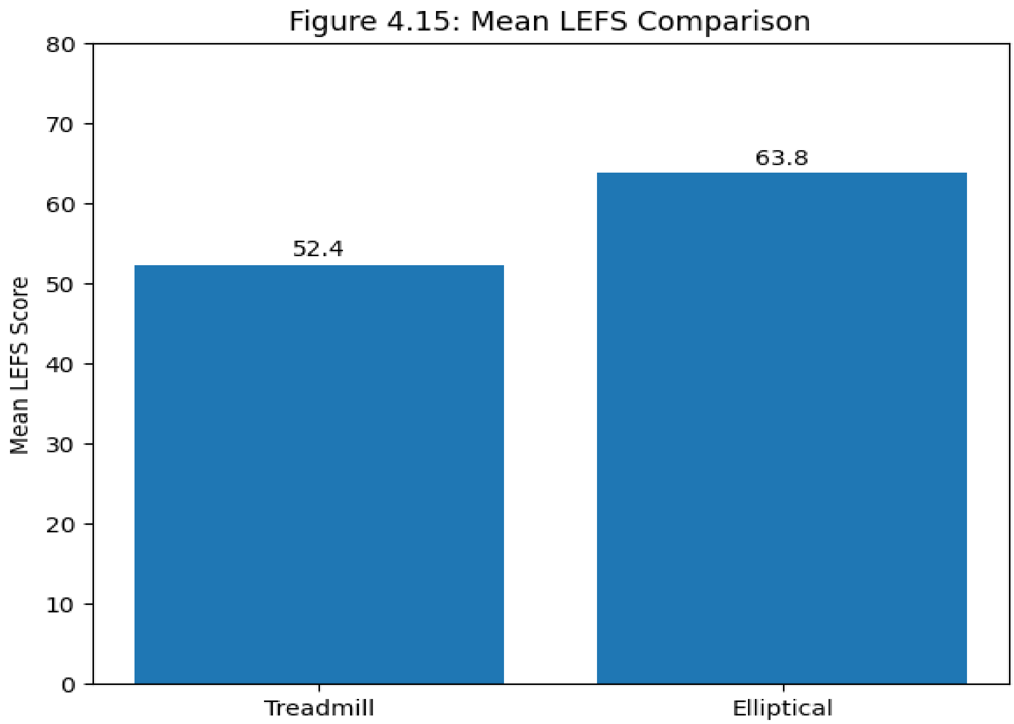


Figure 4.15: Mean LEFS comparison

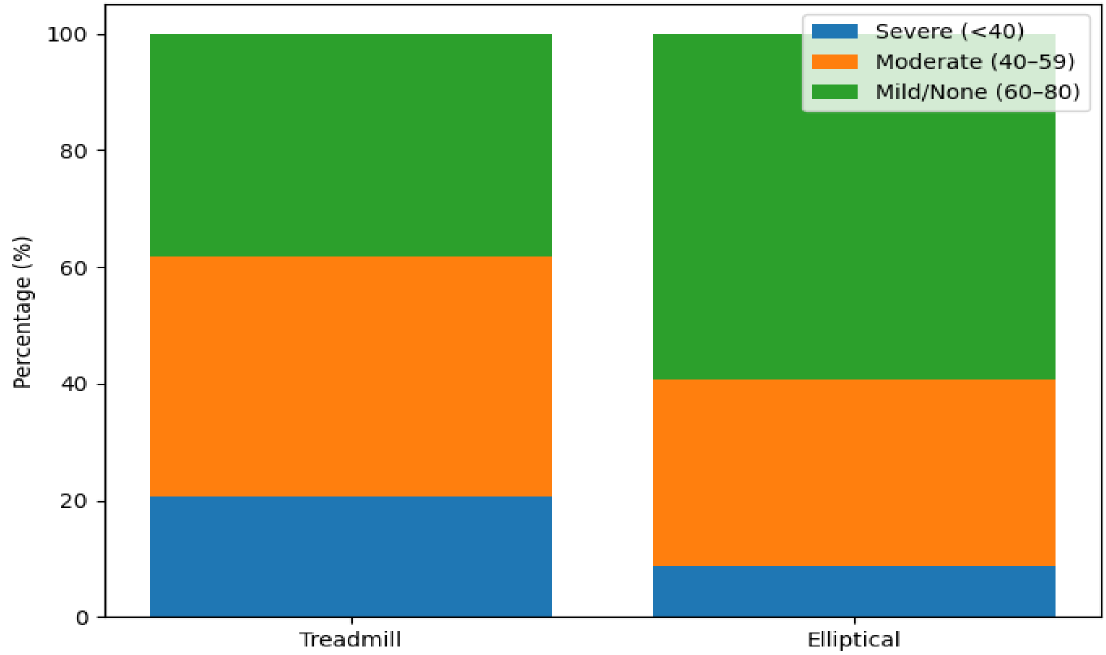


Figure 4.16: LEFS severity categories (stacked bar chart)

The overall mean VAS pain score was higher in the treadmill users than elliptical users (4.2 ± 2.4 versus 2.8 ± 2.1, p<0.001). Among the ITBS-positive individuals, the mean VAS score was significantly higher for the treadmill users than the elliptical users (5.9±1.8 versus 4.4±1.9, p=0.002). There were significantly more pain-free users in the elliptical group (34.8%) than in the treadmill group (17.6%, p=0.024). Moderate (4-6) VAS pain scores were significantly more likely to occur in treadmill users (41.2%) than elliptical users (24.6%, p=0.040), but this was not the case for severe (7-10) pain (treadmill users 19.1%, elliptical users 10.1%, p=0.142). Overall, incline treadmill use produced a much higher degree of pain than the elliptical in a gym population, and this was consistent with the greater prevalence of ITBS in this population.

4.8 Hypothesis Testing Summary

The null hypothesis (H_0) stating that there is no significant difference in the prevalence of ITBS between incline treadmill users and elliptical trainer users was tested using the Chi-square test.

Hypothesis	Result
H_0: No significant difference in ITBS prevalence between groups	REJECTED ($\chi^2 = 8.68$, p = 0.003)
H_1: Significant difference exists; treadmill users at higher risk	ACCEPTED (p < 0.05)

Statistical analysis:Null hypothesis is rejected.There is a statistically significant difference between inclined treadmill users (60.3%) and elliptical trainer users (34.8%) in the incidence of ITBS. Inclined treadmill users have a statistically significantly greater chance of ITBS (= 8.68, p = 0.003). The alternate hypothesis is accepted.

4.9 Summary of Chapter 4

This chapter provided a detailed description and interpretation of data obtained from 137 individuals training at a gym. Major conclusions are:

- Overall ITBS rates were significantly greater among incline treadmill users (60.3%) compared with elliptical users (34.8%).
- All 4 clinical assessment tests (Ober's, Modified Ober's, Noble compression and Renne's) had significantly higher positive rates in the treadmill group.
- Weak hip abductors and dynamic knee valgus are the two most important biomechanical factors of ITBS.
- Training volume of more than 180 min per week and lack of warming-up are two most important training factors contributing to the development of ITBS.
- Treadmill users had significantly lower scores of LEFS and significantly higher scores ofVAS than those of elliptical users.
- Female participants trended to have higher probability of ITBS, in agreement with previous literature.

CHAPTER 5

5.1 Discussion

This cross-sectional comparative study sought to determine the prevalence of iliotibial band syndrome (ITBS) in incline treadmill and elliptical trainer users within a gym-going population in Faisalabad, Pakistan. Using a sample size of 137, participants underwent a multi-modal assessment strategy including clinical tests, pain scales and functional outcome measures. It was found that the prevalence of ITBS was significantly higher in incline treadmill users (60.3%) than elliptical trainer users (34.8%) and this was confirmed by Chi-square analysis ($p = 0.003$). This chapter will discuss the relevance of these findings in the context of current literature, examine their biomechanical, training, and clinical relevance.

Overall, the ITBS prevalence among incline treadmill users in this study (60.3%) is considerably high compared to several other treadmill runners in the literature. While studies in general running populations suggest that prevalence may be anywhere between 1.6%-14% (Opara and Kozinc, 2023), Park et al. (2021) also reported prevalence in runners at 12%, and cyclists at 15-24%. However, care must be taken when drawing comparison, the greater prevalence reported here could be due to the use of inclines, where it has been established that loading at the posterior chain and activation of the hip flexors is greater than with horizontal running. Furthermore, the subjects here may include a more avid, higher volume, but potentially lower skilled fitness enthusiast which would include less controlled technique than in competitive athletes often represented in the research.

Although less prevalent than among incline treadmill users, the 34.8% ITBS prevalence in elliptical users remains clinically significant. This finding is comparable with those by Park et al. (2022) who identified prevalence of 15-24% among cyclists which is highly comparable due to similarity in mechanics (reduced impact, closed kinetic chain), yet still indicates the possibility of ITBS development on a more "safe" machine, compared to incline treadmill users.

The prevalence of ITBS found in Barauh and Vijayakumar (2020) amongst treadmill users, revealed repetition, lack of flexibility and accumulation of load as primary contributing factors. This correlates with the current findings as treadmills present repetitive motion and could potentially be the contributing factor in this specific study, yet expand it to show elliptical trainers do not inherently lack these risks completely, though there are notable differences.

Multiple biomechanical factors may be attributed to the increased prevalence of ITBS on incline treadmill running, which have previously been documented. It is known that while running inclines the body requires additional support due to increased anterior leaning of the trunk, increased recruitment of the hip flexors and greater activation of the quadriceps to generate forward motion against gravity. This requires increased compression force generation across the lateral aspect of the knee structures at the critical angle of approximately 30 degrees, at which point the ITB passes over the lateral femoral epicondyle and causes potential friction (Friede et al., 2022).

The ITB is a dense multi-functional structure, which helps in transmitting power from the gluteus maximus and TFL to the lower limb (Hutchinson et al., 2022). Inclined treadmill running involves the gluteus maximus to a greater extent than in flat running, which helps to resist collapse at the hip. This consequently leads to an increase in tension forces in the ITB itself and increased activity of the TFL to assist as a hip abductor, particularly over a greater duration during the stand phase as this can exacerbate muscular tightness, and thus contribute to clinical symptoms (Hutchinson et al., 2022).

Conversely, elliptical exercise results in a low impact, closed kinetic chain pattern and provides a elliptical motion which minimizes repetitive vertical loading at the knee, leading to less friction at the lateral aspect of the knee than predicted. It is well known that a lower impact at the knee leads to a decreased likelihood of developing pain at the lateral femoral epicondyle (Strauss et al., 2011), and indeed the 30 degree angle would appear to occur much less readily in the elliptical compared to the treadmill during continuous movement at a reasonable pace.

Chen et al. (2023) found that both exercise speed and muscle fatigue significantly increase the ITB strain rate, indicating the importance of muscle activation and loading when causing injury. Elliptical machines are used for much longer duration with similar but not identical demands as incline treadmill training and hence muscles will experience fatigue. Incline treadmill running is generally accompanied with less gluteal and TFL activity and reduced overall hamstring and gluteal fatigue, however in terms of training a lack of eccentric control of the hip flexors on inclined running leads to greater strain on the hip flexors which will in turn cause the ITB to become tight. The weakest hip abductors was also identified in the analysis of risk factors to be the strongest predictor of ITBS (OR=4.96), indicating lack of muscle control around the hip leads to ITBS (Chen et al., 2023).

Strong evidence in this study shows a significant correlation between hip abductor weakness and ITBS (OR = 4.96, $p < 0.001$) which is in line with the findings of Foch, Brindle, and Pohl's (2023) systematic review, where diminished hip abductor strength was a major factor found in current ITBS in runners, more prominent in female individuals. Reduced hip abductor strength leads to poor control of the femur during stance phase, thus creating increased femoral adduction and internal rotation. This proximally directed shift, or collapsed medial, is presumed to lead to excessive mechanical stress on the ITB and generate larger lateral knee compressive forces, especially during repetitive activity like exercise treadmill.

Dynamic knee valgus, the second most powerful risk factor in this study (OR = 4.49, $p < 0.001$) is the clinical representation of this proximal instability of the hip. Kumarantini et al. (2025) found that abnormal lower limb alignment as measured by the Q-angle greatly increases risk of ITBS among recreational runners, which again supports poor knee kinematics contributing to ITBS. This study confirms this in the gym setting and relates this to specific forms of exercise performed.

Aderem and Louw (2015) observed through their systematic review that female runners with ITBS increased hip adduction and knee internal rotation duringstance phase. The results of this study align with these findings, however expand on them by indicating similar biomechanics also occur during gym based exercise, but the severity of such pronation is much more pronounced on the treadmill compared to the elliptical and more common among the treadmill users. The addition of a hip strengthening protocol including exercises targeting the glute medialis, glute minimialis, and external hip rotators is recommended for high frequency treadmill users.

Weekly training volume over 180 minutes was also a significant risk factor in this study (OR = 3.85, $p < 0.001$). This is most likely due to the fact that those participating on the treadmill have a significantly higher average weekly training volume (198.1) compared to elliptical users (173.9) and it is cumulative mechanical stress over longer time that is expected to be detrimental. This also agrees with Friede et al. (2022) who emphasize that cumulative mechanical stress is the driving force for overuse injuries among runners.

Marais et al. (2024), found that training variables that influence ITBS history in distance runners include training volume and sudden increase in training load; This study showed that in a gym setting, there may be similar factors affecting prevalence of ITBS, such as absence of planned training, progression, and appropriate recovery among gym-goers. Absence of appropriate warm-ups led to significant ITBS risk (OR = 2.21, $p = 0.027$). Neuromuscular activation of the hip abductors during warm up using drills such as side-lying clam shells, hip circles, or banded side walks may enhanceproximal stabilityand reduce lateral knee force and hip abduction moment, leading to a more desirable mechanical setup during cardiovascualr exercise.

Although it was found that female treadmill users had a higher prevalence of ITBS (65.4%) compared to male treadmill users (57.1%) in this study, this was not statistically significant in gender stratified analysis ($p = 0.069$). Similar to the results of Foch et al. (2023) where women were almost two times as likely to experience ITBS than males due to wider pelvis to femur ratio, greater tendency to adducted hip in terminal stance and lower absolute hip abductor strength, we have similar results, however sample size limitations in the present study may have limited ability to detect significance between the genders for each mode of exercise. The differences in forces experienced in the runners gait of males vs females have also been found to be significant (De Souza Jnior et al., 2023). Small sample sizes of females among each mode may have inhibited the ability to detect significant differences between genders.

Clearly the LEFS scores were significantly poorer among those who used treadmill for their exercise (mean 52.4 vs 63.8, $p < 0.001$) than in the elliptical user cohort. This corroborates that training that is carried out while performing the exercise that elicits ITBS is most strongly associated with impairment. The functional capacity was significantly poorer in ITBS patients who trained on incline treadmill (mean LEFS 44.2); they are significantly more restricted in activities of daily living such as running, stair climbing, and squatting because of their pain. Amjad et al. (2025) noted that in ITBS patients that physical activity levels were directly correlated with quality of life, with pain and functional limitations "negatively affecting health-related quality of life and reducing the level of participation in physical activities". A clinically important finding of the study from the LEFS was that for gym-goers with ITBS physiotherapists should administer functional assessments using validated measures and rehabilitation programs that address the limiting activities specifically rather than merely reducing pain.

The poorer VAS pain score reported by the treadmill user group (mean 4.2 vs 2.8, $p < 0.001$) again suggests a clinically larger problem for the treadmill user cohort. The levels reported, in particular the 19.1% reporting severe pain (VAS > 7), strongly suggests interference with gym activity and potential exercise abandonment.

The rates of ITB tightness observed in this study are in line with a number of other studies focusing on occupations where people perform physically demanding tasks. Arif et al. (2022) reported that 45.69% of office workers in Pakistan had tight ITBs. Humayun et al. (2023) described the incidence of tight ITBs among Pakistani healthcare workers and it was associated with anterior knee pain. A prolonged sitting population had a 47% Ober's Test positive rate reported by Mane and Yadav (2020). All of these findings demonstrate that ITB tightness is a common musculoskeletal issue across multiple populations in Pakistan, and the even higher incidence seen among incline treadmill users in the current study (55.9% Ober's positive) shows the unique risk this specific type of exercise imposes. The lack of an association between cross-legged sitting and ITB tightness observed by Hani et al. (2024) in university students suggests that postural issues are not the primary drivers of ITB tightness in active individuals and that type and level of physical activity are stronger influences.

There are a number of limitations that must be taken into account. First, as the study is cross-sectional, a causal relationship between exercise modality and ITBS cannot be assumed. Although a strong association between treadmill exercise and ITBS was shown it is possible that ITBS patients who use treadmills had pre-existing ITB tightness prior to initiating gym training. Second, the method used to recruit subjects was that of convenient sampling, thus potentially limiting the generalizability of the findings to the entirety of gym users in Pakistan or other areas. Subjects recruited at Faisalabad gym facilities may not be representative of other locations, cities, or cultures and socio-economic statuses. Third, while standard clinical testing methods were used, reliability can be an issue for the Ober's test (and its variations). A prospective study utilizing diagnostic tools such as ultrasound imaging or objective dynamometric measures of hip abductor strength could improve the quantification of ITB thickness and hip abductor strength. Fourth, self-reported frequency and intensity of exercise may be subject to memory bias. Objective monitoring of activity level using wearable devices or the acquisition of gym access records would provide a more objective measure of training load. Fifth, controls for footwear, running style, pre-existing injuries, and the demands of the job in terms of standing may not have been sufficiently accounted for.

5.2 Conclusion

The main purpose of the study; 'to determine the comparison of occurrence of ITBS among incline treadmill exercisers and elliptical trainer exercisers in gym attending population of Faisalabad Pakistan' was met successfully. The major findings of this study are;

Occurrence of ITBS among incline treadmill exercisers (60.3%) was higher than elliptical trainer exercisers (34.8%) with statistically significant result of chi square value(=8.68, p=0.003) hence; the null hypothesis was rejected and the alternative hypothesis was accepted. It is inferred that type of exercise is a significant determinant of risk of ITBS in gym population and incline treadmills pose higher risk of ITBS in comparison to elliptical trainers for comparable gym attenders.

The strongest identifying risk factor of ITBS among gym attending populations (OR =4.96) was identified as weakness of hip abductors. Other significant risk factors for developing ITBS were found to be dynamic knee valgus (OR=4.49) and total weekly duration of exercise above 180min/week(OR=3.85). The results signify that ITBS is a multifactorial syndrome, where the main biomechanical and exercise based factors should be targeting while devising prevention and management strategies. Absence of warm up exercises (OR =3.10) and BMI being more than 25(OR =2.25) are also important and preventable risk factors in gym attending people.

The presence of ITBS among incline treadmill exercisers showed significantly more functional limitation as measured by significantly lowLEFS score (mean 52.4 vs 63.8, $p < 0.001$) and significantly more pain (mean 4.2 vs 2.8 on VAS, $p<0.001$) as compared to that among the ellipse exercisers. These findings indicated the necessity of early identification of treadmill associated ITBS for improved functional outcomes and reduction in exercise attrition.

The overall incidence of ITBS was highest among female gender, both in tread mill exercisers (65.4%) as well as in the whole study population, which is in accordance with many published studies revealing women to be more biomechanically susceptible than men. Incline tread mill exercisers women, particularly, need focus on strengthening exercises for hip abductors and prevention of dynamic knee valgus in physiotherapy assessment and prescription of exercises in a gym setting.

This research adds a valuable piece of evidence to the ongoing accumulation of information about gym-related overuse injuries in the Pakistani and worldwide population. Its finding of a significant relationship between the use of incline treadmills and the occurrence of ITBS as well as identifying several key and changeable risk factors for this injury provides a rational evidence-base for physiotherapists, fitness professionals, gym owners and public health workers who aim to minimize the injury load in physically active people. Elliptical training serves as a biomechanically safer choice of cardio machine for people with increased risk for ITBS but still carries some risk that needs to be managed by adequate conditioning.

5.3 Recommendations

In light of the above study outcomes, the following recommendations should be given to physiotherapists and medical professionals working with a gym-going population.

All pre-exercise physiotherapy screens in individuals starting or advancing an incline treadmill training regime should include pre-screening for ITB tightness and hip abductor weakness with particular emphasis on the female and overweight BMI individuals.

A specific battery of tests that comprises Ober's Test, Modified Ober's Test, Noble Compression Test and Renne's Test should be used as a clinical battery to identify the early presentation of ITBS in asymptomatic or early-stage ITBS patients prior to functional limitations. All patients testing positive for the standardized ITBS test battery should complete LEFS to quantify functional loss and inform the rehabilitation goal-setting process.

Hip abduction strength should be at the core of all injury-prevention and rehabilitation programs for incline treadmill users. A hip abduction-strengthening program that addresses the gluteus medius, gluteus minimus, and external rotator muscle groups, with exercise choices that could include side-lying hip abduction, clamshells, lateral band walking, and single-leg squats, should be assigned to any patient identified at risk of ITBS.

Physiotherapists should counsel gym users and fitness trainers about the biomechanical risks associated with incline treadmill training, adequate program progressions and the importance of warm-up and cool-down routines, and signs of lateral knee pain.

In those presenting with an existing ITBS, a rehabilitation program with a clearly defined and progressive pathway incorporating pain-management strategies (guided by VAS scale),hip- and gluteal-strengthening exercises, biomechanical retraining to ameliorate dynamic knee valgus and progressive return to activity protocols is recommended; while foam rolling and stretching exercises may offer short-term pain-relief, they should not be the primary long-term treatment strategy as suggested by Opara and Kozinc (2023).

Use of the Visual Analog Scale should be recommended to track pain progression and determine return to full incline treadmill training at a score of less than three.

Fitness professionals serve a critical role as gatekeepers for preventing overuse injuries from gym-based exercise. The following recommendations are targeted at fitness professionals:

Pre-participation screening forms completed by new gym members should query previous lateral knee pain, prior ITBS history, hip weakness and past lower limb trauma. Individuals identified with a concern should be referred for a physiotherapy assessment prior to commencing treadmill incline exercise.

Incline treadmill training programs should follow the principle of progressive volume overload: a brief workout at low incline should commence followed by weekly increments in both incline grade and duration over 4-6 weeks. Sudden changes in incline or duration should not be made as they represent significant mechanical load jumps which may precipitateITBoveruse injury.

Gym instructors should be educated to recognize signs and symptoms of ITBS in clients, which include lateral knee pain during or after exercise, tenderness over the lateral femoral condyle and pain upon stair descent.Clients should be instructed to cease training volume and attend for physiotherapy assessment at the onset of any symptoms.

Warm up protocols including 5-10 minutes of dynamic activation drills targeting hip muscles (hip circles, lateral band walks, clamshells, high knees etc.) should be mandatory for all incline treadmill users and actively promoted by gym staff. Only 45.6% of tread mill users in this study reported regularly performing a warm up exercise routine.

Cardiovascular exercise using the elliptical trainer should be actively promoted as a less injury-prone alternative cardio option for individuals with a history of lateral knee pain, ITB stiffness or noted hip abductor weakness. Signage and guidance may be beneficial to promote informed equipment selection.

Gym facilities should have equipment inspected regularly for any wear and tear. Treadmill belts should move smoothly without stuttering or abnormal resistance, while elliptical and incline mechanisms should be well lubricated and smooth to minimize any additional, unnatural stresses on the ITB.

Individuals using incline treadmills regularly should incorporate into their regular exercise routine, strength training exercises to strengthen gluteal medius and external hip rotators at least 3 times per week.

All gym users should perform both a warm-up (dynamically focused) and cool down (statically focused on hips flexors, quads, hip abductors and IT band) on completion of any treadmill session. Static stretching of the ITB and foam rolling may be added to a post workout cool-down regime.

An individual reporting knee pain during or after treadmill work should decrease the load by significantly reducing their incline gradient and session volume, and seeking physiotherapy intervention to guide a safe return to normal training volume.

Overweight (25-29.9 kg/m 2) BMI individuals using incline treadmills should also be careful of their training volume and incline gradient, and may consider alternation with elliptical training to decrease total lateral knee loading.

Appropriate athletic footwear with good lateral support and cushioning is essential during any treadmill exercise. Running shoes that are worn out and have compromised lateral support can increase pronation and tibial rotation, which would further stretch the ITB.

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5.4 Final Remarks

This study adds a unique and welcome contribution to a small volume of comparative studies, reporting on ITBS prevalence between two modalities of indoor cardio training within a Pakistani gym population. As shown in the results,cline treadmill exercise poses a significantly greater burden of ITBS compared to elliptical training, and this trend is mediated by identifiable and modifiable biomechanical and training-related risk factors. These implications extend to physiotherapy, gym operations, personal training, and public health: by defining hip abductor weakness, dynamic valgus, high training volume, and insufficient warm-up as key risk factors, this study establishes a defined set of strategies for the prevention of ITBS which evidence-based clinicians and trainers may employ to improve and maintain the physical health of the ever-expanding gym-going community. At a wider level, this research corroborates the call for preventive physiotherapy intervention in gym and exercise facilities, especially given the rapid growth in Pakistan's fitness industry, where a significant need remains to improve awareness of overuse injury risk. A move towards safe exercise practices, controlled training progression, and a standardized assessment of the musculoskeletal system would be a beneficial and cost-effective approach to reducing the incidence of ITBS and overuse injuries in active populations. Therefore, for individuals predisposed to developing ITBS, elliptical exercise appears to be a more biomechanically sound option compared tocline treadmill exercise, and when incline treadmill exercise is engaged in, adequate hip strengthening, dynamic warm-up, progressive load management, and frequent clinical examination are warranted to optimize protection of the lateral knee.

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