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**Wrist Injury Prevention in Gymnastics:
Gymnast and Coach Perspectives**

A thesis
submitted in fulfilment
of the requirements for the degree
of
Master of Health Sport & Human Performance [Health Science]
at
The University of Waikato
by
SNEHA DALAL



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2025

Acknowledgements

I want to extend my heartfelt thanks to Prof. Patrick Rodrigues, Lecturer at the Division of Health – School of Sport and Human Movement. I genuinely value the time he dedicated to offering me invaluable support and guidance throughout my journey. His expertise and encouragement have significantly contributed to my personal and academic growth.

Many thanks to all the participants for their time in filling out the survey and sharing their knowledge on the subject. Special thanks to the institutes and the coaches who put their trust in me and shared their valuable insights to help this research be a success. I am grateful to Prof Brett Langley for his time from his busy schedule and for supporting me with my thesis planning. Special thanks to Atul for his help with survey data analysis.

I am using this opportunity to acknowledge all my family and friends who supported me throughout the journey of this research program. I am thankful for their aspiring guidance and friendly advice in achieving my goals. I am sincerely grateful to them for their belief in me, which has kept my spirits and motivation high during the process.

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Abstract

This study assesses the understanding and awareness of injury prevention programmes in minimising wrist injuries in gymnastics. The study uses a mixed-method approach, collecting extensive data via an anonymous online survey for gymnasts and their parents or guardians, and interviews with coaches. The research aims to understand program awareness, implementation, barriers, and outcomes from various perspectives. The findings from the study contribute to the existing body of knowledge on wrist injury prevention in gymnastics and provide valuable insights for improving training practices and program design to create safer gymnast-centric training programs. The study shows that flexibility and strength training alone do not significantly reduce wrist injuries in gymnastics, suggesting the need for a more comprehensive injury prevention approach. Findings also highlight the importance of balancing training frequency with adequate rest days to minimise injury risk. The lack of awareness and inconsistent implementation of injury prevention programs indicates a need for better communication and education among gymnasts, coaches and their parents/guardians. Interviews with coaches emphasise gradual training progression, strength building, and holistic well-being, underscoring the importance of a multifaceted approach to injury prevention. The study concludes that injury prevention programs must be prioritised and implemented effectively to further reduce the risk of wrist injuries, highlighting the importance of a multifaceted individualised approach to wrist injury prevention in gymnastics.

Introduction

Gymnastics is a sport that exemplifies the fusion of strength, agility, and grace, requiring athletes to perform a myriad of complex movements on various apparatuses. The Olympic disciplines of Artistic Gymnastics, Rhythmic Gymnastics, and Trampoline Gymnastics enjoy global popularity, as evidenced by the considerable media coverage they receive during the quadrennial Olympic Games (Caine et al., 2013). The Gymnasts achieve this extraordinary performance through years of rigorous training, mental resilience and unwavering dedication, inspiring generations and redefining excellence in the sport (Abad-Santos, 2024; Time, 2024). However, in the pursuit of excellence in gymnastics, there is an inherent risk of injuries. Athletes, especially in gymnastics, often start training at a comparatively young age, work rigorously to achieve peak physical condition, and strive for perfection in their routines, pushing the boundaries of human capability and joint mobility (Root et al., 2019). Elite gymnasts may initiate training as early as 4 or 5 years of age and quickly accelerate the difficulty and intensity of their training (Webb & Rettig, 2008). On most days during the week, elite-level gymnasts usually have two practice sessions a day, one to four hours each, and they have one rest day per week. Typically, they train 20 hours per week, while the peak season may require as many as 30 to 40 hours of training per week (Malina et al., 2013). According to a blog released by Strategic Market Research in August 2023; gymnastics injuries average 100,000 yearly, with wrist and ankle sprains being the most frequent (Team, 2023). It is important for gymnasts and people associated with sports training to be mindful of the risks and take preventive measures to avoid such injuries.

The demands of gymnastic training and competition, with repetitive stress and high impact on the upper extremities, often result in distinct injury patterns in the upper limb, including skeletal trauma and muscular or ligamentous injuries (Emily, 2020). Furthermore, participation occurs at a relatively young age, which means that these conditions frequently impact athletes who are still growing, leading to concerns about their future growth and long-term consequences, performance, longevity in the sport, and overall well-being (Maffulli et al., 2010).

The prevalence of wrist sprains, strains, fractures, and overuse injuries in gymnastics is well-documented in the literature, highlighting the need for targeted interventions to mitigate this risk (Hume et al., 2013). Wrist injuries not only result in pain and discomfort but can also lead to long-term complications such as reduced range of motion, chronic instability and osteoarthritis (contributors). Ultimately, these jeopardise an athlete's ability to perform at their peak and increase the likelihood of early retirement from the sport. Many times, a sports injury may lead to a lifelong disability, leaving the athlete and their family with a deep, long-term impact (Theobald & Dennis, 2022).

Injury prevention programs in sports are based on proactively identifying and reducing risk factors associated with specific injuries (Abernethy & Bleakley, 2007). These programs typically encompass a multifaceted approach, including strength and conditioning exercises, flexibility training, technique refinement, and education on proper biomechanics and injury mechanisms. They may also include hydration and nutrition, along with cross-functional training (Binder; Hospital; Newman, 2024; Theunissen, 2024). The “best” injury prevention program is one that can and will be adopted and sustained by athletes, coaches, and sporting bodies (Emery & Pasanen, 2019). While injury prevention programs have shown promise in various sports, their

efficacy in the context of gymnastics, particularly in reducing wrist injuries, remains a topic of ongoing research and debate.

Despite the growing recognition of the importance of injury prevention in every sport, including gymnastics, there is a paucity of comprehensive research evaluating the impact of injury prevention programs specifically tailored to reducing wrist injuries. Some existing studies have provided valuable insights into the prevalence and mechanisms of wrist injuries in gymnasts and return to play post-rehabilitation but have failed to evaluate the efficacy of injury prevention interventions (Hart et al., 2024). Existing research has not adequately gathered data on the practical impact and reception of injury prevention programs in gymnastics, which is crucial for tailoring effective interventions in real-world settings (Daly et al., 2001). Most studies rely on systematic reviews and literature studies, with some discussing the efficacy of external aids (Thomas & Thomas, 2019). Furthermore, while past and recent research emphasizes the effectiveness of injury prevention programs, very few have evaluated their impact from the viewpoint of the main stakeholders in the sport—the gymnasts and the coaches (Patel et al., 2021). Current research highlights the prevalence of wrist injuries among gymnasts, but there is a noticeable gap in comprehensive studies evaluating the effectiveness of injury prevention programs through direct feedback and perspectives from gymnasts and coaches (Martinez et al., 2024; Patel et al., 2021).

This study addresses this gap by utilising surveys and interviews to gather in-depth insights from the key stakeholders involved by integrating both quantitative and qualitative data to provide a comprehensive understanding of the strengths and challenges associated with wrist injury prevention programs, as perceived by gymnasts and coaches. This dual approach allows for a nuanced exploration of the efficacy of such programs in addressing the specific needs and

perspectives of these stakeholders. Additionally, the coaches' approach and inputs on wrist injury prevention provide a rationale to improve the effectiveness of injury prevention programs specifically for the wrist joint.

By conducting a comprehensive assessment of program effectiveness, adherence, and long-term outcomes, this study seeks to contribute to the development of evidence-based guidelines for injury prevention in gymnastics. Ultimately, the findings of this research have the potential to inform coaching practices, athlete training protocols, and sports medicine interventions aimed at minimising the incidence and severity of wrist injuries in gymnastics, thereby safeguarding the health and performance of gymnasts at all levels of competition.

Literature review

The sport of gymnastics emphasises strength, flexibility, agility, and coordination. Artistic gymnastics is the most well-known and widely practised discipline of gymnastics, featuring both men's and women's events. Athletes perform routines on various apparatuses, including the vault, uneven bars, balance beam, and floor exercise (*Gymnastics New Zealand*). Rhythmic Gymnastics, heavily influenced by ballet and modern dance, merges sport and art as gymnasts perform breathtaking routines to music, skilfully using hand-held apparatus like hoop, ball, clubs, ribbon, and rope, either individually or in groups (*Gymnastics New Zealand*). The sport requires discipline, dedication, and perseverance as gymnasts strive to master challenging skills and improve their performance over time. In addition to its competitive aspect, gymnastics also serves as a recreational activity for individuals of all ages and abilities, promoting health, fitness, and social interaction. According to new research from the Australian Sports Commission, an estimated 122,000 more Australian children participated in gymnastics in the year 2023

compared to the year before. The research found that the gymnastics is now the second most popular activity in Australia for girls, with 465,000 participants, and is ranked fifth for boys, with 191,000 participants (*Australian Sports Commission, 2023*). However, there is a concern about the potential risks and long-term effects of injuries for young gymnasts due to the increased involvement and difficulty of skills practiced at an early age, alongside the rigorous training required for competition (Dennis J. Caine et al., 2013). Gymnastics is a sport that demands a high level of physicality, requiring athletes to perform a variety of dynamic movements, jumps, flips, and landings. Performing these movements comes with an inherent risk of injury due to their high impact. The dynamic and high-impact nature of the sport places significant stress on the musculoskeletal system, making gymnasts susceptible to a range of injuries, including sprains, strains, fractures, and overuse injuries (Emery et al., 2016). Common injury sites include knee, ankle, shoulder, elbow, wrist and spine (Dennis John Caine et al., 2013). Of these, wrist injuries are particularly prevalent due to the repetitive stress placed on the wrist joint during dynamic weight-bearing activities such as handstands, tumbling, and apparatus routines. Some of the most common injuries in gymnastics are sprains and strains, fractures, dislocations, torn ligaments or tendons, back injuries, concussions, and overuse injuries. The classification of these injuries can be organised based on the nature of the injury, the affected body parts, and the severity of the injury ((NIAMS), 2024) (Contributors, 2024b) (Table 1).

Table 1 Classification of Injuries Associated with Gymnastics

<i>CLASSIFICATION</i>	<i>TYPE OF INJURY</i>	<i>EXAMPLES</i>
<i>Nature of Injury</i>	<i>Acute Injury</i>	<i>Sprains: Ankle sprain, wrist sprain Strains: Hamstring strain, lower back strain Fractures: Colles' fracture, stress fracture of the metatarsals</i>

		<p>Dislocations: Shoulder dislocation, finger dislocation</p> <p>Contusions: Muscle bruise, bone contusion</p>
	Chronic Injury	<p>Tendinitis: Rotator cuff tendinitis, patellar tendinitis</p> <p>Stress Fractures: Tibial stress fracture, metatarsal stress fracture</p> <p>Bursitis: Subacromial bursitis, trochanteric bursitis</p> <p>Shin Splints: Medial tibial stress syndrome</p>
Affected Body Part	Upper Limb Injury	<p>Shoulder Injuries: Rotator cuff tendinitis, labral tears, shoulder dislocation</p> <p>Elbow Injuries: Medial epicondylitis (golfer's elbow), lateral epicondylitis (tennis elbow)</p> <p>Wrist and Hand Injuries: Scaphoid fracture, wrist sprain, finger dislocation, De Quervain's tenosynovitis</p>
	Lower Limb Injury	<p>Knee Injuries: Anterior cruciate ligament (ACL) tear, meniscus tear, patellar tendinitis</p> <p>Ankle Injuries: Ankle sprain, Achilles tendinitis, lateral malleolus fracture</p> <p>Foot Injuries: Metatarsal stress fracture, plantar fasciitis, turf toe</p>
	Spinal and Core Injury	<p>Back Injuries: Lumbar sprain, spondylolysis, herniated intervertebral disc</p> <p>Hip and Groin Injuries: Hip flexor strain, labral tear, iliopsoas tendinitis</p>
Severity of Injury	Minor Injuries	Bruises, minor ankle sprain, grade I muscle strain
	Moderate Injuries	Grade II ligament sprain, moderate muscle strain, non-displaced fracture
	Severe Injuries	Complete ligament tear (grade III sprain), displaced fracture, joint dislocation, severe overuse injuries requiring surgery, such as rotator cuff tear

The risk factors include comparatively young age (10-14 years), training intensity, earlier onset of training, radial epiphysitis, continuing loading of a stress-injured wrist, lack of seeking timely medical attention, close medical supervision, lack of consensus on injury definition, gradual onset of overuse injuries, and limited research specifically on wrist injuries in gymnastics (Kox et al., 2015).

Wrist injuries can range from sprains and strains to fractures and overuse injuries. About 73.4% of gymnastics injuries are due to overuse (Lindner, 2024). The onset of injury is discomfort and pain in the wrist joint, and between 46% and 87.5% of gymnasts experience this pain at some point in their careers (Stephanie Choo, 2021).

According to the latest study on the epidemiology of gymnastics injuries, upper limb fractures (10.5%) were the most commonly reported injuries, whereas overuse injuries (10.5%) were the most frequently reported injuries sustained to upper limbs (Williams et al., 2023). Gymnasts aged 10 to 13 accounted for 50% of upper limb fractures and 40% of sprains. Gymnasts aged 14 to 17 accounted for 62.5% of all upper limb overuse injuries (Williams et al., 2023).

Injury Statistics

Injury rates among gymnasts are among the highest in any sport at the high school and collegiate level per athletic exposure (Benjamin et al., 2017). Data published by the U.S. Centers for Disease Control and Prevention in their Morbidity and Mortality Weekly Report cited an injury rate for women's collegiate gymnastics of 10.4 (9.5-11.2) per 1000 Athletic Exposures (AE) (Benjamin et al., 2017). A study reported that from 2001 to 2011, 64 male gymnasts sustained 240 injuries, while 55 female gymnasts sustained 201 injuries, resulting in rates of 8.78 per 1000 AE for men and 9.37 per 1000 AE for women (Westermann et al., 2015). A retrospective analysis

of injury data collected over six seasons from 2014-2020 found that a mean of 91.4% of 111 participating gymnasts had at least one injury per season, with an average of 2.6 injuries per gymnast each season (Charpy et al., 2023). In another study analysing women's gymnastics exposure and injury data gathered from 2014-2015 through 2018-2019 by the National Collegiate Athletic Association (NCAA), it was reported that the overall competition injury rate was higher than the overall practice injury rates (Chandran et al., 2021). Most injuries were classified as strains (16.5%), sprains (16.4%), and inflammatory conditions (12.3%), with overuse injuries being particularly prevalent among practice injuries (22.5%) (Chandran et al., 2021). According to the study, concussions were the most reported injuries, with an injury rate of 8.4% among athletes (Chandran et al., 2021). One study on paediatric injury pathologies indicated that upper limb fractures and overuse injuries were the most frequently reported injuries sustained to upper limbs, comprising 10.5% of all injuries (Farana et al., 2023). Gymnasts aged between 10-13 years accounted for 50% of upper limb fractures and 40% of sprains, while those aged between 14-17 years represented 62.5% of all upper limb overuse injuries (Williams et al., 2023). Descriptive analysis showed that injury incidence and prevalence varied from 0.3 to 3.6 injuries per gymnast, with female gymnasts experiencing between 0.3 to 3.6 injuries and male gymnasts averaging 0.7 injuries (Campbell et al., 2019). Floor exercises were associated with the greatest number of injuries for both male and female gymnasts, with the floor identified as the major apparatus linked to the highest number of injuries, ranging from 15.0% to 58.0%. The most frequent injury locations were the lumbar spine (13.5%), knee (10.9%), and wrist (9.4%). The most common injury type was ligament sprains, accounting for 19.0% of all injuries (Campbell et al., 2019). Wrist injuries are among the most prevalent types of injuries in gymnastics, comprising approximately 10% to 20% of all

gymnastics-related injuries. A study by Lystad et al. (2019) found that the wrist/hand was the most injured body part among artistic gymnasts, accounting for 20.6% of all reported injuries. Studies have shown that there are gender differences in gymnastics injury rates and patterns. Earlier studies indicated that female gymnasts tend to sustain injuries at a higher rate compared to male gymnasts (Caine & Nassar, 2005). Recent studies have found that male gymnasts mainly sustain upper limb injuries, while female gymnasts report lower limb injuries (Campbell et al., 2019). A study spanning from 2001 to 2011 found similar injury rates for male and female gymnasts, with men experiencing more hand and wrist-associated injuries and women suffering more ankle and foot injuries (Westermann et al., 2015).

Wrist injuries can significantly impact a gymnast's ability to train and compete. Athletes affected by wrist injuries may experience pain, swelling, and functional limitations, hindering their performance and training progression. Lystad et al. (2019) found that wrist injuries resulted in an average of 16 days of time lost from training or competition, highlighting the substantial impact of these injuries on gymnasts' participation and performance. Rehabilitation typically involves immobilisation, physical therapy, and gradual return-to-sport protocols, with recovery times ranging from 4 to 12 weeks, depending on the severity and nature of the injury. Approximately one in four Olympic gymnastics athletes will experience a career-ending injury (Lindner, 2024). A cross-sectional study of retired British Olympians, covering 36 Olympic Games from Berlin 1936 to Sochi 2014, revealed that gymnasts had a high lifetime injury prevalence, with 75.0% reporting injuries, of which wrist injuries constituted 3.5% of overall injuries (Cooper et al., 2021).

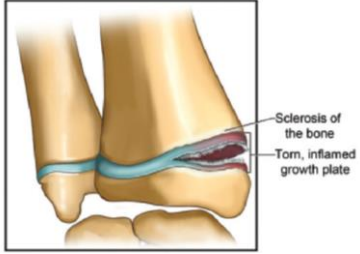

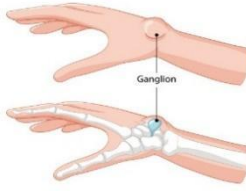
Wrist Injuries in Gymnastics

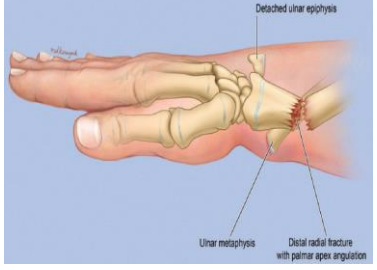

In gymnastics, the hands and upper limbs are crucial in supporting weight and enduring high-energy, repetitive axial loads. These features distinguish gymnastics as a sport that uniquely challenges these body parts. Indeed, wrist pain has been reported in up to 88% of gymnasts (Mauck et al., 2020). Several factors contribute to the risk of wrist injuries, including, improper hand placement, inadequate wrist alignment, and faulty landing mechanics, all of which can increase the stress on the wrists and predispose gymnasts to injury (Tilley, 2013). Worn-out or improperly maintained equipment, such as worn grips or uneven landing surfaces, can increase the risk of falls and injuries. Factors such as age, skill level, flexibility, and prior injury history can influence an athlete's susceptibility to wrist injuries (Kara et al., 2023).

Overtraining without adequate rest and recovery can analyse injury statistics in gymnastics to reveal essential insights into the frequency, characteristics, and consequences of injuries in the sport (Kox et al., 2020) (Rogers). Chronic overuse of the wrist can lead to various repetitive strain injuries, such as tendonitis-inflammation of the tendons, tenosynovitis-inflammation of the tendon sheath, and stress fractures. According to USA Gymnastics, over 40% of gymnastics injuries are due to overuse and are almost always preventable. Wrist sprains occur when the ligaments supporting the wrist joint are either stretched or torn, typically due to a sudden force or impact. Strains involve stretching or tearing of the muscles or tendons surrounding the wrist joint. Both sprains and strains can result in pain, swelling, bruising, and limited range of motion in the wrist (Emery et al., 2016). Fractures of the wrist bones, such as the scaphoid, radius, and ulna, can occur from falls, improper landings, or excessive loading on the wrist joint. Fractures may be simple (closed) or compound (open), and symptoms can include severe pain, swelling, deformity, and difficulty moving the wrist (Caine & Nassar, 2005). The distal radial physis is a

common site for injury in gymnasts because of the significant amount of load applied during upper extremity weight-bearing (Mauck et al., 2020) (Table 2). Some of the most commonly seen wrist injuries associated with gymnastics are_ Distal Radial Epiphysitis (Gymnast’s Wrist), Dorsal wrist impingement, Scaphoid stress fracture, Scapholunate and Lunotriquetral ligament injury, TFCC injuries, Ulnar impaction, De Quervain’s Tenosynovitis and Intersection syndromes (Benjamin et al., 2017) (Webb & Rettig, 2008).

Table 2 Common Wrist Injuries in Gymnastics

Common Wrist Injuries	Cause	Signs	Orientation
Distal Radial Physeal Syndrome (Gymnast’s Wrist)	Repetitive weight-bearing or pounding on the hands like in back handspring, vaulting, etc	Injury or inflammation to the radial growth plate	
Triangular Fibrocartilage Complex Tear (TFCC)	Fall or landing with the arm out in front or from repetitive overuse in positive ulnar variance	Pain in wrist extension or weight bearing in the wrist in the ulnar side	<p>TFCC Injury</p> 
Ganglion Cyst	Usually occurs post tendon or joint injury or sometimes without any previous injury	Lump or ball of fluid. May cause pain if pushing or pinching to a nerve or into the joint	<p>Ganglion Cysts</p> <p>Fluid-filled lumps that commonly develop along the tendons or joints of the wrists or hands.</p> 

Grip lock injuries	While performing a circular movement on an uneven bar, high bar or ring using an external grip	Fracture of the forearm causing immediate pain and deformity	
Scaphoid Fracture	Landing or falling in an outstretched hand	Pain on scaphoid bone	<p>Scaphoid Fracture</p> 

These injuries often develop gradually over time and are characterised by persistent pain, stiffness, and weakness in the wrist ((NIAMS), 2024). During adolescence, it has been found that boys have a higher likelihood of experiencing injuries compared to girls. Additionally, it was observed that wrist and lower arm fractures were more prevalent during childhood as opposed to adolescence, with a particular emphasis on occurrences among girls (Tisano et al., 2022). In a retrospective cross-sectional study by Benjamin et al. (2017), which queried the National Electronic Injury Surveillance System (NEISS) for all gymnastics-related musculoskeletal injuries treated in Emergency Rooms between 2013 and 2020. Most visits involved athletes aged 6 to 15 (84.0%); with a rate of 480.7 per 100,000 person-years. Younger gymnasts between the ages of 6 to 10 were most likely to experience a lower arm fracture, while those over the age of 10 years were most likely to experience an ankle sprain (Benjamin et al., 2017). Men and boys presented with a much greater proportion of shoulder injuries (8.0% vs 3.9%), while women and girls presented with a greater proportion of elbow injuries (9.9 % vs 5.9%) and wrist (10.5% vs 8.3%) injuries (Benjamin et al., 2017).

The wrist joint is a complex structure in the human body and a crucial joint that connects and serves as a transition point between the forearm and hand (Erwin & Varacallo, 2023). The wrist comprises 8 small bones called carpal bones, and their articulation with the forearm bones, radius & ulna (**Figure 9**). These eight carpal bones can be divided into two rows: the distal row and the proximal row. The distal row articulates with metacarpal bones that form the palm, while the proximal row articulates with the forearm bones to form the wrist joint. Three major joints in the wrist are formed by the combination of these bones: the radiocarpal joint, ulnocarpal joint, and distal radio-ulnar joint. The cluster of these tiny carpal bones in the wrist joint gives it ultimate strength, mobility and flexibility. The wrist joint would not offer the same flexibility in movements and mobility along with a strong grip if there were fewer bones in the joint (Eschweiler et al., 2022).

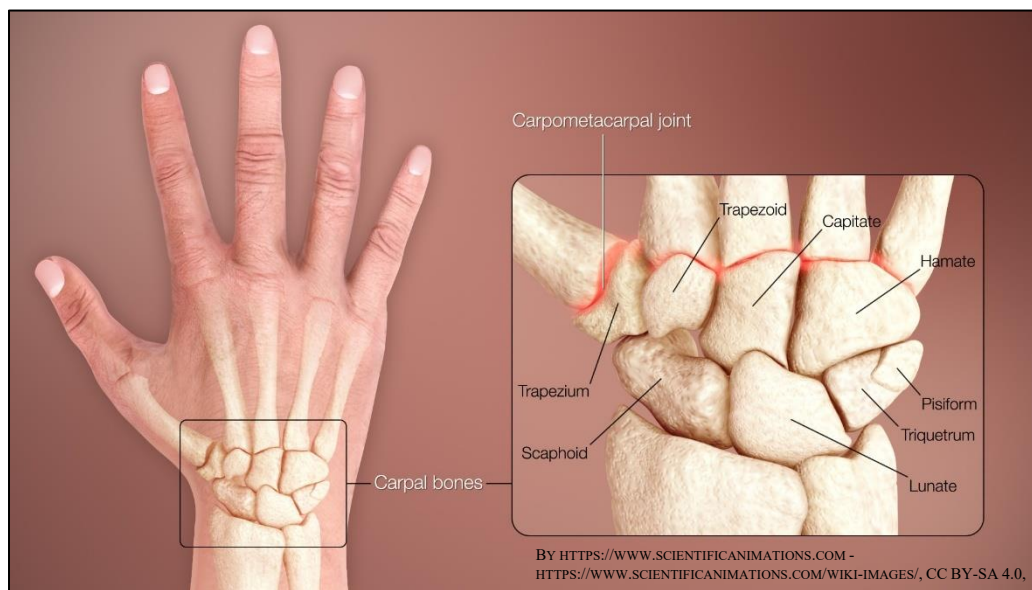


Figure 1 Joint Structure of the Wrist Joint

Apart from its complex bony structure, the wrist joint comprises ligaments, tendons and nerves. The wrist ligamentous structure is extremely complex, comprising 33 intra-articular and intra-capsular ligaments (Eschweiler et al., 2022). The muscles causing wrist joint movements are

situated outside of the wrist joint, within the forearm, while their tendons crossing the wrist joint and inserted into the hand or fingers. Of the numerous muscles in the forearm, six muscles are inserted at the carpal bones or the base of the metacarpal bones (Eschweiler et al., 2022). These six muscles are dedicated solely to the wrist and contribute to moments of the wrist joint (Bawa et al., 2000).

The wrist joint is designed to facilitate a wide range of movements, including flexion, extension, radial and ulnar deviation, supination and pronation (Contributors, 2023)(**Figure 10**). Wrist motion is a complicated interaction of seven carpal bones excluding the pisiform which is a sesamoid bone and the forearm. Each of them with a separate motion axis yet is interdependent on the position of adjacent carpal components and the carpal alignment with the distal radius (Eschweiler et al., 2022).

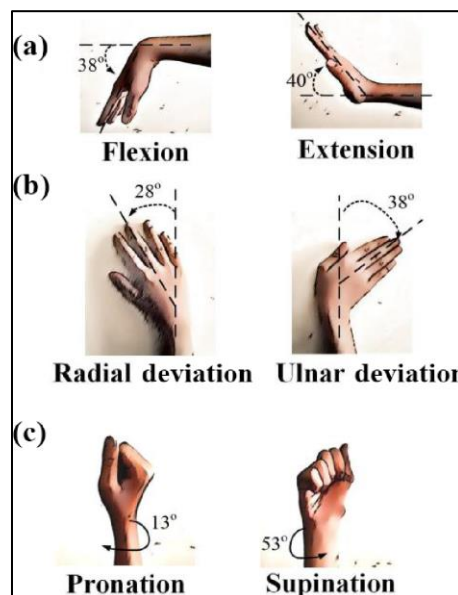


Figure 2 Movements of the Wrist Joint

These movements are essential for performing various activities that require dexterity and strength. All these movements combined provide the utmost mobility and stability to the joint

along with the strength to perform daily tasks when performed in its active range of motion. Range of motion (ROM) is the capability of a joint to go through its complete spectrum of movements, either passive or active. The passive range of motion (PROM) is the one that can be achieved when an outside force is applied to the joint, and usually defines, the maximum range that a joint can achieve without any harm to the joint or its supporting structures. An active range of motion (AROM) is the joint movements caused by an active contraction and relaxation of the opposing muscles supporting the joint. Apart from AROM & PROM, the functional ROM is also important in understanding joint biomechanics. The functional ROM is the range of any joint required for an individual to perform their activities of daily living with maximum independence in optimal conditions (Contributors, 2024a). The functional ROM for the wrist joint movements is described in Table 3 (Palmer et al., 1985) (Nelson et al., 1994).

Table 3 Functional ROM for the Wrist Joint

<i>MOVEMENT</i>	<i>FUNCTIONAL ROM</i>	<i>NORMATIVE RANGE OF MOTION (ROM)</i>
Flexion	5°	80 - 90°
Extension	30°	70 - 90°
Ulnar Deviation	15°	30 - 45°
Radial Deviation	10°	15°

The unique skillset required to perform a variety of routines in gymnastics, together with the complex structure of the wrist joint, makes it susceptible to pain and injuries. The upper extremity, specifically the wrist, plays a crucial role in gymnastics due to its importance in executing skills, generating power, absorbing energy, and being part of the kinetic chain while performing weight-bearing tasks like handstands, tumbling, vaults and similar skills (Tilley, 2013) (Elizabeth J. Bradshaw & Patria A. Hume, 2012). Pain is common while performing these tasks. Some of the studies on biomechanics suggest that up to 2.5 times an athlete's body weight force can be loaded during some gymnastics skills with weight bearing on the upper extremity,

and these loads can rise to 5 times during heavy tumbling and vaulting (Tilley, 2013). Unlike the ankle and foot, the wrist and hand joint structures are not designed to be heavy weight-bearing. Furthermore, the wrist is exposed to many different types of stresses, including axial compression, torsional forces, and distraction in gymnastics, all of which compromise joint stability during excessive loading of the forces (Webb & Rettig, 2008). These repetitive compressive loading and shear forces combined with varying degrees of ulnar and radial deviation and hyperextension of the wrist predispose the joint to higher rates of injury during gymnastics (Webb & Rettig, 2008). Such information is crucial for crafting targeted injury prevention programs, refining safety protocols, and improving gymnasts' overall health (E. J. Bradshaw & P. A. Hume, 2012).

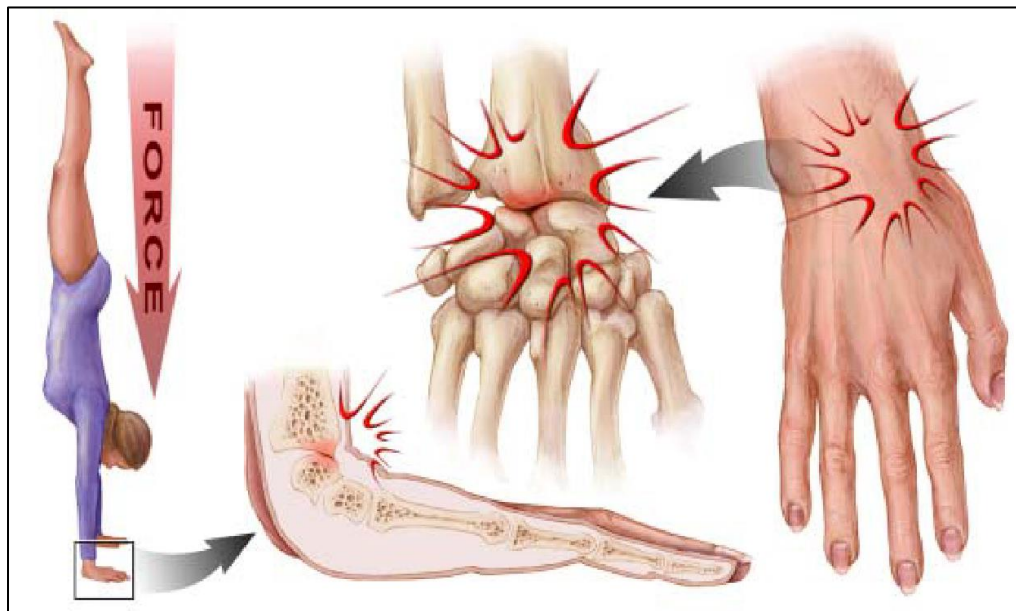


Figure 3 Wrist Joint Loading By [_www.hughston.com](http://www.hughston.com)

Impact of Injuries on the Life of Athletes

Wrist injuries can have significant long-term effects on both the life and athletic performance of gymnasts. Chronic pain and discomfort are some of the most common side effects. Persistent pain in the wrist can be a constant issue in gymnasts, affecting daily activities and overall quality of life. Pain may worsen with activities involving wrist loading and can trigger the pain. Along with pain, the gymnast can experience reduced ROM and grip strength (Guerra et al., 2016). This can limit a gymnast's ability to perform certain manoeuvres and skills, potentially affecting their performance and progression in the sport (Dennis J. Caine et al., 2013). Over time, wrist injuries can increase the risk to development of arthritis at early age, particularly if the injuries involve damage to the cartilage. This can again result in chronic pain, stiffness, and further reduced mobility (Avery et al., 2016). Repeated injury to the wrist joint and inflammation of the soft tissues like tendons, muscles and sheaths surrounding these tissues can lead to pain, swelling and difficulty moving the wrist in the long term. Sometimes severe, improperly healed or chronic injuries may require surgical interventions (Franca Bisneto et al., 2020). Surgeries have their risks and can lead to prolonged recovery periods. Moreover, post-surgery rehabilitation can sometimes take longer than expected, further impacting a gymnast's career and daily life. The demands of the sport require healthy wrists, as ongoing issues can impact a gymnast's career, causing them to miss potential opportunities, career-changing breaks or even sometimes shorten a gymnast's career or end up in a long time loss (Guerra et al., 2016). In addition to the physical impacts, long-term injuries and ongoing rehabilitation can result in psychological effects such as frustration, anxiety, and depression due to chronic pain and limitations (Crossman, 1997).

Injury Prevention Strategies

There are some important injury prevention guidelines provided for the coaches under the guideline of FIG (International Gymnastics Federation) (Binder).

1. Reduce Acute Injuries with common sense and safety awareness:
 - Follow proper skill progression order
 - Use the right kind of spot and spotter
 - Create a safe environment at practice and competition
 - Know when to use mats, belts, pits and trampolines
 - Eliminate “goofing around” or rough play
 - Don’t try to work when athletes too fatigued or sweaty
 - Teach athletes to report any injury early
 - Speak to older coaches about prevention strategies they use
2. Reduce Chronic Injuries with common sense and program design:
 - Cross-train with low impact or low weight work (elliptical, EFX, biking, swimming, weights)
 - Pre-season conditioning- low weight, high repetition, avoid fatigue, discipline specific
 - Logical training allowing muscle recovery and some time off between seasons
 - Create an environment that encourages early reporting of injuries for early treatment
 - Teach coaches to be aware of signs of chronic and overuse injuries
 - Use acute injury prevention strategies to prevent chronic ones
 - Reduce “wear and tear” repetition

A study on injury prevention strategies concluded that effective prevention strategies focus on preseason conditioning, functional training, education, balance and sport-specific skills, which should be continued throughout the sporting season (Abernethy & Bleakley, 2007). Another study summarises that the appropriately graded prescription of high training loads should improve players' fitness, which in turn may protect against injury, ultimately leading to more significant physical outputs and resilience in competition (Gabbett, 2016). A systematic review, qualitative analysis and meta-analysis on strength training concluded that increasing strength training volume and intensity were associated with sports injury risk reduction (Lauersen et al., 2018). A comprehensive warm-up programme designed to improve strength, awareness, and neuromuscular control can prevent injuries in young female footballers. The risk of injury can be reduced by about one-third and the risk of severe injuries by as much as half (Soligard et al., 2008).

Knowledge Gap

Wrist injuries frequently occur in gymnastics because of the sport's intense, weight-bearing activities. While some injury prevention programs have been implemented to address wrist injuries in gymnastics, many are not specifically designed for the sport. Current research often focuses on general upper extremity injury prevention, with limited emphasis on wrist-specific strategies. The components of injury prevention programs- such as flexibility training, strength conditioning, and bracing- are frequently examined in isolation rather than as part of an integrated approach (Heck et al., 2021; Lauersen et al., 2018; Soligard et al., 2008). Current evidence strongly advocates for wrist braces as protective gear to prevent wrist pain and injuries in gymnasts, while also identifying critical gaps regarding brace design and application (Stephanie Choo, 2021). A review published in the *British Journal of Sports Medicine* identifies

key injury countermeasures in gymnastics, including physical preparation, education, proper technique, and a supportive health system. This holistic approach underscores the necessity of combining various preventive strategies rather than relying on isolated interventions (Daly et al., 2001). Additionally, the literature lacks comparative analysis that considers variables like age, gender, skill level and competitive context, which are crucial for developing targeted and adaptable interventions. There is also insufficient exploration of coaches' and gymnasts' perceptions of these programs, which directly impacts adherence and long-term implementation. A study identifies a high incidence of overuse injuries in artistic gymnastics and suggests that injury prevention programs may need to be tailored differently for male and female gymnasts (Campbell et al., 2019). However, the study does not provide a comparative analysis of different prevention strategies or their adherence rates among athletes and coaches (Campbell et al., 2019). A systematic review identifies key injury countermeasures in gymnastics, including coaching techniques, equipment modifications, and health support systems (Dennis J. Caine et al., 2013). While these components are crucial, the review does not offer insights into the comparative effectiveness or feasibility of implementing these measures in various gymnastics environments (Dennis J. Caine et al., 2013). Several studies have also identified common challenges coaches face in implementing injury prevention programs, including limited time, financial constraints, and a lack of injury prevention knowledge. For instance, a systematic review highlighted that frequently reported barriers to implementing injury prevention training programs include the perceived time and financial burden, as well as coaches lacking confidence in their ability to implement the programs properly (Minnig et al., 2022).

After closely studying the scientific literature, the following questions become evident from the existing work literature:

1. What existing injury prevention programs and interventions have been implemented within gymnastics settings to address wrist injuries, and what are their component and outcomes?
2. How do injury prevention programs designed to target wrist injuries in gymnastics compare their effectiveness, feasibility, and adherence among athletes, coaches, and other stakeholders?
3. What are the barriers, challenges, and facilitators associated with the implementation and sustainability of injury prevention programs aimed at reducing wrist injuries in gymnastics?

Addressing these questions requires a multifaceted research approach that integrates both quantitative and qualitative methodologies, drawing on an understanding of the key stakeholders in the sport—gymnasts, their parents or guardians, and coaches—regarding the concept of injury prevention programmes tailored to wrist injuries. By elucidating the underlying mechanisms, evaluating existing interventions, and identifying best practices, this research aims to advance our understanding of injury prevention strategies in gymnastics and facilitate informed decision-making to promote the health and longevity of gymnasts.

Methodology

Participants

The subjects for this study included gymnasts, their parents or guardians, and gymnastics coaches. 53 individuals participated in the online survey, but only 22 completed it thoroughly. Among them, 12 were gymnasts over 16, five were parents or guardians of gymnasts aged 5-16, and four were gymnasts aged 5-16 who completed the survey with parental assistance. In addition to the survey participants, four gymnastics coaches were selected for semi-structured interviews. These coaches represented various levels of competition, including grassroots or recreational gymnastics, regional competitions, national-level events, and elite or international competitions. Ethical approval for the research was secured from The University of Waikato's ethics committee under the reference number HREC(Health) 2023#66. Ethical considerations were strictly followed, with informed consent obtained from all the subjects before participation. The survey featured a landing page with detailed information about the survey. Five selection boxes displayed on the landing page at the end of the information section contained information regarding the participant's age. Participants had to choose from options such as ages 5-16 years and taking the survey with a parent or guardian, parents or guardians of gymnasts aged 5-16 years, gymnasts taking the survey who are 16 years or older, and questions regarding consent, indicating whether they give consent or do not give consent. The survey questions were only visible after selecting the appropriate combination and consenting to use the information. The survey was designed to collapse and close the page if inappropriate selections were made, preventing participants from proceeding further. Anonymity and confidentiality were maintained throughout the study. For the interview recruits, detailed information about the survey was sent

via email to the gymnastics academics, and from there, it was forwarded to the coaches to encourage their participation. Interested coaches were then sent a separate email once again with details about the research and their role in the survey, along with consent forms to be signed. E-signed consent forms were collected from them. Moreover, they were also asked about their consent to participate at the beginning of the interview. After the interview, the coaches were sent the transcripts and were asked to give their consent or withdraw their participation within seven days. All the participants agreed to continue with their involvement and did not withdraw.

Data Source

Qualitative and quantitative data were collected from coaches, gymnasts, and their parents or guardians using a mixed-methods approach. An anonymous online survey was conducted to gather quantitative data on the experiences and knowledge of injury prevention programs among gymnasts and their parents or guardians. The second part of the research involved online interviews with coaches from different backgrounds to gather qualitative data on their perspectives regarding the implementation and barriers of injury prevention programs used in gymnastics, with a focus on the wrist.

A systematic search was conducted in FIG, PubMed, Research Gate, OrthoInfo, Physio Inq, Exercise New Zealand, ScienceDirect and Google Scholars to gather information about similar research in sports medicine. The data was scanned to find any evidence of literature for similar studies, specifically in relation to wrist injuries in sports. This database search provided a foundation for understanding current practices and gaps in injury prevention. Moreover, it helped to develop a detailed questionnaire to cover all the necessary aspects required to evaluate the impact of injury prevention programs in reducing the risk of injuries.

Survey Questionnaire

The survey was designed to collect extensive information regarding the implementation and popularity of injury prevention programs among gymnasts. The survey questions for the study were designed to collect comprehensive data on gymnast demographics, training routines, injury history, awareness of injury prevention programs, and the effectiveness of such programs.

Demographic questions, including age, gender, years of experience, and competition levels, were included to categorize respondents and assess injury risks at different developmental stages.

Training details, such as weekly training hours, rest periods and cross-training activities, were collected to evaluate training intensity and its relationship with injury prevalence. Questions regarding wrist injury history were aimed at identifying common injury patterns, severity, and recovery time, providing insights into the necessity of injury prevention measures. Additionally, the survey assessed participants' familiarity with injury prevention programs, their sources of knowledge, like coaches, research and workshops, and whether they had received specific training on wrist injury prevention. Participants were asked to identify known injury prevention strategies, rate their importance, and report on their implementation frequency to measure the effectiveness of injury prevention programs. The survey also examined gymnasts' perceptions of the impacts of these programs, including reduced injury rates, improved performance, and better technique. Furthermore, coach involvement and support questions were included to evaluate the coaching staff's role in injury prevention. Participants were also asked to identify potential reasons for injuries and suggest additional resources that could enhance prevention efforts. Finally, open-ended questions allowed gymnasts to provide recommendations for improving wrist injury prevention programs and share their personal experiences.

Interview Schedule

The interview questions aimed to collect detailed qualitative insights from gymnastics coaches about their experiences, perceptions, and challenges in implementing injury prevention programs for wrist injuries. It began by assessing the coaches' backgrounds—such as their experience, coaching levels, and involvement in injury prevention programs—to gauge their expertise and familiarity with prevention strategies. Questions regarding program implementation investigated whether specific wrist injury prevention initiatives were established, how they were communicated to gymnasts, and the coaches' roles in evaluating their effectiveness. For those coaches already implementing injury prevention programs, additional questions focused on any observed changes in gymnast behaviour, reductions in injury rates, and the overall success of these programs. Further inquiries pinpointed challenges encountered during implementation, strategies for overcoming these obstacles, and key factors that lead to effective programs. Coaches were also encouraged to provide suggestions for enhancing injury prevention initiatives. For those not utilizing injury prevention programs, the interview examined the barriers to adoption, including resource constraints, lack of awareness, or institutional limitations. Questions explored coaches' views on the significance of injury prevention, their awareness of existing programs, and their openness to integrating such strategies into their coaching methods. Additionally, the interview delved into the importance of resource availability, coaching philosophy, and potential educational needs to bolster injury prevention efforts. Coaches were queried about their willingness to consider implementing injury prevention programs in the future and what changes or support might motivate them to do so. The interview ended with an invitation for coaches to share any further insights, ensuring comprehensive perspectives were included. By structuring the interview to engage both coaches who have implemented and those

who have not, the questionnaire offered a well-rounded view of the factors affecting the adoption, effectiveness, and sustainability of wrist injury prevention strategies in gymnastics.

Data Collection

The survey questionnaire and interview schedule were attached to the research ethics application for approval from the ethics committee. A poster was designed using the Canva platform to enhance visual appeal and engage the target audience. The paid subscription to the platform helped to make it more personalised while preventing copyright issues. The poster was also attached to the ethics application for approval. Changes recommended by the ethics committee were incorporated into the questionnaires, interview schedule, and poster, and final approval was. The study utilised the Qualtrics platform to gather primary data for designing and implementing the survey. This platform was chosen for its user-friendly interface, robust security measures and advanced reporting capabilities. the questionnaire was transferred to the platform in two weeks after receiving the final approval. A QR code and a specific link for the survey page were generated and attached to the poster to make it convenient for interested participants to launch the survey page. The researcher's contact details were also mentioned on the poster to welcome any queries and clarify the subject matter for the participant's ease. A test run for the survey was conducted by sharing the poster with family and friends for seven days to estimate survey completion time, to eliminate errors and to ensure a smooth data collection process. It took nearly 20-25 minutes for each participant to complete the survey test run. Once the test run was successful, the survey was made live and distributed through diverse channels to reach a broad audience within the gymnastics community. The distribution strategy included gymnastics-related forums and pages on social media platforms like Facebook and Instagram, and targeted email lists for gymnastics institutes across New Zealand. The survey was then made

live to accomplish the data collection, and unpaid promotions were made extensively for three months on selected social media platforms using a cross-sectional design. A detailed survey description and appropriate keywords were posted on the sites to make it easily approachable. Participants were not compelled to answer any survey questions they wished to avoid, and they could exit the survey at any time by simply closing the window. Once the survey was completed and submitted, they could not withdraw their participation. Information regarding this was included in the consent form.

The promotional posters were shared on the researcher's personal social media accounts and to the dedicated page for survey to encourage participation. Admins of the Gymnastics-related communities and their pages on Facebook, public and private, were contacted using personal messages to seek permission to promote the survey. It took nearly seven days to four weeks' time to receive permission from the admins of the Gymnastics-related forums and groups on Facebook. Furthermore, gymnastics institutes were contacted directly to promote the research and encourage participation from their members. Some local institutes were approached in person to seek permission from their gymnastics academies to encourage participation in the survey and recruit coaches to participate in the interview. Initial contact was made to 'Gymnastics New Zealand' for conducting the survey and recruiting the coaches for interviews at their training institute through an email with detailed information on the research. They provided further contact details of some of the well-known institutes around the country. Moreover, they shared a link to their website to get contact information for all the listed clubs in New Zealand. Additionally, snowball sampling techniques were employed to leverage existing networks and broaden the survey's reach.

In addition to the survey, qualitative data was collected through semi-structured interviews with four gymnastics coaches who showed interest in participation. These coaches were selected to represent a range of competition levels, including grassroots, regional, national, and elite, ensuring diverse perspectives on injury prevention practices. Online interviews with the participants were scheduled on the Zoom platform using a paid subscription at mutually convenient times and dates. Interviews were conducted in semi structured methods and started with the introduction to the coaches. All the questions were covered to gather insights into the topic throughout a one-hour Zoom meeting. The interviews provided in-depth insights into injury prevention programs' implementation, challenges, and effectiveness.

Data Analysis

Survey

The data collected through the comprehensive survey was meticulously analysed, producing detailed primary reports utilizing Qualtrics' advanced online survey platform. These generated reports were then systematically downloaded in both Excel sheet and PDF formats for ease of access and sharing. To ensure a thorough understanding of the findings, the data sheets underwent additional processing, which included converting them into own Excel format, thereby enhancing their readability and user-friendliness for various audiences. The data was analysed with the help from an expert with detailed knowledge of the data analysis methods and the designated software for in detailed analysis to get the accurate results. the excel sheet with containing data was sent for further analysis using SPSS software. This sophisticated statistical tool allowed for a thorough evaluation of multiple factors impacting wrist injury risk. The Kruskal-Wallis test was applied to explore the relationship between several training variables—

such as training days, hours dedicated to training, and rest days. This statistical method is particularly useful in comparing the ranks of different groups, offering insights into how various training practices correlate with injury risk. Moreover, to detect any trends in injury risk in relation to different training factors, the Jonckheere-Terpstra test was employed. This test provides valuable information on ordered alternatives, illustrating how changes in training conditions might influence injury outcomes. A Chi-Square test was conducted to further investigate the role of coaches' involvement in injury prevention programs and their association with the implementation of these programs on the ground. This statistical analysis plays a crucial role in determining whether there is a significant relationship between categorical variables—in this case, the engagement of coaches and the active application of injury prevention strategies. Collectively, these rigorous statistical tests not only facilitated a deeper understanding of the data but also helped in identifying key factors that contribute to the effectiveness of injury prevention initiatives within gymnastic training environments.

Interview

The interviews with gymnastics coaches were analysed through thematic analysis to uncover key patterns, insights, and recurring themes related to injury prevention programs and wrist injury management. Recorded interviews were transcribed and thoroughly reviewed to gather significant information. Initially, a coding process categorized responses into broad themes such as training practices, injury prevention strategies, implementation challenges, the effectiveness of existing programs, and coaching philosophies. This created an organized framework for systematically examining coaches' perspectives. After coding, themes were refined and grouped according to their relevance to the research objectives. Thematic clusters emerged from the data, including the importance of strength training, prehabilitation techniques, communication

between coaches and athletes, and perceptions of injury prevention program effectiveness. The analysis also compared responses from coaches who had implemented injury prevention programs with those who had not, revealing insights into implementation barriers and areas for improvement. Differences in approach and understanding were assessed by examining perspectives from experienced coaches versus those newer to the field. Additionally, patterns of consensus and disagreement among interviewees were identified to evaluate common challenges, best practices, and gaps in injury prevention awareness. Coaches' opinions on training load, wrist support, hydration, and proper technique were compared with existing literature to highlight consistencies or discrepancies with established research. Open-ended responses were further analysed to extract nuanced insights and practical recommendations based on direct experiences. To enhance reliability, member checking was conducted, allowing interviewees to review summaries of their responses and clarify any misunderstandings, thus ensuring the accuracy and credibility of the findings. The data were synthesized to create a comprehensive analysis that contributes to understanding the effectiveness of injury prevention programs, the role of coaching in injury mitigation, and the challenges of integrating structured injury prevention strategies within gymnastics training. These findings guided the development of recommendations to improve wrist injury prevention initiatives and bolster gymnast safety in both competitive and recreational environments.

Results

Survey

Out of a total of 53 recorded responses, 22 participants completed the survey. The remaining 31 responses were not recorded. These responses were registered as incomplete. Out of all the completed responses, there were a total of 12 respondents over 16 years of age, five respondents were parents or guardians of the gymnasts aged 5-16 years, and four respondents were between 5-16 years of gymnasts who filled the survey with their parents or guardians(Figure 4).

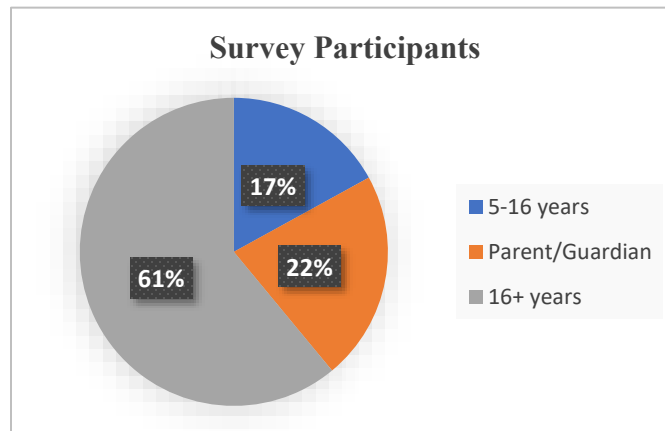


Figure 4 Survey Responses

The survey results provided valuable insights into the demographics and experiences of individuals involved in gymnastics (Figure 5). The majority of respondents identified themselves as having roles categorised as "Other," followed by parents/guardians of gymnasts and gymnasts.

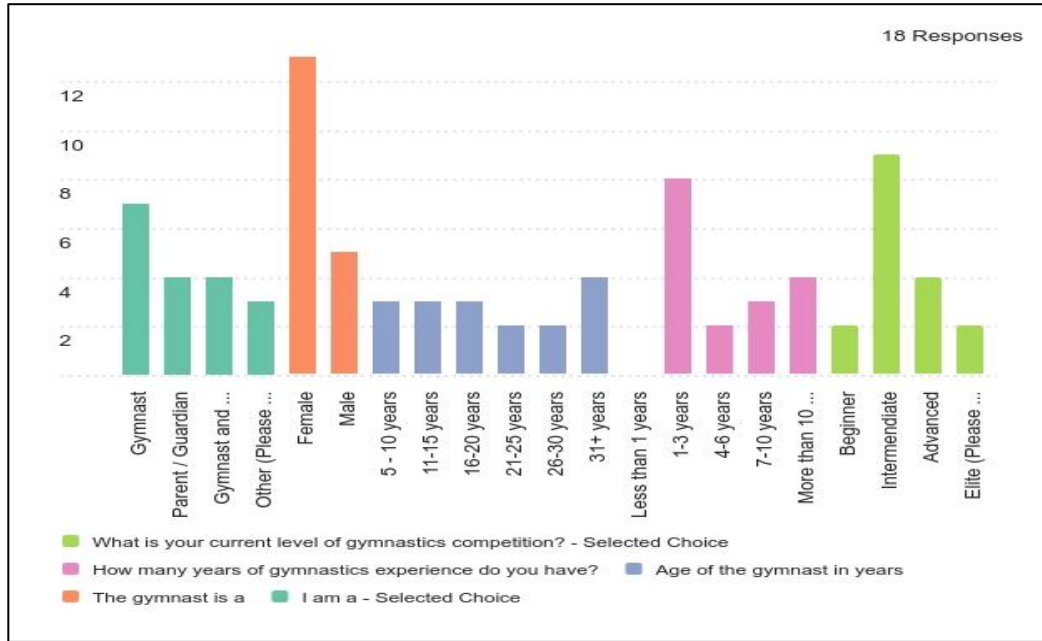


Figure 5 Demographics of Survey Participants

Furthermore, the findings revealed a higher proportion of female gymnasts (72%) compared to male gymnasts (28%), with the majority of gymnasts falling within the 5-20 years of age range, followed by equal participation of gymnasts from 21-30 years and above the age of 31 (Figure 6).

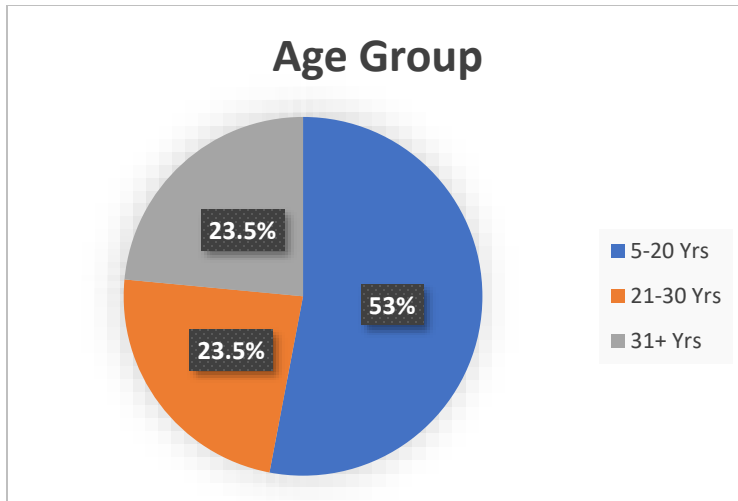


Figure 6 Age Group of Gymnasts

The participants registered their experience as 1-3 Years (47%), 4-6 Years (12%), 7-10 Years (18%) and 10+ years (24%) with no participants having experience of less than 1 year. Many respondents have also participated in gymnastics competitions, with most identifying as intermediate-level competitors followed by advanced and beginners and elite at the same ratio (Figure 7).

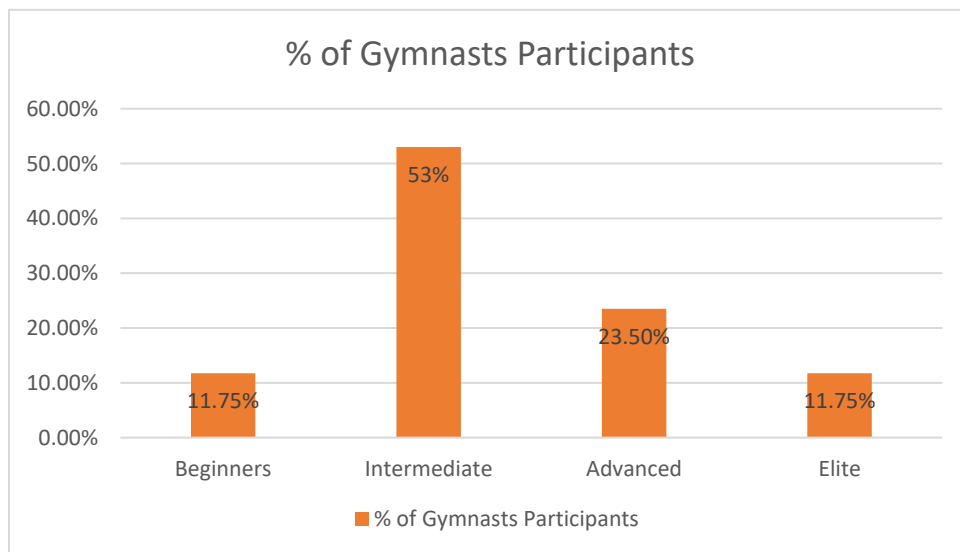


Figure 7 Level of Gymnastics Competition

Additionally, the survey shed light on various aspects of training, such as coaching presence, weekly training frequency, training hours, rest days, training surfaces, cross-training, and wrist support or braces. Of all the participants, nine respondents reported personal experience with wrist injuries or witnessed such injuries among their peers.

All participants (100%) reported having a coach for their training and mostly trained on mats.

The majority of the respondents trained for an average of 8 hours over 4 days per week.

However, the number of training days per week varied from 1 to 7 days. 16 participants provided a response about their weekly training hours out of which 25% trained 1-3 days, 50% trained 4-6 days, and 25% trained an average 7 days a week. For the hours of training per training day, 17 participants provided a response, showing a distribution of less than 1 hour (6%), 1-2 hours

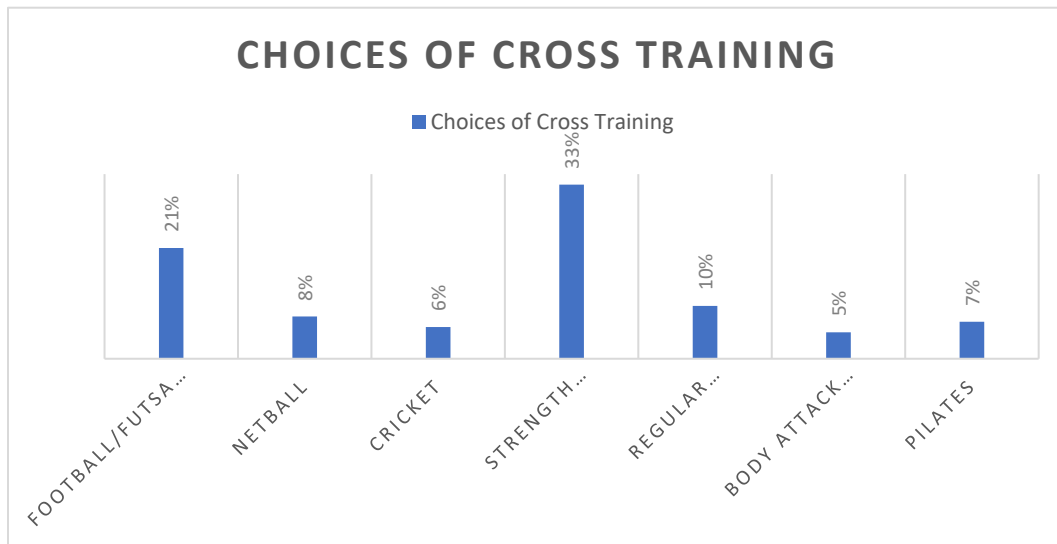


Figure 8 Choices of Cross Training

(31%), 3-4 hours (38%), and 5+ hours (25%). In terms of training hours per week, 16 participants responded, with a breakdown of less than 5 hours (6%), 5-10 hours (25%), 11-15 hours (19%), 16-20 hours (19%), and 21+ hours (31%). Additionally, 17 participants provided a response to the distribution of rest days per week, with 6% having 0-1 day and 94% having 2-3 days of rest. The results indicate that approximately 82% of gymnasts engage in cross-training

activities as part of their routines, while 18% of the participants do not engage in cross-training. Additionally, most participants stated that cross-training is not part of their training hours for gymnastics. 11 participants provided a list of the cross-training activities they are involved in, while 12 participants specified other sports they play as part of their cross-training. Football/futsal/soccer, netball, cricket, strength training and weightlifting, regular workouts, body attack training and Pilates were all mentioned as their choices of cross-training mode (Figure 8).

70.6% of all the participants stated that they were familiar with the injury prevention programs, while 17.6% were unsure and 11.8% were unfamiliar with any injury prevention strategies incorporated into gymnastics training. The participants responded that they were familiar with various injury prevention programs, including proper technique (59%), flexibility training (82%), strength training (82%), conditioning (59%), plyometric exercises (41%), progressive skill development (35%), rest and recovery (65%), injury surveillance and management (47%), education (41%), and equipment safety (47%) (Figure 9). The responses collected for the sources of this knowledge varied among the participants. They gathered awareness about injury prevention strategies through coaches (94%), teammates (24%), personal research (24%), seminars or workshops (12%), and other sources (12%). While only seven participants received specific training or guidance on wrist injury prevention and management, others were unsure or had not received such training or had selected not to respond.

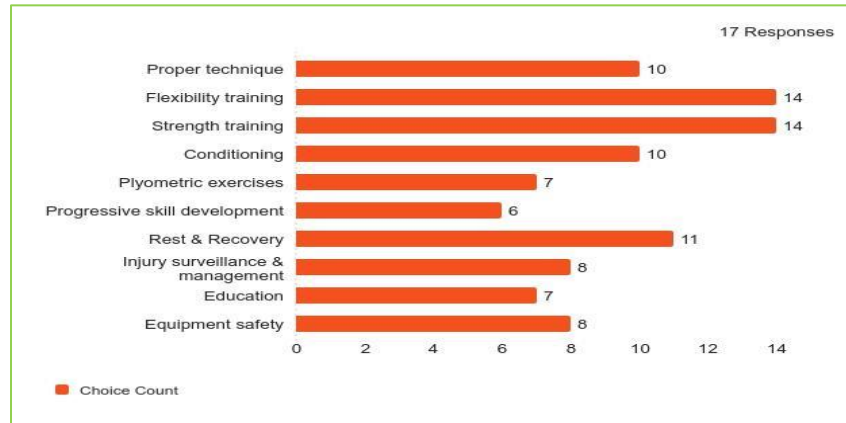


Figure 9 Awareness of Various Injury Prevention Strategies

The data collected from the survey observed that 43.75% of respondents had received specific training or guidance on wrist injury and prevention. In comparison, 18.75% of respondents were not sure about it, and 37.5% of respondents had never received any such training or guidance.

The respondents considered wrist strengthening exercises, forearm and grip strengthening, flexibility and mobility training, technique emphasis, wrist guards and supports, rest and recovery, injury awareness and reporting, progressive skill development, proper equipment, consultation with sports medicine professionals, periodisation, and monitoring and feedback very important or extremely important for preventing wrist injuries. Some respondents stated that their gymnastics training centres or organisations have implemented injury prevention programs for wrist injuries, while others are unsure or have not implemented such programs. 15 of the participants reported using wrist support or braces during their training. The frequency of participating in injury prevention programs varied among the respondents, with some reporting daily, weekly, monthly, or no programs.

According to the data, participants observed various changes or improvements after implementation of injury prevention programs, improved performance, including reduced injury

rates, enhanced flexibility, long-term athlete development, better technique, increased confidence, improved education, healthy training environment, reduced healthcare costs, fewer

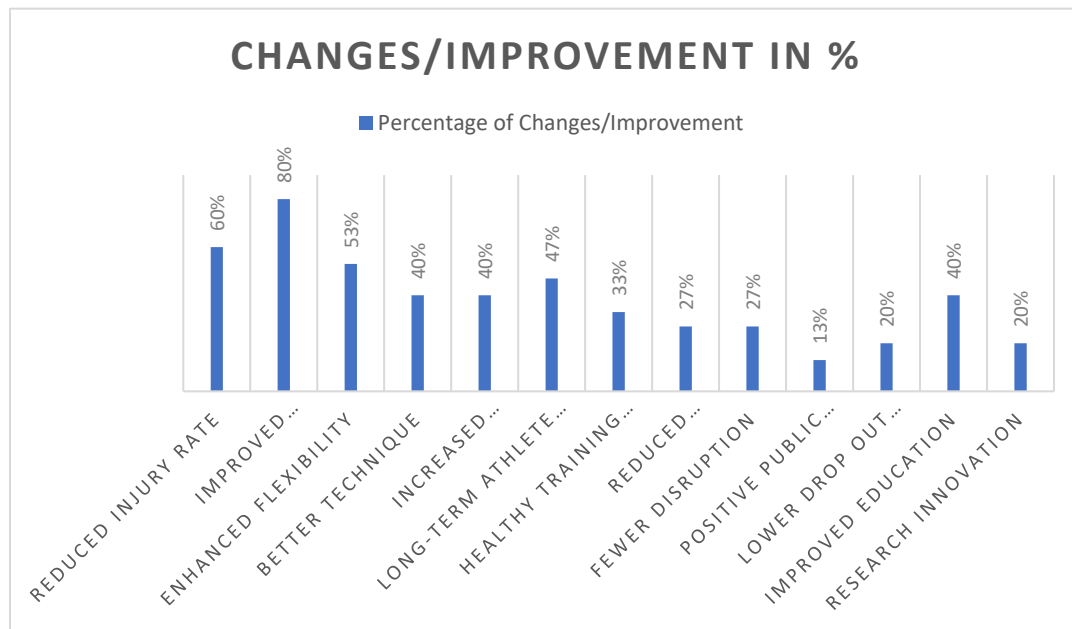


Figure 10 Changes or Improvement Noted after using Injury Prevention Strategies

disruptions, lower dropout rates, and research innovation, positive public image respectively (Figure 10).

27% of the respondents have experienced injuries since participating in injury prevention programs, and 73% of participants have not experienced wrist injuries after. Most respondents reported a positive impact on their gymnastic performance by participating in injury prevention programs, including reduced injury risk, improved strength and flexibility, enhanced technique, better body awareness, increased endurance, quicker recovery, long-term athletic development, positive psychological benefits, and educational benefits.

The participants reported mixed views on the involvement of the coaches or trainers in promoting and implementing injury prevention programs. Out of all the reported responses, the participants believed the involvement was either too little (14%), slight involvement (14%) or

too much involvement (14%), whereas 57% of the respondents reported that the involvement was neutral.

The respondents provided recommendations for improving injury prevention programs, including making injury prevention a priority, providing proper guidance and education, using wristbands for support, implementing expert-created programs, and prioritising injury prevention over recovery.

Research Question 1:

Which injury prevention programs and interventions currently exist in gymnastics to tackle wrist injuries, and what are their elements, approaches, and results?

Kruskal-Wallis Test

Table 3 Kruskal-Wallis Test

Ranks			
	Reduced Injury Risk	N	Mean Rank
Flexibility Training	TRUE	12	9.50
	FALSE	6	9.50
	Total	18	
Strength Training	TRUE	12	9.50
	FALSE	6	9.50
	Total	18	

To investigate the effects of flexibility training and strength training on decreasing risk of wrist injury in gymnastics, the Kruskal-Wallis test was conducted. The results show that the mean rank for both flexibility training and strength training is 9.50, whether the intervention is applied (TRUE) or not (FALSE).

It would be useful to confirm these findings by checking the p-value from the Kruskal Wallis test output. If the p value is greater than 0.05, we fail to reject the null hypothesis; there is no

significant difference. However, if it is less than 0.05, this would indicate that these training programs have a significant effect on reducing injury risk.

Table 4

Test Statistics^{a,b}		
	Flexibility training	Strength Training
Kruskal-Wallis H	0.000	0.000
Df	1	1
Asymp. Sig.	1.000	1.000
a. Kruskal Wallis Test		
b. Grouping Variable: Reduced injury risk		

The results of the Kruskal-Wallis test showed that neither flexibility training nor strength training significantly reduced the risk of wrist injury in gymnastics since they had the same mean ranks (9.50) and a Kruskal-Wallis H value of 0.000. The p values for both variables are 1.000, which are much larger than the 0.05 significance level.

Table 5

Jonckheere-Terpstra Test^a		
	Flexibility Training	Strength Training
Number of Levels in Reduced Injury Risk	2	2
N	18	18
Observed J-T Statistic	36.000	36.000
Mean J-T Stastic	36.000	36.000
Std. Deviation of J-T Stastic	6.903	6.903
Std. J-T Stastics	.000	.000
Asymp. Sig. (2-tailed)	1.000	1.000
a. Grouping Variable: Reduced Injury Risk		

A Jonckheere-Terpstra test was conducted to determine if flexibility training and strength training affected the reduction of the risk of wrist injury in gymnastics. Results from the test indicate an Observed J-T Statistic of 36.000, the same as the Mean J-T Statistic (36.000) for both training types and a Standard J-T Statistic of 0.000.

Research Question 2:

How do injury prevention programs designed to target wrist injuries in gymnastics compare their effectiveness, feasibility, and adherence among athletes, coaches, and other stakeholders?

Kruskal-Wallis Test

Table 6 Kruskal-Wallis Test

Ranks			
	Reduced Injury Risk	N	Mean Rank
Training days in a week	TRUE	12	10.88
	FALSE	6	6.75
	Total	18	
Hours of training per day	TRUE	12	9.50
	FALSE	6	9.50
	Total	18	
Weekly training hours	TRUE	12	10.29
	FALSE	6	7.92
	Total	18	
Weekly rest days	TRUE	12	8.46
	FALSE	6	11.58
	Total	18	

To determine the relationship between different training variables and their effect on reduced wrist injury risk in gymnastics, the Kruskal-Wallis test was conducted. The results show different mean ranks for the factors under study.

Gymnasts who trained more frequently (TRUE, Mean Rank = 10.88) reduced injury risk more than those who trained fewer days (FALSE, Mean Rank = 6.75) for training days per week.

Therefore, it appears that more training days can have a positive effect on injury prevention.

Regarding hours of training per day, the mean ranks for both groups (TRUE and FALSE) were identical (9.50).

Gymnasts with more training hours (TRUE, Mean Rank = 10.29) reduced injury risk more than those with fewer weekly hours (FALSE, Mean Rank = 7.92).

An inverse trend was observed for rest days per week with gymnasts with more rest days (FALSE, Mean Rank = 11.58) having a greater reduction in injury risk than those with fewer rest days (TRUE, Mean Rank = 8.46).

Table 7

Test Statistics ^{a,b}				
	Training Days in a Week	Hours of Training per Day	Weekly Training Hours	Rest days Weekly
Kruskal-Wallis H	2.771	.000	.841	1.492
Df	1	1	1	1
Asymp. Sig.	.096	1.000	.359	.222
a. Kruskal Wallis Test				
b. Grouping Variable: Reduced Injury Risk				

A Kruskal-Wallis test was conducted to determine if training variables significantly affect reduced risk of wrist injury in gymnastics. Statistical significance of various factors is different.

The Kruskal-Wallis H value is 2.771 for training days per week with a p-value of 0.096.

The H value is 0.000, the p-value is 1.000 for daily , which indicates no significant relationship between injury risk reduction and daily training hours for hours of training per day.

For total weekly training time, H is 0.841 and p is 0.359 and the H value for rest days per week is 1.492 with a p value of 0.222.

Table 8

Jonckheere-Terpstra Test ^a				
	Training Days in a Week	Hours of Training per Day	Weekly Training Hours	Rest Days Weekly
Number of Levels in Reduced Injury Risk	2	2	2	2
N	18	18	18	18
Observed J-T Stastic	19.500	36.000	26.500	48.500

Mean J-T Statistics	36.000	36.000	36.000	36.000
Std. Deviation of J-T Statistic	9.911	10.522	10.358	10.233
Std. J-T Statistic	-1.655	.000	-.917	1.222
Asymp. Sig. (2-Tailed)	.096	1.000	.359	.222
a. Grouping Variable: Reduced Injury Risk				

To determine if various training variables have an ordered trend in reducing gymnast wrist injury risk, the Jonckheere-Terpstra test was performed. The results show different levels of association.

The Observed J-T Statistic is 19.500 for training days per week, Mean J-T Statistic 36.000 and Standard J-T Statistic -1.665. With a p-value of 0.096. The Observed J-T Statistic is equal to the Mean J-T Statistic (36.000) for hours of training per day and the Standard J-T Statistic is 0.000, and the p-value is 1.000. For weekly training hours, Observed J-T Statistic is 26.500, Standard J-T Statistic is -0.917 and p-value is 0.359. The Observed J-T Statistic is 48.500 for rest days per week, the Standard J-T Statistic is 1.222 and the p-value is 0.222.

Research Question 3:

What are the barriers, challenges, and facilitators associated with the implementation and sustainability of injury prevention programs aimed at reducing wrist injuries in gymnastics?

Chi-Square Tests

Table 9

Has your gymnastics training centre or organization implemented any injury prevention programs for wrist injuries? Crosstabulation		
Count		
	Has your Gymnastics training centre or Organisation implemented	Total

		an injury prevention program for wrist injuries?			
		Yes	No	Maybe	
Participants	Yes	2	5	9	16
	No	0	1	1	2
Total		2	6	10	18

The relationship between participant's response and the implementation of injury prevention programs for wrist injuries in gymnastics was explored by means of a Chi-Square test of independence. It can be further described in the cross-tabulation as falls where out of 18 gymnasts surveyed, 2 fall under the "Yes" column which means their gymnastics organization has incorporated injury prevention programs, 5 fall under the "No" column which means no such programs are in-place. Moreover, 9 were uncertain and answered 'Maybe,'. Of the gymnasts who answered "No", only 1 was unsure ("Maybe") and the other 1 stated that no programs were implemented.

We would further analyse whether this is a statistically significant association between the participant's response (Yes, No, Maybe) and the implementation of wrist injury prevention programs.

Table 10

Chi-Square Test			
	Value	Df	Asymptomatic Significance (2-sided)
Pearson Chi-Square	.450 ^a	2	.799
Likelihood Ratio	.650	2	.723
Linear-by-Linear association	.014	1	.906
N of Valid Cases	18		
a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is 0.22			

With 2 degrees of freedom, Pearson Chi-Square is 0.450 and Asymptotic Significance (p-value) is 0.799, which is much higher than the typical significance level of 0.05. Furthermore, the Likelihood Ratio test has a value of 0.650 with a p-value of 0.723. The p-value of 0.906 for Linear-by-Linear Association with the value of 0.014. It should be noted that 4 cells (66.7%) in the contingency table have an expected count less than 5, with the minimum expected count being 0.22.

Table 11

Symmetric Measures			
		Value	Approximate Significance
Nominal by Nominal	Contingency Coefficient	.156	.799
N of Valid Cases		18	

The table of Symmetric Measures indicates the Contingency Coefficient of the relationship between responses and the implementation of injury prevention programs for wrist injuries. The value of the Contingency Coefficient is 0.156 and the Approximate Significance (p-value) is 0.799, which is much higher than the commonly accepted significance threshold of 0.05.

Interview

The interviews with the gymnastic coaches provide valuable insights into injury prevention strategies and training approaches in gymnastics, as discussed with experienced coaches and experts in the field. The interviews shed light on the prevalence of wrist injuries in gymnastics, emphasizing the importance of managing these injuries through gradual increases in weight bearing activities' duration and repetitions over time. Strength training and proper technique are highlighted as crucial elements in gymnastics training, particularly for children and teenagers.

Effective communication, hydration, and nutrition are also emphasized to prevent injuries and promote overall well-being. The challenges faced in implementing gymnast-centred training programs were also discussed, along with the significance of practical experience and hands-on learning. These findings contribute to a comprehensive understanding of injury prevention and training in gymnastics, prioritizing the well-being of gymnasts over competition goals.

According to the coaches, wrist injuries are a concern but do not need major attention, affecting both women's and men's gymnastics. Coaches and experts recommended using wrist blocks and techniques to prevent overextension during activities that require sustained hand support or repetitive rebounding from the hands. Strategies such as using curved surfaces and shorter work periods were suggested to reduce intensity and pressure on the wrists during training.

Incremental increases in repetitions and duration of hand support were thought to be crucial in managing wrist injuries effectively.

Strength training was also thought to play a vital role in gymnastics, especially for children and teenagers. The rope climb was highlighted as a simple yet effective exercise to target the hands, wrists, and shoulders, and prepare gymnasts for the demands of gymnastics. Gradual progression of handstand repetitions in inverted support was recommended to build strength and prevent injuries. However, challenges such as boredom and lack of understanding among children in gymnastics programs need to be addressed to enhance progress and enjoyment.

Interviewed coaches felt that injury prevention in gymnastics goes beyond physical training.

Coaches are encouraged to prioritize gymnasts' well-being over competition goals and to promote seeking medical attention for injuries. Effective communication between coaches and gymnasts is crucial in preventing injuries, and coaches should also emphasize hydration,

nutrition, and the provision of healthy snacks to support gymnasts' overall well-being and performance.

Another theme from the interviews was that implementing gymnastics training programs with a focus on injury prevention can be challenging. Coaches need to consider the strength-weight ratio for gymnasts to achieve success. Lack of communication and follow-through were identified as obstacles in implementing gymnast-centred training programs. Attending injury prevention seminars was recommended for coaches seeking to improve their coaching practices. Practical experience and hands-on learning were emphasized as essential components of gymnastics training.

Insights from expert interviews on youth sports injury prevention further enrich the understanding of injury prevention in gymnastics. Coaching methods, warm-up exercises, stretching, and hydration were discussed as important factors in preventing injuries. The evolution of gymnastics techniques to prevent wrist injuries was highlighted, and strategies for handling late arrivals in youth sports and addressing parents' anxiety were shared. The appropriate training hours for gymnasts are debated, taking into account age and puberty stage. In conclusion, the interviews with experienced coaches and experts provided valuable insights into injury prevention strategies and training approaches in gymnastics. They highlighted the importance of managing wrist injuries, incorporating strength training and proper technique, effective communication, and prioritizing gymnasts' well-being. The challenges in implementing gymnast-centred training programs were acknowledged, and the significance of practical experience and hands-on learning was emphasized. These findings contribute to a comprehensive understanding of injury prevention and training in gymnastics, promoting the overall health and success of gymnasts.

The challenges faced in implementing gymnast-centred training programs include:

1. **Lack of Communication and Follow-Through:** Coaches face challenges in effectively communicating the importance and benefits of gymnast-centred training programs to gymnasts, their parents, and other stakeholders. Additionally, there may be a lack of follow-through in implementing the recommended strategies and techniques, hindering the effectiveness of the training programs. To avoid this, there is a need to build a healthy and friendly gymnast-trainer relationship to gain trust and fulfil that communication gap.
2. **Resistance to Change:** Some coaches may be resistant to change and may prefer traditional training methods over gymnast-centred approaches. This resistance can stem from various factors, including personal beliefs, a lack of awareness about the benefits of gymnast-centred training, or a reluctance to deviate from established practices. Overcoming this resistance and fostering a culture of openness to new approaches can be challenging.
3. **Balancing Competition Goals:** Coaches often face the challenge of balancing the competitive goals of gymnasts with their well-being. In a highly competitive environment, there may be pressure to prioritise performance and results over gymnasts' long-term health and development. Sometimes, even parents and the gymnast can neglect the importance of healthy joints and carry on with the training to achieve their goals, despite pain or discomfort. The onset of discomfort can lead to severe pain and chronic injuries in future. On the other hand, if reported at the early signs can help to take care of the issue at the earliest and can avoid the post complications. This challenge requires a shift in mindset and a commitment to placing the well-being of gymnasts at the forefront.

4. **Limited Resources:** Implementing gymnast-centred training programs may require additional resources, such as specialized equipment, qualified trainers, educational materials and timely update in outdated training techniques and skills. Limited availability or access to these resources can pose a challenge in effectively implementing these programs. Coaches may need to find creative solutions or seek external support to overcome resource limitations.
5. **Resistance from Ego-Centred Coaches:** The interview findings suggest that coaches who are ego-centred may ignore injury prevention seminars and learning opportunities and fail to prioritize the well-being of gymnasts. Overcoming resistance from such coaches and fostering a culture of continuous learning and improvement can be a challenge in implementing gymnast-centred training programs.

Addressing these challenges requires a multi-faceted approach, including effective communication and education, providing necessary resources, fostering a supportive and open-minded coaching environment, and emphasizing the long-term benefits of gymnast-centred training programs. Collaboration between coaches, gymnasts, parents, and other stakeholders is essential to overcome these challenges and ensure the successful implementation of gymnast-centred training programs.

Discussion

Wrist injuries are among the most common musculoskeletal issues faced by gymnasts due to repetitive weight-bearing activities on the hand, such as tumbling, vaulting and uneven bar routines (Dennis J. Caine et al., 2013). These injuries can hinder the performance and, in severe cases, lead to chronic pain or early retirement (DiFiori et al., 2014). The findings of this study provide valuable insights into the effectiveness and implementation of injury prevention strategies in gymnastics, particularly concerning wrist injuries. Despite the typical emphasis on flexibility and strength training as fundamental components of injury prevention, the data analysis indicates that these methods alone do not significantly reduce the risk of wrist injuries among gymnasts. Instead, the findings suggest that a more comprehensive and multifaceted approach that integrates strength training with proper load management, progressive skill development, and adequate recovery periods is essential for effective injury prevention. Moreover, the study highlighted that the lack of awareness and inconsistent implementation of injury prevention programmes indicates a need for improved communication and education among the stakeholders of the gymnastics_ coaches, gymnasts and their parents/guardians. Interviews with coaches emphasise the importance of gradual training progression, strength building, and holistic well-being, highlighting the need for a multifaceted approach to injury prevention.

Survey

The results of the survey with gymnasts and their parents/guardians provide insightful understanding of the current training programs and knowledge of the targeted community into the injury prevention programs in gymnastics in general as well as focused on wrist injuries.

Firstly, the Kruskal-Wallis test results indicate that neither flexibility training nor strength training alone significantly reduced wrist injury risk among gymnasts. This suggests a potential need for a more holistic approach integrating these elements into a broader injury prevention strategy rather than relying on them in isolation. These findings contradict traditional injury prevention approaches that often prioritise flexibility and strength training (Lauersen et al., 2018) without considering the broader biomechanical and physiological demands placed on gymnasts (Soligard et al., 2008). The findings support results identifying essential wrist injury countermeasures in gymnastics, such as physical preparation, education, proper technique, and a robust health system. This comprehensive approach highlights the importance of integrating multiple preventive strategies instead of depending on separate interventions (Daly et al., 2001). Moreover, these injury prevention programs should be based on demographic data, such as age, gender, training and level of competition, which plays a crucial role in creating targeted injury prevention protocols. These findings support the results from another study that states that each age group displays unique musculoskeletal structures, and their individual needs are different for injury prevention protocols (Mendonca et al., 2022).

Secondly, the data reveals a notable trend regarding training frequency and rest days. Gymnasts who trained more frequently (in terms of days per week) showed a trend towards reduced injury risk, although this was not statistically significant. Conversely, those who had more rest days per week also demonstrated a trend towards reduced injury risk. These findings highlight the importance of balancing training intensity with adequate rest and recovery periods to optimize injury prevention. Studies have shown that when someone's workload increases by 15% or more relative to the previous week, their risk of injury also increases from roughly 10% to almost 50% (FRANCOIS GAZZANO). These results align with the recommendations from Sport New

Zealand. It emphasizes that the American Academy of Paediatrics Council on Sports Medicine and Fitness advises children to have at least one day off each week from organized sports and to limit participation in a single sport to no more than five days per week (Rogers). Additionally, it suggests that young athletes should take 2-3 months off each year from their selected sport to recover, heal from injuries, and lower the risk of burnout (Rogers).

The lack of significant association between the responses and the implementation of injury prevention programs suggests potential areas for improvement in communication and program implementation within gymnastics institutes. The high percentage of participants were unsure about the existence of such programs points to a need for better awareness and training regarding injury prevention strategies.

Interview

The interviews with gymnastics coaches provide valuable qualitative insights that complement the quantitative data. The coaches highlight the emphasis on gradual progression in weight-bearing activities, the importance of strength training, and the role of effective communication and holistic well-being in injury prevention. The coaches' opinions and perceptions correlate with the study that states that rapid and excessive increases in training loads contribute significantly to non-contact, soft-tissue injuries. Conversely, well-structured and appropriate training enhances physical qualities, thereby providing protection against such injuries (Gabbett, 2016). These qualitative findings underscore the complexity of injury prevention in gymnastics and the necessity of a multifaceted approach that addresses physical, psychological, and educational components. These findings correlate with the results of the study that states that a coach's knowledge and support are critical factors in the injury prevention of elite youth athletes.

Both evidence-based and non-evidence-based approaches are used, and the biopsychosocial perspective is not always considered (Kempe et al., 2023).

Conclusion

In conclusion, the study reveals that while specific training programs like flexibility and strength training are essential, they may not be sufficient on their own to significantly reduce wrist injuries in gymnastics. A balanced approach that includes adequate rest, proper technique, and comprehensive injury prevention strategies is crucial. The findings highlight the need for better communication and implementation of injury prevention programs within the gymnastics community, as well as the importance of holistic approaches that encompass physical, psychological, and educational aspects of training.

Future research should focus on developing and testing integrated injury prevention programs that combine multiple strategies and evaluate their long-term effectiveness in reducing wrist injuries and enhancing gymnasts' overall well-being. Additionally, efforts should be made to improve coaches' awareness and training regarding injury prevention to ensure the successful implementation and sustainability of these programs. These steps are vital to promote the health, safety, and performance of gymnasts, ultimately contributing to the sport's positive development and public image.

Limitations of the Study

The study's limited sample size restricts the generalizability of its findings to the broader gymnastics population, potentially overlooking the perspectives from various competitive levels, ages, and cultures. The reliance on self-reported data introduces a degree of subjectivity, as

participants may inaccurately recount their experiences and adherence to injury prevention programs. Furthermore, the cross-sectional design restricts the assessment of causal relationships, underscoring the need for longitudinal studies to evaluate the long-term effectiveness of the proposed strategies. Additionally, the study may insufficiently account for critical factors such as equipment quality and training intensity, which could affect wrist injury risks and the efficacy of the prevention programs. The qualitative data obtained from interviews and surveys lack objective metrics, such as biomechanical assessments, thereby limiting a comprehensive evaluation of injury prevention methods. This study primarily focuses on perspectives rather than outcomes; therefore, future research should incorporate outcome-based evaluations to assess the effectiveness of the proposed strategies. Participants may provide socially desirable responses due to perceived pressure, which could compromise the authenticity of the data. Implementing the suggested injury prevention programs may require additional resources and expertise, presenting challenges for smaller clubs with limited access to sports medicine services.

Implications / Recommendations

Gymnasts: Gymnasts can enhance their performance and wrist stability through a holistic injury prevention strategy that includes flexibility, strength, and neuromuscular training. By engaging in customized injury prevention programs and fostering clear communication with coaches and physiotherapists, they can mitigate injury risks and promote sustained athletic success.

Furthermore, consistently following preventive exercises enables gymnasts to develop resilience and maximize their competitive potential.

Coaches: Coaches are essential in establishing effective programs for wrist injury prevention through holistic training methods. By increasing their understanding of injury prevention techniques and fostering open dialogue with gymnasts, coaches can cultivate a safer training environment and ensure gymnasts consistently follow preventive measures. This proactive strategy not only minimizes the risk of injuries but also enhances gymnasts' performance and longevity in their athletic careers.

Institutes: Gymnastics training institutes can improve athlete safety and performance by implementing thorough wrist injury prevention programs that encompass all elements of preventive strategies. By prioritizing coach education and providing access to necessary resources and equipment, these institutes can cultivate a strong emphasis on injury prevention and contribute to long-term athletic success. This forward-thinking approach also bolsters their standing as safe and effective training facilities.

Policy Makers: Policymakers can enhance gymnast safety and performance by creating standardized guidelines for wrist injury prevention programs that include holistic training methods such as strength, flexibility, and neuromuscular exercises. By requiring regular training sessions with practical components for coaches and ensuring sufficient resource allocation, they can improve the implementation and adherence of these programs across gymnastics organizations. This strategy promotes safer sporting environments while supporting athlete well-being and development.

In conclusion, wrist injuries are a significant concern in gymnastics, requiring careful attention to prevention, proper technique, and prompt management. By implementing injury prevention strategies and promoting safe training practices, coaches, athletes, and healthcare providers can

help reduce the incidence and severity of wrist injuries in gymnastics and promote the long-term health and well-being of gymnasts.

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Appendix-1

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25 January 2024

Sneha Dalal
Te Huataki Waiora School of Health
DHECS
By email: drsnehadalal@gmail.com

Dear Sneha

HREC(Health)2023#66 : Evaluating the Impact of Injury Prevention Programs on Reducing Wrist Injuries in Gymnastics

Thank you for your responses to the Committee feedback.

We are now pleased to provide formal approval for your project.

Please contact the Committee by email (humanethics@waikato.ac.nz) if you wish to make changes to your project as it unfolds, quoting your application number with your future correspondence. Any minor changes or additions to the approved research activities can be handled outside the monthly application cycle.

We wish you all the best with your research.

Regards,



Emeritus Professor Roger Moltzen MNZM
Chairperson
University of Waikato Human Research Ethics Committee

Appendix 2

Coache's Interview Schedule:

Coaches' Interview Schedule

Evaluating The Impact of Injury Prevention Program in Reducing Wrist Injuries in Gymnastics

Welcome and Introduction (5 minutes)

- Greet the coach.
- Introduce yourself and the purpose of the interview.
- Briefly explain the background of the research topic*.
- Ask if there are any questions and answer any that are asked.
- Confirm that the coach wants to continue with the interview.

*Background of the research topic [The focus of this research is to evaluate the effectiveness of injury prevention programs specifically designed for gymnasts to reduce wrist injuries. As gymnastics is a sport that demands unique physical abilities and poses intricacies, wrist injuries are a common concern that can significantly affect the athlete's performance and long-term health. This study aims to investigate the practical impact of existing injury prevention initiatives in gymnastics by seeking insights from experienced coaches like yourself. Through this examination, the research aims to identify successful strategies, evaluate observed changes in gymnasts' behaviours and performance, and understand any challenges encountered in implementing prevention programs. The findings of this research

aspire to provide valuable knowledge for refining and developing targeted injury prevention approaches to ensure the sustained health and performance of gymnasts in this physically demanding sport]

Section 1: Coach Background

1. Can you provide a brief overview of your
 - coaching background
 - the sports you have coached
 - the level of athletes you have worked with or are working with
2. How long have you been involved in coaching, and what motivated you to pursue a coaching career?
3. Have you been involved in injury prevention programs in the past, and if so, could you share some details about those experiences?

Section 2: Program Implementation

4. Are you currently implementing any specific injury prevention program for your gymnasts, especially focusing on wrist injuries?
5. Can you provide an overview of the specific injury prevention program that was implemented for wrist injuries?
6. How was the injury prevention program introduced to the athletes under your coaching?
7. What role did you play in implementing and monitoring the injury prevention program?

Section 3: Program Effectiveness (skip if no wrist injury program implemented)

7. Have you observed any changes in athletes' behaviour or performance since implementing the injury prevention program?
8. Specifically focusing on wrist injuries, have you noticed a reduction in the number or severity of such injuries among your athletes?
9. From your perspective, how would you rate the overall effectiveness of the injury prevention program?

Section 4: Challenges and Success Factors (skip if no wrist injury program is implemented)

10. Can you identify any challenges you faced while implementing the injury prevention program?
11. How were these challenges addressed, and were there any lessons learned from overcoming them?
12. On a positive note, what do you consider as the key success factors that contributed to the effectiveness of the injury prevention program?

Section 5: Recommendations (skip if no wrist injury program is implemented)

13. Based on your experience, are there any specific improvements or modifications you would suggest for the current injury prevention program?
14. Are there additional strategies or elements that you believe could enhance the overall effectiveness of injury prevention efforts, especially concerning wrist injuries?

Section 6: Knowledge and Interest (To be asked if no wrist injury program is implemented)

15. How familiar are you with injury prevention programs designed for gymnasts, particularly those targeting wrist injuries?
16. Have you considered incorporating injury prevention strategies into your coaching routine?

Section 7: Barriers and Challenges (To be asked if no wrist injury program is implemented)

17. Are there specific challenges or barriers that have prevented the implementation of an injury prevention program for wrist injuries?
18. What factors do you believe contribute to the absence of such programs in your coaching context?

Section 8: Perceived Importance (To be asked if no wrist injury program is implemented)

19. How do you perceive the importance of injury prevention, especially concerning wrist injuries, in the context of gymnastics?
20. Have you observed an increase in wrist injuries among your gymnasts, and if so, how do you currently address these concerns?

Section 9: Resource Availability (To be asked if no wrist injury program is implemented)

21. Are there any resource limitations, such as time, equipment, or access to training materials, that have influenced your decision not to implement an injury prevention program?

Section 10: Training Philosophy (To be asked if no wrist injury program is implemented)

22. Can you share your coaching philosophy regarding injury prevention and athlete safety?
23. In your opinion, how can injury prevention programs complement gymnastics training without disrupting the overall coaching approach?

Section 11: Educational Needs (To be asked if no wrist injury program is implemented)

24. Would you be interested in educational resources or training sessions on effective injury prevention strategies tailored for gymnastics and wrist injuries?
25. What kind of support or information would you find most helpful in incorporating injury prevention into your coaching practices?

Section 12: Future Considerations (To be asked if no wrist injury program is implemented)

26. Given the opportunity, would you consider implementing an injury prevention program in the future? Why or why not?
27. What changes or improvements would make you more inclined to integrate injury prevention strategies into your coaching approach?

Conclusion:

28. Is there anything else you want to share or highlight regarding your experiences with injury prevention programs and their impact on wrist injuries?
29. Thank you for your insights. If we have any follow-up questions, may we contact you in the future?

Appendix 3

Approved Survey Questionnaire:

Tēnā koe,

My name is Sneha Dalal. I am a student at the University of Waikato completing a Master's degree in Te Huataki Waiora, the School of Health. As a part of my degree, I want to find out about wrist injury prevention programmes that are being used in gymnastics.

If you are a gymnast, please consider being a part of my study. It doesn't matter what level you compete at, but you will need to be older than 5 years of age. If you are between the ages of 5 and 16, you will need to complete the survey with your parent or guardian. You can also complete this survey if you are a parent or guardian of a gymnast. If you are completing the survey as a guardian of a gymnast, we kindly ask that you answer the questions as if you were the gymnast in your care.

I have put together a list of questions in the following pages of this survey, which should take 20 to 30 minutes to finish. I am keen to know if you know about wrist injury prevention if you or your gymnasium use them, how well you think they work, and whether you have had a wrist injury. I assure you that any answer you provide will not be linked to you in any way and I will not know who the survey is from (it is anonymous). None of the questions in the survey ask for your name or who you might be. Please note that there are no wrong or right answers – just answer to the best of your knowledge. You also don't have to answer any questions you don't want to.

If you start the survey and then decide you no longer want to do it, you don't have to. All you need to do is simply close the survey window. This will withdraw you from the survey and erase anything you have already answered. At the end of the survey, there will be a button that says "submit survey". Once you do this, you will no longer be able to withdraw as I will not know which survey is yours.

Your answers will contribute to a better understanding of wrist injury in gymnastics and how it can be prevented. To do this, I will use your answers and the answers of other gymnasts who participated in the survey to write a Master's thesis, as well as publish a research paper in a Journal. I also plan to talk about my findings in seminars and conferences, provide online educational reports, and possibly provide policy recommendations. So that you can see what I found out in this study, the online educational report will be posted online in the same place that you found this survey.

The data from this survey will be stored in a password-protected, secure, and encrypted server (H-Drive) at the University of Waikato for five years, after which it will be permanently erased. Only myself and my supervisor will have access to this data.

You can ask any question about my study that you want. If you have a question please feel free to contact me at sd615@students.waikato.ac.nz. You can also contact my supervisor at brett.langley@waikato.ac.nz.

This research project has been approved by the Human Research Ethics Committee of the University of Waikato under HREC(HEALTH)2023#[number to be provided]. For any ethical questions or concerns please contact the Chair of the Committee, email

humanethics@waikato.ac.nz, postal address, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

Consent:

- I have read and understood the information above
- I am over the age of 16
- I am between 5 and 16 years of age and completing this with my parent or guardian
- I give my consent to have my answers used in the study described above
- I am the parent or guardian of the 5 to 16 year old and give my consent for participation in this study

1. I am a

- Gymnast**
 - Parent / Guardian**
 - Gymnast and Parent / Guardian together**
 - Other (Please Specify)**
-

2. The gymnast is

- Male**
- Female**

3. Age of the gymnast in years

- 5-10**

- 11-15
- 16-20
- 21-25
- 26-30
- 31+

4. How many years of gymnastics experience do you have?

- Less than 1 year
- 1-3 years
- 4-6 years
- 7-10 years
- More than 10 years

5. Have you participated in any gymnastics competitions?

- No
- Maybe
- Yes

6. What is your current level of gymnastics competition?

- Beginner

- Intermediate**
 - Advanced**
 - Elite (Please specify level of competition)**
-

7. Please provide the details about the nature of your training.

- Do you have a coach?**
-

- Number of training days in a week**
-

- Hours of training per training day**
-

- Hours of training per week**
-

- Rest days per week**
-

- What type of surface do you primarily train on?**
-

- Do you engage in cross-training?**
-

- Does cross-training include in your training hours?**
-

- Give the list of cross-training you are engaged in.**
-

Do you play any other sport as a part of cross-training? Give name

Do you use wrist support or braces during training?

8. Have you personally experienced or seen a co gymnast suffer from a wrist injury while participating in gymnastics?

No

Yes, please provide details like type of injury, severity and recovery time

9. Are you familiar with the concept of injury prevention programs in gymnastics? or have you been introduced to any such programs?

No

May Be

Yes

10. Please select the appropriate program you have known of. You can select multiple options.

Proper technique

Flexibility training

Strength training

- Conditioning**
- Plyometric exercises**
- Progressive skill development**
- Rest & Recovery**
- Injury surveillance & management**
- Education**
- Equipment safety**

11. How did you become aware of injury prevention strategies in gymnastics? (Select all that apply)

- Through my coaches**
 - From my teammates**
 - Personal research**
 - Seminars/Workshops**
 - Other (Please Specify)**
-

12. Have you ever received specific training or guidance on wrist injury prevention and management?

- Yes**

Maybe

No

13. Please select the programs from the following that you are aware of and the importance of their purpose and technique.

You can select multiple options.

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Wrist strengthening exercises	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Forearm & Grip strengthening	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Flexibility & mobility training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Technique emphasis	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wrist guards & supports	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rest & Recovery	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Injury	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Awareness &					
Reporting					
Progressive	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Skill					
Development					
Proper	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Equipment					
Consultation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
with Sports					
Medicine					
Professionals					
Periodization	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Monitoring	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
& Feedback					

14. Has your gymnastics team or organization implemented any injury prevention programs for wrist injuries?

Yes, please describe

Maybe

No

15. How often are these injury prevention programs conducted?

Daily

Weekly

Monthly

Rarely

Never

Other (Please Specify)

16. In your opinion how effective have injury prevention programs been in reducing wrist injuries in competitive gymnasts?

Not effective at all

Slightly effective

Moderately effective

Very effective

Extremely effective

17. What specific changes or improvements have you noticed since the implementation of injury prevention programs? You can select multiple options.

- Reduced injury rates**
- Improved performance**
- Enhanced flexibility**
- Better technique**
- Increased confidence**
- Long-term athlete development**
- Healthy training environment**
- Reduced healthcare costs**
- Fewer disruptions**
- Positive public image**
- Lower dropout rates**
- Improved education**
- Research innovation**

18. Have you experienced any injuries since participating in the injury prevention program?

- No
 - Yes, please specify details
-

19. How often does your coach emphasize proper wrist techniques and form?

- Always
- Most of the time
- About half the time
- Sometimes
- Never

20. Do you feel adequately supported by your coaches and training staff in preventing wrist injuries?

- Definitely not
- Probably not
- Might or might not
- Probably yes
- Definitely yes

21. How involved are your coaches and trainers in promoting and implementing injury prevention programs for wrist injuries?

- Far too little
- Slightly too little
- Neither too much nor too little
- Slightly too much
- Far too much

22. Do you believe that more education and training for coaches and trainers regarding wrist injury prevention would be beneficial?

- Definitely not
- Probably not
- Might or might not
- Probably yes
- Definitely yes

23. In your opinion, what could be the possible reasons for gymnasts to suffer with the injury during the sports.

24. What additional resources or support do you think would be beneficial for preventing wrist injuries in gymnastics?

25. How regularly do you and your fellow gymnasts participate in the injury prevention programs?

- Always
- Often
- Ocassionally
- Rarely
- Never

26. Have you noticed any impact on your gymnastic performance as a result of participating in injury prevention programs?

- No

Maybe

Yes

27. Please select the impact on your performance you have noticed after participating in injury prevention.

- Reduced injury risk**
 - Improved strength and flexibility**
 - Enhanced technique**
 - Better body awareness**
 - Increased endurance and stamina**
 - Quicker recovery**
 - Long-term athletic development**
 - Positive psychological effect**
 - Educational benefits**
 - Long term athlete retention**
 - Others (Please Specify)**
-

28. What recommendations do you have for improving injury prevention programs for wrist injuries in gymnastics?

29. Do you have any additional comments, suggestions, or experiences related to wrist injuries and injury prevention in gymnastics that you would like to share?

End of Block: Survey Questions

Conclusion: Thank you for taking the time to complete this survey. Your insights are valuable in advancing our understanding of wrist injury prevention in competitive gymnastics. Your input will contribute to the safety and well-being of gymnasts in the sport. Please submit the survey

when you are ready. Once your survey is submitted, it cannot be withdrawn or modified as all survey submissions are anonymous.