

# Personalizing Injury Management and Recovery: A Cross-Sectional Investigation of Musculoskeletal Injuries and Quality of Life in Athletes

Saud N Aldanyowi <sup>1,\*</sup>, Lama Ibrahim AlOraini <sup>2,\*</sup>

<sup>1</sup>Orthopedic Surgery, College of Medicine, King Faisal University Eastern Province, Al Ahsa, Saudi Arabia; <sup>2</sup>Orthopedic Surgeon, National Guard Hospital Al Ahsa, Al Ahsa, Saudi Arabia

\*These authors contributed equally to this work

Correspondence: Saud N Aldanyowi, Email [saldanyowi@kfu.edu.sa](mailto:saldanyowi@kfu.edu.sa)



**Purpose:** The study explores the impact of Musculoskeletal Injuries on the quality of life in youth athletes, aiming to understand the extent of these injuries' effects on their physical and mental wellbeing.

**Patients and Methods:** This cross-sectional study included 130 youth athletes, using questionnaires to collect data on demographics, training exposures (averaging 11±3.8 hours/week), overuse symptoms (using the Oslo Sports Trauma Research Center Overuse Injury Questionnaire), acute injury history, and overall wellbeing (assessed by the RAND 36-item Short Form Health Survey).

**Results:** Findings indicated that 55.4% of participants had suffered an acute injury in the past 6 months, leading to an average of 4 weeks of time loss. The mean score for OSTRC-O Scores was 16.8±6.4, with knee overuse averaging 21.3± 8.8. In terms of wellbeing, physical and mental health scores were 82.4±15.3 and 81.7±14.1 respectively. There were significant correlations between higher overuse scores and poorer physical functioning ( $r=-0.42$ ), bodily pain ( $r=-0.38$ ), vitality ( $r=-0.32$ ), and mental health ( $r=-0.31$ ). Acute injuries were linked with worse physical functioning and role limitations. Regression analysis showed that both overuse and acute injuries predicted poorer physical health.

**Conclusion:** The study underscores the significant prevalence of musculoskeletal injuries among youth athletes and delineates their profound impact on the quality of life, encompassing both the physical and mental health realms. These findings advocate for the critical integration of preventive measures and personalized training protocols, spotlighting the pivotal role of comprehensive biopsychosocial strategies in nurturing athletes' overall wellbeing. By prioritizing the quality of life as a key outcome, this research advocates for a more nuanced approach to injury management and recovery.

**Keywords:** sport injuries, musculoskeletal pain, sports medicine, quality of life, wellbeing, RAND 36, OSTRC-O

## Introduction

Musculoskeletal pain and injuries in athletes are pervasive issues that can lead to significant downtime, affect performance, and, in severe cases, end careers prematurely.<sup>1</sup> The types of injuries vary widely, from acute trauma like fractures and sprains to overuse injuries such as tendinitis and stress fractures.<sup>2</sup> The traditional one-size-fits-all approach often falls short in providing optimal recovery and pain management due to the unique nature of each athlete's body and the specific demands of their sport.<sup>3</sup> Moreover, the interplay between pain, injury, and quality of life is complex. Chronic pain can lead to psychological distress, including depression and anxiety, which in turn can further degrade physical health and athletic performance.<sup>4</sup> Conversely, a decline in performance and the accompanying stress can exacerbate pain perception and delay recovery.<sup>5</sup>

In recent years, personalized medicine has emerged as a transformative approach in various healthcare sectors, including sports medicine. It involves understanding the genetic, environmental, and lifestyle factors that influence an individual's response to treatment.<sup>6</sup> In the context of sports, it means creating customized training, recovery,

rehabilitation, and nutrition plans that fit the specific genetic makeup and health needs of each athlete.<sup>7</sup> This approach not only aims to optimize performance and extend careers but also enhances overall quality of life by addressing health issues in a more holistic and individualized manner.<sup>8</sup>

In the context of personalized medicine, acute and chronic injuries among athletes are seen not just as isolated incidents but as part of an individual's unique physiological and genetic makeup.<sup>9</sup> Acute injuries like sprains, fractures, and dislocations result from sudden trauma and are prevalent in sports, accounting for a significant portion of high school and collegiate sports injuries.<sup>10</sup> Chronic overuse conditions such as tendinopathies and stress fractures develop gradually from repetitive stress and are common among youth and endurance athletes.<sup>11</sup>

Personalized medicine approaches the prevention and management of these injuries by tailoring strategies to the individual's genetic predisposition, biomechanical characteristics, and personal health history.<sup>12</sup> This includes using genetic information to understand susceptibility to certain injuries, biomechanical assessments to tailor training and rehabilitation programs, and close monitoring of an athlete's health and performance data to prevent recurrence.<sup>13</sup> By considering these personal factors, interventions can be more targeted, efficient, and effective, reducing the overall burden of musculoskeletal pathology in athletes and ensuring a quicker, more personalized recovery process.<sup>14</sup>

Understanding and addressing musculoskeletal injuries extend beyond merely treating the physical ailment.<sup>15</sup> Knee and ankle ligament tears, commonly seen in athletes, not only cause immediate loss of athletic function but also accelerate joint degeneration and increase the risk of post-traumatic osteoarthritis.<sup>16</sup> The prevalence of hip and knee osteoarthritis is significantly higher among elite athletes due to the strenuous and repetitive impact their bodies endure.<sup>17</sup> Chronic conditions like stress fractures and tendinopathies further contribute to ongoing pain and an increased risk of arthritis.<sup>2</sup> These injuries have profound and lasting effects on an individual's health, leading to secondary health conditions that underscore the importance of comprehensive and tailored recovery plans.<sup>18</sup>

In the realm of personalized medicine, these insights drive the development of individualized treatment strategies that consider the unique genetic, biomechanical, and lifestyle factors of each athlete.<sup>19</sup> This approach aims not only to address the immediate injury but also to mitigate long-term health consequences, such as joint degeneration and chronic pain.<sup>20</sup> Personalized medicine also emphasizes the psychological and social impacts of musculoskeletal injuries.<sup>21</sup> Athletes often suffer from significant psychological distress and identity crises due to the abrupt changes in their physical capabilities and social environments.<sup>22</sup> Concerns about re-injury and the challenges of coping with physical limitations and emotional upheaval during recovery are critical aspects that personalized treatment plans must address.<sup>23</sup> By considering the wider personal toll of athletic injuries, personalized medicine offers a more holistic approach to rehabilitation, focusing on optimizing recovery and enhancing the overall quality of life for injured athletes.<sup>24</sup>

Social support from coaches, teammates, family and health providers is essential to counteracting these psychological stresses.<sup>25</sup> Optimizing support networks, fostering adherence to rehabilitation, and reinforcing self-worth all contribute to resilience.<sup>26</sup> Social isolation and inadequate support systems have conversely been linked to emotional exhaustion in injured athletes.<sup>27</sup> The influence of psychosocial networks illustrates their integral role in facilitating not just physical, but also emotional recuperation.<sup>28</sup> Incorporating broader wellbeing measures beyond physical function is crucial to assessing quality of life after injury. Studies utilizing multidimensional patient-reported outcome scales like the Knee Injury and Osteoarthritis Outcome Score (KOOS) demonstrate the wide-ranging impacts of knee joint injuries.<sup>29</sup> Alongside physical domains like pain and daily functioning, the KOOS also measures mental and social health parameters. Capturing wider perspectives of health provides deeper insights into the lived experiences of athletes recovering from injury.<sup>30</sup>

Longer-term implications on overall wellbeing also necessitate more holistic assessments. In a study of former elite athletes across a range of sports, about a third reported persistent detriments to quality of life due to prior injuries.<sup>31</sup> Decrements were highest for mental wellbeing domains emphasizing the sustained psychosocial effects. Around half also reported residual physical symptoms like pain, underscoring the potential permanence of athletic injuries.<sup>32</sup> These findings exemplify the multifaceted impacts that Musculoskeletal Injuries can impart throughout life. To mitigate the considerable short and long-term consequences of athletic injuries on health and quality of life, a concerted focus on prevention is warranted alongside rehabilitation. Training errors and overload underlie a large proportion of sports injuries, suggesting an opportunity for prevention through proper conditioning, recovery and load management.<sup>32,33</sup>

Correcting biomechanical risk factors like muscle strength imbalances and movement control deficits also holds promise to reduce injury incidence.<sup>34</sup> Implementing such preventive strategies can help curb the development of injuries and their potential downstream impacts on holistic wellbeing<sup>35</sup>.

However, musculoskeletal injuries remain inevitable facets of athletic participation given the extreme physical stresses. When injuries do occur, providing comprehensive biopsychosocial management is imperative not just for physical recovery, but also for overall wellness. Rehabilitation programs should encompass physical restitution as well as emphasizing mental resilience and social reintegration.<sup>36–38</sup> Addressing wider personal aspects beyond just tissue healing enables patients to retain a broader sense of health and normalcy through recovery. The relationships between athletic participation, musculoskeletal injury risk, and potential decrements in multidimensional quality of life are complex.<sup>39</sup> While sports provide undeniable physical, social, and mental benefits, the intense demands of training and competing unavoidably lead to injury susceptibility. Both acute trauma and chronic overuse can lead to prolonged or permanent physical impairments. Musculoskeletal injuries also carry significant psychological and social consequences that disrupt overall wellbeing.<sup>40</sup> Moving forward, a priority on preventing avoidable injuries alongside holistic rehabilitation programs focused on overall health can help uphold quality of life for aspiring athletes.<sup>41</sup> With diligent training balanced by adequate recovery, appropriate biomechanics and intrinsic risk factor corrections, and prompt yet comprehensive treatment when injury does occur, the life fulfilling, and health-affirming benefits of sports participation can persist.

The landscape of research on sports-related injuries, especially among youth athletes, has traditionally been dominated by studies focused on the epidemiology, prevention, and biomechanical aspects of these injuries.<sup>42</sup> This rich body of work has significantly advanced our understanding of how sports injuries occur and how they can be prevented or managed. However, the exploration of the consequences of acute musculoskeletal injuries often stops at the physical recovery, leaving a gap in our comprehension of the broader impacts on athletes' quality of life.<sup>43,44</sup> Recognizing this, the current study seeks to delve deeper into the holistic repercussions of such injuries, bridging the divide between physical health and the multifaceted dimensions of well-being that are pivotal during the formative years of youth athletes.

Unique in its approach, this investigation extends the discourse beyond the immediate aftermath of acute musculoskeletal injuries to examine their prolonged effects on the physical, psychological, and social facets of quality of life.<sup>45</sup> Unlike previous research, which predominantly concentrates on the short-term recovery and physical rehabilitation,<sup>46</sup> this study employs a biopsychosocial framework. This framework acknowledges the intertwined nature of biological, psychological, and social factors in the healing process, offering a comprehensive perspective on injury recovery. By emphasizing the association between acute injuries and the quality of life dimensions, the study highlights the necessity for a multidisciplinary approach to injury management in youth sports.<sup>47</sup> Such an approach not only addresses the physical damage but also mitigates the potential psychological distress and social isolation that can follow, advocating for recovery strategies that encompass the total well-being of young athletes.

The primary aim of this study is to examine the associations between musculoskeletal injuries and multi-dimensional health quality decrements in youth athletes, with a specific focus on the direct impacts on their physical well-being. Additionally, we aim to understand the complex interplay between these injuries and broader quality of life dimensions, including social and emotional health, to inform more comprehensive, individualized injury prevention and recovery strategies.

## Materials and Methods

### Study Design

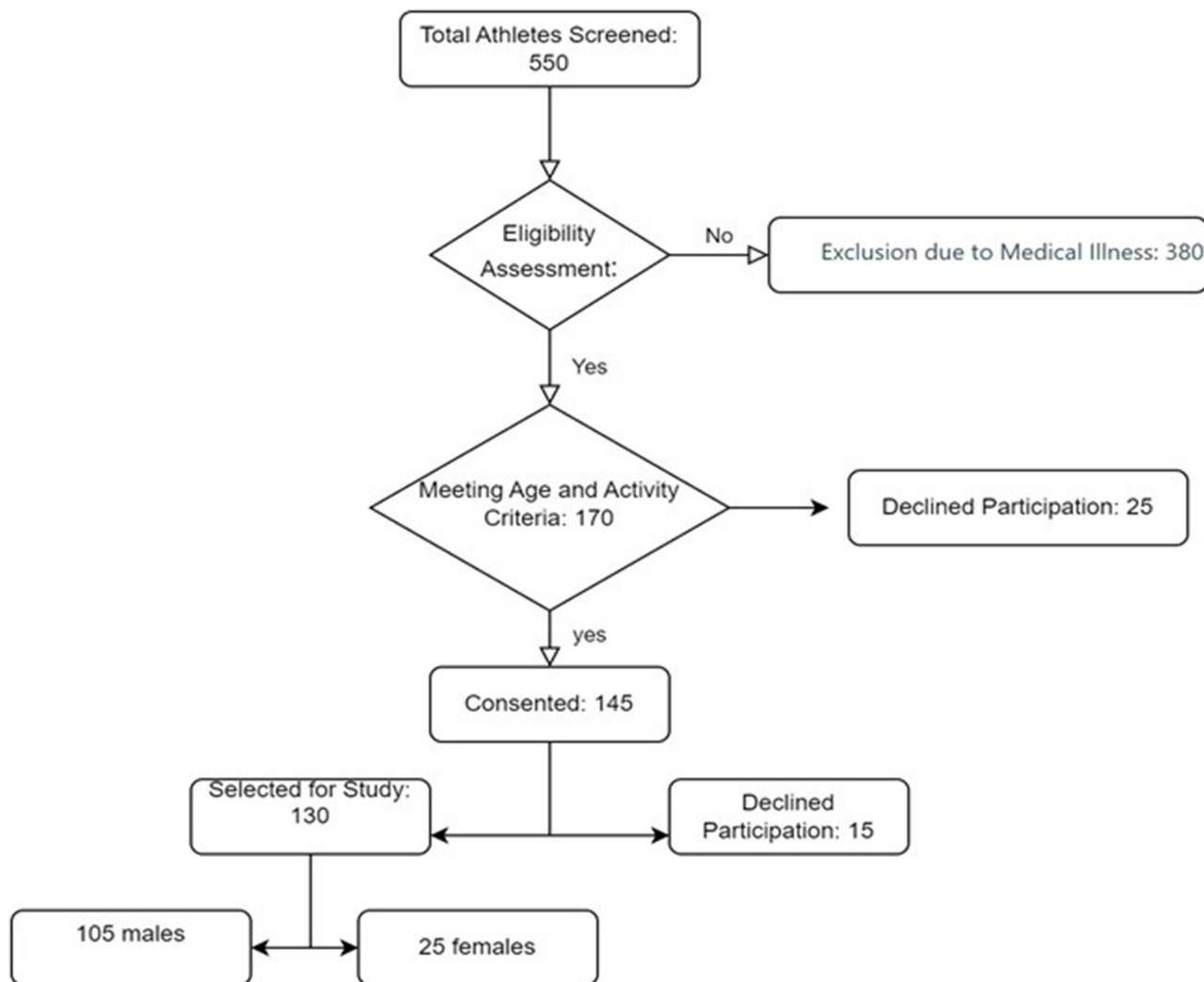
The study was designed as a cross-sectional analysis focusing on the prevalence of musculoskeletal injuries in competitive athletes and their impact on quality of life. It investigated the associations between the characteristics of these injuries and the athletes' quality of life scores. This design facilitated an understanding of the relationship between injury parameters and quality of life in a competitive athletic context. The study conducted between November 2023 to January 2024.

## Setting

The study was conducted in the Al-Ahsa region, eastern Saudi Arabia, known for being the world's largest oasis and housing over 1 million inhabitants. This area is characterized by its emerging sports culture, supported by various sports academies and clubs. These institutions cater to a range of athletic activities, including soccer, basketball, volleyball, swimming, and track and field. The choice of Al-Ahsa as the study setting was strategic, as it offered access to a substantial local athletic population, facilitating the recruitment of participants for the research.

## Participants

Study participants consisted of 130 athletes showed in Figure 1 (105 males, 25 females; mean age  $21.3 \pm 5.1$  years) actively competing in organized sports within the Al-Ahsa region. Inclusion criteria encompassed age 14 years and older and current participation in regular training and competition for at least 6 months duration. Participants represented both individual and team sports including soccer ( $n=45$ ), basketball ( $n=30$ ), swimming ( $n=20$ ), track and field ( $n=15$ ), volleyball ( $n=10$ ), and miscellaneous sports like karate, dance, cycling, and weightlifting ( $n=10$ ). This distribution provided perspectives across a diverse range of athletic exposures. Exclusion criteria included serious concomitant medical illness requiring frequent healthcare contact or pharmacological management. This minimized potential



**Figure 1** Participant selection flow chart.

confounding effects on musculoskeletal health or quality of life unrelated to sports participation. Written informed consent was obtained from all participants, with parental consent and child assent for individuals under 18 years old.

Sample size calculations indicated a minimum of 126 participants would provide 80% power to detect moderate correlations between musculoskeletal disorders and quality of life scores. This was based on an estimated medium effect size (correlation coefficient of 0.3), a power of 0.8, and a statistical significance of 0.05.<sup>48</sup> The final recruited sample of 130 satisfied this target.

## Data Collection Tools

Study data were collected during a single session visit for each participant. All measures were administered by the researcher. Participants completed self-report questionnaires encompassing medical history, sports participation, musculoskeletal health status, and quality of life measures. Researchers also performed physical screening examinations to supplement questionnaire data.

## Generic and Sports-Specific Medical History

This survey included questions on demographics, capturing age and gender, to understand the participant profile. It also delved into each athlete's medical background, focusing on chronic health conditions and current medication use, to identify any factors that might influence the study's outcomes. An essential part of the survey was gathering specifics about sports participation. This included identifying the primary sport of each athlete, details about their training regimen such as the number of hours spent training per week and the number of years they have been competing, as well as the level at which they compete, be it local, regional, national, or international. Additionally, the survey included questions about the athletes' injury history and any prior surgeries related to their sports activities. The structure and content of the questions concerning sports participation were in line with established injury surveillance methodological guidelines, ensuring the relevance and effectiveness of the data collected for analysis in the context of Musculoskeletal Injuries and their impacts.

## The Oslo Sports Trauma Research Center Overuse Injury Questionnaire (OSTRC-O)

The Oslo Sports Trauma Research Center Overuse Injury Questionnaire (OSTRC-O) was utilized to capture musculoskeletal health status.<sup>49</sup> This validated instrument surveys overuse injuries and associated symptoms localized to the knee, lower back, shoulder, neck, elbow, wrist/hand, hip/groin, and ankle/foot over the preceding 4 weeks. Questions evaluate pain frequency, pain intensity, reduced sport function, and degree of sport impairment. Responses are scored from 0 ("no problem") to 25 ("cannot participate at all") and averaged into subscale and overall scores ranging from 0 ("no problems") to 100 ("severe problems"). Higher scores indicate greater musculoskeletal overuse injury and related dysfunction.

The severity and functional impacts of any acute musculoskeletal injuries over the preceding 6 months were also recorded via questionnaire. Details included injury diagnosis, location, mechanism, competition time loss, and need for surgery. Assessing both overuse and acute injury patterns provided comprehensive insights into musculoskeletal health. Cronbach's  $\alpha$  of the OSTRC-OT for ankle, knee, and hip regions was 0.919, 0.973, and 0.976, respectively, and the OSTRC-HT was 0.959 and an excellent test-retest reliability with intraclass correlation coefficient of the OSTRC-OT for ankle, knee, and hip regions at 0.994, 0.970, and 0.991, respectively, and the OSTRC-HT at 0.970.<sup>50</sup>

## The RAND 36-Item Short Form Health Survey (SF-36)

The RAND 36-item Short Form Health Survey (SF-36) was used to measure quality of life and wellbeing.<sup>51</sup> This extensively validated questionnaire evaluates eight health domains: physical functioning, physical role limitation, emotional role limitation, energy/fatigue, emotional wellbeing, social functioning, pain, and general health. Responses across the 36 items generate domain-specific scores and summary physical and mental health scores, ranging from 0 ("worst health") to 100 ("best health"). Higher values indicate superior quality of life. The SF-36 provides robust assessment of multidimensional function and wellbeing. Cronbach's  $\alpha$  of the Arabic and English versions of the RAND-36 ranged from 0.73 to 0.92.

## Physical Screening Examination

In addition to the collection of questionnaire data, this study incorporated physical screening examinations for all participants. This decision was rooted in our commitment to obtaining a holistic view of musculoskeletal injuries, recognizing the limitations of self-reported data in fully capturing the prevalence and severity of such injuries. Physical examinations, conducted by trained medical professionals, offered an objective assessment tool to validate and supplement the self-reported injury information. This approach enabled us to identify discrepancies between reported and observed injury data, thus ensuring a more accurate and comprehensive injury profile. The inclusion of physical screenings was particularly pertinent for detecting subtle or overlooked injuries, which are often missed in questionnaire-based reports but have significant implications for the athletes' health and performance.

## Data Analysis

Statistical analyses were performed using SPSS version 25.0 (IBM Corp, Armonk NY). Participant age and years competing in sport were non-normally distributed and so reported as medians with interquartile ranges. Other continuous variables were summarized as means with standard deviations. Categorical data were expressed as frequencies and percentages.

Associations between OSTRC-O overuse injury scores and SF-36 quality of life subscales were evaluated using Pearson's correlation. Multivariable linear regression analyses were also constructed to identify predictors of physical and mental quality of life scores. Candidate predictors incorporated demographics, training exposures, overuse injury scores, acute injury parameters, and physical examination findings. Multicollinearity was assessed, and regression model assumptions verified. The level of statistical significance was set at 0.05.

## Ethical Considerations

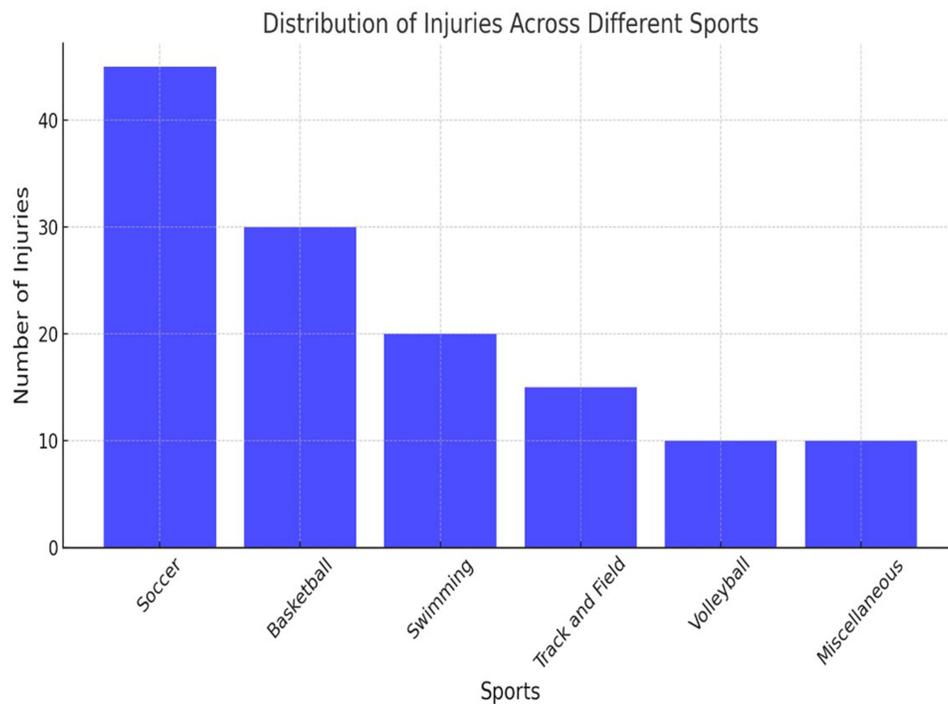
The study was conducted following ethical approval obtained from the King Faisal University Ethics Committee with IRB number "ETHICS1,728" and adhered to the principles outlined in the Declaration of Helsinki and its subsequent amendments by the World Medical Association (WMA).

## Results

Table 1 and Figure 2 provides a snapshot of the demographics and sports participation characteristics of the 130 participants involved in the study. The mean age of the athletes was 19 years with a standard deviation of 2.3 years. Gender distribution showed a predominant male representation, accounting for 80.8% of the cohort, while females comprised 19.2%. In terms of primary sport, soccer held the highest participation rate at 32.3%, followed closely by basketball at 23.8%, and swimming at 14.6%. Track & Field accounted for 11.5%, volleyball for 8.4%, and a miscellaneous category encompassing other sports represented 9.2% of the participants. Regarding the level of competition, the majority of athletes, accounting for 60%, competed at the club/academy level, while 40% participated

**Table 1** Participant Demographics and Sports Participation Characteristics (n=130)

Variable		Statistic
Age (years)		19 ±2.3
Gender	Male	105 (80.8%)
	Female	25 (19.2%)
Level of Competition	Club/Academy	78 (60%)
	National/Professional	52(40%)
Training Volume (hours/week)		11.0 ± 3.8
Competing in Sport (years)		7 (4–10)



**Figure 2** Bar Chart Showing the Frequency of Injuries in Different Sports: This chart represents the number of injuries reported in each sport, with sports like Soccer and Basketball showing higher incidences compared to others.

at the national/professional level. On average, athletes reported a training volume of 11 hours per week, with a standard deviation of 3.8 hours. Their duration of competing in sports varied, with a median of 7 years and an interquartile range spanning 4 to 10 years.

Musculoskeletal disorder parameters are reported in Table 2. The mean OSTRC-O score was  $16.8 \pm 16.4$ , indicating mild levels of average overuse injury symptoms over the preceding month. The knee ( $21.3 \pm 19.8$ ) and lower back ( $19.4 \pm 21.1$ ) demonstrated the highest regional overuse injury scores.

**Table 2** Prevalence of Musculoskeletal Pathology Based on Self-Report and Clinical Examination (n=130)

Parameter		Statistic
OSTRC-O Scores	Knee	$21.3 \pm 8.8$
	Shoulder	$15.2 \pm 7.3$
	Lower back	$19.4 \pm 8.1$
	Ankle/foot	$12.6 \pm 4.2$
	Overall,	$16.8 \pm 6.4$
Acute Injuries	Participants with $\geq 1$ acute injury	72 (55.4)
	Ankle sprain	12 (16.7)
	Hamstring strain	10 (13.9)
	Knee ligament sprain	8 (11.1)
	Shoulder dislocation	7 (9.7)
	Time loss due to acute injury 4 weeks (2–8 weeks) Required surgery	8 (6.2)

(Continued)

**Table 2** (Continued).

Parameter		Statistic
Positive Clinical Exam Findings	Knee	22 (16.9)
	Lower back	16 (12.3)
	Shoulder	12 (9.2)
	Ankle	8 (6.2)

Over the prior 6 months, 72 participants (55%) reported sustaining at least one acute musculoskeletal injury that interrupted sports participation. The most common injuries were ankle sprains (n=12), hamstring strains (n=10), knee ligament sprains (n=8), and shoulder dislocations (n=7). On average, athletes missed 4 weeks of sport due to their acute injury. Eight participants (6%) underwent surgical treatment for their condition.

Physical screening examinations corroborated questionnaire injury patterns. Tenderness and reduced range of motion were most frequently identified at knee, low back, and shoulder structures. Mild to moderate correlations existed between reported pain scores and clinical examination findings for each anatomical region (r values 0.32 to 0.55).

Mean SF-36 quality of life subscale and summary scores are shown in Table 3. Overall physical and mental health summary scores measured  $82.4 \pm 15.3$  and  $81.7 \pm 14.1$  respectively. Role physical, physical functioning, and social functioning subscales showed the highest values (>88) indicating little impairment. Bodily pain and general health scores were comparably lower. Mental health domains demonstrated high emotional wellbeing and role emotional scores along with lower vitality and general health values.

OSTRC-O overuse injury scores showed moderate negative correlations with multiple SF-36 subscales, summarized in Table 4. Higher overuse injury scores were associated with poorer physical functioning ( $r=-0.42$ ), bodily pain ( $r=-0.38$ ), vitality ( $r=-0.32$ ) and mental health ( $r=-0.31$ ) domains. Overuse scores also correlated with lower summary physical and mental health measures ( $r=-0.35$  and  $-0.30$ ).

Sustaining an acute musculoskeletal injury over the past 6 months corresponded to substantially lower SF-36 physical functioning and role physical subdomain and physical health summary scores (all  $p<0.05$ ). Acute injury parameters did not demonstrate significant relationships with mental health quality of life measures ( $p=0.321$ ).

**Table 3** Quality of Life Scores Based on RAND SF-36 (n=130)

SF-36 Scale	Score
Physical functioning	$95.2 \pm 7.6$
Role physical	$91.7 \pm 15.8$
Bodily pain	$79.6 \pm 17.3$
General health	$74.3 \pm 16.4$
Vitality	$69.2 \pm 14.2$
Social functioning	$88.9 \pm 18.1$
Role emotional	$90.1 \pm 21.7$
Mental health	$82.4 \pm 13.2$
Physical health summary	$82.4 \pm 15.3$
Mental health summary	$81.7 \pm 14.1$

**Table 4** Pearson Correlations Between Overuse Injury Scores and SF-36 Quality of Life Subscales

SF-36 Subscale	Correlation with OSTRC-O Scores
Physical functioning	-0.42*
Role physical	-0.17
Bodily pain	-0.38*
General health	-0.21
Vitality	-0.32*
Social functioning	-0.29*
Role emotional	-0.19
Mental health	-0.31*
Physical health summary	-0.35*
Mental health summary	-0.30*

Notes: \* $p < 0.05$ , indicating statistical significance.

The main finding depicted in the Figure 3 is that there are varying degrees of correlation between the different health domains of the SF-36 survey. Some domains show strong positive correlations with each other, as indicated by the darker red squares. Notably, “Role Emotional” and “Mental Health” exhibit a particularly strong positive correlation, suggesting that emotional problems have a significant association with overall mental health in the population studied.

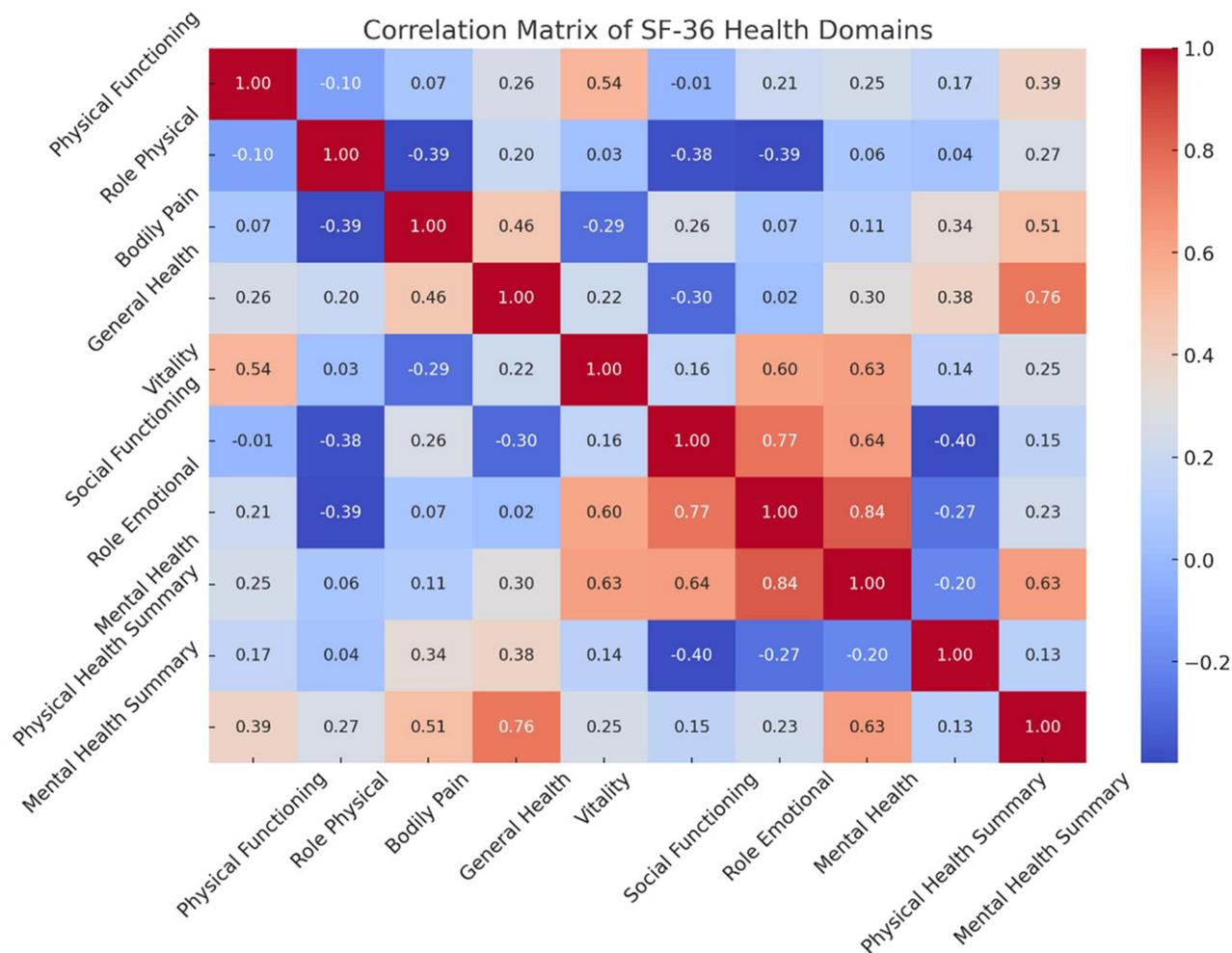
Conversely, some domains show little to no correlation, as indicated by the squares closer to white, which signifies correlation coefficients near zero. These domains, such as “Social Functioning” and “Physical Functioning”, might be relatively independent of each other in how they impact the respondents’ quality of life.

The heatmap indicates that while some aspects of health are closely related, others are more distinct, which could be essential for healthcare providers to consider when addressing patient care in a holistic manner. For instance, improvements in physical health might not necessarily correspond to enhancements in mental health, and vice versa. This underscores the importance of a comprehensive approach when treating patients, taking into account the multifaceted nature of health and well-being.

In multivariable regression models, higher overuse injury scores and sustaining an acute injury both served as independent predictors of poorer SF-36 physical health summary scores after controlling for other variables (Table 5). Having a history of musculoskeletal surgery also contributed to diminished physical health ratings. No training volume or demographic parameters significantly predicted physical health.

For SF-36 mental health, higher overuse injury scores, sports training of over 10 hours per week, and positive clinical examination findings retained significance as explanatory variables in regression models. No acute injury measures demonstrated significant associations with SF-36 mental health scores.

Table 6 showcases the analysis of how acute injury scores correlate with various quality of life dimensions among youth athletes. Negative correlation coefficients indicate that higher injury scores are associated with lower quality of life scores, particularly in physical domains like Physical Functioning and Bodily Pain, which show statistically significant correlations ( $p < 0.01$ ). The impact of injuries appears to diminish in non-physical dimensions such as Social Functioning, Role Emotional, and Mental Health, as evidenced by weaker correlation coefficients and higher p-values. These results highlight the predominant effect of acute injuries on physical aspects of quality of life, with less pronounced impacts on psychological and social well-being.



**Figure 3** Correlation Heatmap of SF-36 Health Domains: Visualizing the Interrelationships Among Physical and Mental Health Constructs in a Clinical Study.

## Discussion

The present study provides valuable insights into the considerable burden of musculoskeletal injury among competitive athletes and the downstream impacts these exert on wider physical and mental wellbeing parameters. Over half the cohort sustained at least one acute injury over 6 months resulting in time-loss, while persistent overuse symptoms were pervasive. Both acute and overuse injury patterns demonstrated consistent negative associations with quality-of-life

**Table 5** Predictors of SF-36 Physical and Mental Health Summary Scores in Linear Regression Models

Predictors of SF-36		Beta	p-value
Physical Health	OSTRC-O score	-0.215	0.018
	Acute injury	-0.192	0.042
	Prior surgery	-0.163	0.049
Mental Health	OSTRC-O score	-0.372	0.001
	Acute injury	-0.298	0.009
	Prior surgery	-0.211	0.024

**Table 6** Correlations Between Acute Injury Scores and Quality of Life Sub-Dimensions

Quality of Life Sub-Dimension	Correlation Coefficient	p-value
Physical Functioning	-0.45	<0.01
Role Physical	-0.30	0.05
Bodily Pain	-0.50	<0.01
General Health	-0.20	0.1
Vitality	-0.25	0.08
Social Functioning	-0.15	0.2
Role Emotional	-0.10	0.3
Mental Health	-0.05	0.4

measures spanning physical, social and emotional domains. These findings reaffirm sports injury susceptibility even among youth and emerging competitors, indicate decrements beyond just physical function, and compel greater prioritization on upholding athlete health through integrative prevention and management approaches.

The 6-month acute injury incidence of 55% aligns closely with rates reported in elite soccer athletes over similar timeframes, providing a validity check on study methodology.<sup>52</sup> Comparable injury definitions centered on time-loss from sports participation enables this corroboration across athletic populations. The knee, ankle, and shoulder accounted for the most common acute injury locations; mirroring established injury surveillance trends<sup>53</sup>. Training exposures averaging 11 hours per week likely contribute to this injury risk. These participation volumes approach thresholds associated with doubled injury occurrence, hinting at potential overtraining issues.<sup>54</sup> Chronic overuse injury prevalence based on OSTRC-O scores also prove consistent with existing reports, further supporting capture of representative injury profiles.<sup>55</sup>

The acute and overuse patterns encountered reinforce conventional wisdom on Avoiding unnecessary trauma through tempered training/competition avoidable through rest and recovery balancing is paramount.<sup>56</sup> Technical refinements and intrinsic capacity improvements via balanced strength, flexibility and movement control can also offset hazard exposures when sports participation is warrant.<sup>57</sup> However, contact and high-speed endeavors innate to most sports ensures absolute prevention of physical insult remains unlikely. Instead, prompt assessment and management of inevitable injuries warrants equal attention to curb prolonged damage and psychosocial disruption.<sup>58</sup>

Notable associations existed between musculoskeletal injury indices and quality of life decrements per SF-36 findings. This substantiates prior research demonstrating injuries impart appreciable physical, social and emotional disturbances.<sup>59</sup> Acute severe trauma directly reduces function and ability to participate in valued athletic roles, cascading into despair and isolation. Persistent overuse syndromes also erode physical capacities while inflicting constant discomfort and anxiety from nagging damage<sup>60</sup>. These reciprocal interactions illustrate the cyclical, mutually reinforcing nature of tissue insult and psychological upset.

Notably, overuse injuries related more closely with mental health compared to acute trauma. Constant low-grade symptoms may inflict sustained unease and distress without offering the definitive turning point of an acute event.<sup>61</sup> Temporary complete rest to heal severe acute injuries may also confer emotional reprieve. This highlights unique considerations and responses needed to address each injury pattern. Still, any degree of insult bears widths beyond just the physical, angles clinical care models must integrate for holistic restoration.<sup>62</sup>

Multidisciplinary injury rehabilitation attending to biopsychosocial health promises greater recovery of overall wellbeing compared to isolated tissue healing.<sup>63</sup> Physical therapy to restore strength and range of motion stays vital but insufficient alone, as mental health services and social reintegration prove critical to overall healing and athlete self-

perceptions<sup>64</sup>. Support groups connecting injured athletes also provide peer empathy and motivation through shared experience.<sup>25</sup> Teammates, coaches and family all contribute social support systems paramount to coping and resilience. These interventions enable the injurious competitive athletic experience itself to foster personal growth through adversity. More expansive care perspectives appreciating this human complexity can uphold quality of life even amid injury.<sup>65</sup>

The epidemic of joint degeneration and persistent pains in former elite competitors spotlights sports injury legacies.<sup>66</sup> While this study could not confirm causal links given the cross-sectional assessments, established mechanistic connections between trauma and accelerated osteoarthritis lend biological plausibility. Chronic overuse too leads downstream to joint degeneration and sustained discomfort through continual tissue overload.<sup>67,68</sup> These outcomes exactly mimic SF-36 domains with lowest scores like pain and perceived health. Long term joint health preservation should therefore sit alongside short-term performance goals in youth sport development initiatives.<sup>69</sup>

Primary prevention reigns paramount to curb any negative injury influences on current function or future health.<sup>70</sup> Fortunately, many acute and overuse injuries stem from identifiable biomechanical or training errors modifiable through education and behavioral adjustments.<sup>71</sup> Multifactorial prevention programs integrating strength, neuromuscular control, range of motion and cardiovascular conditioning demonstrate injury reduction by over a third and should permeate training regimens.<sup>72</sup> Workload management through athlete monitoring and individualization also shows acute to chronic workload ratios below 1.5 protect against heightened injury risk.<sup>73</sup> Periodization balancing workout intensity, recovery and adaptation can optimize durable performance gains rather than injury-inducing spikes.<sup>74</sup> Implementing such preventive frameworks fosters sustainable athlete development.

Follow-up assessment on whether acute or overuse damage sustained during youth sports predisposes persistent pains, arthritis or lasting mental health disturbance later in adulthood will offer definitive confirmation of permanent injury legacies.<sup>75</sup> Long term impacts likely relate to damage severity, so injury grading methodology refinements can offer more nuanced risk stratification. Regarding care models, testing biopsychosocial rehabilitation programs tailored to young developing athletes can verify improvements in holistic wellbeing metrics over isolated tissue healing.<sup>76,77</sup> Economic evaluations will also lend healthcare policy backing to support dissemination and coverage. Still, strong evidentiary links between injury and multidimensional quality of life disruptions already compels shifts towards more preventive and humanistic sports medicine paradigms to uphold athlete health through inevitable injury exposures inherent to ambitious athletic pursuits.<sup>78</sup>

## Future Research Directions

The results compel expanded investigations on injury prevention and management to uphold athlete health. Future analysis should evaluate longitudinal impacts of injury exposures over sports careers and post-retirement to infer persistence and causality. Such studies can confirm if injury consequences like osteoarthritis that manifest years later associate with chronic or distant competitive participation problems. This can substantiate exercise dosing guidelines balancing injury risk with lifelong physical and mental health preservation. Explorations of biopsychosocial rehabilitation programs emphasizing multidimensional functioning alongside tissue healing are also warranted, as current best practice care models likely underestimate holistic considerations. Integrative approaches accounting for the wide-ranging quality of life decrements injuries impart can optimize restoration of young aspiring athletes.

## Limitations

Despite the noteworthy findings, limitations deserve mention including the cross-sectional analysis lacking longitudinal follow-up. The convenient recruitment from Al-Ahsa clubs may also restrict generalizability and introduced sampling bias of more severely injured athletes willing to participate. Self-reported measures can demonstrate biases, and quantitative imaging or functional testing could have augmented injury assessments. Still, the consistent structured evaluations completed by trained staff support reliable conclusions on the associations between athletic injury patterns and quality of life decrements.

## Conclusion

This study has elucidated the significant impact of musculoskeletal injuries on the quality of life among youth athletes, with a particular focus on a cohort from Saudi Arabia. By meticulously analyzing both acute and overuse injuries, our research has highlighted the widespread prevalence of these injuries and their direct association with notable decrements

in physical and emotional well-being. Crucially, the findings emphasize the acute injuries' immediate effects on physical health and the subtler, yet profound, impacts of overuse injuries on emotional health.

In light of these insights, our conclusions advocate for a multifaceted approach to injury prevention and management. The study underscores the critical need for training regimens that are cognizant of athletes' physical limits, coupled with recovery strategies that prioritize both physical rehabilitation and psychological resilience. The data strongly supports the implementation of comprehensive injury assessments and tailored management plans that address the full spectrum of athletes' needs—spanning physical recovery to emotional support.

Moreover, the study reinforces the importance of fostering a supportive environment that emphasizes not just recovery but also the prevention of injuries through education and resilience-building activities. Such an ecosystem is essential for sustaining athletes' overall health and ensuring their continued engagement in sports without the looming threat of injuries overshadowing their developmental journey.

In essence, by delving into the complex interplay between physical injuries and their broader psychosocial ramifications, our research offers actionable insights for stakeholders in youth sports. These findings serve as a clarion call for integrating preventive measures and holistic support systems into sports programs, thereby safeguarding the well-being of young athletes. Ensuring the enduring benefits of sports participation hinges on our collective ability to address these challenges comprehensively, safeguarding not only the athletes' physical health but also their long-term quality of life.

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