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INJURY RISK IN KITESURFING: A LITERATURE REVIEW OF THE MOST COMMON TRAUMA PATTERNS AND SAFETY IMPLICATIONS

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ABSTRACT

Objective: This review aims to synthesize current evidence on the injury epidemiology of kitesurfing, focusing on common trauma patterns, underlying risk factors, and the effectiveness of safety strategies.
Methods: A systematic literature search was conducted in PubMed and SPORTDiscus for articles published between 2000 and 2024. Studies were included if they reported original quantitative data on kitesurfing-related injuries, including incidence, anatomical distribution, severity, or safety practices. A narrative synthesis was applied due to methodological heterogeneity.
Results: Injury incidence rates ranged from 4.3 to 10.5 per 1, 000 hours of kitesurfing exposure. The most frequently injured areas were the lower extremities, particularly the foot, ankle, and knee. Common injury types included abrasions, sprains, and soft-tissue trauma, with serious injuries such as spinal fractures and head trauma occurring less frequently but with notable severity. Experience level was inversely correlated with injury risk, while environmental factors—such as wind instability and shallow water—significantly contributed to accidents. Although quick-release harness systems are now widely adopted (97%), their real-time use during injury events remains low (7.3%). Helmet (4%) and impact vest (19.5%) usage remains limited despite recommendations.
Conclusion: Kitesurfing presents a distinct injury profile influenced by biomechanical demands, environmental variables, and user behavior. While most injuries are mild and permit rapid return to sport, severe cases still occur, underscoring the need for improved safety education, structured training, and increased protective gear compliance. Future research should emphasize standardized reporting and long-term outcome tracking to better inform injury prevention strategies.

KEYWORDS

Kitesurfing, Kiteboarding, Injury Prevention, Sports Medicine, Water Sports, Trauma Patterns, Protective Equipment

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Introduction.

Kitesurfing, also known as kiteboarding, has become one of the most popular water sports in recent years. Compared to traditional disciplines such as surfing and windsurfing, kitesurfing has seen a significant rise in global participation (*History of Kitesuring, n.d.)*. The sport involves the use of a large, controllable kite and a board, with wind serving as the primary source of power (*The Complete Beginner's Guide To Know Everything About Kitesurfing | IKO*, n.d.). Athletes use a handlebar system to control the kite while remaining connected via a harness and safety leash (Fig. 1), which creates a distinctive biomechanical environment compared to other aquatic board sports. Kitesurfers glide across the water's surface and can perform aerial maneuvers, jumps, and tricks due to the vertical lift capabilities of the kite.

The dynamic nature of kitesurfing, characterized by high-speed movement, acrobatics, and reliance on variable wind conditions, introduces a unique set of physiological demands and trauma risks. These factors require specialized medical attention for effective injury management and prevention strategies. Due to its expanding popularity, culminating in its official Olympic debut at the Paris 2024 Games, kitesurfing now demands increased academic and clinical focus (Gastol et al., 2025).

Given these developments, it is crucial to explore injury patterns within the kitesurfing community. Kitesurfing includes several sub-disciplines such as kitefoiling, freestyle, freeride, and strapless riding, each associated with distinct biomechanical profiles and injury risks. As such, the sport is often categorized as high-risk due to its combination of speed, environmental unpredictability, and physical demands (Nickel et al., 2004).

Over the past 25 years, international organizations such as the International Kiteboarding Organization (IKO) and the Polish Kiteboarding Association have emerged to enhance the safety and quality of instruction within the sport. These bodies have introduced structured training systems and safety guidelines that have

contributed to a reduction in injury incidence (*The Complete Beginner's Guide To Know Everything About Kitesurfing | IKO*, n.d.)

Despite these efforts, the medical literature remains limited regarding the full spectrum of injuries associated with kitesurfing. While orthopedic trauma has been a primary focus, there is a noticeable gap in the literature concerning the wider health impacts of kitesurfing.

The primary aim of this article is to raise awareness within the medical community regarding the wide range of injuries sustained in kitesurfing, extending beyond musculoskeletal trauma. This article presents a comprehensive literature review on the incidence of kitesurfing-related injuries, with a focus on identifying the most common types, underlying mechanisms, and their potential long-term health consequences. Furthermore, it aims to provide evidence-based recommendations for clinical practice, inform injury prevention initiatives, and guide future research in the growing field of kitesurfing sports medicine.

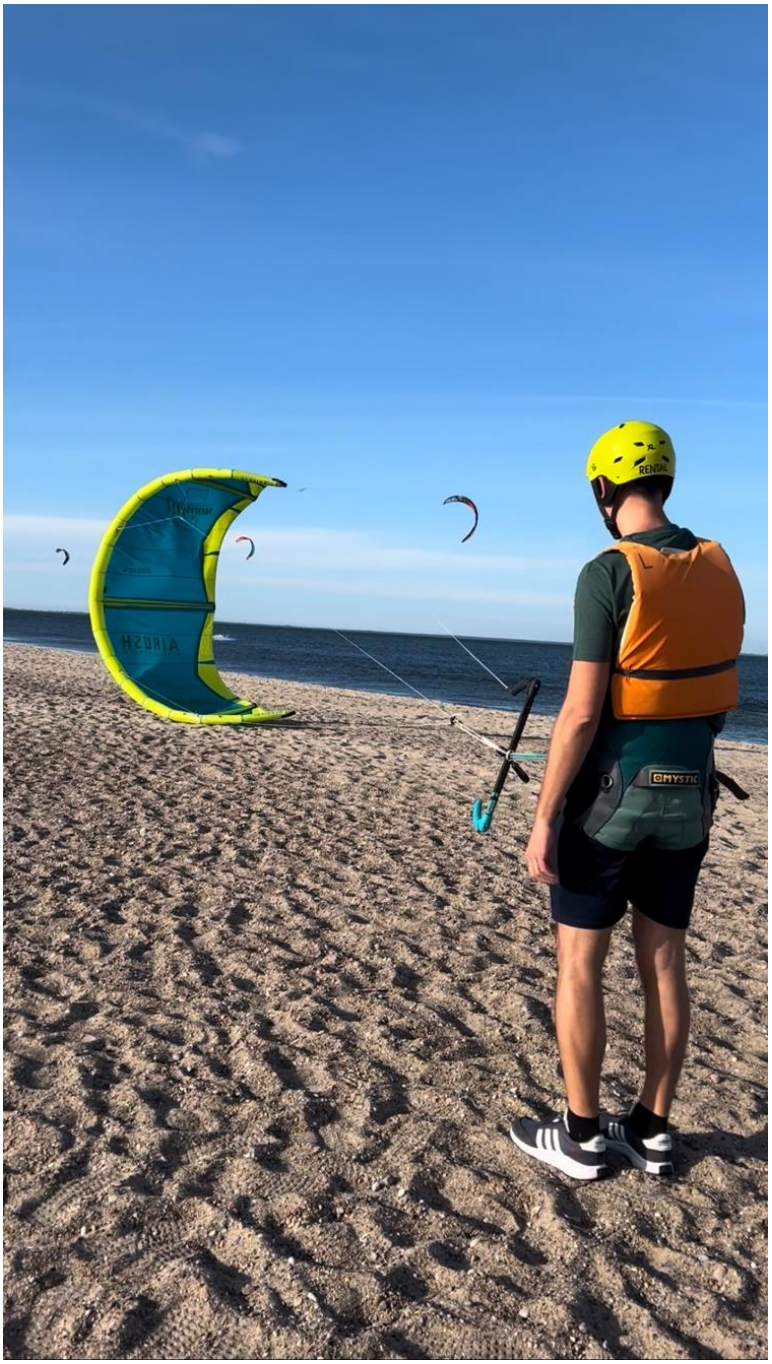

Fig. 1. *Kitesurfer with a handlebar system to control the kite while remaining connected via a harness and safety leash*

Methodology

A comprehensive literature search was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to identify studies examining injury patterns and safety aspects in kitesurfing. The search strategy targeted two major electronic databases: PubMed (MEDLINE) and SPORTDiscus, and covered literature published between January 2000 and December 2024. This timeframe was chosen to reflect the modern era of kitesurfing, characterized by significant advancements in equipment design and safety practices.

Search Strategy

The search was conducted using a combination of keywords relevant to the sport and injury epidemiology. The terms included:"kitesurfing, ""kiteboarding, " and"kitefoiling, " combined with"injury, ""trauma, ""safety, " and"prevention." Boolean operators (AND/OR) were applied to refine results. Only articles published in English or Polish were considered. Eligible study types included case reports, retrospective and prospective studies, review articles, systematic reviews, and meta-analyses, provided they addressed injury mechanisms, patterns, or safety outcomes directly related to kitesurfing.

Inclusion and Exclusion Criteria

Studies were included if they met the following criteria:

1. Published in peer-reviewed journals in English;
2. Reported original research data related specifically to kitesurfing injuries;
3. Included quantitative data such as injury incidence, anatomical distribution, or injury types;
4. Included participants of any age or skill **level**.

Exclusion criteria were as follows:

- Conference abstracts and **case reports** with fewer than five subjects;
- Studies lacking **clear injury definitions**;
- Publications focused solely on **equipment evaluation** without presenting injury data;
- Articles not available in **English, German or Polish**.

Data Extraction

Data extraction was performed independently by two reviewers using standardized extraction forms designed to ensure consistency and accuracy across studies. For each included publication, relevant data were systematically gathered, including key characteristics such as study design, total sample size, and duration of the observation period. Reviewer teams also recorded participant demographics, including age, sex, and reported experience level in kitesurfing.

Information regarding exposure metrics, such as hours of kitesurfing participation or number of sessions, was extracted when available to contextualize injury incidence. Injury-related outcomes were collected in detail, focusing on incidence rates, types of injuries reported, anatomical locations affected, and severity classification. Where applicable, the reviewers also extracted data on identified risk factors contributing to injury, such as environmental conditions or biomechanical variables, and documented the usage patterns of personal protective and safety equipment (e.g., helmets, impact vests, or safety leashes).

Any discrepancies in extracted data between the two reviewers were resolved through discussion. If disagreements persisted, consensus was achieved through a joint re-evaluation of the original study.

Quality Assessment

The methodological quality of the included studies was assessed using a modified Newcastle-Ottawa Scale tailored for sports injury research. This tool evaluated the selection of study populations, comparability of groups, and objectivity in outcome measurement.

Data Synthesis

Due to the heterogeneity in study designs, definitions, and reported outcomes, a narrative synthesis approach was adopted instead of a quantitative meta-analysis. This approach allowed for integration of findings across diverse study methodologies while preserving context-specific interpretations.

Results

Study characteristics

The literature search yielded 11 potentially relevant articles, of which 8 were included after full-text evaluation as original empirical studies. These studies collectively encompassed data from approximately 2, 850 kitesurfers, spanning various regions such as Western and Northern Europe (e.g., Germany, Norway, the Netherlands), North America, and the Eastern Mediterranean (e.g., Turkey). The final set of included publications consisted of four prospective cohort studies, two retrospective cohort studies, and two cross-sectional studies. Follow-up durations ranged from single-event or seasonal snapshots to multi-year observational periods.

Despite variation in study design, sample size, and methodology, the collective evidence reflects an increasing academic interest in kitesurfing-related injuries, while also underlining the current heterogeneity and methodological fragmentation in the field.

Participant demographics in most studies demonstrated a clear male predominance, with around 10:1 male to female participants (Lundgren et al., 2011).The mean age across studies ranged from 27.2 to 31 years (Nickel et al., 2004; van Bergen et al., 2020).Experience levels varied considerably, though wasn't mentioned in all eligible studies, a pattern of intermediate athletes (3-5 years of experience) predominates. For example, one study (van Bergen et al., 2020) included population with the largest portion of participants (43.8%) reporting 3-5 years of kitesurfing experience, while 14.9% received no lessons at all.

Injury Incidence and Frequency

Injury incidence rates reported across the included studies varied from 4.3 to 10.5 injuries per 1000 hours of kitesurfing participation. These differences reflect variations in study populations, experience levels, and exposure conditions. Notably, competitive and advanced recreational athletes tended to exhibit slightly higher injury rates compared to beginners, primarily due to increased engagement in complex manoeuvres.

In one of the most comprehensive prospective studies to date, a cohort of 194 Dutch kitesurfers was analyzed over a full season. A total of 177 injuries were reported during 16816 hours of exposure, yielding an injury incidence of 10.5 per 1000 hours. Interestingly, despite widespread adoption of safety systems, the study found that the actual usage of a kite quick-release mechanism during the injury was noticed only in 7.3% of the injuries (van Bergen et al., 2020). In just 15.8% of cases, athletes indicated that limited experience contributed to the occurrence of the injury (van Bergen et al., 2020).

An earlier six-month prospective study involving 235 kitesurfers recorded 124 injuries across 17714 hours of activity, corresponding to 7.0 injuries per 1000 hours. That study emphasized the elevated injury risk during launching and landing phases, particularly in turbulent wind conditions and on the beach. The majority of beach-related injuries (15%) were sustained during kite launching (Nickel et al., 2004).

In a more recent observational study, 66 German kitesurfers were examined and 24 injuries were documented during approximately 5600 hours of participation, yielding the lowest reported injury rate of 4.3 per 1000 hours among the reviewed studies. Importantly, the authors found a significant inverse association between experience and injury occurrence ($p=0.010$), suggesting that skill development and practice may provide a protective effect (Bockmann et al., 2025)

At first glance, these findings might appear contradictory because one study noted that most injuries occurred during trick execution or jumps, which are activities generally performed by experienced riders, while another concluded that more experienced individuals were less frequently injured. However, this discrepancy likely reflects a key nuance: although experienced riders engage in more technically demanding actions, their advanced skillset and environmental awareness and experience, which is just more time spent in the water may enable them to avoid preventable accidents. Conversely, novice kitesurfers are more likely to be injured during basic errors, such as kite relaunching, equipment entanglement, or misjudging environmental conditions (Bockmann et al., 2025; van Bergen et al., 2020).

Further supporting this multifactorial view, a comparative study between windsurfers and kitesurfers at the North Sea reported a significantly higher injury rate in the kitesurfing group—7.0 vs. 5.2 injuries per 1000 hours ($p = 0.005$). While both groups experienced similar distributions of injury severity, kitesurfers were more likely to sustain high-energy trauma during jumps or landings, again pointing to the influence of maneuver complexity on injury risk (van Bergen et al., 2016).

Additionally, an analysis of 626 athletes participating in surfing-related sports revealed that kitesurfers had among the highest injury rates, particularly to the lower extremities. Their injuries were more often caused by environmental misjudgment and often linked to trick performance and uncontrolled aerial maneuvers that led to falls. Although exact exposure hours were not reported, the frequency and nature of injury mechanisms aligned with patterns found in prospective studies (Szymski et al., 2021).

Taken together, these findings underscore that injury incidence in kitesurfing is multifactorial, influenced not only by skill level and type of activity, but also by environmental variables and the situational context in which the sport is practiced.

Common Injury Types and Anatomical Locations

Analysis of the reviewed literature revealed consistent patterns in the types and anatomical distribution of injuries sustained during kitesurfing. Joint injuries were the most frequently reported category, with 101 (40.2%), followed by muscle and tendon injuries 47 (18.7%), wounds and lacerations 36 (14.3%), and bone fractures 28 (11.2%). Less common but clinically significant were ligament ruptures 19 (7.6%) and meniscal tears 15 (6.0%) (Fig. 2).

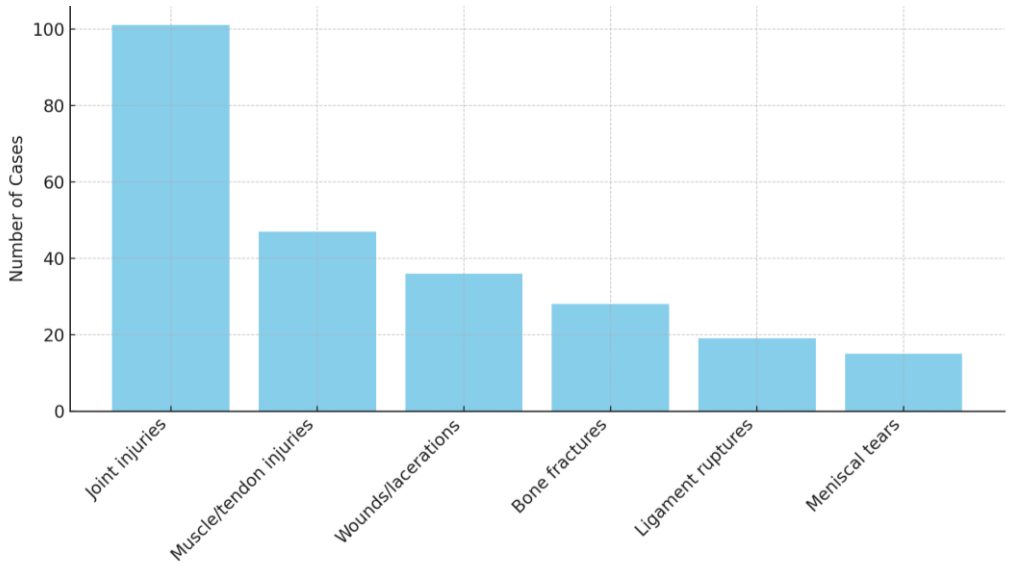

Fig. 2. *Shows the distribution of injury types reported in the reviewed literature.*

Regarding anatomical distribution (n = 98), injuries to the lower extremities were most prevalent. The knee was affected in 23 (23.5%) and the foot and ankle in 17 (17.3%), together accounting for over 40% of reported trauma. Trunk injuries followed with 15 (15.3%), then shoulder injuries 10 (10.2%) and arm injuries 8 (8.2%). Although head and neck trauma were less frequent, 4 (4.1%) and 1 (1.0%) respectively, they included serious pathologies such as concussion and cervical spine trauma, with potentially significant clinical consequences (Fig. 3) (Lundgren et al., 2011)

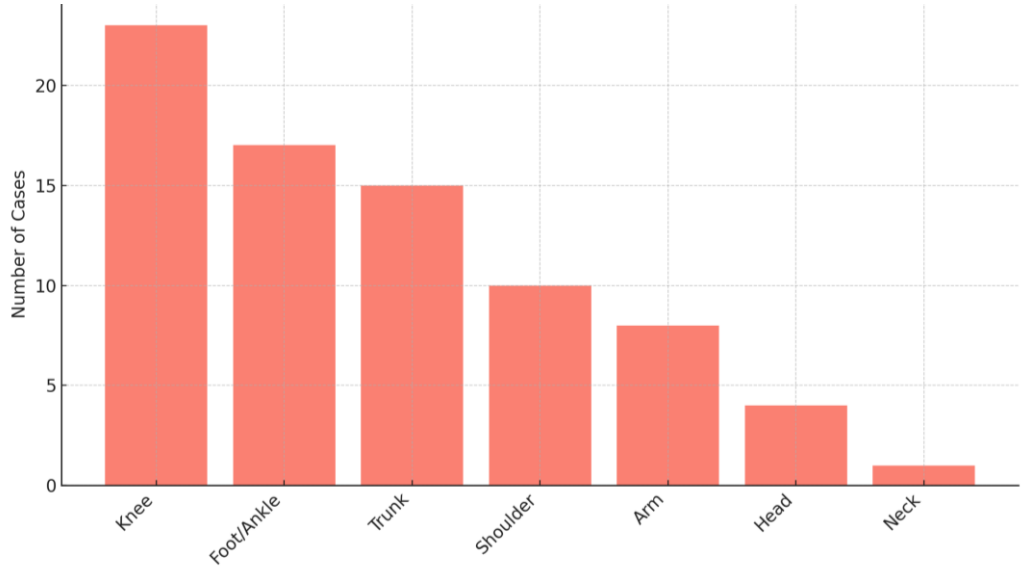

Fig. 3. *Illustrates the anatomical regions most commonly affected during kitesurfing.*

Injury Mechanisms and Situational Context

The reviewed studies consistently indicate that most kitesurfing injuries occur during high-energy maneuvers, particularly during jumps, landings, and tricks. These actions place considerable biomechanical stress on joints and muscles and increase the risk of uncontrolled falls (van Bergen et al., 2020; Nickel et al., 2004). Unstable wind condition, such as gusts or sudden directional shifts and choppy water also play a critical role in injury events. Launching and landing the kite, especially in strong or inconsistent wind, has been identified as a particularly hazardous phase of the activity (Nickel et al., 2004).

Environmental hazards such as shallow water, hard surfaces, submerged obstacles, or proximity to infrastructure (e.g., piers, rocks) are often contributing factors. Furthermore, entanglement of kite lines, sudden kite power surges, and loss of board contact frequently precede accidents. A significant number of reported injuries are linked to pilot error, such as poor technique during takeoff, delayed activation of safety systems, or inappropriate kite size selection for the conditions (Torland et al., 2024; Szymski et al., 2021)

These findings underline the complex and multifactorial nature of kitesurfing trauma, where human, environmental, and equipment-related variables interact to increase injury risk.

Risk Factors: Individual and Environmental Contributors

Multiple studies highlight the importance of both intrinsic and extrinsic risk factors in the development of kitesurfing injuries. Individual factors such as low skill level, limited experience, or overconfidence are frequently mentioned. One study reported a significantly lower injury incidence among experienced riders, supporting the notion that progressive skill acquisition plays a protective role ((Bockmann et al., 2025)). In contrast, novice kitesurfers are more susceptible to basic control failures and poor judgment of environmental hazards.

Environmental contributors also play a key role. These include strong or unpredictable wind patterns, busy or crowded kitesurfing zones, and poor visibility. Some injuries result from inadequate assessment of water depth, obstacles, or weather forecasts. The reviewed cases suggest that severe injuries frequently occur in response to sudden wind gusts and challenging surface conditions, such as snow, ice, or rocks. These incidents are often exacerbated by insufficient familiarity with the environment and limited time to respond appropriately. Loss of kite control, uncontrolled dragging, or abrupt landings appear to reflect a combination of environmental unpredictability and rushed decision-making, both of which substantially increase injury risk (Torland et al., 2024; Szymski et al., 2021).

Another important risk factor is improper equipment setup or mismatch between rider weight, wind speed, and kite size, which may lead to loss of control or overpowered lift during maneuvers.

Severity of injuries

When evaluating the severity of kitesurfing-related injuries, one important factor is the extent of medical care required. According to a prospective study, medical consultation was sought in 14.1% of injuries, with 7.3% involving a medical specialist, 5.1% a general practitioner, and 1.7% an emergency physician. Hospitalization was necessary in only 2.9% of cases. Remarkably, 83.1% of injured athletes were able to return to kitesurfing within one week of the incident, suggesting that most injuries were mild to moderate in severity (van Bergen et al., 2020).

Similar findings were reported in another study, which observed that although the overall injury incidence was relatively high (7.0 per 1000 hours), only a minority of injuries required advanced medical intervention. Of 124 recorded injuries, 11 were classified as severe (knee ligament injuries and fractures), and one incident resulted in death due to polytrauma and traumatic brain injury. The majority of injuries were superficial or involved mild soft-tissue trauma that resolved without hospitalization.(Nickel et al., 2004).

A more recent study confirmed a low rate of severe injuries among experienced German kitesurfers. Out of 24 recorded injuries, the majority were classified as minor or moderate. No hospitalizations or life-threatening cases were reported. The authors emphasized that experience may play a protective role not only in reducing injury incidence but also in mitigating the severity of injuries when they occur (Bockmann et al., 2025).

In contrast, a retrospective analysis of kitesurfing and snowkiting injuries in Norway reported a higher proportion of moderate-to-severe injuries. Among 33 documented cases, 28 involved bone fractures and 24 involved significant soft tissue trauma, with multiple cases requiring hospitalization and surgical intervention. Notably, 82% of injuries were linked to operator error or inexperience, which may have contributed to increased injury severity (Torland et al., 2024).

Additional insight comes from a comparative study, which found that a larger proportion of kitesurfing injuries involved high-energy trauma, such as rib fractures and concussions, particularly during uncontrolled landings during jumps and sudden wind gusts (van Bergen et al., 2016).

Furthermore, data from a large cross-sectional study, which included 626 athletes across surfing, windsurfing, and kitesurfing disciplines, showed that In the kitesurfing subgroup, 53.3% of injuries involved the lower extremities, while 5.2% were classified as head trauma. Although most cases were mild, several required medical attention or short-term activity restriction, particularly in relation to ligament or skeletal involvement (Szymski et al., 2021).

Safety equipment usage and effectiveness

Safety equipment adoption patterns revealed substantial improvements over the past two decades, particularly in the usage of quick-release harness systems. In 2004, only 18% of kitesurfers reported using such systems (Nickel et al., 2004), whereas recent prospective studies show adoption rates as high as 97.9% (van Bergen et al., 2020). Despite widespread availability, actual deployment of quick-release mechanisms during injury events remains infrequent, only 7.3% of injured athletes reported having used the release system during an incident. This low activation rate can be partly attributed to the fact that loss of kite control, the primary situation requiring quick-release deployment, occurred in just 10.7% of injury scenarios) (van Bergen et al., 2020). These findings suggest that although the technical presence of safety equipment has improved, its effective use still requires a high degree of situational awareness and rider proficiency.

In terms of passive protective gear, compliance remains low despite longstanding safety recommendations. One study found that only 19.5% of kitesurfers regularly wore impact vests, while helmet use was limited to just 4% of participants. Additional equipment such as knee braces and spinal protectors was used by 12.3% of surveyed athletes. This underutilization is concerning given the known injury risks associated with high-speed and aerial sports like kitesurfing (van Bergen et al., 2020).

These observations are consistent with findings from a broader cohort of water sport athletes, which revealed similar patterns of equipment avoidance. Although precise gear usage rates were not detailed for each subgroup, the authors emphasized a general reluctance to adopt protective equipment, even among those frequently exposed to risk scenarios. This trend highlights the ongoing need for education and behavioral interventions aimed at improving not only access to, but also proper use of, available safety systems (Szymski et al., 2021).

Return-to-Sport Time and Functional Outcomes

Injuries sustained during kitesurfing vary widely in severity, but the majority allow for rapid return to activity. One study reported that over 83% of athletes resumed kitesurfing within one week of injury, suggesting that most incidents involve superficial trauma or mild musculoskeletal strain. Only 2.9% required hospitalization, and severe outcomes were relatively rare (van Bergen et al., 2020).

In contrast, more serious outcomes were documented in a minority of cases, including fractures and a fatal head injury, indicating that although rare, life-threatening trauma can occur, particularly in high-risk conditions or when safety protocols fail (Nickel et al., 2004).

Another study found no reports of long-term disability, and all injured athletes recovered without the need for surgical intervention (Bockmann et al., 2025). Similarly, extended absences from sport participation were not reported, though some soft-tissue injuries led to short-term functional limitation (Szymski et al., 2021)

These findings indicate that, in most cases, kitesurfers can expect a short recovery time and full functional return, if injuries are properly managed and safety guidelines are followed.

However, severe injuries, such as those leading to permanent disability or death, are classified as catastrophic, while those causing absence from sports are categorized as severe, medium, or mild, depending on the duration of incapacitation (Bourgois et al., 2013). A different cross-sectional study among kitesurfers revealed that 36.7% of injuries necessitated hospitalization, with 50.0% requiring physical therapy and rehabilitation, suggesting a notable proportion of injuries with more protracted recovery (Dut et al., 2020).

Discussion

Interpretation of Injury Patterns

The findings of this literature review confirm that kitesurfing demonstrates injury patterns consistent with its dynamic, high-velocity nature and the significant biomechanical stresses placed on the lower extremities and axial skeleton. The predominance of foot and ankle injuries (31.8%) likely reflects the substantial impact forces generated during landing maneuvers, combined with the rotational stresses imposed by fixed foot positioning in board bindings during aerial tricks (van Bergen et al., 2020). The high frequency of cuts and abrasions (25.4%) distinguishes kitesurfing from many traditional sports, reflecting the unique environmental hazards of the aquatic setting including contact with boards, lines, and water surface impact at

high velocities. While these superficial injuries typically represent minor trauma, they may serve as indicators of near-miss events that could result in more severe injuries under different circumstances (Crimmins et al., 2025; van Bergen et al., 2020).

Experience as a Protective Factor

The inverse relationship between experience level and injury risk supports the hypothesis that technical proficiency and situational awareness developed over time serve as primary protective mechanisms in kitesurfing. Novice kitesurfers face elevated injury risk likely due to incomplete mastery of kite control techniques, inadequate hazard recognition, and insufficient experience with equipment limitations and environmental conditions (Bockmann et al., 2025; Torland et al., 2024). These findings emphasize the critical importance of structured instruction and progressive skill development in injury prevention. Targeted educational interventions for beginning kitesurfers, focusing on fundamental safety principles and gradual progression through increasingly complex maneuvers, may represent the most effective strategy for reducing overall injury burden.

Environmental and Situational Contributors

Environmental factors such as strong or unpredictable wind patterns, shallow water, submerged obstacles, and crowded or poorly separated launch zones repeatedly emerged as key contributors to injury events (Nickel et al., 2004; Torland et al., 2024). For example, data from Norway revealed that 82% of injuries related to inexperienced users or rushed decision-making (Torland et al., 2024). While direct comparisons are limited, some studies suggest that kitesurfing may involve higher exposure to environmental hazards than windsurfing, particularly in the context of wind variability and launch area complexity (van Bergen et al., 2016).

Equipment Safety Considerations

While the dramatic increase in quick-release harness adoption (from 18% to 97%) represents a significant safety advancement, the limited utilization during actual injury events (7.3%) raises important questions about efficacy (van Bergen et al., 2020). Studies show that only 10.7% of injuries resulted from loss of kite control, suggesting that many injuries occur during controlled maneuvers rather than equipment failures limiting the protective potential of quick-release systems (van Bergen et al., 2020). Passive protective gear adoption remains low: impact vests (19.5%) and helmets (4%), despite documented effectiveness in preventing serious head and chest trauma (van Bergen et al., 2020; Petersen et al., 2002; Crimmins et al., 2025). This indicates significant barriers, such as discomfort, cost, and lack of awareness. This problem should be addressed through targeted education and potentially regulatory incentives.

Comparison with Related Aquatic and Board Sports

When compared to injury patterns in traditional surfing, windsurfing, and other board sports, kitesurfing demonstrates both similarities and distinct differences. Injury incidence rates of 4.3–10.5 per 1000 hours place kitesurfing within the range of other extreme sports (van Bergen et al., 2020; Bourgois et al., 2014). While the injury distribution particularly to the lower extremities is similar to that seen in surfing and windsurfing, kitesurfing differs biomechanically due to aquatic landings, harness dynamics, and aerial lift mechanics (Bourgois et al., 2014).

Severity and Return-to-Sport

Although most injuries are mild to moderate and allow for a recovery and return-to-sport within about a week (van Bergen et al., 2020; Bockmann et al., 2025), the literature documents occasional severe traumas including ACL tears, spinal fractures, polytrauma and rare fatalities (Nickel et al., 2004; Crimmins et al., 2025; Petersen et al., 2002). These more serious outcomes, although infrequent, highlight the importance of emergency preparedness and prompt clinical intervention.

Methodological Limitations and Future Research

Heterogeneity in study methodologies ranging from definitions of injury and exposure measurements to reliance on self-report versus clinical confirmation limits comparability in our work. This is compounded by a scarcity of large-scale, long-term prospective cohort studies and the underreporting of non-musculoskeletal injuries (Szymski et al., 2021; Torland et al., 2024). Training protocols intended for kitesurfers should reflect the sport's distinct physical requirements, and this should be clearly addressed when drafting recommendations

for coaching and medical personnel. It appears that exercise and training programs designed for kitesurfing should go beyond standard protocols, given the sport's multifaceted physical demands. Kitesurfing requires a combination of strength, coordination, agility, and endurance. Aerobic fitness, in particular, plays a critical role in disciplines like course racing and should be appropriately emphasized in preparatory programs (Dut et al., 2020). Future investigations should implement standardized surveillance protocols, stratified by sub-discipline and risk characteristics, and explore psychological, behavioral, and long-term health outcomes.

Conclusions

This review highlights that kitesurfing, while an increasingly popular and dynamic aquatic sport, carries a multifaceted injury risk profile strongly influenced by rider experience, environmental conditions, and equipment use. The most common trauma patterns include foot, ankle, and knee injuries and reflect the biomechanical demands of aerial maneuvers and water-based landings. Superficial injuries such as cuts and abrasions, although typically minor, are also frequent and often linked to environmental hazards or technical errors.

Importantly, the data consistently show that experience plays a protective role, reducing both the incidence and severity of injuries. Novice kitesurfers remain disproportionately affected by preventable trauma due to poor hazard recognition and insufficient technical control. While safety equipment such as quick-release systems has become nearly universal in presence, its effective deployment remains limited, suggesting a need for improved training and situational awareness. Meanwhile, the underutilization of passive protective gear like helmets and impact vests represents an ongoing challenge in risk mitigation.

Compared to related sports such as windsurfing, snowboarding, and skateboarding, kitesurfing exhibits both similar injury mechanisms and unique biomechanical risks arising from aquatic lift, harness systems, and environmental variability. Although most injuries are of mild to moderate severity and allow for rapid return to sport, rare but serious injuries—such as spinal trauma or fatal head injuries—underscore the importance of structured prevention strategies and emergency preparedness.

Future research should prioritize large-scale, standardized, and longitudinal studies with validated exposure data and medical confirmation of injuries. In parallel, prevention efforts must target not only technical skill development but also behavioral education and improved compliance with protective equipment guidelines. Professional organizations should place greater emphasis on promoting risk-awareness practices, such as consulting with local communities when entering unfamiliar kitesurfing areas, to identify potential hazards and site-specific challenges.

In sum, a multi-tiered approach which combines structured instruction, targeted safety interventions, and evidence-based equipment recommendations is essential to reducing the injury burden in kitesurfing as it continues to grow in both recreational and competitive settings. Future research should extend beyond orthopedic considerations and focus on identifying individuals who may be at increased risk due to underlying internal medicine conditions, such as osteoporosis or other systemic diseases.

This comprehensive understanding of injury epidemiology is crucial, especially as kitesurfing gains Olympic status, thereby attracting a broader participant base and potentially increasing overall exposure hours (Gastol et al., 2024).

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