# Diving Into the Health Problems of Competitive Divers: A Systematic Review of Injuries and Illnesses in Pre-elite and Elite Diving Athletes

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**Context:** The Olympic sport of diving involves the competitive disciplines of 3 m springboard and 10 m platform. Although it is generally accepted that lumbar spine injuries are common in diving athletes, the existing literature of health problems in diving athletes remains scarce.

**Objective:** To identify the incidence, prevalence, and type of health problems that occur in competitive diving athletes.

**Data Sources:** Medline, EMBASE, SportsDiscus, PsycINFO, and Google Scholar.

**Study Selection:** Studies written in English investigating elite or pre-elite competitive diving (springboard, platform) injuries and/or illnesses were eligible. Two independent reviewers screened for inclusion by title, abstract, and full text in accordance with the eligibility criteria.

**Study Design:** Systematic review.

**Level of Evidence:** Level 4.

**Data Extraction:** Data extraction was completed by 1 author using a structured form. A second author then independently reviewed and verified the extracted data, any discrepancies were resolved through consensus.

**Results:** The search identified 2554 potential articles, with 28 studies meeting eligibility criteria. The surveillance setting of most studies was restricted to competition-based events, with the reported injury incidence proportion ranging from 2.1% to 22.2%. The reported injury incidence rate ranged from 1.9 to 15.5 per 1000 athlete-exposures. Injuries to the shoulder, lower back/lumbar spine, trunk, and wrist/hand were reported most frequently. The prevalence of low back pain was reported as high as 89% (lifetime), 43.1% (period), and 37.3% (point). The illness incidence proportion ranged from 0.0% to 22.2%, with respiratory and gastrointestinal illness reported most frequently.

**Conclusion:** Up to 1 in 5 diving athletes sustain an injury and/or illness during periods of competition. A reporting bias was observed, with most cohort studies limiting surveillance to short competition-based periods only. This limits the current understanding of the health problems experienced by diving athletes to competition periods only and requires expansion to whole-of-year surveillance.

**Keywords:** athletic injuries; aquatic sport; epidemiology; injury; illness; surveillance

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Diving is an aesthetic sport requiring a high level of acrobatic ability.[30,55] Introduced into the Olympic Games in 1904, the origins of diving can be traced back to 480 BC.[55] The Olympic sport of diving involves the competitive disciplines of 3 m springboard and 10 m platform, which are subcategorized into individual and synchronized competition events.[28] In each competition event, athletes are required to complete a dive list, with 1 dive selected from each dive type: (1) front, (2) back, (3) reverse, (4) inward, (5) twist, and, in platform, (6) handstand.[21,30] Female athletes compete with 5 competition dives, and male athletes with 6. Female diving athletes are not required to compete a handstand dive in competition. The sixth dive for male athletes in the 3 m springboard event is selected from any dive type group to replace the handstand, which is not competed in the springboard event. Each dive consists of a take-off, flight, and entry phase.[21,30,55] The flight component comprises somersault rotations, a twist, or a combination of both, and is completed in 1 of 4 positions: (1) straight, (2) pike, (3) tuck, or (4) free.[21]

Achieving success in diving depends on many factors, including expert skill, strength, power, and psychological readiness.[3,14,30,55] However, performance can be impaired due to reduced health status, which has been demonstrated consistently to impair athletic performance across sport.[17,50] Reducing the occurrence and burden of health problems diving athletes experience is critical to support performance. Health problems can be defined as any condition that reduces an athlete's normal state of full health irrespective of its consequences on the athlete's sports participation or performance or whether the athlete sought medical attention.[13] Lumbar spine injuries have been reported to occur frequently in diving athletes, but the existing literature of health problems in diving athletes is scarce.[10,30,55]

The quantification and understanding of athlete population health provides an opportunity to intervene with targeted health strategies to mitigate risk of injury and illness to improve athlete health.[22,23] Methods of injury and illness surveillance in competitive diving are well established and provide a foundation for understanding and preventing health problems in the sport.[4,39]. To date, there has been no comprehensive review of the literature to provide a summary of the distribution and type of health problems reported in the competitive sport of Olympic diving athletes. This limits current understanding of what health problems exist in elite diving athletes and is a barrier for the development of targeted preventive health strategies. Therefore, the objective of this review is to identify the incidence, prevalence, and characteristics of health problems (injuries and illnesses) reported in elite and pre-elite diving athletes.

## METHODS

The guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) were followed (Appendix 1, available in the online version of this article),[2,46,47] and the review protocol registered with PROSPERO international prospective register for systematic reviews (Registration number: CRD42020157117, available at https://www.crd.york.ac.uk/PROSPERO).

### Search Strategy

A search of the MEDLINE, EMBASE, SportsDiscus, PsycINFO, and Google Scholar electronic databases was undertaken from their inception date until July 5, 2021. Medical subject headings (MeSH) and free-text search terms were derived from the research question. Further additional articles eligible for inclusion were identified by searching manually the reference lists of all included papers (backward citation tracking); forward citation tracking of the included papers was also undertaken. The full search strategy can be found in Online Appendix 2.

### Study Selection

References from each of the databases were imported into Covidence (Covidence systematic review software, Veritas Health Innovation), where duplicates were removed. Two authors independently screened for inclusion by title and abstract, and then by full text in accordance with the eligibility criteria. Disagreement was resolved by consensus, and if consensus could not be reached a third independent reviewer was consulted to resolve the discrepancy. Agreement between the 2 reviewers, for both title and abstract screening and full-text screening, was evaluated for absolute agreement using the Prevalence- and Bias-Adjusted Kappa (PABAK) in the epiR package in R.[9]

#### Inclusion Criteria

Studies were eligible if (1) they included competitive diving (springboard, platform) injuries and/or illnesses; (2) they included human participants; (3) they included the following research designs: prospective cohort, retrospective cohort, cross-sectional, case series, and case studies; (4) the full text was available; and (5) they were written in English.

#### Exclusion Criteria

Studies were excluded if they included (1) only noncompetitive diving populations (ie, scuba, cave, deep-sea, or cliff diving); (2) high diving; (3) recreational/community diving injuries or illnesses; (4) other aquatic sport athlete data (swimming, open water swimming, water polo, artistic swimming, high diving) without delineation from diving athletes data; (5) studies with the following research designs: reviews, opinion articles, abstracts, conference proceedings; and (6) athletes below subelite level: categorized using the FTEM (Foundations, Talent, Elite, Mastery) framework, athletes at T2 level (or equivalent) and below.[24]

### Data Extraction

Data extraction was completed by 1 of the authors using a structured form. A second author then independently reviewed and verified the extracted data, where any discrepancies were resolved through consensus. For all injury and illness papers, the study design, surveillance setting, number of participants, sex (male/female) of participants, age, level of sport, dropouts, inclusion/exclusion criteria, and injury/illness definition were extracted. For studies concerning injury, the number of injuries, body site, nature, mechanism, time-loss/nontime loss, competition or training incidence, prevalence, and reported incidence data were extracted. For studies regarding illness, the number of illnesses, type of illness, cause of illness, time-loss/nontime loss, prevalence, and reported incidence data were extracted.

### Risk of Bias Assessment

The Appraisal Tool for Cross-Sectional Studies (AXIS) was used to assess the risk of bias for cross-sectional studies,[15] and a tailored version of the Newcastle-Ottawa Scale (NOS) that incorporated specific decision rules was used for the assessment of cohort studies.[60] A risk of bias assessment was not undertaken for the eligible case studies and case series included in the review, as the purpose of their inclusion was only to identify the type of health problem detailed and not to evaluate the effect of any specified intervention. Two authors independently conducted a risk of bias assessment on each cohort and cross-sectional study. Disagreement between the 2 assessors was resolved through discussion. Absolute agreement and Cohen's kappa were calculated to measure the agreement between the 2 assessors.

### Statistical Analysis

The summary measures for injury and illness outcomes reported in each study (incidence proportion, incidence rate, point prevalence, period prevalence, and lifetime prevalence) were presented for the entire cohort and for subcategories (eg, athlete sex, body site) where possible. Comparison between these measures considered the injury definition used in each study. No meta-analysis was completed due to the heterogeneity of study design and methodology.

## RESULTS

### Search Results

The electronic search yielded 2554 records, of which 319 were duplicates. Screening of title and abstract resulted in 85 articles to be assessed by full text. A further 797 records were identified from backward and forward citation tracking, of which 21 articles were eligible for full-text assessment following screening from the 2 independent reviewers. The absolute agreement rate for selection between the 2 reviewers for title and abstract screening was 96.5% (95% CI, 95.7-97.2), with a PABAK of 0.92 (95% CI, 0.91-0.94), with 12 articles requiring discussion to reach consensus. Of the 106 papers screened by full text, 28 were eligible for inclusion in the review (Figure 1). Absolute agreement between the assessors for full-text screening was 90.7% (95% CI, 85.1-96.3), with a PABAK of 0.81 (95% CI, 0.70-0.93).

### Characteristics of Included Studies

A total of 14 cohort studies,[1,6,20,26,31-33,35,40,41,44,49,56,58] 4 cross-sectional,[29,34,45,48] and 10 case series/studies were included.[3,7,8,12,19,34,38,51,52,59] Injury characteristics were reported in 19 papers (Online Appendix 3).[1,6,20,26,29,31-35,40,41,44,45,48,49,54,56,58] Of these 19 papers, 12 had surveillance settings that involved competition (competition-based). Athletes were of an elite level in 15 studies, pre-elite in 3 studies, and collegiate level in 1 study. Of these 19 papers, 10 defined injury according to the "medical attention" injury definition construct; 8 studies reported body site injured, 7 reported the nature of injury, 10 reported time-loss versus nontime loss, 11 reported on whether injury occurred during competition or training, and 1 study reported the mechanism of injury.

There were 9 studies that reported on illness (Online Appendix 4),[20,26,35,40,41,44,49,56,58] with all 9 studies having a competition-based surveillance period. Of these 9 studies, 8 defined illness as according to the "medical attention" definition, 7 included participants at the elite athlete level, 4 studies reported severity, and the type and cause of illness were reported in 4 studies. There were 9 included case studies (Table 1),[3,7,8,12,19,38,51,52,59] all related to injury occurrence. All case studies reported a diagnosis, with 7 reporting mechanism of injury and time loss versus nontime loss. All 9 papers reported whether the injury occurred during competition or training.

### Risk of Bias Assessment

The inter-rater absolute agreement between the assessors for the risk of bias was 93.7%, with a Cohen's kappa of 0.81.[46,47] A total of 14 cohort studies were assessed using a tailored version of the NOS,[60] with scores ranging from 5 out of 9 to 8 out of 9. Six papers demonstrated that the outcome (injury or illness) was not present at the start of the study. Sex and age were selected to assess comparability, with 11 of 14 papers comparing sex, whereas 0 of 14 papers compared by age. Half of the papers (7/14) did not demonstrate that there was adequate follow-up of the cohorts. Four cross-sectional studies were assessed using The Appraisal Tool for Cross-Sectional Studies (AXIS).[15] Total scores ranged from 17 to 20 out of a possible 20 (Online Appendix 5).

### Injury Occurrence

The incidence proportion of injuries at competition-based events ranged from 2.1% to 22.2%.[26,31] The reported incidence rate of injuries ranged from 1.9 to 15.5 per 1000 athlete-exposures.[32,33] The injuries reported most frequently were to the shoulder, lower back/lumbar spine, trunk, and wrist/hand.[6,32,40,41] The prevalence of low back pain (LBP) was reported as high as 89% (lifetime),[6] 43.1% (period),[54] and 37.3% (point).[45] A point prevalence of 85.7% was identified for wrist pain in 10 m platform diving athletes.[34] A muscle strain or ligament sprain were the most commonly reported nature of injury.[32,40,56] Reported injuries were most likely to result in a nontime-loss injury.[31,40,41,56,58] Injuries in a competition-based period were reported as occurring primarily during training

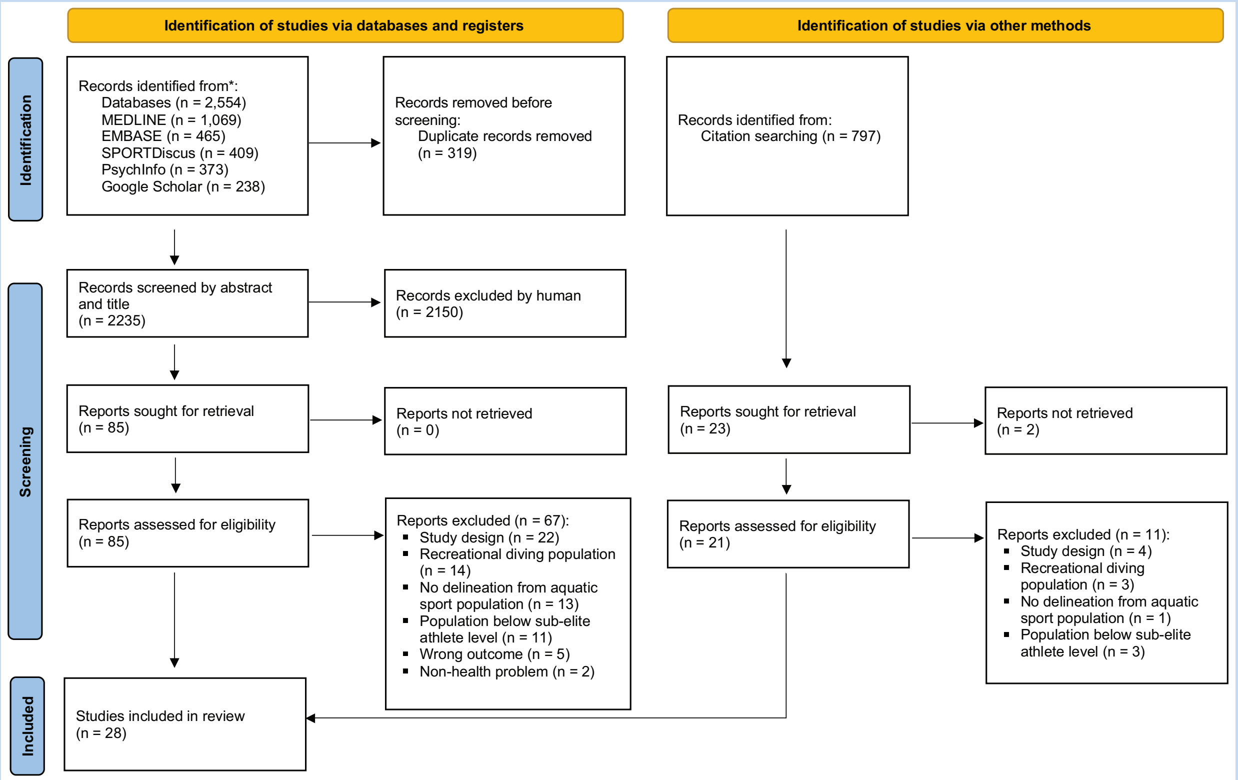

Figure 1. PRISMA flow chart, PRISMA, preferred reporting items for systematic reviews and meta-analysis.

periods, as opposed to when the diving athlete was completing competition dives.[31,32,40]

### Illness Occurrence

The incidence proportion of illness ranged from 0.0% to 22.2%.[26,44] The illness types reported most frequently were respiratory (80%) and gastrointestinal (29%).[20,41,56,58] The most common cause of illness was reported as infection.[20,56,58] Illness was most commonly reported as nontime-loss.[40,41,56,58] Diving athletes had the highest illness incidence proportion (11.9%) of all competing sports at the Rio de Janerio 2016 Olympic Games.[56] There were also high illness incidence proportions reported at other international competitions of 22.2%, [26] 13.9%,[58] and 8.5%.[49]

### Case Series/Studies in Diving Athletes

There were 10 case series/studies included in the review. Upper limb injuries (5 shoulder, 3 hand/wrist) represented 80% of injuries reported,[7,8,12,38,51,52,59] with 50% of case series/studies attributed to be of bony nature. Where reported, the mechanism of injury was described as water entry in 71.4% of cases.[3,7,12,51,52,59] Of the 10 case series/studies, 9 included injuries that were reported to occur in the daily training environment outside of competition events.[3,7,8,12,38,51,52,54,59]

## DISCUSSION

We provide the first comprehensive review of the published health problems reported for pre-elite and elite competitive diving athletes. Injury occurrence in diving athletes is common and often under-reported in short competition-based surveillance studies. Illness, inclusive of mental health complaints, in diving populations are typically reported only in large multisport cohort studies. It is difficult to compare previous studies due to considerable variance in the study design and definitions of injury and illness used. The presence of reporting and survivor biases were identified in the existing literature, where studies typically restricted surveillance to capture only the occurrence of new health problems recorded in short competition-based periods.

### Injury

Injury occurrence in diving is lower than in many other sports at the Olympic Games.[20,31,56] However, there is evidence to suggest that injuries are commonplace in diving,[10,30,32,55] and can be long-lasting, often impacting an athlete well into retirement.[48] The high level of monotonous training required to participate in competitive diving can result in the occurrence of frequent minor injuries, for example, sprains or strains, but also more severe and

Table 1. Case studies reporting injury or illness in competitive diving athletes

| First Author (Year) | Sex | Age | Level of Sport | Injury Diagnosis | Injury Site | Injury Nature | Injury Mechanism | Time Loss vs Nontime Loss | Competition or Training |
|---|---|---|---|---|---|---|---|---|---|
| Rietberg (2018)[52] | Male | 19 | Collegiate | Wrist bone bruise | Hand | Bone | Water entry | Time-loss | Training |
| Edler (2016)[19] | Female | 14 | Elite | Depression fracture of the lateral tibial plateau (Schatzker type IIIa) | Lower Leg | Bone | Take-off from 3 m Springboard (warm-up to competition) | Time-loss | Competition |
| Buonopane (2015)[8] | Male | 18 | Collegiate | Type II AC joint sprain (indicative of an AC ligament rupture and a sprain of the CC ligament | Shoulder | Ligament | Gym (overhead shoulder press with free weights) | Time-loss | Training |
| Chandra (2014)[12] | -[a] | -[a] | Collegiate | TOS: upper extremity symptoms caused by compression of the neurovascular structures in the area of the neck above the first rib | Shoulder | Neurovascular | Water entry (repeated/ overuse) | Unknown | Training |
| Mohamed Haflah (2014)[38] | Male | 16 | Elite | Bilateral scaphoid stress fracture | Hand | Bone | -[a] | Time-loss | Training |
| Berkoff (2011)[7] | Male | 15 | Elite | Contiguous contusion to the lunate, capitate, hamate and distal radius | Hand | Bone<br>Joint | Water entry | Time-loss | Training |
| Badman (2004)[3] | Female | 19 | Collegiate | C5-C6 ligamentous instability | Neck | Ligament | Water entry from 3 m springboard performing a 105B (Forward 2 1/2 somersaults in the pike position) | Time-loss | Training |
| Richardson (1999)[51] | Female | 18 | Collegiate | TOS | Shoulder | Neurovascular | -[a] | Time-loss | Training |
| Waninger (1997)[59] | Male | 19 | Collegiate | Stress fracture of the clavicle | Shoulder | Bone | Water entry | Time-loss | Training |

AS, acromioclavicular; CC, coracoclavicular; TOS, thoracic outlet syndrome.
[a]Not available.

catastrophic injuries such as pulmonary contusions, and even death.[11,30,36] The severity of injury was recorded in a small number of the injury papers reviewed here. In competition-based surveillance, reported injuries were most likely to be of a nontime-loss nature[31,33,40,41,56,58]; however, case series and studies of reported high severity time loss injuries highlight that diving athletes are also at risk of severe time loss injuries that can occur outside of competition events. In addition, recent evidence suggests that nontime-loss injuries can lead to subsequent time-loss injuries, and irrespective of whether the initial injury resulted in time loss, subsequent injuries are most likely to occur within the first week of return to play or full participation.[57,61]

A range of body sites are reported to be injured in competitive diving athletes. Injuries to the lumbar spine/lower back, shoulder, and wrist/hand have been commonly reported.[10,14,30,55] At the 1993 French National Diving Championships, 85.7% of 10 m platform diving athletes were found to be experiencing current wrist pain.[34] Although not as high, wrist injury period prevalence was 8.0% in male and 16.2% in female athletes over a 5-year period at National Collegiate Athletic Association (NCAA) level,[32] whereas the occurrence of wrist/hand injuries accounted for 15.2% and 13.6% of injuries recorded at the 2009 and 2013 FINA World Championships, respectively.[40,41] Specific injury diagnostic details were generally not reported in the cohort studies. However, case studies that detailed wrist/hand injuries found that bone contusions/fracture were reported in training, where water entry was the mechanism of injury, and time loss as the outcome.[7,38,52] It has been hypothesized that most wrist injuries occur due to repetitive microtrauma, with competitive diving athletes completing many training and competition dives that can reach speeds of approximately 60 km per hour when they impact the water.[30,34,38]

LBP and lumbar spine injuries are common in competitive diving athletes. A lifetime LBP prevalence of 100% has been reported in elite-level diving athletes, where all diving athletes reported LBP within 12 months of commencing competitive diving training and competition.[6] More than one-third (37.3%) of junior elite Japanese diving athletes reported LBP at the commencement of joining national training.[45] Furthermore, the literature indicates that diving athletes likely incur changes to the lumbar disc (reduced disc height, reduced disc signal on magnetic resonance imaging, and disc bulging),[6] and/or the lumbar vertebrae (abnormal configuration of the vertebral body, ring apophyses, and Schmorl's nodes),[54] while competing in the sport. It has been suggested that lower back injuries are common in competitive diving due to the highly repetitive and monotonous training requirements,[6] repeated movement into lumbar extension in back and reverse dives,[30] and the susceptibility to injury of the lumbar spine in the athlete during physiological maturation.[5,6,55] Due to the high prevalence of LBP coupled with ongoing implications of tissue changes at the lumbar spine, further research is warranted to understand the cause and mechanistic factors of LBP and lumbar spine injuries in diving athletes, to better inform the development of prevention strategies.

Shoulder injuries were also found to be common in diving athletes, accounting for almost a quarter of all elite diver injuries (22.7%) at the 2013 FINA World Championships.[41] Shoulder-complex injuries identified from the case series/studies, include injuries to the clavicle,[59] acromioclavicular joint,[8] and thoracic outlet syndrome.[12,51] The 5-year NCAA study found that shoulder injuries were more likely to occur in male (32%) rather than female (8%) diving athletes.[32] Shoulder complex injuries in diving are often attributed to the repetitive overhead component of diving.[10,55] It has been reported that impact forces at the point of water entry may lead to injury along the kinetic chain, with the wrist, arms, and shoulders all absorbing these forces.[10,30] Increased laxity of the shoulder joint is common in diving athletes as they repeatedly abduct and internally rotate in the underwater component of the entry[14]; however, whether this contributes to risk of shoulder injury in this population is unknown.

Case series and studies identified in this review suggest that there could be different injury profiles for the different disciplines in competitive diving. Upper limb injuries were typically reported in platform divers,[7,38] whereas lower limb injuries were reported in springboard divers.[19]

The findings from this review suggest that the prevention of lumbar spine, shoulder, and wrist injuries are important in pre-elite and elite competitive diving athletes. A deeper understanding of causation is required, and sport specific injury characteristics such as mechanism of injury need to be investigated further to better understand the cause of these injuries. Further prospective longitudinal research is required to provide a comprehensive injury profile for each diving discipline.

## Illness

There were limited published data found to describe illness occurrence in diving elites. Diving-related illnesses were reported only in competition-based surveillance studies, limiting the understanding of illness occurrence in diving athletes to competition periods. Diving athletes had the highest illness incidence proportion (11.9%) of all competing sports at the Rio de Janeiro 2016 Olympic Games.[56] Respiratory illness was the most common type of illness reported at both the London and Rio De Janeiro Olympic Games, accounting for 57.1% and 43.8% of diving athlete illnesses, respectively. Infection was the most common cause of diving athlete illness reported, accounting for 71.4% and 62.5% of diving illnesses at the London and Rio De Janeiro Olympic Games, respectively. Other types of illnesses reported in competitive diving athletes to date include gastrointestinal, dermatological, environmental, and immunological.[20,41,56,58] Recent literature suggests links between illness in athlete populations and hygiene practices and travel to international competition.[18] Furthermore, evidence continues to highlight low energy availability, particularly in female athlete populations, is linked to both illness and injury.[37,43] The mechanisms that contribute to illness in diving athletes require further research to enable preventative strategies to be specifically developed.

Evidence related to the existence of mental health problems were identified in the search of the literature; however, no studies presented summary or raw data that related to defined mental health problems in diving athletes.[25,27,42] Mental health problems, as a subcategory of illness, are particularly relevant to aesthetic sports.[25] Athletes participating in aesthetic sports are more likely to experience symptoms of body image dissatisfaction, have disordered eating or a clinically diagnosed eating disorder.[25,27] It is common for disordered eating behaviors and eating disorders to contribute to low energy availability, and subsequently, a heightened risk of illness, injury, and reduced performance.[43,53] This is further supported by evidence linking poor mental health and illness.[16,18] Further research to understand the mechanisms and cause that contribute to illness in diving athletes is required to develop preventative health strategies.

### Study Design, Bias, and Implications for the Sport

There were notable inconsistencies in the reporting of injury and illness across the included studies. Incidence and prevalence were often used interchangeably, and severity of injury was commonly reported as nontime-loss; however, when these were categorized, they were reported using several different methods. Future research should comply with International Olympic Committee and World Aquatics guidelines on reporting incidence, prevalence, and severity.[4,39] We suggest that severity be reported as a continuous variable rather than categorical. Future studies should report on both acute and overuse injuries to investigate what kind of injuries cause the greatest burden in diving.

Specific diving injury characteristics are not represented in large cohort designs. A small number of papers identified injuries specific to diving discipline (springboard or platform).[7,19,51,52] There is limited evidence to suggest that there are differing levels of risk of injury associated with training or competition on either the 3 m springboard or 10 m platform, and this should be considered an area for future research to understand the cause of diving injuries. Case series and studies identified in this review suggest that there could be different injury profiles for the different disciplines in competitive diving.[3,19,52]

Overwhelmingly, the literature concerning injury and illness in elite diving athlete populations is reported from competition-based surveillance settings.[20,26,31,34,40,41,44,49,56,58] A reporting bias toward competition-based surveillance was identified. This leads to a potential survivor biased view of the health problems experienced by diving athletes when considered alone without comparison with studies that also capture exposure to training completed outside of competition events. The high prevalence of long-term injuries (such as lumbar spine and wrist injuries) that enter competition surveillance as pre-existing injuries, may explain why injury incidence (new injury occurrence) in diving is reported to be lower than many other sports during the Olympic Games.[20,31,56] This is further evidenced by precompetition survey results that demonstrate up to 52% of diving athletes experience a health complaint in the 4 weeks leading into major events, with 23% of diving athletes experiencing a time-loss health complaint that would impact their ability to perform.[41,49] This may explain the lower rates of new injuries reported during competitions,[41,49] but also underestimates the full extent of injury occurrence and consequently how this could negatively affect performance in competitive diving populations.[3,19,52]

Both time-loss and nontime-loss injuries sustained within 4 weeks of competition are considered to increase the risk of sustaining further injury at competition, and evidence from other sports would suggest that these may reduce a diving athlete's chances of achieving their desired competition result.[17,50] While competition-based surveillance provides an important insight into the health profile of diving athletes, the true breadth of injury and illness occurrence outside of competition remains unknown. If used in isolation, the significant survivor bias in competition-based surveillance studies may lead to the incorrect prioritization of health problems. A reporting bias also exists in the literature with most surveillance occurring at major benchmark events. As only a small number of studies have considered out-of-competition surveillance periods, further research to determine the incidence of out-of-competition injuries is required.

### Limitations

A limitation of this study is that only English articles were included (the sport has a history that involves European countries, and, most recently, China has had great international and Olympic level success). However, many studies in this review were conducted in Europe and Asia. In addition, the heterogeneity of the articles meant that it was not possible to perform a meta-analysis. Although it is not common to include case studies/series in a systematic review of sports injury and illness epidemiology, their inclusion in this study provides an additional perspective and detail related to severity and the mode of injury in the daily training environments of competitive diving athletes. This may present a selection bias, as it is noteworthy cases of interest that are presented in case study designs.

## CONCLUSION

This review found that injuries to the lumbar spine, shoulder, and wrist as well as respiratory illness were the health problems reported most commonly in competitive diving athletes. Compared with other sports, diving athletes experience one of the highest incidence proportions of illness during competition-based events. The current literature limits the understanding of the health problems experienced by diving athletes to competition periods only and requires expansion to whole-of-year surveillance.

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