

# BMJ Open Investigating correlates of athletic identity and sport-related injury outcomes: a scoping review

Tian Renton <sup>1,2</sup> Brian Petersen,<sup>3</sup> Sidney Kennedy<sup>1,2,4</sup>

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<sup>1</sup>Rehabilitation Sciences Institute, University of Toronto Faculty of Medicine, Toronto, Ontario, Canada

<sup>2</sup>Centre for Depression and Suicide Studies, St Michael's Hospital, Toronto, Ontario, Canada

<sup>3</sup>Faculty of Kinesiology and Physical Education, University of Toronto, Toronto, Ontario, Canada

<sup>4</sup>Department of Psychiatry, University of Toronto Faculty of Medicine, Toronto, Ontario, Canada

## Correspondence to

Tian Renton;  
tian.renton@mail.utoronto.ca

## ABSTRACT

**Objectives** To conduct a scoping review that (1) describes what is known about the relationship between athletic identity and sport-related injury outcomes and (2) describes the relationship that an injury (as an exposure) has on athletic identity (as an outcome) in athletes.

**Design** Scoping review.

**Participants** A total of n=1852 athletes from various sport backgrounds and levels of competition.

**Primary and secondary outcome measures** The primary measure used within the studies identified was the Athletic Identity Measurement Scale. Secondary outcome measures assessed demographic, psychosocial, behavioural, physical function and pain-related constructs. **Results** Twenty-two studies were identified for inclusion. Samples were dominated by male, Caucasian athletes. The majority of studies captured musculoskeletal injuries, while only three studies included sport-related concussion. Athletic identity was significantly and positively associated with depressive symptom severity, sport performance traits (eg, ego-orientation and mastery-orientation), social network size, physical self-worth, motivation, rehabilitation overadherence, mental toughness and playing through pain, as well as injury severity and functional recovery outcomes. Findings pertaining to the association that an injury (as an exposure) had on athletic identity (as an outcome) were inconsistent and limited.

**Conclusions** Athletic identity was most frequently associated with psychosocial, behavioural and injury-specific outcomes. Future research should seek to include diverse athlete samples (eg, women, athletes of different races, para-athletes) and should continue to reference theoretical injury models to inform study methodologies and to specify variables of interest for further exploration.

## INTRODUCTION

Participation in sport, be it in a formal (eg, registered league) or informal (eg, pick-up, drop-in) setting, is a popular pastime for individuals the world over. Positive benefits associated with sport participation include increased mental toughness,<sup>1</sup> perseverance<sup>1 2</sup> and positive self-esteem,<sup>2-4</sup> as well as the development of fine and gross motor skills, team work and problem-solving abilities.<sup>5</sup> These benefits are aside from the countless physical (eg, maintenance of a healthy body weight<sup>6</sup>), mental (eg, reduction in depression<sup>7</sup> and

## Strengths and limitations of this study

- The search strategy was constructed in consultation with a University of Toronto librarian.
- Citation management (EndNote) and systematic review citation screening software (Covidence) were used to allow reviewers to independently screen citations and extract data.
- Data extraction variables thoroughly described the study sample, injuries sustained, theoretical models referenced, athletic identity scores and timeline of administration, significant key findings as well as study strengths and limitations.
- A quality assessment was not conducted, and level of evidence ratings were not assigned to studies.

anxiety symptoms<sup>8</sup>) and cognitive benefits (eg, improved academic performance<sup>9</sup> and memory recall<sup>10</sup>) associated with physical activity in general. Despite these benefits, negative outcomes should also be considered, namely risk of injury. However, not all athletes are created equal, nor are their respective risks of sport injury. This is illustrated by several large-scale epidemiological studies describing marked differences in injury incidence when stratified by sport.<sup>11-16</sup> Internal risk factors, such as an athlete's biological and physical characteristics (eg, age, sex, anthropometry, skill level and physical fitness) as well as their psychological predisposition (eg, personality, history of stressors and availability of coping resources) are also posited to modify injury risk.<sup>17-19</sup> External factors, such as level of competition and playing surface, have also been implicated.<sup>18 19</sup>

Despite individual athlete (eg, physicality, disposition) and sport-specific differences (eg, type, level, frequency of involvement, injury risk), all athletes are thought to embody an 'athletic identity' (AI). Initially defined by Brewer *et al* in 1993, AI is defined as 'the exclusivity and strength with which an individual identifies with the athlete role, and looks to others for confirmation of that role'.<sup>20</sup>

To some extent, an athlete's self-perception of their AI can provide an important measure of their longevity in sport.<sup>21</sup> Stronger AIs have been associated with positive health outcomes, increased sport engagement, enhanced athletic performance, improved global self-esteem and confidence, as well as improved social relationships.<sup>20 22–25</sup> Conversely, following a sport-related injury, stronger AIs have been associated with depressive symptoms.<sup>26</sup> It has also been suggested that athletes who hold a stronger AI may neglect other identities and role responsibilities to maintain the athlete role.<sup>20</sup> Therefore, a strong AI may be helpful in some cases and harmful in others, especially within a sport injury context.

Athletes will continue to sustain injuries so long as sport exists, thus illustrating the need to understand factors associated with recovery. To inform stakeholders' (eg, clinicians, coaches, athletes) understanding and expectations, many theoretical injury recovery models have been developed, several of which are presented here: *The Biopsychosocial Model*<sup>27 28</sup>; *Biopsychosocial Model of Stress and Athletic Injury*<sup>29</sup>; *Integrated Model of Psychological Response to the Sport Injury and Rehabilitation Process*<sup>30</sup>; and *Cognitive Appraisal Model of Psychological Adjustment to Athletic Injury*.<sup>31</sup> Although not specific to sport, some models have been developed to explain and predict outcomes associated with a *specific* injury, such as concussion (*Neurobiopsychosocial Model of Concussion*<sup>32</sup>). Others have been adapted from existing models (*Transactional Stress Model*<sup>33</sup>) to suit a sport injury context (*Injury Response Model*<sup>34 35</sup>). For a more comprehensive review of select models, please see the following article.<sup>36</sup> Despite variation in the labelling used within the models cited above, constructs can be categorised as modifiable (ie, flexible, subject to intervention) or non-modifiable (ie, fixed, unchanging). With respect to addressing recovery outcomes, attention is best focused on modifiable factors because they are subject to intervention. Prior to implementing an intervention however, efforts should focus on describing recovery outcomes observed for a given factor. To our knowledge, AI (a modifiable factor) has not been summarised in detail with respect to its association with sport injury recovery outcomes.

To address this knowledge gap and to provide a comprehensive summary of what is known about AI in relation to sport-related injury outcomes, authors conducted a scoping review. To guide this review, the following questions were established *a priori*:

1. Is there an association between athlete self-reported AI and response to a sport-related injury? If so, what is known? Response to injury is operationally defined as any outcome observed following injury (eg, psychosocial, behavioural, functional, cognitive or performance).
2. Is there an association between a sport-related injury (as an exposure) and athlete self-reported AI (as an outcome)? If so, what is known?

## METHOD

### Search strategy and study identification

Search strategies and terms were developed in consultation with a University of Toronto health science librarian (EN; 20 January 2020). The following databases were searched in March and April 2020 by one reviewer (TR): MEDLINE, EMBASE, SPORTDiscus, CINAHL, APA PsycInfo, and Sport Medicine & Education Index (Proquest). The number of citations identified were recorded in [table 1](#).

Search results were exported to EndNote<sup>37</sup> and duplicates were discarded (n=334). Thereafter, article titles and abstracts (n=1122) were exported to Covidence.<sup>38</sup> Covidence collates each reviewer's decision to accept or reject a citation and identifies screening conflicts for resolution. The programme also populates a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart to reflect the number of citations included or excluded at each screening stage (see online supplemental appendix 1). Reasons for exclusion were cited at the full-text screening stage only. Studies identified for inclusion at full-text screening also had their reference lists reviewed for additional studies. ClinicalTrials.gov was also searched using the following terms: "athlete", "identity", "injury" and "sport", but did not identify any additional studies. TR and BP independently performed each stage of the screening process (titles, abstracts and full-text screening) as well as full-text data extraction. After completing each stage, reviewers met virtually (via Zoom) to discuss and resolve conflicts. Progression to the next screening stage occurred only after 100% agreement was achieved. The same process was applied throughout the data extraction phase. For quality assurance, this scoping review was structured according to the PRISMA extension for scoping reviews checklist (see online supplemental appendix 2).

### Study inclusion criteria

1. AI was assessed using a self-report quantitative measure.
2. Study sample consisted of at least one group with a sport-related injury which prevented them from engaging in sport.
3. Injuries were real or hypothetical (ie, imaginary).
4. Studies captured athletes of any age and playing status (eg, amateur or professional, retired or active). Studies that included athletes with disabilities (eg, para-athletes) were permissible, however, the injury must have been secondary to the existing disability (ie, study must pertain to a sport-related injury).
5. An objective measure was used to assess the injury or post-rehabilitation status or post-injury AI.

### Study exclusion criteria

1. Article not available in the English language.
2. Full-text article could not be located following direct request to author(s) (if not available online).
3. Injury was not specified or assessed for severity.

Table 1 Search strategies by database

Database	Search Strategy & Terms	Search Date	Number of Articles Returned
MEDLINE (OVID) 1946–present	<ol style="list-style-type: none"> <li>1. Athletes/</li> <li>2. (Paralympian or Olympian or athlete*).tw,kf.</li> <li>3. sports/ or baseball/ or basketball/ or bicycling/ or boxing/ or cricket sport/ or football/ or golf/ or gymnastics/ or hockey/ or martial arts/ or mountaineering/ or racquet sports/ or running/ or skating/ or snow sports/ or soccer/ or sports for persons with disabilities/ or "track and field"/ or volleyball/ or walking/ or water sports/ or weight lifting/ or wrestling/</li> <li>4. (archery or artistic swimming or athletics or badminton or baseball or softball or basketball or beach volleyball or boxing or canoe or cycling or diving or equestrian or fencing or football or golf or gymnastics or handball or hockey or judo or karate or marathon or pentathlon or rowing or rugby or sailing or shooting or skateboarding or climbing or surfing or swimming or tennis or taekwondo or trampoline or triathlon or waterpolo or weightlifting or wrestling or skiing or biathlon or bobsleigh or cross country or curling or figure skating or ice hockey or luge or Nordic or skeleton or jumping or snowboard or dance or cheerleading or soccer or running).tw,kf.</li> <li>5. 1 or 2 or 3 or 4</li> <li>6. exp Self Concept/</li> <li>7. ((identity or esteem or efficacy or schema) adj 3 self).tw,kf.</li> <li>8. ((identity or esteem or efficacy or schema) adj 3 athlete*).tw,kf.</li> <li>9. ((identity or esteem or efficacy or schema) adj 3 himself).tw,kf.</li> <li>10. ((identity or esteem or efficacy or schema) adj 3 herself).tw,kf.</li> <li>11. ((identity or esteem or efficacy or schema) adj 3 themselves).tw,kf.</li> <li>12. 7 or 8 or 9 or 10 or 11</li> <li>13. ((coherence or self) adj 3 sense of).tw,kf.</li> <li>14. 6 or 12 or 13</li> <li>15. 5 and 14</li> <li>16. exp "wounds and injuries"/</li> <li>17. (tear or separation or sprain or strain or break or fracture or contusion or damage or dislocation or bruise or concussion or hernia or rupture or injur*).tw,kf.</li> <li>18. 16 or 17</li> <li>19. 5 and 14 and 18</li> <li>20. Athletic Injuries/</li> <li>21. 14 and 20</li> <li>22. 19 or 21</li> </ol>	31 March 2020	n=250
EMBASE CLASSIC+EMBASE (OVID) 1947–30 March 2020	<ol style="list-style-type: none"> <li>1. Athletes/</li> <li>2. (Paralympian or Olympian or athlete*).tw,kf.</li> <li>3. sports/ or baseball/ or basketball/ or bicycling/ or boxing/ or cricket sport/ or football/ or golf/ or gymnastics/ or hockey/ or martial arts/ or mountaineering/ or racquet sports/ or running/ or skating/ or snow sports/ or soccer/ or sports for persons with disabilities/ or "track and field"/ or volleyball/ or walking/ or water sports/ or weight lifting/ or wrestling/</li> <li>4. (archery or artistic swimming or athletics or badminton or baseball or softball or basketball or beach volleyball or boxing or canoe or cycling or diving or equestrian or fencing or football or golf or gymnastics or handball or hockey or judo or karate or marathon or pentathlon or rowing or rugby or sailing or shooting or skateboarding or climbing or surfing or swimming or tennis or taekwondo or trampoline or triathlon or waterpolo or weightlifting or wrestling or skiing or biathlon or bobsleigh or cross country or curling or figure skating or ice hockey or luge or Nordic or skeleton or jumping or snowboard or dance or cheerleading or soccer or running).tw,kf.</li> <li>5. 1 or 2 or 3 or 4</li> <li>6. exp Self Concept/</li> <li>7. ((identity or esteem or efficacy or schema) adj 3 self).tw,kf.</li> <li>8. ((identity or esteem or efficacy or schema) adj 3 athlete*).tw,kf.</li> <li>9. ((identity or esteem or efficacy or schema) adj 3 himself).tw,kf.</li> <li>10. ((identity or esteem or efficacy or schema) adj 3 herself).tw,kf.</li> <li>11. ((identity or esteem or efficacy or schema) adj 3 themselves).tw,kf.</li> <li>12. 7 or 8 or 9 or 10 or 11</li> <li>13. ((coherence or self) adj 3 sense of).tw,kf.</li> <li>14. 6 or 12 or 13</li> <li>15. 5 and 14</li> <li>16. exp "wounds and injuries"/</li> <li>17. (tear or separation or sprain or strain or break or fracture or contusion or damage or dislocation or bruise or concussion or hernia or rupture or injur*).tw,kf.</li> <li>18. 16 or 17</li> <li>19. 5 and 14 and 18</li> <li>20. Athletic Injuries/</li> <li>21. 14 and 20</li> <li>22. 19 or 21</li> </ol>	31 March 2020	N=357

Continued

Table 1 Continued

Database	Search Strategy & Terms	Search Date	Number of Articles Returned
SPORTDiscus (EBSCO) 1800–present	<p>S1. DE "ATHLETES" OR DE "AFRICAN athletes" OR DE "AMATEUR athletes" OR DE "ARAB athletes" OR DE "ARCHERS" OR DE "ASIAN athletes" OR DE "ATHLETES with disabilities" OR DE "BADMINTON players" OR DE "BASEBALL players" OR DE "BASKETBALL players" OR DE "BLACK athletes" OR DE "BOBSLEDDERS" OR DE "BODYBUILDERS" OR DE "BOWLERS" OR DE "BOXERS (Sports)" OR DE "BULLFIGHTERS" OR DE "CANADIAN athletes" OR DE "CANOEISTS" OR DE "CELEBRITY athletes" OR DE "CHILD athletes" OR DE "CHILDREN of athletes" OR DE "CHRISTIAN athletes" OR DE "COLLEGE athletes" OR DE "CRICKET players" OR DE "CROQUET players" OR DE "CURLERS (Athletes)" OR DE "CYCLISTS" OR DE "DEFENSIVE players" OR DE "DIABETIC athletes" OR DE "ELITE athletes" OR DE "ENDURANCE athletes" OR DE "EUROPEAN athletes" OR DE "FENCERS" OR DE "FOOTBALL players" OR DE "GAY athletes" OR DE "GLADIATORS" OR DE "GOLFERS" OR DE "GYMNASTS" OR DE "HANDBALL players" OR DE "HIGH school athletes" OR DE "HOCKEY players" OR DE "INTERSEX athletes" OR DE "JAI alai players" OR DE "JEWISH athletes" OR DE "JUNIOR high school athletes" OR DE "KABADDI players" OR DE "LACROSSE players" OR DE "LAWN bowlers" OR DE "LGBTQ athletes" OR DE "LONG-term athlete development" OR DE "MALE athletes" OR DE "MARTIAL artists" OR DE "MEXICAN athletes" OR DE "MIDDLE school athletes" OR DE "MOUNTAINEERS" OR DE "MUSLIM athletes" OR DE "NATIVE American athletes" OR DE "NETBALL players" OR DE "OFFENSIVE players" OR DE "OLDER athletes" OR DE "OLYMPIC athletes" OR DE "ORIENTEERS" OR DE "PACIFIC Islander athletes" OR DE "PROFESSIONAL athletes" OR DE "ROWERS" OR DE "RUGBY football players" OR DE "RUNNERS (Sports)" OR DE "SKATERS" OR DE "SKIERS" OR DE "SKYDIVERS" OR DE "SNOWBOARDERS" OR DE "SOCCER players" OR DE "SOFTBALL players" OR DE "SQUASH players" OR DE "STARTING players" OR DE "SUBSTITUTE players" OR DE "SURFERS" OR DE "SWIMMERS" OR DE "TABLE tennis players" OR DE "TEAM handball players" OR DE "TENNIS players" OR DE "TRACK &amp; field athletes" OR DE "TRIATHLETES" OR DE "VOLLEYBALL players" OR DE "WATER polo players" OR DE "WEIGHT lifters" OR DE "WINDSURFERS (Persons)" OR DE "WOMEN athletes" OR DE "WRESTLERS"</p> <p>S2. AB (Paralympian or Olympian or athlete) OR TI (Paralympian or Olympian or athlete) OR SU (Paralympian or Olympian or athlete) OR KW (Paralympian or Olympian or athlete)</p> <p>S3. DE "RECREATION" OR DE "AMATEUR sports" OR DE "AQUATIC sports" OR DE "BALL games" OR DE "BASEBALL" OR DE "COLLEGE sports" OR DE "CONTACT sports" OR DE "ENDURANCE sports" OR DE "EXTREME sports" OR DE "GYMNASTICS" OR DE "HOCKEY" OR DE "INDIVIDUAL sports" OR DE "MILITARY sports" OR DE "OLYMPIC Games" OR DE "PROFESSIONAL sports" OR DE "RECREATIONAL sports" OR DE "SCHOOL sports" OR DE "SOFTBALL" OR DE "SPORTS competitions" OR DE "SPORTS for children" OR DE "SPORTS for girls" OR DE "SPORTS for people with disabilities" OR DE "SPORTS for youth" OR DE "SPORTS teams" OR DE "TARGETS (Sports)" OR DE "TEAM sports" OR DE "WINTER sports" OR DE "WOMEN'S sports"</p> <p>S4. TI (archery or artistic swimming or athletics or badminton or baseball or softball or basketball or beach volleyball or boxing or canoe or cycling or diving or equestrian or fencing or football or golf or gymnastics or handball or hockey or judo or karate or marathon or pentathlon or rowing or rugby or sailing or shooting or skateboarding or climbing or surfing or swimming or tennis or taekwondo or trampoline or triathlon or waterpolo or weightlifting or wrestling or skiing or biathlon or bobsleigh or cross country or curling or figure skating or ice hockey or luge or Nordic or skeleton or jumping or snowboard or dance or cheerleading or soccer or running) OR AB (archery or artistic swimming or athletics or badminton or baseball or softball or basketball or beach volleyball or boxing or canoe or cycling or diving or equestrian or fencing or football or golf or gymnastics or handball or hockey or judo or karate or marathon or pentathlon or rowing or rugby or sailing or shooting or skateboarding or climbing or surfing or swimming or tennis or taekwondo or trampoline or triathlon or waterpolo or weightlifting or wrestling or skiing or biathlon or bobsleigh or cross country or curling or figure skating or ice hockey or luge or Nordic or skeleton or jumping or snowboard or dance or cheerleading or soccer or running) OR KW (archery or artistic swimming or athletics or badminton or baseball or softball or basketball or beach volleyball or boxing or canoe or cycling or diving or equestrian or fencing or football or golf or gymnastics or handball or hockey or judo or karate or marathon or pentathlon or rowing or rugby or sailing or shooting or skateboarding or climbing or surfing or swimming or tennis or taekwondo or trampoline or triathlon or waterpolo or weightlifting or wrestling or skiing or biathlon or bobsleigh or cross country or curling or figure skating or ice hockey or luge or Nordic or skeleton or jumping or snowboard or dance or cheerleading or soccer or running)</p> <p>S5. S1 OR S2 OR S3 OR S4</p> <p>S6. DE "SELF-perception" OR DE "BODY image" OR DE "SELF-esteem"</p> <p>S7. DE "ATHLETIC identity (Psychology)" OR DE "IDENTITY (Psychology)" OR DE "ATHLETIC identity (Psychology)" OR DE "PHYSICALLY active people -- identity" OR DE "PSYCHOLOGY of athletes" OR DE "ATHLETIC identity (Psychology)"</p> <p>S8. TI ((identity or esteem or efficacy or schema) N3 self) OR AB ((identity or esteem or efficacy or schema) N3 self) OR SU ((identity or esteem or efficacy or schema) N3 self) OR KW ((identity or esteem or efficacy or schema) N3 self)</p> <p>S9. TI ((identity or esteem or efficacy or schema) N3 athlete) OR AB ((identity or esteem or efficacy or schema) N3 athlete) or SU ((identity or esteem or efficacy or schema) N3 athlete) or KW ((identity or esteem or efficacy or schema) N3 athlete)</p> <p>S10. TI ((identity or esteem or efficacy or schema) N3 himself) OR AB ((identity or esteem or efficacy or schema) N3 himself) OR SU ((identity or esteem or efficacy or schema) N3 himself) or KW ((identity or esteem or efficacy or schema) N3 himself)</p> <p>S11. TI ((identity or esteem or efficacy or schema) N3 herself) OR AB ((identity or esteem or efficacy or schema) N3 herself) OR SU ((identity or esteem or efficacy or schema) N3 herself)</p> <p>S12. TI ((identity or esteem or efficacy or schema) N3 themselves) OR AB ((identity or esteem or efficacy or schema) N3 themselves) OR SU ((identity or esteem or efficacy or schema) N3 themselves)</p> <p>S13. S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12</p> <p>S14. TI ((coherence or self) N3 sense of) OR AB ((coherence or self) N3 sense of) OR SU ((coherence or self) N3 sense of) OR KW ((coherence or self) N3 sense of)</p> <p>S15. S13 OR S14</p> <p>S16. S5 AND S15</p> <p>S17. (DE "SPORTS injuries" OR DE "ACHILLES tendinitis" OR DE "AEROBICS injuries" OR DE "AQUATIC sports injuries" OR DE "BASEBALL injuries" OR DE "BASKETBALL injuries" OR DE "BOXING injuries" OR DE "COMMOTIO cordis" OR DE "CRICKET injuries" OR DE "EQUESTRIAN accidents" OR DE "FOOTBALL injuries" OR DE "GOLF injuries" OR DE "GYMNASTICS injuries" OR DE "HIKING injuries" OR DE "HOCKEY injuries" OR DE "HORSE sports injuries" OR DE "IN-line skating injuries" OR DE "JOGGING injuries" OR DE "JUDO injuries" OR DE "JUMPER'S knee" OR DE "KARATE injuries" OR DE "MARTIAL arts injuries" OR DE "NETBALL injuries" OR DE "RACKET game injuries" OR DE "RUGBY football injuries" OR DE "RUNNING injuries" OR DE "SKATEBOARDING injuries" OR DE "SOCCER injuries" OR DE "TENNIS injuries" OR DE "TURF toe" OR DE "VAULTING injuries" OR DE "VOLLEYBALL injuries" OR DE "WALKING (Sports) injuries" OR DE "WEIGHT training injuries" OR DE "WINTER sports injuries") AND (DE "SPORTS injuries" OR DE "SPORTS emergencies" OR DE "SPORTS injuries" OR DE "SPORTS ophthalmology" OR DE "WOUNDS &amp; injuries" OR DE "BACKPACKING injuries" OR DE "BLUNT trauma" OR DE "CHRONIC wounds &amp; injuries" OR DE "CRASH injuries" OR DE "DANCING injuries" OR DE "DECOMPRESSION sickness" OR DE "DISABILITIES" OR DE "DISLOCATIONS (Anatomy)" OR DE "HEAD injuries" OR DE "MARTIAL arts injuries" OR DE "MOUNTAINEERING injuries" OR DE "OVEREXERTION injuries" OR DE "OVERUSE injuries" OR DE "PENETRATING wounds" OR DE "PHYSIOLOGIC strain" OR DE "RUPTURE of organs, tissues, etc." OR DE "SOFT tissue injuries" OR DE "SPORTS injuries" OR DE "SUBLUXATION" OR DE "WOUND care")</p> <p>S18. TI (tear or separation or sprain or strain or break or fracture or contusion or damage or dislocation or bruise or concussion or hernia or rupture or injury) OR AB (tear or separation or sprain or strain or break or fracture or contusion or damage or dislocation or bruise or concussion or hernia or rupture or injury) OR SU (tear or separation or sprain or strain or break or fracture or contusion or damage or dislocation or bruise or concussion or hernia or rupture or injury) OR KW (tear or separation or sprain or strain or break or fracture or contusion or damage or dislocation or bruise or concussion or hernia or rupture or injury)</p> <p>S19. S17 OR S18</p> <p>S20. S16 AND S19</p> <p>*Use of Thesaurus Function to find DE Terms</p>	2 April 2020	N=433

Continued



Table 1 Continued

Database	Search Strategy & Terms	Search Date	Number of Articles Returned
CINAHL plus with full text (EBSCO) 1937–present	<p>S1. (MH "Athletes, Amateur") OR (MH "Athletes, College") OR (MH "Athletes, Disabled") OR (MH "Athletes, Elite") OR (MH "Athletes, Female") OR (MH "Athletes, High School") OR (MH "Athletes, Male") OR (MH "Athletes, Master") OR (MH "Athletes, Professional") OR (MH "Athletes")</p> <p>S2. AB (Paralympian or Olympian or athlete) OR TI (Paralympian or Olympian or athlete)</p> <p>S3. (MH "Sports+")</p> <p>S4. TI (archery or artistic swimming or athletics or badminton or baseball or softball or basketball or beach volleyball or boxing or canoe or cycling or diving or equestrian or fencing or football or golf or gymnastics or handball or hockey or judo or karate or marathon or pentathlon or rowing or rugby or sailing or shooting or skateboarding or climbing or surfing or swimming or tennis or taekwondo or trampoline or triathlon or waterpolo or weightlifting or wrestling or skiing or biathlon or bobsleigh or cross country or curling or figure skating or ice hockey or luge or Nordic or skeleton or jumping or snowboard or dance or cheerleading or soccer or running) OR AB (archery or artistic swimming or athletics or badminton or baseball or softball or basketball or beach volleyball or boxing or canoe or cycling or diving or equestrian or fencing or football or golf or gymnastics or handball or hockey or judo or karate or marathon or pentathlon or rowing or rugby or sailing or shooting or skateboarding or climbing or surfing or swimming or tennis or taekwondo or trampoline or triathlon or waterpolo or weightlifting or wrestling or skiing or biathlon or bobsleigh or cross country or curling or figure skating or ice hockey or luge or Nordic or skeleton or jumping or snowboard or dance or cheerleading or soccer or running)</p> <p>S5. S1 OR S2 OR S3 OR S4</p> <p>S6. (MH "Self Concept+")</p> <p>S7. (MM "Professional Identity") OR (MM "Social Identity") OR (MM "Role")</p> <p>S8. TI ((identity or esteem or efficacy or schema) N3 self) OR AB ((identity or esteem or efficacy or schema) N3 self)</p> <p>S9. TI ((identity or esteem or efficacy or schema) N3 athlete) OR AB ((identity or esteem or efficacy or schema) N3 athlete)</p> <p>S10. TI ((identity or esteem or efficacy or schema) N3 himself) OR AB ((identity or esteem or efficacy or schema) N3 himself)</p> <p>S11. TI ((identity or esteem or efficacy or schema) N3 herself) OR AB ((identity or esteem or efficacy or schema) N3 herself)</p> <p>S12. TI ((identity or esteem or efficacy or schema) N3 themselves) OR AB ((identity or esteem or efficacy or schema) N3 themselves)</p> <p>S13. S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12</p> <p>S14. TI ((coherence or self) N3 sense of) OR AB ((coherence or self) N3 sense of)</p> <p>S15. S13 OR S14</p> <p>S16. S5 AND S15</p> <p>S17. (MH "Athletic Injuries+") OR (MM "Contusions and Abrasions") OR (MM "Back Injuries") OR (MM "Fractures") OR (MH "Head Injuries") OR (MH "Leg Injuries") OR (MH "Ligament Injuries") OR (MM "Dislocations") OR (MM "Neck Injuries") OR (MM "Rupture") OR (MM "Soft Tissue Injuries") OR (MM "Spinal Cord Injuries") OR (MM "Spinal Injuries") OR (MM "Sprains and Strains") OR (MM "Tears and Lacerations") OR (MM "Tendon Injuries") OR (MM "Wounds, Penetrating") OR (MM "Wounds, Nonpenetrating") OR (MM "Subluxation") OR (MM "Reinjury")</p> <p>S18. TI (tear or separation or sprain or strain or break or fracture or contusion or damage or dislocation or bruise or concussion or hernia or rupture or injur) OR AU (tear or separation or sprain or strain or break or fracture or contusion or damage or dislocation or bruise or concussion or hernia or rupture or injur)</p> <p>S19. S17 OR S18</p> <p>S20. S16 AND S19</p> <p>*Use of Subject Header Function to identify MH Terms</p>	2 April 2020	N=248
APA PsycInfo (OVID) 1806–March week 4 2020	<ol style="list-style-type: none"> <li>Athletes/</li> <li>(Paralympian or Olympian or athlete).tw,kf.</li> <li>sports/ or baseball/ or basketball/ or bicycling/ or boxing/ or cricket sport/ or football/ or golf/ or gymnastics/ or hockey/ or martial arts/ or mountaineering/ or racquet sports/ or running/ or skating/ or snow sports/ or soccer/ or sports for persons with disabilities/ or "track and field"/ or volleyball/ or walking/ or water sports/ or weight lifting/ or wrestling/</li> <li>(archery or artistic swimming or athletics or badminton or baseball or softball or basketball or beach volleyball or boxing or canoe or cycling or diving or equestrian or fencing or football or golf or gymnastics or handball or hockey or judo or karate or marathon or pentathlon or rowing or rugby or sailing or shooting or skateboarding or climbing or surfing or swimming or tennis or taekwondo or trampoline or triathlon or waterpolo or weightlifting or wrestling or skiing or biathlon or bobsleigh or cross country or curling or figure skating or ice hockey or luge or Nordic or skeleton or jumping or snowboard or dance or cheerleading or soccer or running).tw,kf.</li> <li>1 or 2 or 3 or 4</li> <li>exp Self Concept/</li> <li>((identity or esteem or efficacy or schema) adj 3 self).tw,kf.</li> <li>((identity or esteem or efficacy or schema) adj 3 athlete).tw,kf.</li> <li>((identity or esteem or efficacy or schema) adj 3 himself).tw,kf.</li> <li>((identity or esteem or efficacy or schema) adj 3 herself).tw,kf.</li> <li>((identity or esteem or efficacy or schema) adj 3 themselves).tw,kf.</li> <li>7 or 8 or 9 or 10 or 11</li> <li>((coherence or self) adj 3 sense of).tw,kf.</li> <li>6 or 12 or 13</li> <li>5 and 14</li> <li>exp "wounds and injuries"/</li> <li>(tear or separation or sprain or strain or break or fracture or contusion or damage or dislocation or bruise or concussion or hernia or rupture or injur).tw,kf.</li> <li>16 or 17</li> <li>5 and 14 and 18</li> <li>Athletic Injuries/</li> <li>14 and 20</li> <li>19 or 21</li> </ol>	31 March 2020	N=0

Continued

Table 1 Continued

Database	Search Strategy & Terms	Search Date	Number of Articles Returned
Sport Medicine & Education Index (ProQuest) 1970–current	<p>Concept 1. (MAINSUBJECT.EXACT("Athletes") OR ab((Paralympian or Olympian or athlete*)) OR pub((Paralympian or Olympian or athlete*)) OR if((Paralympian or Olympian or athlete*)) OR (MAINSUBJECT.EXACT("Winter sports") OR MAINSUBJECT.EXACT("Sports") OR MAINSUBJECT.EXACT("College sports") OR MAINSUBJECT.EXACT("High school sports") OR MAINSUBJECT.EXACT("Professional sports")) OR ab(archery or artistic swimming or athletics or badminton or baseball or softball or basketball or beach volleyball or boxing or canoe or cycling or diving or equestrian or fencing or football or golf or gymnastics or handball or hockey or judo or karate or marathon or pentathlon or rowing or rugby or sailing or shooting or skateboarding or climbing or surfing or swimming or tennis or taekwondo or trampoline or triathlon or waterpolo or weightlifting or wrestling or skiing or biathlon or bobsleigh or cross country or curling or figure skating or ice hockey or luge or Nordic or skeleton or jumping or snowboard or dance or cheerleading or soccer or running) OR pub(archery or artistic swimming or athletics or badminton or baseball or softball or basketball or beach volleyball or boxing or canoe or cycling or diving or equestrian or fencing or football or golf or gymnastics or handball or hockey or judo or karate or marathon or pentathlon or rowing or rugby or sailing or shooting or skateboarding or climbing or surfing or swimming or tennis or taekwondo or trampoline or triathlon or waterpolo or weightlifting or wrestling or skiing or biathlon or bobsleigh or cross country or curling or figure skating or ice hockey or luge or Nordic or skeleton or jumping or snowboard or dance or cheerleading or soccer or running))</p> <p>AND</p> <p>Concept 2. (MAINSUBJECT.EXACT("Self esteem") OR ab((identity or esteem or efficacy or schema) NEAR/3 self) OR pub((identity or esteem or efficacy or schema) NEAR/3 self) OR if((identity or esteem or efficacy or schema) NEAR/3 self) OR pub((identity or esteem or efficacy or schema) NEAR/3 athlete*) OR if((identity or esteem or efficacy or schema) NEAR/3 athlete*) OR ab((identity or esteem or efficacy or schema) NEAR/3 himself) OR pub((identity or esteem or efficacy or schema) NEAR/3 himself) OR if((identity or esteem or efficacy or schema) NEAR/3 himself) OR ab((identity or esteem or efficacy or schema) NEAR/3 herself) OR pub((identity or esteem or efficacy or schema) NEAR/3 herself) OR if((identity or esteem or efficacy or schema) NEAR/3 herself) OR ab((identity or esteem or efficacy or schema) NEAR/3 themselves) OR pub((identity or esteem or efficacy or schema) NEAR/3 themselves) OR if((identity or esteem or efficacy or schema) NEAR/3 themselves) OR ab((coherence or self) NEAR/3 sense of) OR pub((coherence or self) NEAR/3 sense of) OR if((coherence or self) NEAR/3 sense of))</p> <p>AND</p> <p>Concept 3. ((MAINSUBJECT.EXACT("Concussion") OR MAINSUBJECT.EXACT("Spinal cord injuries") OR MAINSUBJECT.EXACT("Bodily injury") OR MAINSUBJECT.EXACT("Fractures") OR MAINSUBJECT.EXACT("Traumatic brain injury") OR MAINSUBJECT.EXACT("Head injuries") OR MAINSUBJECT.EXACT("Joint and ligament injuries") OR MAINSUBJECT.EXACT("Sports injuries") OR MAINSUBJECT.EXACT("Trauma")) OR ab((tear or separation or sprain or strain or break or fracture or contusion or damage or dislocation or bruise or concussion or hernia or rupture or injur*)) OR pub((tear or separation or sprain or strain or break or fracture or contusion or damage or dislocation or bruise or concussion or hernia or rupture or injur*)) OR if((tear or separation or sprain or strain or break or fracture or contusion or damage or dislocation or bruise or concussion or hernia or rupture or injur*))</p>	2 April 2020	N=168

Total records identified: n=1456.

- AI was not self-reported (ie, was reported by a coach, teammate or parent).
- Conference proceedings or abstracts.
- Qualitative studies.
- Systematic, scoping or narrative reviews.
- Theses or dissertations.
- Consensus statements.

### Data extraction

The following data were extracted from each of the included studies and logged independently by reviewers into a blank, preformatted table (see [table 2](#) for template).

- Description of sample: country of origin, sample size, sex, race, age, recruitment source, sport background, level of sport and history of sport involvement (eg, frequency and years of participation).
- Injury descriptors: definition of injury used (if any), type and severity of injury, time removed from sport, rehabilitation protocol administered and surgical details (if any).
- Study methodology: study design, primary and secondary objectives.
- Theoretical support: author and model or theory used.
- Outcome measures: AI measured used, timeline of administration, AI score and additional outcome measures used.
- Key findings: findings related to AI and other measured variables.
- Study strengths and limitations.

Findings are presented as a narrative summary, and where possible, presented as a tally (ie, number of studies that reported on a given finding) to denote trends in the literature. In keeping with the purpose of scoping review methodology which is ‘...to identify knowledge gaps, scope a body of literature, clarify concepts or to investigate research conduct’<sup>39</sup> as well as ‘...to identify strengths [and] weaknesses ... in the research’,<sup>40</sup> studies will not undergo quality review (ie, assessment of bias) or be assigned a *Level of Evidence* rating.

### Patient and public involvement

No patient(s) involved.

### RESULTS

The search strategy identified 1456 records for consideration (see [table 1](#) for databases searched, search terms used and number of records identified). Two additional articles were identified via hand searching of the included article reference lists. One additional article was previously known to others, but not identified in the searches. Two articles contained multiple studies. A total of 20 publications reporting on 22 studies were eligible for inclusion. Studies used cross-section observational (n=8), prospective longitudinal (n=13) and mixed-methods (n=1) designs.

### Sample descriptors

Studies originated from Australia (n=1), Canada (n=1), Israel (n=1), Slovenia (n=1) and the USA (n=18). Most

Table 2 Article data extraction

Sample Descriptors										Injury Description		Study Design and Objectives		Model or Theory Referenced		Outcome Measures		Key Findings Pertaining to AI		Study Strengths and Limitations	
1. Country of origin 2. n=(sex, %) 3. Race (%) 4. Age M±SD; range 5. Recruitment source 6. Sport (%) 7. Level of sport 8. History of sport engagement (frequency/years)										1. Definition of injury (yes/no: definition) 2. Sport injury/severity 3. Time out of sport; M(SD) 4. Rehabilitation protocol and surgery details		1. Cross-sectional 2. To examine the psychological trauma, including potential PTSD symptomatology, following ACL rupture among young athletes.		1. — 2. —		1. AIMS: 7 or 10 items 2. Timeline of administration 3. Group: score (M±SD) 4. Names of additional measure(s) used		1. Single sport athletes had significantly higher AIMS scores than multisport athletes 2. No significant difference in AIMS scores by age group (≤14 years old vs 15–21 years old) 3. No significant difference on IES-R between high (AIMS score: >50) and low AI groups (AIMS score: ≤49) 4. Level of sports specialisation: IES-R		Strengths: ► Only study to group athletes by sport specialisation (as per the American Orthopaedic Society for Sports Medicine definition; that is, single vs multisport athletes) and compare AIMS scores between groups ► Only study to examine psychological trauma associated with a sport injury Limitations: ► Small sample size ► Unknown how long athletes were removed from sport ► Figures are provided, but exact values are not referenced ► Does not appear that tests of statistical significance were conducted to compare high and low AI groups ► No pre-injury data available ► Exclusively captured ACL injuries; findings may not be generalisable to other injuries	
Padaki et al (2018) <sup>49</sup>										USA n=24 (male, 50) — 14.5±2.7 Tertiary care centre Single sport (29.2); multisport (58.3) — —		1. Yes: 'ACL rupture requiring surgery' 2. ACL tear; 41.7% reporting concomitant meniscal injury 3. — 4. —		1. — 2. —		1. 10 items 2. Baseline: pre-operation 3. Sex: male=53.4 vs female=56.6 Sport involvement: single sport=57.5 vs multisport=52.8 Age: ≤14 years old=54.5 vs 15–21 years old=54.1 SDs not provided 4. Level of sports specialisation: IES-R		► Single sport athletes had significantly higher AIMS scores than multisport athletes ► No significant difference in AIMS scores by age group (≤14 years old vs 15–21 years old) ► No significant difference on IES-R between high (AIMS score: >50) and low AI groups (AIMS score: ≤49) Limitations: ► Small sample size ► Unknown how long athletes were removed from sport ► Figures are provided, but exact values are not referenced ► Does not appear that tests of statistical significance were conducted to compare high and low AI groups ► No pre-injury data available ► Exclusively captured ACL injuries; findings may not be generalisable to other injuries			
Hilliard et al (2017) <sup>55</sup>										1. USA n=79 (male, 64.6) 2. Caucasian (70) 3. 19.96±1.56 4. Athletic training clinics in colleges or universities in Midwestern USA 5. Football (35); soccer (18); basketball (11); track (10); baseball (6); volleyball (6); gymnastics/dance (6); swimming (4); cross-country (3); field hockey (3); lacrosse (1); wrestling (1); not specified (2) 6. Division I (26%); Division II (15%); Division III (40%) and NAAIA (19%) 7. 14.19±9.40 hours spent training/week prior to injury; 10.45±4.46 years involved in sport		1. Yes: 'experiencing an MSK injury considered moderate in severity that results in at least 7 days of missed practice or competition and receiving physiotherapy for the injury' 2. ACL tear (13.9%); sprains (12.6%); fractures (6.3%); undefined injury, only general area reported (eg, right knee, lower back, etc) (67%) 3. As per definition, '... at least 7 days of missed practice or competition...'; median of 4 weeks reported since time of injury (range 1–63 weeks) 4. 42% of injuries required surgery, not otherwise specified		1. Wiese-Bjornstal et al (1998) <sup>30</sup> 2. Integrated Model of Response to Sport Injury		1. 7 items 2. Baseline: post-injury 3. 5.78±0.72† 4. ROAQ		► Positive moderate and significant association between AIMS score and overadherence to rehabilitation protocols ► Positive moderate and significant association between AIMS score and attempts to expedite rehabilitation process ► Positive moderate but non-significant association between AIMS score and willingness to ignore practitioner recommendations pertaining to rehabilitation ► AIMS negative affectivity subscale independently predicted likelihood that athlete would: (1) ignore practitioner recommendations and (2) attempt to expedite the rehabilitation process Strengths: ► Sample is described clearly and thoroughly (eg, clear definition of injury, sport, level of play, frequency of sport involvement, type of sport injury, time removed from sport) ► Range of sports and levels of play captured increase the generalisability of findings ► Study design used does not prioritise one aspect of the research over the other (ie, quantitative vs qualitative) ► Regression models have sufficient power ► Captured a range of MSK injuries ► Clear operational definition of injuries eligible for inclusion Limitations: ► Only one additional outcome measure administered ► ROAQ assesses athlete beliefs, not actual behaviours ► Sample is predominantly male ► Statistical tests comparing AIMS scores with subscale scores increases likelihood of multicollinearity ► Large variation in 'time since injury': 1 week (acute) vs 63 weeks (chronic) ► No pre-injury data available			

Continued

Table 2 Continued

Author (year)	Sample Descriptors				Injury Description				Study Design and Objectives		Model or Theory Referenced	Outcome Measures				Key Findings Pertaining to AI	Study Strengths and Limitations														
	1. Country of origin	2. n= (sex, %)	3. Race (%)	4. Age M±SD; range	1. Definition of injury (yes/no: definition)	2. Sport injury/severity	3. Time out of sport; M(SD)	4. Rehabilitation protocol and surgery details	1. Study design	2. Primary objective		3. Secondary objective	1. AMS: 7 or 10 items	2. Timeline of administration	3. Group; score			4. Names of additional measure(s) used													
O'Rourke et al (2017) <sup>54</sup>	USA	n=51 (male, 52.9)	—	14.53±1.85	Athletes presenting to a local hospital or university-affiliated outpatient concussion clinic	Soccer (24); lacrosse (10); football (8); other (58): skiing, volleyball, hockey, swimming, ultimate frisbee, cheerleading and wrestling	—	—	1. Yes: suffered a concussion in the past 14 days; unknown diagnostic criteria	2. Concussion	3. —	4. —	1. Prospective longitudinal	2. To assess the role of psychological factors on self-reported post-concussion recovery in youth athletes within an existing theoretical and empirically supported framework.	3. To assess non-psychosocial variables previously shown to influence concussion symptomatology (eg, age, gender, number of days post-concussion and number of previous concussions).	1. Wiese-Bjornstal et al (1998) <sup>30</sup>	2. Integrated Model of Response to Sport Injury	1. 7 items	2. Time 2: ~14–21 days post-concussion	3. 38.25±6.23	4. SCAT-2; AGS-Y; MCS-Y; PIMCQ-2; SMS; SAS-2; SNS	► Moderate positive and significant association with AIMS score: mastery-orientation, ego-orientation, parent ego climate, intrinsic and extrinsic motivation, social network size, post-concussion symptoms at time 2 and 3	► Only study to capture and compare AI with presence of post-concussion symptoms at multiple time points in the acute recovery phase	► Similar number of male and female athletes captured in sample	► Thorough evaluation of athlete motivation captured via measures administered	<i>Limitations:</i>	► Poorly described sample with respect to level of and frequency of sport involvement	► Use of a hospital-based clinic as a recruitment source may have biased the study sample (ie, captured athletes with more severe concussion symptoms)	► Follow-up measures administered in close proximity (time 1: ~1–14 days post-concussion; time 2: ~14–21 days post-concussion; time 3: ~21–28 days post-concussion)	► Diagnostic criteria for concussion not stated	► No pre-injury data available
Baranoff et al (2015) <sup>52</sup>	Australia	Time 1: n=44 (male, 61.4); Time 2: n=26 (male, 46.1)	—	27±9.4	Physiotherapy clinics	Australian rules football (29.5); netball (18.2); basketball (13.6)	—	—	1. Yes: ACL tear	2. ACL tear	3. Mean time between injury and surgery: 7 weeks, 6 days (SD=9 weeks, 4 days)	4. ACLR rehabilitation protocol; ACL allograft reconstruction (11.4%); ACL autograft reconstruction (89%)	1. Prospective longitudinal	2. To assess the roles of catastrophising and acceptance in relation to depression, pain intensity and substance use to cope with an injury 2 weeks post-ACLR reconstructive surgery (time 1) and 5 months of ACLR rehabilitation (time 2).	1. —	2. —	1. 7 items	2. Baseline: 0–2 weeks post-operation	3. 31.0±9.0	4. AAQ; PCS; DASS 21	► Strong positive and significant association between AIMS score and depressive symptom severity	► Equal representation of males and females in sample	► T-tests conducted to determine if there was a significant difference between athletes who submitted questionnaires at both time points versus at time 1 only; no significant difference between groups on measures of depression	► Measure mean/SD provided for both groups (ie, athletes who completed questionnaires at both time points vs time 1 only)	<i>Limitations:</i>	► Small sample size	► Only three sports captured	► Frequency and years of sport involvement not provided for sample	► ~8 weeks between occurrence of injury and questionnaire completion	► No pre-injury data on AI	► Exclusively captured ACL injuries; findings may not be generalisable to other injuries

Continued



Table 2 Continued

Outcome Measures												
1. AIMS: 7 or 10 items												
2. Timeline of administration												
3. Group: score (M±SD)												
4. Names of additional measure(s) used												
Key Findings Pertaining to AI												
Study Strengths and Limitations												
Strengths:												
► No significant difference between AIMS scores as assessed at different time points												
► Years of sport involvement provided with sufficient time between follow-ups												
Limitations:												
► Small sample size												
► Participant raw data provided; means/SDs not calculated												
► Sex distribution of sample not provided												
► Recruitment source not provided												
► Exclusively captured ACL injuries; findings may not be generalisable to other injuries												
Strengths:												
► Only study to exclusively examine concussion reporting behaviours												
► Homogeneous sport sample captured; all participants were NCAA Division I ice hockey players												
Limitations:												
► Large sample size												
► All male sample; not generalisable to females												
► Reporting behaviours subject to recall bias; follow-up questionnaires were administered at the end of hockey season												
► Reporting behaviours based on presence of post-impact concussion symptoms rather than incidence of unreported suspected concussions												
Strengths:												
► equal representation of males and females in sample												
► Assessed AI prior to injury												
► Captured a range of MSK injuries												
Limitations:												
► Frequency and years of sport involvement not provided												
► Small sample size												
► Measure means/SDs not calculated for sample; participant raw data provided												
► Results were presented for each athlete, rather than summary for the entire sample												
► Narrow age range captured (20–21 years old)												

Sample Descriptors	Injury Description	Study Design and Objectives	Model or Theory Referenced	Outcome Measures	Key Findings Pertaining to AI	Study Strengths and Limitations
1. Country of origin	1. Definition of injury (yes/no: definition)	1. Study design	1. Authors (year)	1. AIMS: 7 or 10 items	► No significant difference between AIMS scores as assessed at different time points	Strengths:
2. n= (sex, %)	2. Sport injury/severity	2. Primary objective	2. Model name	2. Timeline of administration	► Years of sport involvement provided with sufficient time between follow-ups	Limitations:
3. Race (%)	3. Time out of sport: M(SD)	3. Secondary objective		3. Group: score (M±SD)	► Small sample size	► Participant raw data provided; means/SDs not calculated
4. Age M±SD; range	4. Rehabilitation protocol and surgery details			4. Names of additional measure(s) used	► Sex distribution of sample not provided	► Recruitment source not provided
5. Recruitment source					► Exclusively captured ACL injuries; findings may not be generalisable to other injuries	Strengths:
6. Sport (%)						► Only study to exclusively examine concussion reporting behaviours
7. Level of sport						► Homogeneous sport sample captured; all participants were NCAA Division I ice hockey players
8. History of sport engagement (frequency/years)						Limitations:
						► Large sample size
						► All male sample; not generalisable to females
						► Reporting behaviours subject to recall bias; follow-up questionnaires were administered at the end of hockey season
						► Reporting behaviours based on presence of post-impact concussion symptoms rather than incidence of unreported suspected concussions

Samuel <i>et al</i> (2015) <sup>45</sup>	Israel	1. Yes: ACL tear	1. Prospective longitudinal	1. Samuel <i>et al</i> (2011) <sup>75</sup>	1. 7 items	► No significant difference between AIMS scores as assessed at different time points
2. n=6 (unknown)	2. ACL tear	2. To examine competitive athletes' experience of severe injuries.	2. To examine competitive athletes' experience of severe injuries.	2. Scheme of Change for Sport Psychology Practice	2. Multiple: time from date of initial injury; time 2: 6.58 months from date of initial injury; time 3: 10.08 months from date of initial injury	► Years of sport involvement provided with sufficient time between follow-ups
3. Range: 7–12 months	3. Range: 7–12 months				3. Time 1=45.17±1.83	Limitations:
4. —	4. —				Time 2=43.33±3.83	► Small sample size
5. Sports medicine centres					Time 3=44.55±3.50	► Participant raw data provided; means/SDs not calculated
6. Basketball (33.3); judo (33.3); track and field (16.7); gymnastics (16.7)					4. CEI; BCope	► Sex distribution of sample not provided
7. Internationally ranked (83.3%); nationally ranked (16.7%)						► Recruitment source not provided
8. 11.17±3.41 years involved in sport						► Exclusively captured ACL injuries; findings may not be generalisable to other injuries

Kroshus <i>et al</i> (2015) <sup>42</sup>	USA	1. Yes: NCAA definition of concussion	1. Prospective cohort	1. Cialdini and Trost (1998) <sup>76</sup>	1. 7 items	► Significant interaction identified between perceived concussion reporting norms and AIMS score with respect to predicting non-reporting behaviours; stronger non-reporting behaviours; stronger AI was associated with non-report
2. n=146 (baseline); n=116 (post-season) (male, 100)	2. Concussion	2. To assess the association between pre-season individual characteristics and post-season recall of within-season concussion symptom-reporting behaviours.	2. To assess the association between pre-season individual characteristics and post-season recall of within-season concussion symptom-reporting behaviours.	2. Social Influence: Social Norms, Conformity and Compliance	2. Baseline: pre-season, pre-injury	► AIMS score alone did not significantly predict non-reporting behaviours
3. —	3. —				3. 39.79±4.73	► All male sample; not generalisable to females
4. —	4. —				4. Concussion history; CKI; CAI; HIQ	► Reporting behaviours subject to recall bias; follow-up questionnaires were administered at the end of hockey season
5. Collegiate teams						► Reporting behaviours based on presence of post-impact concussion symptoms rather than incidence of unreported suspected concussions
6. Ice hockey						
7. Division I (NCAA)						
8. —						

Madrigal and Gill (2014) <sup>44</sup>	USA	1. Yes: 'sport injury that is expected to prevent/limit his/her sport participation for at least 4 days'	1. Prospective longitudinal	1a. Wiese-Bjornstal <i>et al</i> (1998) <sup>30</sup>	1. 10 items	► No significant difference identified between AIMS score as measured at pre-season and return to play following injury
2. n=4 (female, 100)	2. Concussion	2. To examine an athlete's psychological strengths (ie, mental toughness, hardiness and optimism) and emotional response to sport injury and rehabilitation and coping resources.	2. To examine an athlete's psychological strengths (ie, mental toughness, hardiness and optimism) and emotional response to sport injury and rehabilitation and coping resources.	2a. Integrated Model of Response to Sport Injury	2. Multiple: time 1: pre-season; time 4: cleared to play	► Assessed AI prior to injury
3. Only range was provided: 20–21 years old	3. Range: 5 weeks–8 months	3. To examine individual differences and changes over time from injury to being cleared to play.	3. To examine individual differences and changes over time from injury to being cleared to play.	1b. Lazarus and Folkman (1984) <sup>33</sup>	3. Time 1=54.25±7.80	► Captured a range of MSK injuries
4. Meniscus tear, leg injury (not otherwise specified), broken bone in hand, labrum tear in shoulder	4. 50% required surgery			2b. Stress Appraisal and Coping	Time 4=53.67±8.74	Limitations:
5. NCAA Division I school teams; by referral via team athletic trainer					4. MTS; PPI-A; LOT-R; BCOPE; PRSII; RAQ; DRS	► Frequency and years of sport involvement not provided
6. Softball; women's soccer						► Small sample size
7. NCAA Division I						► Measure means/SDs not calculated for sample; participant raw data provided
8. —						► Results were presented for each athlete, rather than summary for the entire sample
						► Narrow age range captured (20–21 years old)

Continued

Table 2 Continued

Sample Descriptors				Injury Description		Study Design and Objectives		Model or Theory Referenced		Outcome Measures		Key Findings Pertaining to AI		Study Strengths and Limitations	
1. Country of origin		2. n= (sex, %)		3. Race (%)		4. Age M±SD; range		5. Recruitment source		6. Sport (%)		7. Level of sport		8. History of sport engagement (frequency/years)	
1. Definition of injury (yes/no: definition)		2. Sport injury/severity		3. Time out of sport; M(SD)		4. Rehabilitation protocol and surgery details		1. Study design		2. Primary objective		3. Secondary objective		1. Authors (year)	
1. Slovenia		2. n=68 (male, 69.1)		3. —		4. M=23.4; range: 16–40		5. years old		6. Handball (20.6); football (20.6); basketball (19.1); volleyball (6); alpine skiing (<3); ice hockey (<3); judo (<3); snowboarding (<3); tennis (<3); running (<3); gymnastics (<3); rugby (<3); standing/acrobatic skiing (<3)		7. World-class and internationally ranking (41.2%); national ranking or uncategorised (58.8%)		8. —	
Masten <i>et al</i> (2014) <sup>38</sup>															
1. Yes: according to a previously proposed injury rating scale; individuals categorised to be in group 4 (ie, rehabilitation time expected to be up to 1 month) or group 5 (ie, rehabilitation time expected to be over 1 month and up to 6 months)		2. Meniscus tear; ACL/ PCL; patella injury; unrepaired (% not reported); group 4 (8.8%); group 5 (76.5%)		3. As per inclusion criteria, removed from sport for at least 1 month		4. Standard rehabilitation protocol, not otherwise specified; ‘knee surgery’, not otherwise specified		1. Cross-sectional		2. To examine if athletes differ from each other in depression, general irritability and inhibition of behaviour regarding injury severity.		3. To examine the psychological response to injury on the basis of specific dispositional characteristics to identify those personality and dispositional traits that make athletes more prone to injury.		1. —	
1. Prospective longitudinal		2. To determine the direct effects of life stress, different sources of social support, AI and mental toughness on athletic injury over the course of a competitive season.		3. To examine the potential moderating effects of social support, AI and mental toughness on the life stress–injury relationship.		1. Andersen and Williams (1988) <sup>77</sup>		2. A Model of Stress and Athletic Injury		6 items; 1 item removed due to lack of variability		Baseline: pre-season (ie, pre-injury)		3. 32.23±5.71	
1. USA		2. n=26 (male, 100)		3. Black (52.2)		4. 20.08±1.46		5. Football teams from the Southwestern USA		6. Football		7. NCAA Division I		8. —	
Petrie <i>et al</i> (2014) <sup>41</sup>															
1. Yes: ‘an injury defined as having occurred as a result of participation in an organised intercollegiate practice or game, requiring medical attention by a team athletic trainer or physician, and having resulted in the inability to participate for one or more days beyond the day of injury’		2. Lower extremity not otherwise specified (69%); upper extremity (31%)		3. 11.88 days±27.71		4. —		1. No significant associations between AIMS score: (1) life stress, (2) injury outcome, (3) social support or (4) mental toughness were identified		2. AIMS score was not a significant predictor of ‘time lost’ (ie, number of days removed from sport due to injury); AIMS score interaction terms with (1) positive and (2) negative life stress were also non-significant		3. No significant		4. AIMS score was not a significant predictor of ‘time lost’ (ie, number of days removed from sport due to injury); AIMS score interaction terms with (1) positive and (2) negative life stress were also non-significant	
Strengths:															
Homogeneous sport sample captured; all participants were NCAA Division I football players															
Sample was racially diverse															
Assessed AI prior to sport injury															
Clear operational definition of injuries eligible for inclusion															
Limitations:															
Small sample size															
Frequency and years of sport involvement not provided															
Findings not generalisable to females															
No post-injury assessment of AI															
No comparison between injured and uninjured athletes with respect to AIMS baseline scores															

Continued

Table 2 Continued

Sample Descriptors		Injury Description		Study Design and Objectives		Model or Theory Referenced		Outcome Measures		Key Findings Pertaining to AI		Study Strengths and Limitations	
1. Country of origin 2. n= (sex, %) 3. Race (%) 4. Age M±SD; range 5. Recruitment source 6. Sport (%) 7. Level of sport 8. History of sport engagement (frequency/years)		1. Definition of injury (yes/no: definition) 2. Sport injury/severity 3. Time out of sport; M(SD) 4. Rehabilitation protocol and surgery details		1. Study design 2. Primary objective 3. Secondary objective		1. Authors (year) 2. Model name		1. AIMS: 7 or 10 items 2. Timeline of administration 3. Group: score (M±SD) 4. Names of additional measure(s) used		Key Findings Pertaining to AI		Study Strengths and Limitations	
Brewer <i>et al</i> (2013) <sup>50</sup>	1. USA	1. Yes: ACL tear	1. Prospective longitudinal	1. 7 items	1a. Lazarus and Folkman (1984) <sup>33</sup>	1. AIMS score did not significantly predict home exercise completion ratio (ie, number of sets of home exercises completed compared with what was prescribed)	Strengths: ▲ Similar distribution of competitive versus recreational athletes ▲ One of three studies that assessed actual rehabilitation behaviours (eg, home exercise completion, cryotherapy)						
	2. n=91 (male, 63.7) 3. Caucasian (92) 4. 29.73±10.24; range 14–54 years old 5. Physical therapy clinics 6. — 7. Competitive (43%); recreational (54%) 8. —	2. ACL tear 3. At least 6 weeks 4. Accelerated ACL rehabilitation protocol as developed by Shelbourne <i>et al</i> ; emphasis placed on early attainment of ROM, quadriceps strength and normal gait. Exercises tailored to and considered safe for patients' stage of recovery; patients may be encouraged to exceed the prescribed number of sets to hasten their recovery	2. To identify predictors of adherence to a postoperative ACL home rehabilitation programme.	2. Once: pre-operation 3. 30.07±9.73 4. NEO-FFI-Neuroticism; LOT-R; POMS-B; Subjective Pain Rating; Subjective Daily Stress Rating	2a. Stress, Appraisal and Coping 1b. Wiese-Bjornstal <i>et al</i> (1998) <sup>30</sup> 2b. Integrated Model of Response to Sport Injury	▲ Significant interaction identified between AIMS score and daily stress as predictors of home exercise completion ratio; when daily stress was high, individuals with stronger AIs were more likely to complete their prescribed exercises ▲ Sample was predominantly male ▲ Sample was poorly described; frequency and years of sport involvement and sports captured were not provided ▲ Exclusively captured ACL injuries; findings may not be generalisable to other injuries	Limitations: ▲ Sample was predominantly Caucasian; findings may not be generalisable to other racial groups ▲ Sample was predominantly male ▲ Sample was poorly described; frequency and years of sport involvement and sports captured were not provided ▲ Exclusively captured ACL injuries; findings may not be generalisable to other injuries						
McKay <i>et al</i> (2013) <sup>43</sup>	1. Canada	1. Yes: 'any injury that required medical attention, resulted in the inability to complete the current session of activity, and/or required the cessation of sporting activity for at least 24 hours; Subsequent injury: 'any injury that occurred during the season, after the first reported injury, regardless of anatomical position or injury type'	1. Prospective cohort	1. 10 items	1. —	▲ Athletes with AIMS score below the 25th percentile were at greater risk for incurring an injury; this finding was significant	Strengths: ▲ Large sample size ▲ Athletes grouped by age for analysis ▲ Only study to examine AI in relation to injury risk ▲ Injuries were reported by an external source						
	2. n=316 (male, 100) 3. — 4. Median=15; range 13–17 years old 5. Elite ice hockey teams in Calgary, Alberta 6. Ice hockey 7. AAA, AA, A 8. Bantam age group: mean of 8.06 years of organised hockey; midget age group: mean of 9.57 years of organised hockey	2. n=143 injuries reported: concussion (22.4%); muscle strain (14.7%); joint/ligament sprain (14.7%) 3. As per definition 4. —	2. To determine the risk of injury associated with AI, attitudes towards body checking, competitive state anxiety and re-injury fear in elite youth ice hockey players. 3. To determine if there is an elevated risk of subsequent injury associated with return to play before medical clearance.	2. Baseline: within 3 weeks of hockey season start, pre-injury 3. 55.72±7.54 4. CSAI-2R; BCQ; FRQ; MPQ-SF	2. —	* Findings omitted due to publishing authors' error; discrepancy between findings communicated in text of the Results section and tables	▲ Homogeneous sport sample captured; all participants were elite male ice hockey players ▲ Only study to capture concussion and MSK injuries ▲ Clear operational definition of injuries eligible for inclusion Limitations: ▲ Reporting discrepancy in findings pertaining to AI; authors were contacted for clarification but no response was provided ▲ No post-injury assessment of AI ▲ Findings not generalisable to females ▲ Narrow age range captured (13–17 years old)						

Continued

Table 2 Continued

Sample Descriptors	Injury Description	Study Design and Objectives	Model or Theory Referenced	Outcome Measures	Key Findings Pertaining to AI
1. Country of origin 2. n= (sex, %) 3. Race (%) 4. Age M±SD; range 5. Recruitment source 6. Sport (%) 7. Level of sport 8. History of sport engagement (frequency/years)	1. Definition of injury (yes/no: definition) 2. Sport injury/severity 3. Time out of sport; M(SD) 4. Rehabilitation protocol and surgery details	Study 1: 1. Cross-sectional 2. To provide initial validation of a novel injury-rehabilitation overadherence measure.  Study 2: 1. Cross-sectional 2. To examine correlates of overadherence and premature return to sport.	1. Authors (year) 2. Model name	1. AIMS: 7 or 10 items 2. Timeline of administration 3. Group; score (M±SD) 4. Names of additional measure(s) used	Study Strengths and Limitations
Podlog et al (2013) <sup>36</sup>	Study 1: 1. USA 2. n=118 (male, 51.7) 3. — 4. 15.97±1.41 5. Teams in Texas 6. Football (36); basketball (24); soccer (11); volleyball (8); track and field (5); baseball (4); softball (4); cheerleading (3); tennis (1.7); dance (0.8); swimming (0.8) 7. School teams, local clubs or community leagues 8. 14.18±8.93 hours per week spent training prior to injury; 6.68±2.80 years involved in current sport (range: 1–14 years)  Study 2: 1. USA 2. n=105 (male, 59) 3. — 4. — 5. NCAA teams across the USA 6. Football (21); basketball (15); soccer (11); volleyball (9); track and field (4); baseball (16); softball (3); cheerleading/ gymnastics (9); tennis (5); golf (0.9); rugby (0.9); swimming (2); lacrosse (2); snowboarding (2); missing (0.9) 7. NCAA Division I, II, III 8. 14.06±6.14 hours per week spent training prior to injury; 9.74±4.60 years involved in current sport (range: 1–20 years)	Study 1: 1. Yes: 'were currently experiencing an injury requiring a minimum 2-week absence from sport training and competition, and currently receiving physiotherapy for their injury' 2. ACL tear (34.7%); medial malleolus/fibula/ distal tibia fracture (22.9%); shoulder dislocation (7.6%); carpal tunnel syndrome (<1%) 3. M=2.7 months (SD=2.01); range: 0.5–7 months 4. 57.6% required surgery, not otherwise specified  Study 2: 1. Same as above 2. ACL (17.1%); fractured humerus/femur/clavicle (14.3%); shoulder dislocation (8.6%); sprain (7.6%) 3. M=2.49 months (SD=2.10); range: 0.5–7 months 4. 50.5% required surgery, not otherwise specified	Study 1 and Study 2: 1. Wiese-Bjornstal et al (1998) <sup>30</sup> 2. Integrated Model of Response to Sport Injury	Study 1 only: ▲ AIMS scores significantly predicted attempts to expedite the rehabilitation process; athletes with a stronger AI were significantly more likely to think and behave in a way that would expedite rehabilitation  Study 1 and study 2: ▲ Small positive and significant association between AIMS score and tendency to ignore practitioner rehabilitation recommendations ▲ AIMS scores significantly predicted rehabilitation tendencies; athletes with a stronger AI were significantly more likely to ignore practitioner recommendations	Study 1 and Study 2: ▲ Samples captured were thoroughly described ▲ Wide range of sports and levels of involvement captured ▲ Large sample size ▲ Similar number of males and females captured ▲ Captured a range of MSK injuries ▲ Clear operational definition of injuries eligible for inclusion  Limitations: ▲ No post-injury assessment of AI (both studies) ▲ Large variation in time lost (ie, number of days removed from sport) due to sport injury (both studies) ▲ Sample age (mean/SD) not provided in study 2

Continued



Table 2 Continued

Author (year)	Sample Descriptors				Injury Description		Study Design and Objectives		Model or Theory Referenced		Outcome Measures		Key Findings Pertaining to AI	Study Strengths and Limitations
	1. Country of origin	2. n= (sex, %)	3. Race (%)	4. Age M±SD; range	5. Recruitment source	6. Sport (%)	7. Level of sport	8. History of sport engagement (frequency/years)	1. Study design	2. Primary objective	3. Secondary objective	1. Authors (year)	2. Model name	
Weinberg <i>et al</i> (2013) <sup>57</sup>	1. USA 2. n=130 (52.3)	3. —	4. 20.03±1.60; range: 18–24 years old	5. Intramural teams at a mid-sized university in the Midwestern USA	6. Basketball (100)	7. Recreational	8. 6.64±3.98 years involved in sport	1. Yes: playing through injury was defined in the current study as participating while still feeling pain so that (a) the pain/injury needs some sort of mental attention during participation, (b) involves some sort of loss of or change in function that would directly affect performance capabilities, therefore indicating a threat to well-being, and (c) a decision process was necessary as to whether participation should and/or would be initiated and continued during the experience of pain/injury. <sup>58</sup>	1. Cross-sectional	2. To determine whether athletes' attitudes and behavioural intentions regarding playing through pain and injury differ as a function of their level of AI and their gender.	1. — 2. —	1. 10 items 2. Baseline: post-injury 3. 4.15±1.21† 4. RPIQ†; PIB†	▲ Men scored significantly higher on each AIMS subscale compared with women ▲ AI significantly predicted athlete attitudes towards sport risk, pain and playing through pain; athletes scoring ≥75th percentile on the AIMS were more likely to have positive attitudes and behavioural tendencies to play through pain and injury compared with the moderate (between 25th and 75th percentile) and low AI groups (≤25th percentile) ▲ AIMS exclusivity and negative affect subscales significantly predicted RPIQ toughness (in regards to risk, pain and injury in sport), social role choice (willingness to accept risk, pain and injury in sport), and 'perceptions' of pressure exerted by others to play with pain and injury (subscale scores; athletes scoring higher on the exclusivity and negative affect AIMS subscales were more likely to endorse toughness (ie, risk, pain and injury) ▲ AIMS negative affect subscale scores significantly predicted athlete behavioural intentions to play through an injury. Athletes with stronger AIs were more likely to play through an injury	▲ Large sample size ▲ Equal representation of men and women ▲ Homogeneous sample of intramural basketball players; findings not generalisable to other sports ▲ Few details provided about injury reporting behaviours subject to recall bias; questionnaires administered at an unknown time point following injury ▲ Did not assess actual behaviours following injury; operational definition (playing through injury as defined...) applied as an inclusion criteria only ▲ Narrow age range captured (18–24 years old)

Continued

Sample Descriptors		Injury Description		Study Design and Objectives		Model or Theory Referenced		Outcome Measures		Key Findings Pertaining to AI		Study Strengths and Limitations	
1. Country of origin 2. n= (sex, %) 3. Race (%) 4. Age M±SD; range 5. Recruitment source 6. Sport (%) 7. Level of sport 8. History of sport engagement (frequency/years)		1. Definition of injury (yes/no: definition) 2. Sport injury/severity 3. Time out of sport; M(SD) 4. Rehabilitation protocol and surgery details		1. Study design 2. Primary objective 3. Secondary objective		1. Authors (year) 2. Model name		1. AIMS: 7 or 10 items 2. Timeline of administration 3. Group; score (M±SD) 4. Names of additional measure(s) used		Time 1 and time 2, time 3 and time 4 AIMS scores were not significantly different; all other time point comparisons were significantly different and adjusted for age and gender Subjective ratings of rehabilitation progress significantly predicted AIMS score differences between time 2 and 3 after adjusting for time 1 AIMS score, gender and age; athletes who experienced a slower recovery were more likely to experience greater decreases to their AI		<b>Strengths:</b> ► Sufficient time between follow-up points ► Long-term follow-up; only study to gather information 2 years post-injury ► Bonferroni correction applied to tests of multiple comparisons ► Equal distribution of competitive and recreational level athletes ► Wide age range captured (14–54 years old) <b>Limitations:</b> ► Details about sports captured not provided ► Frequency and years of sport involvement not provided ► Details about sport injury not provided ► Men and Caucasians were over-represented in the sample; findings not generalisable to women and other races ► Small number of cases included in the data set for analysis (53.7% of total sample); no indication if tests of significance were conducted between included/excluded cases ► Limited number of covariates included in regression models ► Exclusively captured ACL injuries; findings may not be generalisable to other injuries	
Brewer et al (2010) <sup>48</sup>		1. Yes: ACL tear 2. ACL tear 3. — 4. —		1. Prospective longitudinal 2/3. To test the following predictions in a sample of physically active people who tore their ACL and underwent reconstructive surgery and rehabilitation: (a) decreasing one's AI after ACL surgery could help to preserve self-esteem in the face of formidable threat to short-term and potentially long-term sport participation, and (b) greater decrements in AI are expected for those individuals who are experiencing slow post-operative recovery.		1. — 2. —		1. 7 items 2. Multiple: time 1: pre-operation; time 2: 6months post-operation; time 3: 12months post-operation; time 4: 24months post-operation 3. Time 1=32.14±8.83 Time 2=31.62±8.23 Time 3=29.07±8.47 Time 4=28.45±8.09 4. Subjective rating of rehabilitation progress (%)		Time 1 and time 2, time 3 and time 4 AIMS scores were not significantly different; all other time point comparisons were significantly different and adjusted for age and gender Subjective ratings of rehabilitation progress significantly predicted AIMS score differences between time 2 and 3 after adjusting for time 1 AIMS score, gender and age; athletes who experienced a slower recovery were more likely to experience greater decreases to their AI		<b>Strengths:</b> ► Sufficient time between follow-up points ► Long-term follow-up; only study to gather information 2 years post-injury ► Bonferroni correction applied to tests of multiple comparisons ► Equal distribution of competitive and recreational level athletes ► Wide age range captured (14–54 years old) <b>Limitations:</b> ► Details about sports captured not provided ► Frequency and years of sport involvement not provided ► Details about sport injury not provided ► Men and Caucasians were over-represented in the sample; findings not generalisable to women and other races ► Small number of cases included in the data set for analysis (53.7% of total sample); no indication if tests of significance were conducted between included/excluded cases ► Limited number of covariates included in regression models ► Exclusively captured ACL injuries; findings may not be generalisable to other injuries	

Continued

Table 2 Continued

Author (year)	Sample Descriptors				Injury Description				Study Design and Objectives				Model or Theory Referenced		Outcome Measures				Key Findings Pertaining to AI							
	1. Country of origin	2. n= (sex, %)	3. Race (%)	4. Age M±SD; range	5. Recruitment source	6. Sport (%)	7. Level of sport	8. History of sport engagement (frequency/year)	1. Study design	2. Primary objective	3. Secondary objective	1. Authors (year)	2. Model name	1. AIMS: 7 or 10 items	2. Timeline of administration	3. Group; score (M±SD)	4. Names of additional measure(s) used	1. Similar representation of recreational and competitive level athletes	2. One of three studies that assessed actual rehabilitation behaviours (eg, home exercise completion, cryotherapy)	3. Wide age range captured (14–54 years old)	4. Details about sports captured not provided	5. Frequency and years of sport involvement not provided	6. Details about sport injury not provided	7. Males and Caucasians were over-represented in sample; findings not generalisable to females and other races	8. Exclusively captured ACL injuries; findings may not be generalisable to other injuries	
Brewer <i>et al</i> (2007) <sup>47</sup>	USA	n=91 (male, 63.7%)	29.73±10.24; range: 14–54 years old	Physical therapy clinics	Competitive 43%; recreational 54%	1. Prospective longitudinal	2. To examine predictors of daily pain and negative mood over the first 6 weeks of rehabilitation following ACL reconstruction.	1. Yes: ACL tear	2. ACL	3. —	4. ACLR rehabilitation	1. Wiese-Bjornstal <i>et al</i> (1998) <sup>30</sup>	2. Integrated Model of Response to Sport Injury	1. Baseline: preoperation 30.36±9.71	2. NEO-FFI-Neuroticism	3. Subscale: LOT-R; PDS; number of physical therapy appointments per/day; HOMEX (frequency of exercise completion with and without videocassette use); HOMEXRAT (division of HOMEX by number of sets of home rehabilitation exercises prescribed for a given day); EXERCISE (number of minutes spent on vigorous physical activity other than their rehabilitation exercises); NRS; POMS-B	7 items	4. Significant interaction between AIMS score and number of days since surgery with respect to predicting negative mood; athletes with stronger AIs experienced greater decreases in negative mood as number of days since surgery increased	► AIMS score did not significantly and independently predict average daily pain	► AIMS score did not significantly and independently predict negative mood	► Significant interaction between AIMS score and number of days since surgery with respect to predicting negative mood; athletes with stronger AIs experienced greater decreases in negative mood as number of days since surgery increased	► Details about sports captured not provided	► Frequency and years of sport involvement not provided	► Details about sport injury not provided	► Males and Caucasians were over-represented in sample; findings not generalisable to females and other races	► Exclusively captured ACL injuries; findings may not be generalisable to other injuries
Brewer <i>et al</i> (2003) <sup>46</sup>	USA	n=61	Caucasian (92%)	26.03±7.99; range: 14–47 years old	Physical therapy clinic	Competitive 57%; recreational 41%	1. Prospective longitudinal	2. To investigate whether prospective associations among psychological factors and rehabilitation adherence differ as a function of age through re-analysis of data from a previously published report.	1. Yes: ACL tear	2. ACL	3. —	4. ACL reconstruction; accelerated rehabilitation protocol	1a. Wiese-Bjornstal <i>et al</i> (1998) <sup>30</sup>	2a. Integrated Model of Response to Sport Injury	1b. Brewer (1994) <sup>31</sup>	2b. Cognitive Appraisal Models of Adjustment	10 items	4. Significant interaction between age and AIMS score with respect to predicting: (1) home exercise adherence and (2) cryotherapy use; younger athletes with stronger AIs were more likely to complete at-home exercises and to use cryotherapy	► One of three studies that assessed actual rehabilitation behaviours (eg, home exercise completion, cryotherapy)	► Wide age range captured (14–47 years old)	► Competitive athletes were over-represented in sample	► Males and Caucasians were over-represented in sample; findings not generalisable to females and other races	► Details about sports captured not provided	► Frequency and years of sport involvement not provided	► AIMS only assessed at one time point	► Exclusively captured ACL injuries; findings may not be generalisable to other injuries

Continued

Table 2 Continued

Author (year)	Sample Descriptors				Injury Description		Study Design and Objectives		Model or Theory Referenced		Outcome Measures		Key Findings Pertaining to AI		Study Strengths and Limitations	
	1. Country of origin	2. n= (sex, %)	3. Race (%)	4. Age M±SD; range	5. Recruitment source	1. Definition of injury (yes/no; definition)	2. Sport injury/severity	1. Study design	1. Authors (year)	1. Authors (year)	1. AIMS: 7 or 10 items	2. Timeline of administration	1. AIMS score significantly predicted depression scores; athletes with stronger AIs were more likely to experience more severe depressive symptoms	2. Baseline: post-injury	1. AIMS score significantly predicted depression scores; athletes with stronger AIs were more likely to experience more severe depressive symptoms	1. AIMS: 7 or 10 items
Manuel <i>et al</i> (2002) <sup>33</sup>	1. USA	2. Time 1 (baseline): n=48 (female, 58.3); time 2 (3 weeks) n=44; time 3 (6 weeks) n=40; time 4 (12 weeks) n=34	3. Caucasian (85)	4. Range: 15–18 years old	5. MSK Outpatient Physical Therapy Department at Wakeforest University	1. Yes: athletes who would be out of sports for at least 3 weeks	2. Most common injury was ACL (no % provided); Injury Severity Scale as completed by the attending orthopaedic surgeon. Scores range from 1 to 4, with a lower score indicating a less severe injury; M=2.50 (SD=1.26)	1. Prospective longitudinal	1. —	1. —	1. 10 items	2. Baseline: post-injury	1. AIMS score significantly predicted depression scores; athletes with stronger AIs were more likely to experience more severe depressive symptoms	2. Baseline: post-injury	1. AIMS score significantly predicted depression scores; athletes with stronger AIs were more likely to experience more severe depressive symptoms	1. AIMS: 7 or 10 items
Green and Weinberg (2001) <sup>35</sup>	1. USA	2. n=30 (male, 60)	3. Caucasian (93.3)	4. M=30.8 (SD=missing); range: 19–70 years old	5. Sport medicine clinics, physical therapy clinics and orthopaedic centres	1. Yes: 'discontinuation of regular physical activity/sport that was operationally defined as 30 min of physical activity a week, for a period of at least 6 weeks'	2. 50% knee injury; 26.7% other (three foot injuries, one broken tibia/fibula, one herniated disc, one broken arm); 10% shoulder injury; 6.7% hip injury; 3% ankle injury	1. Cross-sectional	1a. Kubler-Ross <i>et al</i> (1969) <sup>38</sup>	1. 10 items (note: 5-point Likert response scale used)	1. AIMS: 7 or 10 items	2. Timeline of administration	1. AIMS score significantly predicted depression scores; athletes with stronger AIs were more likely to experience more severe depressive symptoms	2. Baseline: post-injury	1. AIMS score significantly predicted depression scores; athletes with stronger AIs were more likely to experience more severe depressive symptoms	1. AIMS: 7 or 10 items
	2. —	3. —	4. —	5. —	6. —	7. —	8. —	2. To examine coping skills and social support to better understand those individuals who are most vulnerable to injury.	2a. Stage Models of Grief	3. 43.10±11.51	3. 43.10±11.51	4. POMS; PSPP; SSQ	1. AIMS score significantly predicted depression scores; athletes with stronger AIs were more likely to experience more severe depressive symptoms	2. Baseline: post-injury	1. AIMS score significantly predicted depression scores; athletes with stronger AIs were more likely to experience more severe depressive symptoms	1. AIMS: 7 or 10 items

Continued



Table 2 Continued

Sample Descriptors										Injury Description				Study Design and Objectives		Model or Theory Referenced		Outcome Measures		Key Findings Pertaining to AI		Study Strengths and Limitations					
1. Country of origin 2. n= (sex, %) 3. Race (%) 4. Age M±SD; range 5. Recruitment source 6. Sport (%) 7. Level of sport 8. History of sport engagement (frequency/years)										1. Definition of injury (yes/no: definition) 2. Sport injury/severity 3. Time out of sport; M(SD) 4. Rehabilitation protocol and surgery details				1. Study design 2. Primary objective 3. Secondary objective		1. Authors (year) 2. Model name		1. 10 items 2. Baseline: ~10 days preoperation 3. 41.65±12.16 4. SMI; SSI; BSI; SIRAS; ratio of appointments attended to scheduled; home rehabilitation adherence—exercise completion; home rehabilitation adherence—cryotherapy; KT 1000 (joint laxity); one leg hop distance; LKSS		1. Small positive and significant association between AIMS score and motivation 2. Moderate positive and significant association between AIMS score and joint laxity as measured 6 months following ACL reconstructive surgery		Strengths: Large sample size Only study to measure functional injury outcomes (eg, joint laxity, one leg hop distance, pain) using objective measures Limitations: Exclusively captured ACL injuries; findings may not be generalisable to other injuries Frequency and years of sport involvement not provided Males and Caucasians were over-represented in sample; findings may not be generalisable to females and other races AIMS only assessed at one time point Exclusively captured ACL injuries; findings may not be generalisable to other injuries					
Brewer et al (2000) <sup>31</sup>										1. USA 2. n=95 (male, 70.5) 3. Caucasian (88) 4. 26.92±8.23 5. Physical therapy clinic 6. — 7. Competitive (52%); recreational (43%); non-athletes (3%); missing (2%) 8. —				1. Yes: ACL tear 2. ACL tear 3. — 4. Accelerated ACL rehabilitation protocol as developed by Shelbourne et al; emphasis on early attainment of ROM, quadriceps strength and normal gait				1. Prospective longitudinal relationships among psychological factors, rehabilitation adherence and rehabilitation outcomes after ACL reconstruction.		1a. Brewer (1994) <sup>31</sup> 2a. Cognitive Appraisal Models of Adjustment 1b. Wiese-Bjornstal et al (1998) <sup>30</sup> 2b. Integrated Model of Response to Sport Injury 1c. Self-developed by authors 2c. Adapted model based on above referenced models (see article)		1. 10 items 2. Baseline: ~10 days preoperation 3. 41.65±12.16 4. SMI; SSI; BSI; SIRAS; ratio of appointments attended to scheduled; home rehabilitation adherence—exercise completion; home rehabilitation adherence—cryotherapy; KT 1000 (joint laxity); one leg hop distance; LKSS		Small positive and significant association between AIMS score and motivation Moderate positive and significant association between AIMS score and joint laxity as measured 6 months following ACL reconstructive surgery		Strengths: Large sample size Only study to measure functional injury outcomes (eg, joint laxity, one leg hop distance, pain) using objective measures Limitations: Exclusively captured ACL injuries; findings may not be generalisable to other injuries Frequency and years of sport involvement not provided Males and Caucasians were over-represented in sample; findings may not be generalisable to females and other races AIMS only assessed at one time point Exclusively captured ACL injuries; findings may not be generalisable to other injuries	

Continued

Each number with — means there is missing data point.  
\*Clinician-reported data.

[illegible]

studies included both sex groups, except for three studies which included all-male samples<sup>41–43</sup> and one which included an all-female sample.<sup>44</sup> A total of n=1852 athletes were included; individual study samples ranged from a minimum of n=6 (45) to a maximum n=316.<sup>43</sup> Participants were a minimum of 13<sup>43</sup> to a maximum of 70 years old.<sup>35</sup> Participants were recruited from several clinical and non-clinical settings, with one study failing to specify a recruitment source<sup>45</sup> (see table 2, column 2).

Athletes were involved in a range of team and individual sports; however, several studies did not specify sport background.<sup>26 35 46–51</sup> Furthermore, two studies included a small proportion (3%<sup>48</sup> and 4%<sup>51</sup>) of self-defined ‘non-athletes’. Authors of this review chose to include these studies due to the small number of non-athletes (n=7 total) included in analyses. Samples consisted of recreational (eg, house league) and competitive athletes (eg, elite, National Collegiate Athletics Association). Several studies did not report on this metric.<sup>26 35 49 52–54</sup> Sport involvement (eg, frequency of and years involved in sport) was heterogeneous and reported within six studies.<sup>35 43 45 55–57</sup> Sport participation ranged from 30 min<sup>35</sup> to 14.19 (SD=9.40) hours per week<sup>55</sup> and years of sport involvement ranged from 6.64 years (SD=3.98)<sup>57</sup> to 11.17 years (SD=4.31)<sup>45</sup> (see table 2, column 2).

### Injury descriptors

Musculoskeletal (MSK) injuries were the most common injuries cited. Nine studies reported exclusively on anterior cruciate ligament (ACL) surgical outcomes, while two<sup>42 54</sup> exclusively examined concussion. The remaining 11 studies captured various MSK injuries. Of these 11 studies, 1 did not specify an exact injury but indicated injury to lower or upper extremities,<sup>41</sup> 1 captured both MSK injuries and concussion<sup>43</sup> and 2 studies did not define the injuries sustained.<sup>26 53</sup> Of these two, one indicated injury severity on a scale ranging from 1 (mild) to 3 (severe)<sup>26</sup> while the other stated that the majority of injuries were ACL tears, but did not specify the exact proportion.<sup>53</sup> Time away from sport due to injury varied, ranging from 24 hours<sup>41 43</sup> to 63 weeks.<sup>55</sup> Ten studies did not specify a length of absence. Three studies<sup>41 43 57</sup> reported on athletes who sustained multiple injuries during the data collection period while the remaining 19 captured a first (ie, initial) injury only (see table 2, column 3).

### Definitions and theoretical models

Operational definitions of injury were specified in each study except one.<sup>26</sup> Those that captured ACL and concussions exclusively, indicated a diagnosed ACL tear or diagnosed or self-reported concussion in lieu of an operational definition. Eleven studies referenced injury models as a means of justification for study methodologies used. The most frequently cited model was the *Integrated Model of Response to Sport Injury*.<sup>30</sup> Several other theories unrelated to sport injury were also referenced (see table 2, column 5).

Wiese-Bjornstal *et al*'s injury model<sup>30</sup> (see online supplemental appendix 3) suggests an athlete's cognitive appraisal (eg, rate of perceived recovery, cognitive coping, etc.) of the injury is a primary driver of outcome (ie, physical, behavioural and emotional). Seven studies explicitly measured cognitive appraisal via subjective rehabilitation progress,<sup>48</sup> coping skills and strategies used,<sup>35 44 45 53</sup> psychological response to injury,<sup>44</sup> readiness to return to sport<sup>56</sup> and rehabilitation beliefs.<sup>58</sup> Most outcome measures sought to typify athlete personal factors. A small proportion of studies (n=6) used measures that isolated situational factors (eg, sport, social and environmental),<sup>35 41 46 51 54 58</sup> but only assessed social support (eg, availability, quality and source).

### Measuring AI

The Athletic Identity Measurement Scale (AIMS),<sup>59</sup> 7-item or 10-item version, was used exclusively to quantify the strength of AI (see table 2, column 6). The AIMS consists of three subscales: social identity (ie, the extent to which the individual views themselves as occupying the athlete role), exclusivity (ie, the extent to which the individual defines their self-worth based on the athlete role), and negative affectivity (ie, the extent to which the individual experiences negative emotions from undesired outcomes associated with the athlete role).<sup>59</sup> The findings summarised below are specific to AI. Analyses that did not consider AI were excluded from the summary. Findings were grouped into the following categories: demographic, psychosocial, behavioural, injury-specific and pain. Several studies also investigated the association between injury (as an exposure) and AI (as an outcome). These findings are presented at the end of this section.

### Demographics

Findings pertaining to AI and sex were presented in two studies but were inconsistent. One study found that sex significantly predicted AIMS subscale scores, with males having significantly higher scores on each subscale (eg, social, exclusivity and negative affect) than females.<sup>57</sup> Padaki *et al* also compared AIMS scores by sex (M=56.6 vs 53.4 for females and males, respectively), but this difference was not significant (p=0.092). They also examined AIMS scores by sport involvement (single vs multisport athletes) and was the only study to have done so. Interestingly, single-sport athletes reported a significantly stronger AI (M=57.7) compared with multisport athletes (M=52.8, p=0.043). Two studies investigated AI and age,<sup>42 49</sup> with both identifying a negative non-significant association (as age increased, AI decreased) (see table 2, column 7).

### Psychosocial

Depressive symptoms were measured in six studies, but only five presented findings in relation to AIMS scores. Correlational analyses were conducted in two of the studies<sup>35 52</sup> while regression models were constructed in the other three.<sup>26 47 53</sup> Correlational analysis identified a large positive significant association between AI and

depression scores,<sup>52</sup> while findings from the other study identified a small negative but non-significant association.<sup>35</sup> Beta coefficients generated from regression models illustrated a similar positive relationship between AI and depressive symptom severity, while also adjusting for several covariates. Two studies included AIMS scores in their models as an interaction term, one with injury severity<sup>26</sup> and one with number of days since surgery.<sup>47</sup> Although both models indicated that interaction terms explained a greater variance in depression scores compared to when AIMS scores were entered alone, only one interaction coefficient was significant.<sup>47</sup> Despite evidence suggesting that athletes with stronger AIs were more likely to experience depressive symptoms following a sport-related injury, findings also indicated that they experienced greater improvements in their mood throughout the post-surgical follow-up period.<sup>47</sup> Four studies assessed anxiety, but only one study compared anxiety symptoms (eg, sport-related performance, somatic, concentration disruption and worry) to AI.<sup>54</sup> Despite anxiety symptoms being positively, although weakly, correlated to AI ( $r=0.14$ ;  $0.13$ ;  $0.21$ ;  $0.05$ , respectively, for the type of anxiety symptoms noted in the previous sentence), findings were not significant. Another study assessed athletes for symptoms of post-traumatic stress disorder (PTSD; eg, hyperarousal, avoidance and intrusive thoughts)<sup>49</sup> and compared PTSD scores between 'high' and 'low' AI groups prior to ACL reconstructive surgery. Group differences were not significant.

AI was significantly associated with several other, although more abstract, psychosocial constructs including sport performance traits, physical self-worth, motivation and social network size. Traits associated with sport performance such as ego-orientation (example scale item: 'The most important thing is to be the best athlete') and mastery-orientation (example scale item: 'My goal is to learn new skills and get as good as possible') were significantly associated with AI as represented by the moderate effect sizes observed.<sup>54</sup> One study correlated physical self-worth (ie, perceived sport competence, perceived muscular and physical strength and conditioning) to AI and identified a positive moderate and significant association among athletes shortly after they began a rehabilitation programme.<sup>35</sup> One study also identified a small significant association between AI and generalised motivation.<sup>51</sup> Similarly, a moderate positive significant association was also identified between motivational climate in sport (as facilitated by parental figures) and AI. Athletes with stronger AIs also maintained greater intrinsic and extrinsic motivation towards participation in sport.<sup>54</sup> Although social support was assessed in seven studies, only two presented findings in relation to AI. Findings indicated that the maintenance of larger social networks was moderately positively and significantly associated with AI.<sup>54</sup> Petrie *et al* also examined the relationship between AI and social support but with respect to family, friends and significant others. Small positive but non-significant associations were identified between support provided by

family, friends and AI but a negative association for significant others (see table 2, column 7).

## Behavioural

Several studies investigated the relationship between AI and rehabilitation overadherence, motivation, completion of exercises and accompanying treatments (eg, cryotherapy). One study identified a small significant positive association between AI and beliefs pertaining to rehabilitation overadherence<sup>55</sup> and another found that stronger AIs significantly and independently predicted overadherence (ie, ignoring practitioner recommendations and attempting to expedite the rehabilitation process).<sup>56</sup> Contrariwise, one study found that athletes with AIs >75th percentile were *less* likely attempt to return to sport prior to medical clearance.<sup>43</sup>

Exercise completion was assessed in three studies.<sup>46 50 51</sup> Findings were inconsistent. In one study, correlational analyses identified a small positive but non-significant association between AI and exercise completion.<sup>51</sup> Authors also entered AI as an interaction term in regression models. When entered with subjective stress,<sup>50</sup> a small positive significant interaction was found. However, when entered with age in a different study, a negative significant association was identified.<sup>46</sup> Researchers also found that younger athletes were significantly more likely to complete their exercises and cryotherapy treatments compared with older athletes. Interestingly, the opposite relationship was observed in an earlier study but findings were not significant.<sup>51</sup>

In alignment with the findings discussed above, athletes with stronger AIs were significantly more likely to place a greater value on and maintain greater motivation towards the rehabilitation process.<sup>58</sup> Similarly, beliefs and attitudes regarding rehabilitation were also examined.<sup>57</sup> Authors allocated athletes into subgroups based on their AIMS score ('low'=<25th percentile; 'moderate'=between 25th and 75th percentile; 'high'=>75th percentile). Athletes in the 'high' subgroup reported significantly greater positive attitudes and tendencies to play through pain and injury than athletes in the 'low' and 'moderate' groups. When entered into a hierarchical regression model, AIMS exclusivity and negative affect subscales significantly predicted attitudes pertaining to toughness (ie, regarding risk, pain and injury in sport), social role choice (ie, willingness to accept risk, pain and injury in sport as a part of the athlete role) and 'pressed' (ie, the perception of pressure felt from others to play with pain and injury) across each subgroup. However, only the AIMS negative affect subscale was found to be a significant independent predictor of perceived injury behaviours (ie, intention to play through injury).<sup>57</sup> A similar finding was identified by Kroshus *et al* in their investigation of concussion reporting behaviours. They found that athletes with stronger AIs were slightly and significantly more likely to engage in non-reporting behaviours than athletes with weaker AIs.<sup>42</sup> Additional variance was explained when perceived



concussion reporting norms were added to their model (see [table 2](#), column 7).

### Injury-specific outcomes

Injury severity, risk and functional outcomes were examined in several studies. Significant small effect sizes were identified between AI and physician-rated injury severity.<sup>26</sup> Similarly, another study indicated that stronger AIs were moderately positively and significantly associated with concussion symptom severities at follow-up time points (~14–21 days and ~21–28 days post-concussion). When entered into a hierarchical regression model, AI significantly predicted post-concussion symptom severities ~21–28 days following injury.<sup>54</sup> With respect to injury risk, one study found that athletes with AIMS scores <25th percentile faced a greater risk compared with those >25th percentile, but this difference was not significant.<sup>43</sup> Notably, athletes with AIMS scores >75th percentile were significantly more likely to have incurred a subsequent injury during the data collection period.

Only one study assessed functional recovery outcomes. Measured 6 months following ACL reconstructive surgery, AI was moderately positively and significantly associated with improved joint stability (ie, less anterior and posterior laxity in the knee joint, improved single leg hopping scores and improved subjective knee function (ie, limping, locking, instability, support, swelling, stair climbing and squatting)).<sup>51</sup> Findings were replicated in regression models which indicated that AI was a significant and positive independent predictor of joint stability. Psychological distress was identified as a significant negative independent predictor (see [table 2](#), column 7).

### Pain

Measures assessing subjective ratings of pain were administered in six studies, however only two analysed pain ratings in relation to AIMS scores.<sup>47 52</sup> Both studies identified small negative non-significant associations between AI and post-surgical pain ratings (see [table 2](#), column 7).

### The relationship between injury as an exposure and AI as an outcome

Of the three studies that assessed AI at multiple time points,<sup>44 45 48</sup> only one<sup>44</sup> assessed AI prior to and following injury. One study found that AIMS scores decreased significantly over time (pre-surgery compared with 6, 12 and 24 months post-surgery) after adjusting for age, sex and rehabilitation progress.<sup>48</sup> Scores did not change significantly between pre-op and 6 months nor between 12-month and 24-month follow-up, but all other comparisons were significant. Madrigal and Gill also assessed AIMS at two time points: pre-season and return to sport.<sup>44</sup> Small decrements in AI were observed but were non-significant. The final study did not conduct tests of statistical significance<sup>45</sup> (see [table 2](#), columns 6 and 7).

### Study strengths and limitations

The studies captured within this review have several strengths and limitations for the reader to consider.

First, the body of literature spans a 25-year period (1993–2018). This artefact implies that any trend or change with respect to athletes' conceptualisation of AI that may have occurred as a result of cultural progression (ie, a shift over time in group norms, the importance of the athlete role, and cultural values and ideals as they pertain to sport) is represented within the data itself. Most studies either defined a specific injury (eg, ACL tear) or provided an operational definition of sport injury, thus ensuring that inclusion criteria were applied consistently. Due to exclusive use of the AIMS, AI was conceptualised and assessed equivocally across all studies. This allows for a direct comparison of AIMS scores from one study to another. Finally, almost half of the studies included athletes from a variety of sport backgrounds, increasing the external validity of these respective studies' findings.

One of the most important limitations for readers to consider is that AI was not the primary construct of interest within the majority of the studies identified; only seven studies<sup>26 41 43 48 55 57</sup> explicitly stated that AI was a primary variable of interest within objective statements, and therefore the main variable of interest within statistical tests. Therefore, it is possible that significant relationships between AI and the assessed injury outcomes were present but went unidentified. Being that a self-report measure was used to quantify the strength of AI, reports may have been skewed by a social desirability bias; athletes may have reported a stronger AI than their *actual* AI because this would be seen as desirable to other members (eg, teammates, coaches) of their social group. Another limitation with respect to the AIMS was timing and frequency of administration; 17 of 22 studies administered the AIMS *following* an injury and 19 studies administered the AIMS at one time point. Therefore, the existing body of literature cannot speak definitively to (1) any change over time with respect to the relationships observed between AI and the various injury outcomes observed, and (2) the relationship (if any) that exists between an injury (as an exposure) and AI (as an outcome).

Being that most studies were conducted in the USA, findings represent athletes who embody Western cultural values and attitudes towards sports and athletics. Females and athletes who identify as having a disability (eg, para-athletes) are under-represented in the literature, thus limiting the applicability of findings to these athlete populations. Studies captured a variety of MSK injuries, but few investigated AI in athletes who had sustained a sport-related concussion. Findings may not be generalisable to this population. The majority of studies had small sample sizes ( $n < 100$ :  $n = 15$ ;  $n > 100$ :  $n = 7$ ). This may have limited the type (eg, correlation vs regression modelling) and the extent (eg, number of predictor variables included in regression models) of statistical tests performed by authors. Overall, sport involvement (eg, frequency and years of involvement) as well as injury severity was poorly described within most studies. This oversight makes it difficult to gauge the dose–response relationship that

exists between sport involvement and AI, and how this then relates to the injury outcomes observed (see table 2, column 8).

## DISCUSSION

Literature describing the relationship between AI and sport-related injury outcomes has grown steadily over the past 25 years. Importantly, 18 of 22 studies identified for inclusion in this review originated from the USA. This is important to consider when interpreting the findings presented herein given the cultural importance that different societies place on specific sports and the athlete role.<sup>60–62</sup> The athletes described were representative of many different sports and varying levels of competition, thus increasing the external validity of this review's findings to the general athlete population. Importantly, half of the identified studies referenced a theoretical model to inform study design and methodology. However, most investigators did not discuss or interpret their findings within the context of the models originally used to position their work. The integration of novel findings as they relate to the theoretical injury outcome models referenced is necessary to progress towards predictive modelling.

Injury outcomes associated with AI were grouped into five categories. Psychosocial, behavioural and injury-related outcomes dominated the literature, with relatively few studies reporting results within demographic and pain-related categories. Several studies identified moderate to strong positive relationships between AI and depressive symptoms following injury. This aligns with cognitive diathesis–stress models of depression<sup>63–68</sup> as well as previous research that has identified sport injury as a risk factor for depression in athletes.<sup>69–72</sup> When an athlete is unable to engage in sport, as is the case when an athlete sustains an injury, depressive symptoms may occur due to *ego dissonance* (ie, an incongruence between who an individual believes themselves to be and their ability to fulfil their role responsibilities). As per cognitive diathesis–stress models,<sup>67</sup> athletes low in self-complexity (ie, a self-schemata consisting of a limited number of identities or significant identity overlap) are subject to a greater risk of experiencing depression following an identity disruption (eg, a sport injury) than athletes who maintain a multifaceted self-schemata (ie, maintenance of multiple identities and roles). However, this explanation fails to account for if and how the *strength* and *importance* of a given identity (eg, AI) moderates depression risk. Alternatively, depressive symptoms may manifest due to the fact that the athlete is no longer receiving the reciprocal benefits associated with role engagement. For example, studies captured in this review identified a significant positive relationship between AI and physical self-worth<sup>35</sup> and general motivation.<sup>51</sup>

Behaviourally, evidence suggested that athletes with stronger identities were more likely to overadhere to prescribed rehabilitative protocols.<sup>55 56</sup> This could be due

to an athlete's attempt to remain in an *ego syntonic* state. The athlete seeks congruence between who they think they are (an athlete) and their associated role responsibilities (engaging in competition, training with teammates), so they engage in behaviours that will expedite their recovery. This behaviour may be useful, as evidence suggested that stronger AIs were associated with improved functional outcomes.<sup>51</sup>

Interestingly, pain appears to be negatively associated (although non-significantly) with AI. This might suggest that an element of mental toughness or grit accompanies stronger AIs (ie, the ability to play through and down-play pain); both of the above traits having been previously associated with sport involvement.<sup>1 2</sup> It may also be the case that athletes with stronger AIs develop better coping skills to deal with injury pain and are better equipped to “push through”. An alternative explanation: athletes with stronger identities opt to “push through” minor injuries and ignore minor indicators of injury (ie, pain) up to a certain threshold, which is supported by study findings.<sup>47 52</sup> Additional support for this explanation is provided by studies that identified positive significant associations between AI and injury severity.<sup>26 54</sup>

As stated previously, only three studies<sup>44 45 48</sup> assessed AI at multiple time points, with only one of these three having assessed AI prior to and following injury.<sup>44</sup> Based on the available literature, there is insufficient evidence to define the relationship that exists (if any) between an injury (as an exposure) and AI (as an outcome).

## Strengths and limitations

Readers should consider the following strengths and limitations of the methodology used in this review. The search strategy used to identify studies was co-constructed with the help of a University of Toronto librarian. This collaboration ensured that (1) the relevant databases for the review topic were searched, (2) the search strategy notation was applied correctly for each database, and (3) that the search terms (eg, key words, subject headings) were exhaustive and appropriate to capture studies relevant to the review topic. To prevent bias, Covidence was used to blind reviewers' decisions to accept or reject articles throughout all screening stages. Use of Covidence also ensured that all studies identified within the search were reviewed (ie, records were not missed). Finally, data extraction was conducted independently by both reviewers. This reduced the probability that study findings were transcribed erroneously within the data table and summarised incorrectly.

With respect to methodological limitations, authors did not conduct a quality and bias assessment of the identified studies. This is required and necessary prior to delineating implications for clinical care or conducting an intervention that seeks to alter AI in an attempt to improve injury outcomes. However, authors wish to remind readers that this is not the purpose of a scoping review<sup>73</sup> and is instead better suited to a systematic review. Researchers who wish to update this review with newly

published literature should consider the use of a rigorous and widely accepted method of qualitative evaluation (eg, *Downs and Black's Checklist for Quality Assessment*<sup>74</sup>). The exclusion of qualitative studies, theses/dissertations and non-English articles may have resulted in the exclusion of relevant data. Finally, the search strategy used herein primarily used databases (eg, PubMed) to identify relevant studies. The incorrect labelling (eg, MeSH subject headings) of studies or studies published within journals not indexed within the databases searched were therefore missed (if any).

## CONCLUSIONS

Findings from this review highlighted several significant and positive associations between AI and psychosocial (eg, depressive symptoms, performance traits, physical self-worth, motivation), behavioural (eg, rehabilitation overadherence, playing through pain and suspected injury) and injury-related (eg, function and injury severity) outcomes. Assessing AI prior to the start of a rehabilitation protocol may give both the athlete and treating clinician a road map of what to expect with respect to mindset, behaviours and recovery outcomes. Importantly, readers should consider the floor and ceiling effects of AI with respect to the relationships identified. A somewhat limited variability in mean AIMS scores does not allow for a complete representation of the AI as it relates to injury outcomes. Future studies should aim to capture athletes with a wider range of AIMS scores (ie, AI of varying strengths) as well as non-athletes who have also experienced an injury. Readers should also consider the overrepresentation of Caucasians, males, able-bodied athletes and MSK injuries identified in this review. Homogeneity in these domains limits the external validity of findings to other racial groups, females and populations with sport-related concussion. Subsequent studies should include para-athletes as no study included in this review considered this population. Importantly, limitations associated with study design and methodology within this body of literature preclude any causal inferences from being made (ie, AI as a cause of the injury outcomes observed).

This review also highlights a large gap in knowledge with respect to the association (if any) that exists between injury (as an exposure) and AI (as an outcome). Studies must adopt prospective longitudinal designs that assess AI prior to and following the occurrence of injury in order to speak to this relationship. Additional consideration should be given to the inclusion of multiple long-term follow-up observations. As per the Wiese-Bjornstal *et al* injury model,<sup>30</sup> an athlete's cognitive appraisal of the injury event is a central tenant to the outcomes observed. Despite its importance, few studies directly assessed an athlete's cognitive appraisal of their injury. Researchers may wish to inform the development of their study protocols while referencing a theoretical model. This will facilitate a more holistic understanding of the outcomes observed.

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## ORCID iD

Tian Renton <http://orcid.org/0000-0002-9772-0551>

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