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Preseason Prognostic Factors for Injuries and Match Loss in Collision Sports: A Systematic Review

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ABSTRACT

This study aimed to identify which preseason factors had strong evidence of risks for physical injury during the season of collision sports including rugby, American football, and Australian rules football using qualitative synthesis. Pubmed, EMBASE, MEDLINE, SPORTDiscus, Scopus, and the Cochrane Library were reviewed. Eligibility criteria for selecting studies were: studies involving the collision sports; prospective cohort studies; and studies with outcomes of relative risks, odds ratios, and correlations between players' preseason conditions and injury during the season. The risk of bias based on the Scottish Intercollegiate Guidelines Network quality checklists for cohort studies was assessed in 57 studies. The current study identified strong evidence that 1) anthropometric characteristics (body mass index and estimated mass moment of inertia of the body around a horizontal axis through the ankle), which are calculated with weight and height; 2) physical function, in particular for the trunk and lower limb (trunk-flexion hold and wall-sit hold); and 3) Oswestry Disability Index disability, which is a patient-reported outcome measure for disability due to low back pain, were positive prognostic factors for injury during the collision sports season, regardless of playing experience.

Introduction

To prevent sports injuries, contributions of biomedical factors (including physical conditions), social factors (including environmental conditions), and protectors such as headgear have been examined. Recent studies have shown that psychological factors can also contribute to sports injuries [1, 2]. A biopsychosocial approach is needed to prevent sports injuries [3], and the development of sports injury prevention programs from the biopsychosocial perspective is a part of the future research agenda [4].

Rugby is a popular sport but has one of the highest injury rates [5], and injuries have a significant impact on team results [6, 7]. During preseason, if characteristics that are associated with elevated risk of injury can be identified, appropriate measures can be devised to prevent sports injuries and minimize the negative impact on team results.

Systematic reviews have been conducted on preseason factors that contributed to upper limb [8, 9] and hamstring injuries [10] during the season. However, these systematic reviews included biomedical factors only. No systematic review has been conducted on preseason biopsychosocial factors that contributed to injuries in rugby and similar sports including American football and Australian rules football during the season, operationally defined as collision sports in this manuscript. It is important to identify contributing factors that can be changed by training or management to develop a comprehensive evidence-based injury prevention program.

Therefore, this study aimed to identify which preseason biopsychosocial factors have the strongest evidence to be characterized as risks factors for physical injury during the collision sports season.

Materials and Methods

Identification and selection of studies

This review was registered a priori with PROSPERO (CRD42020205114). The first author (KW) performed a systematic search of the following databases from their inception to January 31, 2022: Pubmed, EMBASE, MEDLINE, SPORTDiscus, Scopus, and the Cochrane Library using search terms outlined in ▶ **Table 1**. There was no language limitation. Inclusion criteria were: 1) studies involving collision sports players including rugby, American football, or Australian rules football players; 2) prospective cohort studies; and 3) studies with outcomes of relative risks, odds ratios, and correlations between players' preseason conditions and injury during the season, which were defined by each study. Studies only including participants with a previous or current episode of medical diagnosis and 2) studies only investigating the effect of environmental conditions or protectors were not eligible. Further, data from control arms of randomized controlled trials were not eligible to avoid potential placebo or nocebo effect on injury. For cross-referencing, we performed a manual search for relevant literature cited in studies included herein.

Two authors (KW and TK) independently screened the literature by reviewing titles and abstracts without blinding the author names. Subsequently, studies for full-text inspection were identified. Disagreements between the two authors were resolved through discussion. Then, both the authors (KW and TK) independently performed a full-text inspection of studies, and disagreements were resolved through discussion. Agreements between the two authors (KW and TK) in the screening and full-text inspection of studies were examined using % agreement.

Assessment of the study characteristics

Two authors (KW and TK) independently examined the risk of bias based on the Scottish Intercollegiate Guidelines Network quality checklists for cohort studies (SIGN checklist) [9, 11], which is a common risk of bias tool for cohort studies [12]. The SIGN checklist includes two sections: Section 1: internal validity, and Section 2: overall risk of bias assessment. Section 1 includes 14 items of one numerical scale (Criterion 5) and 13 categorical scales with varied response options (one 2-category scales [yes or no]; six 3-category scales [yes, no, and can't say] and six 4-category scales [yes, no, can't say, and doesn't apply]). Section 2 is rated as high quality, acceptable quality, or unacceptable quality considering the 14 items in Section 1. The SIGN checklist was selected in this study because there is a rating manual for Section 1, and three categories of the overall risk of bias assessment in Section 2 are available.

Disagreements between the two authors (KW and TK) over the risk of bias were resolved through discussion. Agreement between the two authors (KW and TK) on the risk of bias was examined using Cohen's unweighted kappa and % agreement in each criterion for categorical scales, where κ was interpreted as follows: < 0.4, poor agreement; 0.41–0.60, moderate agreement; 0.61–0.80; good agreement; and 0.81–1.0, very good agreement [13]. Authors agreement on criterion 5 was examined using intraclass correlation coefficient (ICC) and % agreement, where ICC was interpreted as follows: < 0.4, poor agreement; 0.40–0.75, acceptable agreement; and ≥ 0.75, good agreement [14]. The SPSS version 21.0 (IBM Corporation, Armonk, NY, USA) was used for statistical analyses, with a statistical significance set at 5 %.

▶ **Table 1** Search terms for Pubmed.

#1 (rugby[Title/Abstract]) OR (football[Title/Abstract])
#2 (season[Title/Abstract]) OR preseason[Title/Abstract]
#3 (#1) AND #2
#4 (pain[Title/Abstract]) OR (injur * [Title/Abstract])
#5 (#3) AND #4

Data analysis

We followed data synthesis methods used in a previous study [15]. Extracted variables were preseason conditions. The following variables were not included in data extraction: 1) environmental conditions or protectors, 2) games played during the season, 3) time of the season, 4) weight training during the season, and 5) testing time. Only variables where at least one study reported either a risk ratio or odds ratio of > 1.5 or < 0.5 or a statistically significant association was deemed to represent a true "association." The level of evidence for prognostic factors was quantitatively identified as strong, moderate, inconclusive, or no evidence (▶ **Table 2**) [15]. When prognostic factors were identified using cluster analysis, data were extracted in each cluster. In addition to the analysis using dependent variables of all injuries, subgroup analyses were carried out using dependent variables of head injuries, lower limb injuries, or other injuries.

Two authors (KW and TK) independently extracted data and performed data synthesis, and disagreements were resolved through discussion. The extracted data included: 1) study setting; 2) study population and participant demographics; 3) prognostic factors; 4) dependent variables of physical injury during the season; and 5) their associations.

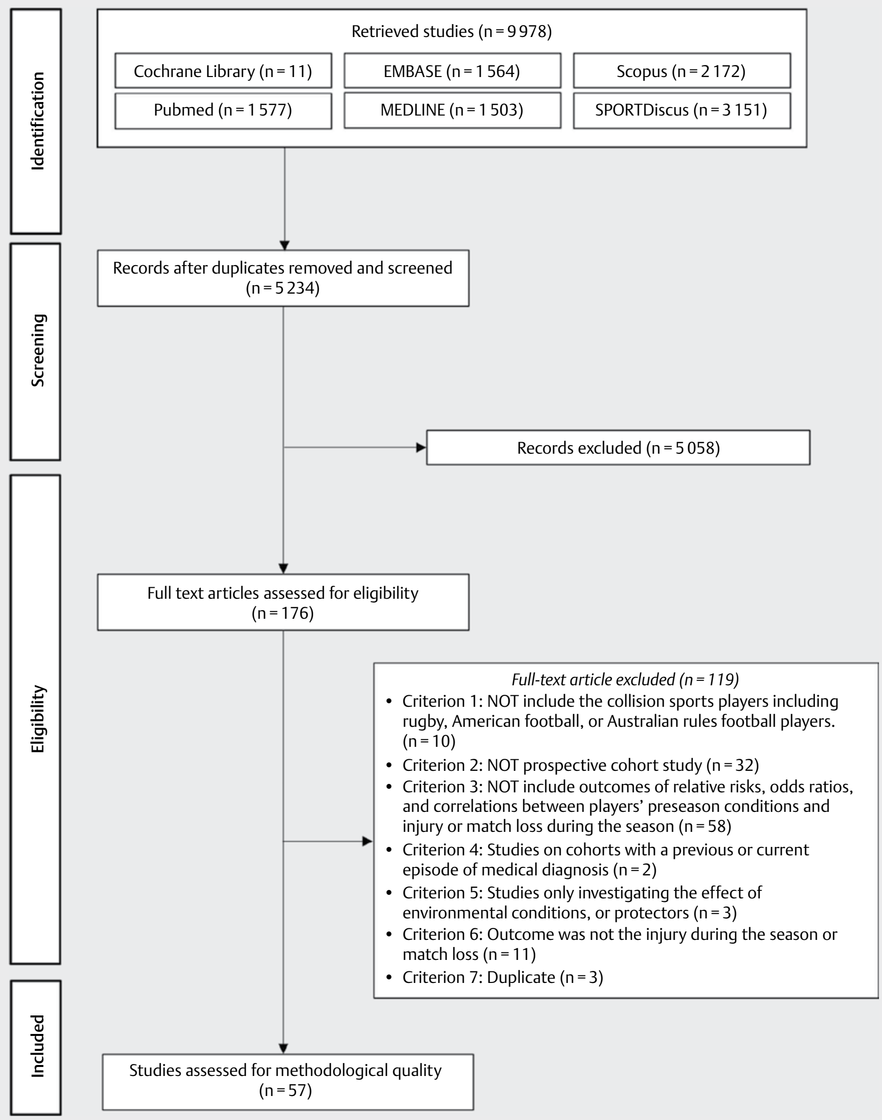
Results

The flow of study selection is shown in ▶ **Fig. 1**. Agreements between the two authors were 98.3 % in screening and 88.1 % in the full-text inspection of studies. The list of the literature excluded in

▶ **Table 2** Criteria for the level of evidence.

Level of evidence	Criteria
Strong evidence	Consistent findings (≥ 75 %) in ≥ 2 high quality studies in the SIGN checklist, which use the multivariable analysis
Moderate evidence	Consistent findings (≥ 75 %) in 1 high quality study and ≥ 1 acceptable quality study in the SIGN checklist, which use the multivariable analysis
Inconclusive evidence	Inconsistent findings irrespective of study quality or findings of 1 high quality study in the SIGN checklist or only acceptable or unacceptable quality studies in the SIGN checklist, which use the multivariable analysis
No evidence	No association found in the multivariable analysis and no association in > 3 high quality studies in the SIGN checklist, which use the univariable analysis

Abbreviation: SIGN checklist, Scottish Intercollegiate Guidelines Network quality checklists for cohort studies



▶ **Fig. 1** Flow diagram of the study selection process.

the full-text inspection is summarized in Supplementary Table 1. The risk of bias was assessed in 57 studies [16–72], whose details have been summarized in Supplementary Table 2. One study was written in Japanese [72], and others were written in English. As seen in ▶ **Table 3**, a moderate agreement on the overall risk of bias assessment was observed between the two authors.

Supplementary Table 3 summarizes the risk of bias of 57 studies and demonstrates the strength of evidence of prognostic factors for all injuries identified among studies. Strong evidence of positive prognostic factors were as follows: 1) body mass index (BMI) and estimated mass moment of inertia of the body around a horizontal axis through the ankle (MMOI), which are calculated with weight and height; 2) physical functions of the trunk-flexion hold and wall-sit hold; and 3) Oswestry Disability Index (ODI), which is a patient-reported outcome measure for disability due to low back pain (LBP). There was strong evidence that playing experience was an irrelevant prognostic factor. Further, there were only five studies involving psychological factors [19, 28, 29, 37, 38] and 14 studies involving social factors of sports-specific factor (i. e., playing experience, competition level, and playing position) in the multivariable analysis [18–20, 22–25, 27, 28, 30, 35, 36, 43, 72]. In the subgroup analyses, Supplementary Tables 4, 5, and 6 demonstrate the evidence of prognostic factors for head injuries, lower limb injuries, or other injuries, respectively. No strong evidence of prognostic factors was observed in the head injuries. In the lower limb injuries, strong evidence of positive prognostic factors were as follows: 1) anthropometric characteristics of BMI and MMOI, 2) physical functions of the trunk-flexion hold and wall-sit hold, and 3) ODI. In other injuries, there was a strong evidence that playing experience was an irrelevant prognostic factor.

▶ **Table 3** Agreements of the risk of bias based on the Scottish Intercollegiate Guidelines Network quality checklists for cohort studies.

Criterion	Percent agreement	Cohen's unweighted kappa (κ) or intraclass correlation coefficient (ICC)
Section 1–1	100.0	κ = 1.00
Section 1–2	94.7	κ = 0.85
Section 1–3	86.0	κ = 0.72
Section 1–4	94.7	κ = 0.90
Section 1–5	89.5	ICC = 0.95
Section 1–6	80.4	κ = 0.62
Section 1–7	100.0	κ = 1.00
Section 1–8	84.2	κ = 0.67
Section 1–9	100.0	κ = 1.00
Section 1–10	98.2	κ = 0.88
Section 1–11	78.9	κ = 0.50
Section 1–12	73.7	κ = 0.65
Section 1–13	89.5	κ = 0.74
Section 1–14	93.0	κ = 0.76
Section 2	75.4	κ = 0.63

Discussion

To the best of our knowledge, this is the first systematic review of preseason biopsychosocial factors that contributed to injuries in collision sports during the season. This study found strong evidence of anthropometric characteristics, physical functions, and disability due to LBP as positive prognostic factors and playing experience as an irrelevant prognostic factor for all injuries. There has been a lack of strong evidence of preseason psychological or social factors contributing to injuries during the season in the currently available literature. In particular for psychological factors, we have identified only five studies involving psychological factors [19, 28, 29, 37, 38]. No psychological factor was examined in the multivariable analysis with high quality rating in the SIGN checklist, resulting in the lack of strong evidence for preseason psychological factors contributing to injuries during the season. These findings indicate a need for future cohort studies involving psychosocial factors.

The three factors identified as strong positive prognostic factors can be managed by medical staff during the preseason in order to minimize possibilities of injuries during the season. Regarding the anthropometric characteristics of BMI and MMOI, these are simply calculated based on height and weight, not a measure of body composition. Height is not expected to change between before and during the season, and thus the increased risk of injury during the season is likely to reflect overweight before the season. There were nine papers that reported BMI as a prognostic factor, but the timing of measurement was not stated or standardized [17, 28, 32–36, 39]. Thus, it is not certain whether the increased risk of injury during the season is due to increased preseason muscle mass or body fat, but medical staff and athletes may need to be careful not to be overweight. Further, the trunk-flexion hold and wall-sit hold should be assessed routinely, and endurance and resistance training of the core, including the lower limb, would be beneficial to minimize possibilities of injuries or match loss during the season. Regarding ODI, both studies [73, 74] providing positive correlations in multivariable analysis used cutoff scores of 4 or 6 out of 50. A study in 2015 [73] did not present ODI scores; however, a study in 2012 [74], which was a preliminary study of the one conducted in 2015, demonstrated that the mean (standard deviations) of ODI in the injured sample (n = 39) and uninjured sample (n = 44) was 4.89 (5.44) and 3.09 (2.38), respectively. Considering the ODI cutoff score of 12 to differentiate between those with and without disability using data of 1,200 individuals [75], the ODI finding in the current review would indicate the importance of perfect control of LBP. A clinically meaningful message from the ODI finding would be that not only conditioning and usual care for LBP with medical staff but also athletes' acquisition of and adherence to effective self-management strategies for LBP through tertiary prevention from medical staff (i. e., behavior modification) are important to minimize the possibilities of injuries during the season.

Strong evidence of the same three positive prognostic factors was detected in the subgroup analyses for lower limb injuries. This finding would not be surprising, considering the influence of trunk functions on the lower limb functions [76, 77], and it also supports the frequent inclusion of trunk resistance training for injury prevention and rehabilitation [78, 79].

Limitations and strengths

This study qualitatively synthesized the evidence of preseason biopsychosocial factors that can be changed by training or management. Therefore, the accuracy of the prediction is not known. The degree of prognostic powers is unknown. Further, the present study used dependent variables of physical injury during the season, which were defined in each study. Moreover, the definitions of dependent variables were diverse. However, it is assumed that the identified factors in the present study should be included in a future comprehensive cohort study to identify preseason factors for physical injury during the collision sports season.

A strong point of the present study would be that this is the first systematic review on biopsychosocial factors that contributed to injuries, and preseason factors that contributed to injuries in collision sports during the season. The present study indicates a need for further cohort studies involving psychosocial factors during the preseason to predict injury during the collision sports season. Further, the present study suggests that future cohort studies should include at least the anthropometric characteristics, i. e., physical functions, in particular for the trunk and lower limb; and disability due to LBP, to develop a comprehensive prediction model.

Conclusion

The current study identified strong evidence that BMI, MMOI, trunk-flexion hold, wall-sit hold, and ODI were positive prognostic factors for injury during the collision sports season, regardless of playing experience.

Conflict of Interest

The authors declare that they have no conflict of interest.

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