



LEEDS
BECKETT
UNIVERSITY

Citation:

Rennie, G and Chesson, L and Weaving, D and Jones, B (2024) The effects of rule changes in football-code team sports: a systematic review. *Science and Medicine in Football*. pp. 1-14. ISSN 2473-3938 DOI: <https://doi.org/10.1080/24733938.2024.2375752>

Link to Leeds Beckett Repository record:

<https://eprints.leedsbeckett.ac.uk/id/eprint/11114/>

Document Version:

Article (Published Version)

Creative Commons: Attribution-Noncommercial-No Derivative Works 4.0

© 2024 The Author(s)

The aim of the Leeds Beckett Repository is to provide open access to our research, as required by funder policies and permitted by publishers and copyright law.

The Leeds Beckett repository holds a wide range of publications, each of which has been checked for copyright and the relevant embargo period has been applied by the Research Services team.

We operate on a standard take-down policy. If you are the author or publisher of an output and you would like it removed from the repository, please [contact us](#) and we will investigate on a case-by-case basis.

Each thesis in the repository has been cleared where necessary by the author for third party copyright. If you would like a thesis to be removed from the repository or believe there is an issue with copyright, please contact us on openaccess@leedsbeckett.ac.uk and we will investigate on a case-by-case basis.

The effects of rule changes in football-code team sports: a systematic review

Gordon Rennie^{a,b}, Lucy Chesson^a, Dan Weaving^{a,c,d} and Ben Jones^{a,e,f,g,h}

^aCarnegie Applied Rugby Research (CARR) Centre, Carnegie School of Sport, Leeds Beckett University, Leeds, UK; ^bCatapult Sports, Melbourne, NSW, Australia; ^cApplied Sports Science and Exercise Testing Laboratory, The University of Newcastle, Ourimbah, Australia; ^dDepartment of Physical Activity and Sport, Faculty of Arts and Sciences, Edge Hill University, Ormskirk, UK; ^eDivision of Physiological Sciences and Health Through Physical Activity, Lifestyle and Sport Research Centre, Department of Human Biology, Faculty of Health Sciences, University of Cape Town, Cape Town, South Africa; ^fSchool of Behavioural and Health Sciences, Faculty of Health Sciences, Australian Catholic University, Brisbane, QLD, Australia; ^gEngland Performance Unit, Rugby Football League, Manchester, UK; ^hRugby Department, Premiership Rugby, London, UK

ABSTRACT

Rule changes within football-code team sports aim to improve performance, enhance player welfare, increase competitiveness, and provide player development opportunities. This manuscript aimed to review research investigating the effects of rule changes in football-code team sports. A systematic search of electronic databases (PubMed, ScienceDirect, CINAHL, MEDLINE, and SPORTDiscus) was performed to August 2023; keywords related to rule changes, football-code team sports, and activity type. Studies were excluded if they failed to investigate a football-code team sport, did not quantify the change of rule, or were review articles. Forty-six studies met the eligibility criteria. Four different football codes were reported: Australian rules football ($n = 4$), rugby league ($n = 6$), rugby union ($n = 16$), soccer ($n = 20$). The most common category was physical performance and match-play characteristics ($n = 22$). Evidence appears at a high risk of bias partly due to the quasi-experimental nature of included studies, which are inherently non-randomised, but also due to the lack of control for confounding factors within most studies included. Rule changes can result in unintended consequences to performance (e.g., longer breaks in play) and effect player behaviour (i.e., reduce tackler height in rugby) but might not achieve desired outcome (i.e., unchanged concussion incidence). Coaches and governing bodies should regularly and systematically investigate the effects of rule changes to understand their influence on performance and injury risk. It is imperative that future studies analysing rule changes within football codes account for confounding factors by implementing suitable study designs and statistical analysis techniques.

ARTICLE HISTORY

Received 18 January 2024
Revised 03 June 2024
Accepted 26 June 2024

KEYWORDS

Rules; laws; competition; injury prevention; match analysis


Introduction


Football codes are defined as invasion-based team sports (Young et al. 2021), characterised by continuous play (Torres-Ronda et al. 2022), and include soccer, rugby union, rugby league, Australian rules football, and Gaelic Football (Whitehead et al. 2018). Rule or law changes within these football-code team sports aim to improve performance (Bradley et al. 2018), enhance player welfare (Stean et al. 2015), and make contests more appealing to spectators (Kraak et al. 2016), often through increased competitiveness (Williams 2011). The term *Laws of the Game* reflects the official and standardised rules established by the governing bodies of the sport and are universally applied at all levels of competition. Changes to laws are usually made by the sport's governing body and are often reviewed periodically. For example, in soccer (i.e., association football), the *Laws of the Game* are established and maintained by the International Football Association Board (IFAB). These laws govern various aspects, such as the field dimensions, the number of players on each team, offside, fouls and penalties.

Rules are a broader term and refer to various regulations, guidelines, and instructions set by sports organisations, leagues, or even individual teams. While some of these rules may align with

the *Laws of the Game*, others may be specific to a particular league, tournament, or event. For instance, a sports league may have its own set of rules regarding player eligibility, substitution limits, match duration, tie-breaking procedures, disciplinary actions, and other operational aspects that are not explicitly covered by the *Laws of the Game*. On-field regulations are generally referred to within football codes as *laws* (as is the case in soccer, Australian rules football, rugby union and rugby league) and seldomly as *rules and regulations* (as is the case in Gaelic football). The interchangeability of this terminology can be a source of confusion and therefore it is necessary to consider a practical example to illustrate when each term is appropriately used. For example, the on-field law within soccer known as offside (Law 11) is universally applied since this is written into the *laws of the game*. Every competition governed under the self-regulatory governing body FIFA (Fédération Internationale de Football Association) applies this law during official matches.

Rules provide the necessary framework and conditions to ensure individuals and teams can participate in sporting contests (Arias et al. 2011). Rules affect both structural (e.g., space, time, equipment, and number of players) and functional (e.g., the player's use of structural elements) aspects

CONTACT Gordon Rennie  g.rennie@leedsbeckett.ac.uk  Carnegie Applied Rugby Research (CARR) Centre, Carnegie School of Sport, Leeds Beckett University, Leeds LS6 3QS, UK

 Supplemental data for this article can be accessed online at <https://doi.org/10.1080/24733938.2024.2375752>

© 2024 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group. This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

(Arias et al. 2011). For example, when participating in rugby, the duration of a match or field dimensions is considered a structural rule, whereas a functional rule indicates the constraints of pass direction between players and the consequences if players fail to comply. This means rules of participation within sport can be categorised into two levels known as ‘establishment’ phase (e.g., the definitive rules of a particular sport which make the sport unique from other sports and ensures the viability of the sport) and the more complex ‘consolidation’ phase which relates to all the rule changes, modifications, clarifications, and rescissions implemented by governing bodies (Kew 1987). Rules will not fully explain the behaviours of participants since rules are open to interpretation and allow the development of strategies or skills within the constraints imposed (Kew 1990). That said, rule modifications should be analysed prior to their final introduction in a sport (Arias et al. 2011) and assessing their effectiveness within sport allows stakeholders to better understand game structures and responses to any changes (Eaves, Hughes, et al. 2008).

Rule changes are considered fundamental to the continual evolution of sports (Eaves, Lamb, et al. 2008) and therefore should be systematically analysed and reviewed to determine their effectiveness in achieving specific outcomes (Williams et al. 2005). Rule changes can affect several outcomes, such as physical performance and technical-tactical events, injury incidence and prevention, match scoring or points awarded, and player development opportunities. Arias and colleagues (2011) narrative review on rule modifications in sport identified that key factors for implementing changes in sport included improving physical performance, attracting spectators, attending to commercial pressures (i.e., increasing revenue), adapting sport to children, reducing risk of injury, and attracting athlete participation. However, their review did not systematically extract outcome measures used to evaluate the effect of rule changes and therefore the influence of rule changes on outcomes such as physical performance and injury within sports has yet to be determined. Moreover, the rules by which sports are contested are constantly evolving and since the narrative review in 2011, the volume of research analysing the effects of rule changes with football-codes has substantially increased therefore a systematic review into the effectiveness of rule changes within football-code team sports is required. This is the first systematic review to examine the effects of rule changes within defined football codes. The aim of this systematic review is to assess the effects of rule changes within football-code team sports which are characterised by continuous play.

Materials and methods

Design and search strategy

The review protocol was prospectively registered with the Open Science Framework (DOI: <https://doi.org/10.17605/OSF.IO/QV3DZ>), and performed in accordance with the Preferred Reporting Items of Systematic Reviews and Meta-analyses (PRISMA) guidelines (Moher et al. 2009). PubMed, ScienceDirect, CINAHL, MEDLINE, and SPORTDiscus (via EBSCOhost) databases were systematically searched from inception to 31st August 2023. Keyword searches were performed for: rule* OR ‘rule change*’ OR ‘rule modification*’ OR ‘rule amendment*’ OR ‘rule manipulation*’ OR law* OR ‘law change*’ OR ‘law modification*’ OR ‘law amendment*’ OR ‘law manipulation* AND rugby OR ‘rugby league’ OR ‘rugby union’ OR ‘rugby 7s’ OR ‘Gaelic football’ OR football OR soccer OR ‘Australian rules football’ OR AFL AND match* OR game* OR fixture* OR competition* (details of the search strategy are outlined in Supplementary Material 1). Reference lists of eligible studies and review articles were also searched.

Study selection

After eliminating duplicates, search results were screened independently by two researchers (GR, LC) against the eligibility criteria. References that could not be eliminated by title or abstract were retrieved and independently evaluated for inclusion via full-text. Reviewers were not masked to the title or authors of the publications. Disagreements were resolved by discussion or via a third researcher (DW). Reference lists of all retrieved papers were manually searched for other potentially eligible papers. To be considered within this review, studies had to meet the inclusion criteria (Table 1). No restriction was placed on participant age or sex.

Data extraction

For each included study, the following data were extracted: first author and publication year, study overview, study aim(s), a description of the rule(s) changed, summary of outcome(s). A meta-analysis was not performed as study designs were heterogeneous and therefore unable to be pooled.

Assessment of methodological quality

Articles were independently assessed for methodological quality by two authors (GR, LC) using a modified version

Table 1. Inclusion and exclusion criteria for the systematic literature search.

| Inclusion criteria | Exclusion criteria |
|---|---|
| <ul style="list-style-type: none"> Human observational, prospective, retrospective, cross-sectional, longitudinal or intervention studies. Study concerned physical performance, injury risk, or technical-tactical characteristics. Full-text publication in a peer-review journal (in English). Data collected in football-code team sports contests. All playing standards and levels of competition. At least one ‘match-play’ relevant rule or law change. | <ul style="list-style-type: none"> No full-text available (in English). Study failed to quantify the change of rule within the football-code team sport. Study failed to investigate football-code team sports. Study was a review article. Studies investigated solely off field outcome variables (e.g., ‘fan engagement’, sports betting and/or viewing figures). |

of the Downs and Black (1998) checklist, whilst maintaining 27 items, which has been previously used within team sport-related literature to assess methodological quality (Farley et al. 2020; Zanin et al. 2021). The Downs and Black checklist is designed to evaluate the methodological quality of both randomised controlled trials (RCT) and non-randomised comparative studies (Silverman et al. 2012). The Downs and Black checklist provides acceptable validity (correlated highly with the score of Standards of Reporting Trials Group [SRTG] [$r=0.90$]) and reliability (measures of internal consistency [$k=0.89$], test-retest reliability [$r=0.88$], and interrater reliability [$r=0.75$]) (Olivo et al. 2008), with similar performance reported between RCTs and non-randomised comparative studies (Zanin et al. 2021).

Several reviews in the football-code research field have used a modified version of this assessment scale, using only 9 to 19 of the 27 criteria (Cummins et al. 2013; Johnston et al. 2018; Dalton-Barron et al. 2020; Naughton et al. 2020; Crang et al. 2021; Chesson et al. 2021), with very few applying all 27 items (Farley et al. 2020; Zanin et al. 2021) in the assessment of methodological quality. Removing items from the Downs and Black checklist was not suitable for this review since the nature of studies included often compared an initial period with a period following which the rule change was implemented (i.e., an interrupted time series approach with a control period). Moreover, the most used modified Downs and Black checklist usually omits all the items related to confounding (items 21–26), which is, given the research question, the main source of bias and methodological concerns in this review. Alterations such as removal of items may not guarantee the maintenance of its psychometric properties, and the validity and reliability of the Downs and Black checklist would need to be reassessed (Zanin et al. 2021).

Nevertheless, item 27 in the Downs and Black checklist, which relates to statistical power, is ambiguous (Eng et al. 2007) and is therefore often modified to award one point for a 'yes' response, indicating the authors had reported a power analysis, or zero points for a 'no' answer, indicating they had not (Lyons et al. 2017). In light of this, and considering the quasi experimental (i.e., non-randomised) nature of studies in this review, all 27 questions were used in this review. In keeping with recent systematic reviews within football-code team sports (Farley et al. 2020; Zanin et al. 2021), item 27 was altered to a dichotomous response. No additional subgroup analysis was undertaken on the basis of methodological quality.

Results

Identification and selection of studies

Through the original database search 3168 articles were identified, with two others found through other sources. Following removal of duplicates and eligibility screening, 83 articles progressed to full-text review. Forty-six articles were included for final analysis. Figure 1 provides a schematic representation of the decision process.

Study characteristics

Study data from the 46 studies are outlined in Supplementary Material 2–5. Four different football-codes were included: soccer ($n=20$) (Shibukawa and Hoshikawa 2022; Guedes and Machado 2002; Vaeyens et al. 2005; Dalton et al. 2015; Vriend et al. 2015; Augste and Cordes 2016; Butler and Butler 2017; Tok et al. 2017; Beaudouin et al. 2019, 2020; Ribeiro et al. 2020; Meyer and Klatt 2021, 2024; Oliveira et al. 2021; Kobal et al. 2022; Kula et al. 2022; Tarzi et al. 2022; Ayabe et al. 2023; Bahamonde-Birke and Bahamonde-Birke 2023; García-Aliaga et al. 2023), rugby union ($n=16$) (Williams et al. 2005; Fuller et al. 2009; van den Berg and Malan 2012; Vahed et al. 2014, 2016; Stean et al. 2015; Spencer and Brady 2015; Kraak et al. 2016; Kraak, Welman, et al. 2017; Kraak, Coetzee, et al. 2017; Bradley et al. 2018; Lo et al. 2019; Ashford et al. 2020; Stokes et al. 2021; van Tonder et al. 2022; Cooke et al. 2023), rugby league ($n=6$) (Gabbett 2005; Eaves, Hughes, et al. 2008; Eaves, Lamb, et al. 2008; Rennie et al. 2021, 2022; Delves et al. 2022) and Australian rules football ($n=4$) (Orchard et al. 2009, 2014; Savage et al. 2012; Wing et al. 2022). Six studies (Gabbett 2005; Tok et al. 2017; Kobal et al. 2022; van Tonder et al. 2022; Delves et al. 2022; Wing et al. 2022) reported the physical characteristics (i.e., age, height, body mass) of participants. One study (Vriend et al. 2015) did not report the league or competition level. The playing standard of participants was determined in accordance with a five-tiered participant classification framework (McKay et al. 2022) which included: Tier 2: Trained/Developmental ($n=2$; 4%) (Vaeyens et al. 2005; Ashford et al. 2020), Tier 3: Highly Trained/National Level ($n=10$; 22%) (Fuller et al. 2009; Vahed et al. 2014, 2016; Vriend et al. 2015; Butler and Butler 2017; Tok et al. 2017; Kraak, Welman, et al. 2017; Ribeiro et al. 2020; van Tonder et al. 2022; Wing et al. 2022), Tier 4: Elite/International Level ($n=29$; 63%) (Shibukawa and Hoshikawa 2022; Guedes and Machado 2002; Gabbett 2005; Eaves, Lamb, et al. 2008; Orchard et al. 2009, 2014; van den Berg and Malan 2012; Savage et al. 2012; Stean et al. 2015; Spencer and Brady 2015; Kraak et al. 2016; Kraak, Coetzee, et al. 2017; Bradley et al. 2018; Beaudouin et al. 2019, 2020; Lo et al. 2019; Meyer and Klatt 2021, 2024; Stokes et al. 2021; Rennie et al. 2021, 2022; Kobal et al. 2022; Kula et al. 2022; Tarzi et al. 2022; Delves et al. 2022; Ayabe et al. 2023; Bahamonde-Birke and Bahamonde-Birke 2023; García-Aliaga et al. 2023) and Tier 5: World Class ($n=5$; 11%) (Williams et al. 2005; Dalton et al. 2015; Augste and Cordes 2016; Oliveira et al. 2021; Cooke et al. 2023). Eighty-seven percent ($n=41$) Guedes and Machado 2002; Williams et al. 2005; Vaeyens et al. 2005; Fuller et al. 2009; Orchard et al. 2009, 2014; van den Berg and Malan 2012; Savage et al. 2012; Vahed et al. 2014, 2016; Dalton et al. 2015; Stean et al. 2015; Vriend et al. 2015; Spencer and Brady 2015; Kraak et al. 2016; Kraak, Coetzee, et al. 2017; Augste and Cordes 2016; Butler and Butler 2017; Tok et al. 2017; Bradley et al. 2018; Beaudouin et al. 2019, 2020; Lo et al. 2019; Ashford et al. 2020; Ribeiro et al. 2020; Meyer and Klatt 2021, 2024; Oliveira et al. 2021; Stokes et al. 2021; Rennie et al. 2021, 2022; Kobal et al. 2022; Kula et al. 2022; Shibukawa and Hoshikawa 2022; Tarzi et al. 2022; van Tonder et al. 2022; Ayabe et al. 2023; Bahamonde-Birke and Bahamonde-Birke 2023; García-Aliaga et al. 2023; Cooke et al. 2023) of studies investigated multiple teams.

All extracted studies could be categorised broadly into four themes, namely effects of rule changes on: physical performance

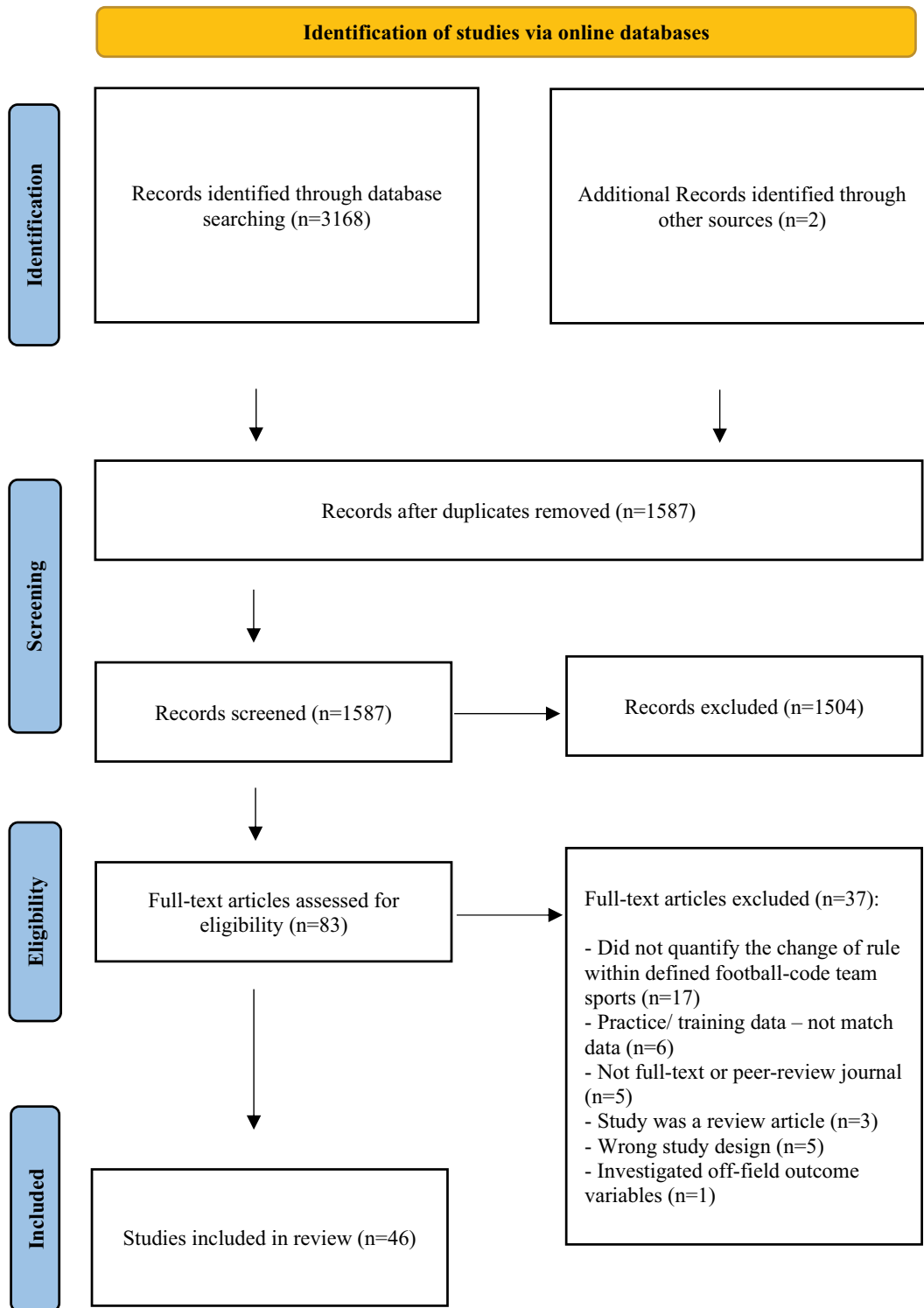


Figure 1. Flow of selection process of eligible studies for inclusion within review.

and technical-tactical events ($n = 22$; 48%) (Williams et al. 2005; Eaves, Hughes, et al. 2008; Eaves, Lamb, et al. 2008; van den Berg and Malan 2012; Spencer and Brady 2015; Augste and Cordes 2016; Vahed et al. 2016; Tok et al. 2017; Kraak, Coetzee, et al. 2017; Lo et al. 2019; Ribeiro et al. 2020; Ashford et al. 2020; Meyer and Klatt 2021, 2024; Oliveira et al. 2021; Rennie et al. 2021, 2022; Kobal et al. 2022; Delves et al. 2022; Wing et al. 2022; Ayabe et al.

2023; García-Aliaga et al. 2023), injury incidence and prevention ($n = 15$; 33%) (Gabbett 2005; Fuller et al. 2009; Orchard et al. 2009, 2014; Savage et al. 2012; Stean et al. 2015; Vriend et al. 2015; Bradley et al. 2018; Beaudouin et al. 2019, 2020; Stokes et al. 2021; Shibukawa and Hoshikawa 2022; Tarzi et al. 2022; van Tonder et al. 2022; Cooke et al. 2023), match scoring or competition points awarded ($n = 8$; 17%) (Guedes and Machado 2002; Vahed et al.

2014; Dalton et al. 2015; Kraak et al. 2016; Kraak, Welman, et al. 2017; Butler and Butler 2017; Kula et al. 2022; Bahamonde-Birke and Bahamonde-Birke 2023) and player development opportunities ($n = 1$; 2%) (Vaeyens et al. 2005). This manual classification, although screened by two authors, may have been influenced by some level of bias (Okholm Kryger et al. 2022). All studies were published from 2002 onwards, with most studies ($n = 36$; 78%) (Vahed et al. 2014, 2016; Orchard et al. 2014; Stean et al. 2015; Dalton et al. 2015; Vriend et al. 2015; Spencer and Brady 2015; Kraak et al. 2016; Kraak, Welman, et al. 2017; Kraak, Coetzee, et al. 2017; Augste and Cordes 2016; Butler and Butler 2017; Tok et al. 2017; Bradley et al. 2018; Beaudouin et al. 2019, 2020; Lo et al. 2019; Ribeiro et al. 2020; Ashford et al. 2020; Meyer and Klatt 2021, 2024; Oliveira et al. 2021; Stokes et al. 2021; Rennie et al. 2021, 2022; Kobal et al. 2022; Kula et al. 2022; Shibukawa and Hoshikawa 2022; Tarzi et al. 2022; van Tonder et al. 2022; Delves et al. 2022; Wing et al. 2022; Ayabe et al. 2023; Bahamonde-Birke and Bahamonde-Birke 2023; García-Aliaga et al. 2023; Cooke et al. 2023) published within the last decade. The highest number of studies published in a single calendar year was in 2022 ($n = 11$; 24%) thus demonstrating that interest in this area of research is increasing.

Methodological quality

Assessment of methodological quality is available in Supplementary Material 6. Summary scores resulting from this type of methodological quality checklist are not an appropriate way to appraise clinical trials (Higgins et al. 2011). A limitation of calculating summary scores from the checklist used is that, in doing so, the five dimensions (*Reporting*, *External validity*, *Internal validity – bias*, *Internal validity – confounding*, and *Power*) give the same weight to all sources of bias (Downs and Black 1998; Higgins et al. 2011). Downs and Black (1998) acknowledge the methodological limitation of weighting, however also acknowledge that weighting requires further investigation and that, at the inception of the checklist, their recommendation to apply equal weighting is based upon insufficient evidence to prioritise one dimension over another rather than on any evidence each dimension is of the same importance. To overcome this issue, each dimension is discussed qualitatively.

All studies included within this review clearly described the hypothesis/aims/objectives, the main outcomes to be measured, and the nature of the intervention (i.e., rule changes), from the perspective of *reporting*. Methodological quality, in particular the presence, description, and acknowledgement of confounding factors, is an important area of this review and 30 studies partially described confounding factors whilst, 12 studies adequately adjusted for confounders within their analyses. From the perspective of *external validity*, participants cannot be considered representative of the entire population due to the different levels of participant which were classified accordance with a five-tiered participant classification framework (McKay et al. 2022). In relation to *internal validity*, included studies cannot feasibly be blinded due to their quasi-experimental nature. In the absence of preregistration (Toth et al. 2021), or a registered report submission format (Impellizzeri et al. 2019; Abt et al. 2021), a reviewer cannot definitively identify that data dredging,

p-hacking, or HARKing (hypothesising after the results are known) has not taken place in which case item 16 is 'unable to determine'. Compliance to a rule change within the context of football-code team sport match-play is often subjective and open to interpretation. Unless the rule changes implemented were objective (i.e., changes in points awarded) or compliance was explicitly outlined within the study, the response to item 19 is 'unable to determine'. Thirty-four studies included the same population of participants when comparing the period following rule changes to the original period whilst 12 studies compared two different populations within a sport (e.g., one competition format which includes the revised rule compared to a competition format with the original rule applied). Forty-one studies included data collected and analysed across multiple seasons or competitions spanning multiple years and therefore ascertaining the period in which participants were recruited could not be determined. One study detailed a statistical *power* calculation to determine the stability of data analysed within their manuscript.

Rules changes within football-code team sports

Soccer

Twenty studies investigated the effects of rule changes within soccer; on physical performance and technical-tactical events ($n = 9$; 45%) (Augste and Cordes 2016; Tok et al. 2017; Meyer and Klatt 2021, 2024; Oliveira et al. 2021; Kobal et al. 2022; Ayabe et al. 2023; García-Aliaga et al. 2023), injury incidence and prevention ($n = 5$; 25%) (Shibukawa and Hoshikawa 2022; Vriend et al. 2015; Beaudouin et al. 2019, 2020; Tarzi et al. 2022), match scoring or points awarded ($n = 5$; 25%) (Guedes and Machado 2002; Dalton et al. 2015; Butler and Butler 2017; Kula et al. 2022; Bahamonde-Birke and Bahamonde-Birke 2023) and player development opportunities ($n = 1$; 5%) (Vaeyens et al. 2005). One study included participants from Tier 2, four from Tier 3, twelve from Tier 4, and three studies from Tier 5.

Seven studies focused on the effect of an increase in substitutions (Ribeiro et al. 2020; Meyer and Klatt 2021, 2024; Kobal et al. 2022; Tarzi et al. 2022; Ayabe et al. 2023; García-Aliaga et al. 2023). Outcome measures included number of substitutions, timing of substitutions, physical characteristics associated with match-play, and subjective measures of exertion and recovery. With additional permitted substitutes, the number of substitutions made increased (Meyer and Klatt 2021, 2024; Ayabe et al. 2023; García-Aliaga et al. 2023). Coaches also made earlier substitutions when permitted (Meyer and Klatt 2024). When 5 vs. 3 substitutions were allowed, physical characteristics (total distance and sprints) for players substituted into matches increased whilst it decreased for players who started or those who started and were replaced in matches (Ayabe et al. 2023). García-Aliaga et al. (2023) categorised players who played the whole-match and, in the event of a substitution, considered the sum of both players combined as a single-match player observation. Physical characteristics (including total distance and distances $>14 \text{ km}\cdot\text{h}^{-1}$) were greater for players substituted at half-time (i.e., data combined with the starting player) when 5 substitutions were permitted (García-Aliaga et al. 2023). There was also a significantly lower RPE, reduced match RPE (RPE x

duration), and a higher total quality recovery score in the presence of 5 vs. 3 substitutions (Kobal et al. 2022).

Three studies investigated changing the number of points awarded for a match victory (Guedes and Machado 2002; Butler and Butler 2017; Kula et al. 2022). When teams were considered as *Favourites*, they scored on average 13.4% more goals per match when three points were awarded however teams which were considered as *Underdogs* were less affected (Guedes and Machado 2002). Kula et al. (2022) also reported an increase in goals scored in Turkish professional soccer when three points were available. The total number of offensive moves during matches and offensive moves per match specifically by those labelled as *underdogs* increased following this rule change (Guedes and Machado 2002).

Eighty-percent of studies investigating the effects of rule changes upon injury incidence and prevention within soccer focused on head trauma (Shibukawa and Hoshikawa 2022; Beaudouin et al. 2019, 2020; Tarzi et al. 2022). Elbow-to-head mechanisms accounted for 35% of head injuries in soccer (Beaudouin et al. 2020). IFAB introduced a rule change in 2006 that penalised intentional elbow-to-head strikes with a direct red card. However, whilst the number of total number of head injuries significantly reduced in the five-year period following this change (Beaudouin et al. 2019), head injuries caused by raising the elbow to the head were not significantly reduced (Beaudouin et al. 2020). The tactic of long goal kicks reduced because of a 2019 rule change that permitted teammates to receive the ball inside their own penalty area from a goal kick which led to an increase in short goal kicks, reduction in aerial challenges, and reduced fouls following goal kicks (Shibukawa and Hoshikawa 2022). There were no differences reported on head collision events per 1000 hours or the duration of medical assessment during the period of additional permanent concussion substitutes (Tarzi et al. 2022).

Rugby union

Sixteen studies investigated the effects of rule changes within rugby union on physical performance and technical-tactical events ($n = 7$; 44%) (Williams et al. 2005; van den Berg and Malan 2012; Spencer and Brady 2015; Vahed et al. 2016; Kraak, Coetzee, et al. 2017; Lo et al. 2019; Ashford et al. 2020), injury incidence and prevention ($n = 6$; 37%) (Fuller et al. 2009; Stean et al. 2015; Bradley et al. 2018; Stokes et al. 2021; van Tonder et al. 2022; Cooke et al. 2023) and match scoring or points awarded ($n = 3$; 19%) (Vahed et al. 2014; Kraak et al. 2016; Kraak, Welman, et al. 2017). One study included participants from Tier 2, five studies from Tier 3, eight studies from Tier 4 and two studies from Tier 5. All sixteen studies involved multiple teams.

Six studies investigated the effects of the change of the scrum engagement call made by a referee from '*crouch, touch, pause and engage*' to '*crouch, bind, set*' (Vahed et al. 2014, 2016; Stean et al. 2015; Kraak et al. 2016; Kraak, Coetzee, et al. 2017; Bradley et al. 2018). Outcome measures included scrum frequency and duration, scrum stability, and infringements (e.g., early engagements). Scrum duration increased in Northern Hemisphere international rugby (Bradley et al. 2018) whereas scrum duration reduced in the second half of Southern

Hemisphere domestic matches (Vahed et al. 2014). Scrum frequency, reset scrum frequency, and frequency of reset scrums due to collapsing increased in northern hemisphere competition (Stean et al. 2015). A reduction in early engagements (Stean et al. 2015; Bradley et al. 2018) and scrums pulled down (Bradley et al. 2018) was also reported. By contrast, Southern hemisphere competition reported a reduction in scrum (Vahed et al. 2014, 2016; Kraak et al. 2016; Kraak, Coetzee, et al. 2017) and scrum reset frequency (Kraak et al. 2016; Kraak, Coetzee, et al. 2017).

The tackle (including tackles, missed tackles and post-tackle work) was an outcome measure in seven studies (Fuller et al. 2009; van den Berg and Malan 2012; Vahed et al. 2014, 2016; Lo et al. 2019; Stokes et al. 2021; van Tonder et al. 2022) and was described as the source of most time-loss injuries (55–57%) (van Tonder et al. 2022). During the standard tackle height period (i.e., 'line of the shoulder'), 45/61 concussions (74%) occurred in tackles, of which tacklers sustained 56% (Stokes et al. 2021). In the lowered tackle height period (i.e., 'line of the armpit'), 27/32 concussions (84%) occurred in the tackle (67% to tacklers) (Stokes et al. 2021). Reducing the maximum tackle height from the line of the shoulder to armpit resulted in no difference to incidence of time-loss injuries, head injuries or sport-related concussions (van Tonder et al. 2022). Reducing tackle height did elicit improved tackler behaviour (evidenced by reduced tackler upright body position and reduced head and neck initial point of contact on ball carrier per 100 tackle actions) (Stokes et al. 2021). Lowered tackle height did not significantly reduce incidence of time-loss injuries, head injuries, or sports related concussion (per 1000 hours of match-play) (Stokes et al. 2021; van Tonder et al. 2022).

Five studies included analyses of the effect of the television match official (TMO; allowing on field referee to consult with TMO) on match duration (Williams et al. 2005; Vahed et al. 2014, 2016; Kraak et al. 2016; Kraak, Coetzee, et al. 2017). Whole-match and ball-in-play duration increased following the introduction of the TMO in January 2000 (Williams et al. 2005). The duration of international matches increased in 2013. In domestic competition, ball-in-play duration reduced following this rule change (Kraak et al. 2016), and match duration during second halves and match stoppage time in first halves increased (Vahed et al. 2014).

Rugby league

Six studies investigated the effects of rule changes within rugby league; on physical performance and technical-tactical events ($n = 5$; 83%) (Eaves, Hughes, et al. 2008; Rennie et al. 2021, 2022; Delves et al. 2022) and injury incidence and prevention ($n = 1$; 17%) (Gabbett 2005). All six studies included participants from Tier 4. Two studies included participants anthropometrical characteristics. Two studies included data collected and analysed from multiple teams.

One study reported reduced injury incidence (per 1000 playing hours) as an outcome measure of changing interchange rules from unlimited to a maximum of 12 during match-play (Gabbett 2005). During the 2019 Super League season, rule changes included reduced interchanges (from 10 to 8), the

introduction of a shot-clock, and addition of 'Golden Point'. Match duration for adjustables and backs reduced in season 2019 after rule changes alongside an increase in average speed for adjustables (Rennie et al. 2021). Three studies investigated the impact of the 'six-again' rule on locomotor variables (i.e., speed and acceleration) and match events (i.e., tackles and ball carries) (Rennie et al. 2021, 2022; Delves et al. 2022). Delves et al. (2022) reported greater acceleration intercepts, ball-in-play duration, and longer ball-in-play phases and greater mean acceleration during ball-in-play periods. An increase in tackle events and ball carry frequency (Rennie et al. 2021, 2022) following this rule change and the removal of scrums were observed and a reduction in average speed and average acceleration for all positional groups (Rennie et al. 2021).

Australian rules football

Four studies investigated the effects of rule changes within Australian rules football; on physical performance and technical-tactical events ($n=1$; 25%) (Wing et al. 2022) and injury incidence and prevention ($n=3$; 75%) (Orchard et al. 2009, 2014; Savage et al. 2012). One study included participants from Tier 3 and three studies included participants from Tier 4. One study included participants anthropometrical characteristics.

Match duration and cumulative physical outputs (e.g., distance, HSR distance and HSR efforts) reduced, therefore average speed ($\text{m}\cdot\text{min}^{-1}$) increased, in response to the shortening of match quarters and reducing number of fixtures within a season (Wing et al. 2022). Lower limb injury incidence (measured by posterior cruciate ligament (PCL) injuries per 10,000 player hours) and injuries specifically related to the centre bounce reduced following limiting the length of ruckman run-up using a 10 m circle (Orchard et al. 2009). Facial fractures recorded were reduced following changes to the Australian Football League (AFL) tribunal system permitting a match review panel to observe incidents and recommend player infringements (Savage et al. 2012). Following a reduction in fixtures during a season and a 20% reduction in quarter length, distance, HSR distance and HSR efforts reduced whilst average speed increased (Wing et al. 2022).

Discussion

This is the first systematic review assessing the effects of rule changes within football-code team sports. Following screening 46 studies were included. Outcome measures aligned to four themes: physical performance and technical-tactical events, injury incidence and prevention, match scoring or points awarded, and player development opportunities. The most researched code was soccer, with most focusing on physical performance and technical-tactical events. Overall, 85% of studies reported an effect of rule changes upon the investigated outcome. Unintended consequences of rule changes within football codes may be attributable to the observational design of most studies which does not allow researchers to control for factors such as environmental conditions, seasonality, and player selection. Furthermore, the application of rules is open to interpretation by coaches, players, and match officials, who may interpret situations

differently from one another, contributing to inconsistencies between studies.

Soccer

Effects on physical performance and technical-tactical events

The introduction of vanishing foam spray during free kicks in the 2014 FIFA World Cup led to longer free kick execution times than in the 2006 FIFA World Cup (without foam spray) (Augste and Cordes 2016). Additionally, a rule change on medical attention (i.e., whether a player stayed on the field to receive treatment [2014 FIFA World Cup] or was removed from the field [2006 FIFA World Cup]) led to longer breaks in play and delays during matches. These findings highlight the potential unintended consequences of rule changes, suggesting the need for continual evaluation and additional modifications to mitigate undesired effects. Several studies investigated changes to permitted substitutions within soccer (Meyer and Klatt 2021, 2024; Kobal et al. 2022; Ayabe et al. 2023; García-Aliaga et al. 2023) revealing that teams used the increased substitution allowance (Meyer and Klatt 2021, 2024; García-Aliaga et al. 2023). Due to this rule change, timing of substitutions was made by coaches significantly earlier during matches (Meyer and Klatt 2024). More substitutions reduced minutes played and perceived exertion by players which was suggested to improve the balance between stress and recovery during matches (Meyer and Klatt 2021). In Japanese soccer, increasing substitutions from 3 to 5 improved running performance (measured by total distance and sprint frequency) (Ayabe et al. 2023). García-Aliaga et al. (2023) also reported improved physical performance (e.g., total distance), when five substitutes were permitted. In junior soccer, increased substitutions did not significantly affect playing time, score, or red cards per match (Ribeiro et al. 2020). Moreover, increasing the number of substitutes from < 3 to 4–5 did not affect physical and technical parameters but did result in lower rating of perceived exertion (RPE) and session-RPE (RPE x duration), higher quality of recovery (measured using total recovery questionnaire on a rating scale of 6–20 (Kenttä and Hassmén 1998)), and lower time played by the player (Kobal et al. 2022). Differing results for similar rule change interventions are likely due to different playing populations, research methods or statistical analysis approaches. The implementation of the video assistant referee (VAR), which is a technological apparatus that enables referees to review their decisions on video, during the 2018 FIFA Men's World Cup affected both physical and technical aspects of matches. Matches with VAR reduced the number of sprints and total passes attempted by players and teams yet resulted in a higher percentage of accurate passes, fewer offsides and fouls but more penalties, more yellow cards, and extended total match time (Oliveira et al. 2021). A study on a revised offside rule showed that dividing the playing surface into thirds instead of halves increased total distance covered by players, particularly in high-speed running (Tok et al. 2017) as this change allowed for more space for players which potentially led to a faster and more entertaining spectacle for spectators.

Effects on Injury Incidence and Prevention

Implementing a red card for an intentional elbow-to-head strike resulted in a 23% reduction in fouls categorised as 'raises elbow to head' but was not statistically significant (Beaudouin et al. 2020). Beaudouin et al. (2019) also investigated injury incidence rate per 1000 match hours in the seasons before and after this rule change reporting a 29% reduction in head injuries following the rule change. These suggest injury prevention strategies using rule changes appear effective in reducing the occurrence of head injuries within male soccer players. The trial of additional permanent concussion substitutes did not show significant differences in head collision events or medical assessments between the pre- and post-implementation periods (Tarzi et al. 2022). Aerial challenges, which often occur because of long goal kicks (Putukian et al. 2019), are a risk factor for head injury and concussion in soccer. A rule change permitting goal kicks to be taken with a teammate inside the penalty area encouraged shorter passes and reduced the number of long goal kicks thereby reducing the number of aerial challenges and fouls following goal kicks (Shibukawa and Hoshikawa 2022). Making the wearing of shin guards mandatory in soccer led to a significant reduction in lower leg injuries in amateur soccer players (Vriend et al. 2015), therefore demonstrating the positive impact of rule changes on reducing risk of injury risk.

Effects on match scoring or points awarded

Prior to the away goal rule all goals were treated equal. The away goal rule states that when both teams score the same number of goals over two matches (i.e., sum of both games) the team scoring more goals away from home would progress. This was introduced to encourage more offensive play and increase scoring. However, this did not show significant effects on goals scored by teams playing away from home (Bahamonde-Birke and Bahamonde-Birke 2023). Prior to 1997, goalkeepers had to remain stationary until the ball was struck during a penalty kick. Permitting goalkeepers to move laterally along their line during penalty kicks reduced the penalty kick conversion rate during match-play (Dalton et al. 2015). Three studies investigated changing the number of points awarded for a victory from two to three points for a win (Guedes and Machado 2002; Butler and Butler 2017; Kula et al. 2022) which was implemented to incentivise teams to win matches rather than settle for a draw. Kula et al. (2022) reported Turkish first division soccer teams scored significantly more goals following this rule change. While the change did not significantly impact total goals scored, one study showed that it affected offensive moves and scoring patterns, with teams considered *favourites* benefiting more from the new rule (Guedes and Machado 2002). Inconsistent findings are perhaps explained by playing personnel, participating teams, competition level, evolution of tactics and philosophy, and changes to physical performance levels which should be considered within future research by taking these random effects into account when exploring and modelling data.

Effects on player development opportunities

Limited research exists on the effects of rule changes on player development opportunities. However, rules are written into

several football codes with this objective. For example, the Union of European Football Associations (UEFA) enforced a *Homegrown Player Rule* in 2008/09 which stipulates that clubs must name a maximum of 25 players for List A (i.e., European competition squad) and that a minimum of 8 players in this squad are trained by clubs from the same national league, with 4 of players being from the club's own youth system. The aim of this UEFA intervention was to protect young players and encourage the local training of young players (UEFA 2023). The 'under-21 rule' introduced by the Royal Belgian Football Association similarly aimed to provide young players with more senior playing opportunities in second and third national division teams. However, compliance with the rule did not result in a significant increase in the playing time of under-21 players (Vaeyens et al. 2005), suggesting that rule changes are not straightforward in providing playing opportunities to young athletes in competitive senior sports and subsequent strategies are required.

Rugby union

Effects on physical performance and technical-tactical events

A rule change that penalised players if the team in possession did not throw the ball into play within 20 seconds of the assistant referee marking the lineout resulted in significant increases in both ball-in-play time and passes per min, whilst a rule change forbidding open play kicks to land directly out of the field of play (i.e., prior to bouncing in field) increased number of kicks per min (Ashford et al. 2020). Set-piece law changes (i.e., Law 19) which states if a team puts the ball back into its own 22 m area and the ball is subsequently kicked directly into touch then there is no gain in territory, was suggested to explain a reduced number of lineouts (Kraak, Coetzee, et al. 2017). Equally, a law change (i.e., Law 20) in scrum engagement from 'crouch, touch, pause, engage' to 'crouch, bind, set' elicited reduced number of scrums which could be due to increased stability during the scrum event (Kraak, Coetzee, et al. 2017). Eleven seasons of analysis of Super Rugby competition data, from 2006 to 2016, revealed that implementation of 2008 experimental law variations, which included amendments to Law 17 – Maul; Law 19 – Touch and Lineout; Law 20 – Scrum; and Law 22 – Corner Posts, led to more offensive and open-play rugby, with increased clean breaks, defenders beaten, and tries scored (Lo et al. 2019). An experimental law variation colloquially known as '*use it or lose it*' was introduced in 2012 to encourage continuity and increase open play. However, research by Spencer and Brady (2015) revealed that the experimental law variation did not achieve its intended objective as evidenced by increased closed game tactics (e.g., increased number of pick-and-go events) and a decrease in open play time. Continuity of matches (measured via whole-match and ball-in-play duration) was also investigated within international and domestic professional rugby over a four-year period with yearly differences established as well as differences between northern and southern hemisphere competition, especially ball-in-play duration where ball-in-play time was significantly greater (Williams et al. 2005). These authors go on to speculate that whilst ball-in-

play time increased, the frequency and ferocity of contacts may also have increased, which would likely increase injury incidence within the game resulting in more stoppages and longer whole-match duration. With specific reference to match events, Super Rugby competition reported reduced set piece (i.e., scrum and lineouts) and an increase in the number of tackles made, meters gained and penalties conceded ruck frequency, defence beaten and passes made in response to multiple experimental law variations (van den Berg and Malan 2012). Rule changes in rugby union have been reported to influence various time-related aspects of the game. Vahed et al. (2014) demonstrated that modifications including extended television match official (TMO) jurisdiction and the 'use it or lose it' rule impacted match duration, ruck and maul time, tackle time, and scrum time. Furthermore, renaming scrummage engagement commands and other adjustments led to decreased scrum time and less resets (Vahed et al. 2014). Collectively, these responses to the implementation of rule changes demonstrate that player behaviours can be manipulated with the application of rule changes leading to changes in team tactics, skill attempts and strategy.

Effects on injury incidence and prevention

The scrum, a set-piece contact area in rugby which elicits high-impact forces between opposing players (Hendricks et al. 2014), has undergone modifications to improve player safety. A revised engagement sequence introduced in 2013 was shown to increase scrum duration and enhance stability (Bradley et al. 2018) and reduce peak load in a training environment measured using 500 Hz shoulder pressure sensors by 35% than the previous sequence (Cazzola et al. 2015). The newly introduced 'crouch, bind, set' sequence also reduced the incidence of collapsed scrums and early engagements, contributing to improved player welfare (Stean et al. 2015). Fuller et al. (2009) compared injury incidence between competitions with experimental law variations related to lineouts, tackles, and mauls and found that the Vodacom Cup (which included experimental law variations) had lower injury rates than the English Premiership, highlighting the potential of rule changes to reduce injuries. Head injury assessment (HIA) protocols were written into World Rugby laws in 2015 prior to the Rugby World Cup. The incidence of concussions almost doubled from 7.8/1000 player hours in 2011 to 13.9/1000 player hours in 2015 and was consistent in 2019 a rate of 12.8/1000 player hours in 2019 therefore suggesting that the implementation of this law change has increased identification of players who may have suffered concussion (Cooke et al. 2023). The tackle event is the incident most associated with time-loss head injuries and sports-related concussion in rugby union (van Tonder et al. 2022). Reducing the legal tackle height from the shoulder to the armpit with the objective of reducing head and neck contact during tackle events did elicit a change in tackler behaviour (i.e., reduced prevalence of illegal tackles) (Stokes et al. 2021); however this law change did not elicit a significant reduction in concussion incidence (Stokes et al. 2021; van Tonder et al. 2022). In light of the change of tackler behaviour, Stokes et

al. (2021) suggested the most efficacious approach to improve player safety around the tackle event may be to improve coach and player education and awareness when implementing law changes.

Effects on match scoring or points awarded

Changes to the number of points awarded for specific actions within rugby union matches have impacted match scoring. A scoring change that increased the points for a conversion and decreased points for penalties and drop goals resulted in more tries and conversions, fewer penalties and drop goals, indicating that teams were more encouraged to attempt scoring tries (Kraak, Welman, et al. , Welman, et al. 2017). When comparing scoring profiles between 2008 and 2013 rugby seasons, Kraak et al. (2016) reported significant differences in the number of tries, conversion kicks, penalties, and drop goals, attributed to the introduction of Law 16.7 (i.e., 'use it') and other relevant law changes. Changes to Law 16.7 (c) have also been investigated within Currie Cup competition. Greater continuity was observed in matches which were shown to be physically more intense (i.e., more successful tackles and passes completed, alongside fewer handling errors and tries scored) which the authors attributed to a more defensive playing style by committing less players to the ruck (Vahed et al. 2016). This study also found fewer tries but more successful tackles and passes completed, suggesting more physically intense and continuous matches as a response to the rule changes (Vahed et al. 2016). These studies demonstrate that rule modifications can influence how teams approach scoring points within matches (e.g., greater or fewer numbers of tries depending on intervention). Law changes related to scoring mechanisms continue to be implemented within rugby union (e.g., introduction of 'shot-clock' at 2023 Rugby World Cup) therefore ongoing research to understand their effects is required.

Rugby league

Effects on physical performance and technical-tactical events

Eaves, Hughes, et al. (2008) studied the effects of several rule changes between 1992 and 2000 in professional northern hemisphere rugby league. While the changes (including the 10 m offside rule, a change in playing season, and the 40–20 kick rule) influenced some match variables, they had little impact on playing patterns overall. The 10 m offside rule reduced ruck time, and the change in playing season to summer further increased ruck speed. However, the overall playing patterns remained relatively unaffected by these rule changes. A 2020 rule change introduced in both northern and southern hemisphere rugby league, the colloquially names 'six-again' rule, aimed at increasing match speed and promoting greater ball-in-play time, which could influence the activity profile of athletes during competition. Under the 'six-again' rule, the defending team's tackle count was reset to a full six tackles when an infringement occurred with the objective of increasing match speed. This was reported to substantially increase acceleration characteristics in the 2020 and 2021 seasons than 2019 (Delves et al. 2022). Mean acceleration during ball-in-play

time was also higher in 2020 than 2019 (Delves et al. 2022). Reduced number of player interchanges, implementation of a shot-clock, and addition of 'Golden Point' (i.e., added time for matches tied at full-time) were three rule changes implemented ahead of the 2019 Super League season. These led to reduced match duration and increased average speed for adjustables in 2019 (Rennie et al. 2021). Additionally, an enforced mid-season suspension in 2020 in Super League brought more rule modifications including the removal of scrums and the 'six-again' rule. These led to a reduction in average speed and acceleration for all positions, yet increased tackle frequency for forwards and adjustables and increased carry frequency for forwards and missed tackles for backs (Rennie et al. 2021). Over seven-years and 1,000,000 tackle events, more tackles and tackler involvements per match were observed for season 2020_b, than all other seasons. This season included the introduction of the 'six again' rule and removal of scrums in response to COVID-19 return-to-play restrictions (Rennie et al. 2022). These findings emphasise the importance of understanding how rule changes affect physical demands and match event characteristics to better prepare players for the evolving performance demands. Coaches and players should consider the evolving physical demands of the sport when adapting to rule modifications.

Effects on injury incidence and prevention

Rugby league operates an interchange rather than substitution policy which since 2019 has been implemented as eight permitted interchanges per side in professional Super League and National Rugby League (NRL) competition. Previous research demonstrated that injury incidence (per 1000 hours) significantly decreased following changes to the interchange limit (i.e., reducing interchanges from unlimited to maximum of twelve) (Gabbett 2005). This suggests that despite potentially increasing the physiological demands on players and causing them to perform more frequently in a fatigued state, this state may reduce match speed and collision forces leading to a lower injury incidence (Gabbett 2005). These findings indicate that the interchange policy has an impact on injury rates and player fatigue during matches. By understanding the relationship between interchanges and injuries, rugby league authorities and coaching staff can implement strategies to manage player health and wellbeing, whilst optimising match performance.

Australian rules football

Effects on physical performance and technical-tactical events

In response to time lost due to the suspension of competition during the COVID-19 pandemic, the 2020 season was reduced by 55% to an 8-game regular season plus finals. Additionally, match quarters were shortened by 20%, from 20 minutes plus time-on (i.e., period of added time to account for stoppages in play) to 16 minutes plus time-on. The effects of these changes revealed significant reductions in match duration, distance covered, high-speed running distance, and high-speed running efforts; however, average speed increased as a result (Wing et al.

2022). Injury rates remained similar between 2019 and 2020, but the proportion of injuries leading to missed matches was higher in 2020 (Wing et al. 2022). This suggests that rule changes can have a considerable influence on player performance and injury likelihood.

Effects on injury incidence and prevention

Australian rules football is played over four-quarters; each beginning with a centre bounce where two opposing players sprint towards a bounced ball in the centre of the field and jump towards the ball to win possession. In 2005, rules were introduced to minimise knee injuries during centre bounces. These changes successfully reduced the incidence of PCL injuries and facial fractures (Orchard et al. 2009). That same year (2005), the AFL changed their tribunal system to a match review panel which would observe incidents and recommend player infringements. A reduction of facial fractures in the period following this 2005 rule change was deemed to be a potential consequence of this implementation (Savage et al. 2012) however these authors did not complete significance testing on this dataset therefore quantifying the magnitude of any effects this rule change may have had are problematic. From 2003 to 2014, the AFL implemented 26 rule changes, many aimed at mitigating head and neck injuries and concussions. A rule change in 2007, awarding a free kick to a player with their head over the ball in case of high contact, led to a significant reduction in facial fractures and head/neck injuries (Orchard et al. 2014). However, concussion rates increased from 2011 onward, attributed to the 'Concussion rule', which prevented concussed players from returning to the game (Orchard et al. 2014). A 2011 'Substitute rule' involving fewer interchanges and a permanent substitute player resulted in lower groin and hamstring injury incidences from 2011 to 2013 (Orchard et al. 2014), indicating that rule changes addressing athlete load can effectively reduce injury risk. These findings underscore the role of rule modifications in shaping injury patterns in Australian rules football.

Cross-sport potential application of rule changes within football-code team sports

This review has outlined rule changes which have taken place within football-code team sports, and their effectiveness in achieving desired outcomes. Findings from specific football codes have potential application across sports. Reducing the risk of head injuries is desirable within all football codes. Rugby union (Cooke et al. 2023) and rugby league have head injury assessment protocols to allow players with suspected concussive symptoms to be assessed off the pitch, prior to permanent removal when necessary. Whereas soccer (Tarzi et al. 2022) has permanent removal following an on-field assessment. Future studies may benefit from evaluating the effectiveness of both approaches from a laws perspective. Rugby league differs from other continuous match-play football codes, such as soccer and rugby union, in that players are interchanged in rugby league rather than substituted. Interchanging allows the player who leaves the field to return to the field later in the match, whereas a substituted player is not allowed to re-enter the match. Within both soccer and rugby union, teams can presently

replace ~50% of their starting players (i.e., eight out of fifteen in rugby union and five out of eleven in soccer). Performing a substitute requires the match to be completely stopped and contributes to inactive on-field time whereas within rugby league the action of interchanging a player occurs during live match-play, potentially contributing to a more continuous experience. The evaluation of number of interchanges on injury incidence (Gabbett 2005) and physical performance and match-play characteristics (Rennie et al. 2021) may be applied to other sports which aim to change the match demands. Player development opportunities are of great importance in soccer which is emphasised by the 'Homegrown Player Rule' (Vaeyens et al. 2005), implemented by UEFA almost 20 years ago. Although not written into the laws of rugby union, the United States competition format, Major League Rugby (MLR), also implemented a similar rule in late-2020 which aims at incentivising sustained player development (Major League Rugby 2020). This MLR-specific rule stipulates that participating teams can designate up to five academy players as 'homegrown' each year, which allows certain protections for the player to be assigned to a team without having to go through a central allocation process such as the 'Collegiate Draft' (Major League Rugby 2020) however the effects of this rule with respect to development opportunities have not been quantified within literature and therefore requires investigation.

Limitations

Findings illustrated within this review may be limited due to several factors related to the content of the selected studies. Firstly, several studies did not account for confounding factors within their analysis which may contribute to the observed changes in measured outcomes over time which are not related to the intervention (i.e., the rule change). For example, whilst contextual factors (i.e., possession, scoreline, or player location on the field) and environmental-related conditions (i.e., venue, temperature, or weather) might influence outcomes within games, when observing pre- and post-changes over longer periods of time (e.g., several seasons), other factors also contribute, such as evolution in tactical approaches by teams that in turn influence outcomes (Dalton-Barron et al. 2020). Confounding should be accounted for using appropriate statistical methods (i.e., accounting for the covariance or hierarchical nature of data) (Balagué et al. 2017). Secondly, a limitation of the current literature investigating the effects of rule changes in football-code team sports is that none of the studies included within this review were preregistered or registered report submissions and therefore methods, including statistical analysis, and presentation of results are susceptible to bias. The prevalence of HARKing in sport and exercise science is unknown, but other disciplines estimate that upwards of 30% of researchers engage in the practice (John et al. 2012) and therefore, to increase transparency, researchers should where possible register their work (Impellizzeri et al. 2019; Caldwell et al. 2020; Abt et al. 2021). Whilst preregistration in and of itself is not an indicator of study quality, preregistration encourages transparency of study methods and analyses (Toth et al. 2021). Thirdly, publication bias is a concept which refers to the selective publication of research studies based on their positive

effect findings (Dickersin 1990; Mesquida et al. 2023). A characteristic of publication bias is greater likelihood of statistically significant findings being published than null findings when research quality is of an equal standard (Franco et al. 2014), and is a limitation within biomedical (Song et al. 2010), social (Coursol and Wagner 1986; Gerber and Malhotra 2008), and sports and exercise (Twomey et al. 2021; Mesquida et al. 2023) sciences. Finally, the authors of this review manually classified the included studies into broad themes, as has been in the case in previous literature (Okholm Kryger et al. 2022) which although screened by two independent reviewers may have been influenced by some level of bias.

Future directions

This review has identified several rule changes within football-code team sports which may be transferrable across sports and can be used to stimulate thought and inspiration for future studies. Previous literature has identified basic stages for researchers to follow when studying rule changes in sports (Arias et al. 2011), yet the pool of evidence appears at a high risk of bias. This is contributed to partly due to the quasi-experimental nature of included studies, which are inherently non-randomised, but also due to the lack of control for confounding factors within most studies in this area. It is important that future studies analysing an interrupted timeseries, as is often the case in studies investigating the effects of rule changes within football codes, account for confounding factors by implementing suitable statistical analysis (e.g., linear mixed effect modelling) (Paul et al. 2015). It remains unclear if rule or law changes completed within specific playing populations cascade across all playing populations in that sport (e.g., a law change in male sport may or may not elicit the same responses in female players) and therefore accounting for playing population is recommended in future studies which will broaden the evidence-based usefulness of rule changes in sport. It is recommended that studies investigating the effects of rule changes within football-code team sports are preregistered or submitted as registered reports whenever possible to reduce risk of bias through reducing the potential for data dredging, p-hacking, HARKing, lack of replications, and selective reporting (Impellizzeri et al. 2019).

Conclusion

Rule changes are common within the context of football-code team sports characterised by continuous match-play and is an emerging area of research. Rule changes have impacted different facets of the sports and their participants, including physical performance and technical-tactical events, injury incidence and prevention, match scoring or points awarded, and player development opportunities. This review provides insight into the depth of research investigating the effects of rule changes within football-code team sports and reveals that the pool of evidence is at risk of bias with studies demonstrating a distinct lack of consistency in research methods, outcome measures and

statistical analyses. Consistent data collection and reporting of outcome measures of rule changes would allow coaches and medical staff to better prepare players for the demands of competition. Overall, the consequences of rule changes within sports can be far-reaching and multifaceted. They require careful consideration, research, and often consultation with stakeholders to ensure that the intended outcomes are achieved whilst maintaining the essence of the sport. Ongoing research is required to evidence the effects of future rule changes within football-code team sports. Such research would broaden the evidence-based usefulness of rule changes and help guide governing bodies to achieve intended outcomes.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The author(s) reported there is no funding associated with the work featured in this article.

Author contributions

GR contributed to the design, search strategy, interpretation of the results, and writing up of the paper. LC contributed to the design, search strategy, interpretation of the results, and writing up of the paper. DW contributed to the design, interpretation of the results, and writing up of the paper. BJ contributed to the design, interpretation of the results, and writing up of the paper. GR and LC prepared the first draft of the manuscript and then all authors made substantial contributions to the various iterations of the manuscript resulting in the final version. All authors read and approved the final version of the manuscript.

References

- Abt G, Boreham C, Davison G, Jackson R, Wallace E, Williams AM. 2021. Registered reports in the journal of sports sciences. *J Sports Sci.* 39(16):1789–1790. doi: [10.1080/02640414.2021.1950974](https://doi.org/10.1080/02640414.2021.1950974).
- Arias JL, Argudo FM, Alonso JI. 2011. Review of rule modification in sport. *J Sports Sci Med.* 10(1):1–8.
- Ashford M, Burke K, Barrell D, Abraham A, Poolton J. 2020. The impact of rule modifications on player behaviour in a talent identification and development environment: a case study of the rugby football union's wellington academy rugby festival. *J Sports Sci.* 38(23):2670–2676. doi: [10.1080/02640414.2020.1795559](https://doi.org/10.1080/02640414.2020.1795559).
- Augste C, Cordes O. 2016. Game stoppages as a tactical means in soccer - a comparison of the FIFA world Cups™ 2006 and 2014. *Int J Perform Anal Sport.* 16(3):1053–1064. doi: [10.1080/24748668.2016.11868947](https://doi.org/10.1080/24748668.2016.11868947).
- Ayabe M, Sunami S, Kumahara H, Ishizaki S. 2023. Effects of substitute allowance on match activity characteristics in Japanese professional football across 2019, 2020, and 2021 seasons. *J Sports Sci.* 40(23):2654–2660. doi: [10.1080/02640414.2023.2182878](https://doi.org/10.1080/02640414.2023.2182878).
- Bahamonde-Birke FJ, Bahamonde-Birke RA. 2023. About the “Away Goals Rule” in association football. Does scrapping the rule increase the fairness of the game? *J Sports Econom.* 24(3):310–328. doi: [10.1177/15270025221128957](https://doi.org/10.1177/15270025221128957).
- Balagué N, Torrents C, Hristovski R, Kelso JAS. 2017. Sport science integration: an evolutionary synthesis. *Eur J Sport Sci.* 17(1):51–62. doi: [10.1080/17461391.2016.1198422](https://doi.org/10.1080/17461391.2016.1198422).
- Beaudouin F, Aus der Fünten K, Tröb T, Reinsberger C, Meyer T. 2019. Head injuries in professional male football (soccer) over 13 years: 29% lower incidence rates after a rule change (red card). *Br J Sports Med.* 53(15):948–952. doi: [10.1136/bjsports-2016-097217](https://doi.org/10.1136/bjsports-2016-097217).
- Beaudouin F, der Fünten K, Tröb T, Reinsberger C, Meyer T. 2020. Match situations leading to head injuries in professional male football (Soccer) —A video-based analysis over 12 years. *Clin J Sport Med.* 30(1):S47–S52. doi: [10.1097/JSM.0000000000000572](https://doi.org/10.1097/JSM.0000000000000572).
- Bradley EJ, Hogg B, Archer DT. 2018. Effect of the PreBind engagement process on scrum timing and stability in the 2013–16 six nations. *Int J Sports Physiol Perform.* 13(7):903–909. doi: [10.1123/ijspp.2017-0531](https://doi.org/10.1123/ijspp.2017-0531).
- Butler D, Butler R. 2017. Rule changes and incentives in the league of Ireland from 1970 to 2014. *Soccer Soc.* 18(5/6):785–799. doi: [10.1080/14660970.2016.1230347](https://doi.org/10.1080/14660970.2016.1230347).
- Caldwell AR, Vigotsky AD, Tenan MS, Radel R, Mellor DT, Kreutzer A, Lahart IM, Mills JP, Boisgontier MP. 2020. Moving sport and exercise science forward: a call for the adoption of more transparent research practices. *Sports Med.* 50(3):449–459. doi: [10.1007/s40279-019-01227-1](https://doi.org/10.1007/s40279-019-01227-1).
- Cazzola D, Preatoni E, Stokes KA, England ME, Trewartha G. 2015. A modified prebind engagement process reduces biomechanical loading on front row players during scrummaging: a cross-sectional study of 11 elite teams. *Br J Sports Med.* 49(8):541–546. doi: [10.1136/bjsports-2013-092904](https://doi.org/10.1136/bjsports-2013-092904).
- Chesson L, Whitehead S, Flanagan K, Deighton K, Matu J, Backhouse SH, Jones B. 2021. Illness and infection in elite full-contact football-code sports: a systematic review. *J Sci Med Sport.* 24(5):435–440. doi: [10.1016/j.jsams.2020.11.001](https://doi.org/10.1016/j.jsams.2020.11.001).
- Cooke R, Strang M, Lowe R, Jain N. 2023. The epidemiology of head injuries at 2019 Rugby union world cup. *Phys Sportsmed.* 51(4):336–342. doi: [10.1080/00913847.2022.2083458](https://doi.org/10.1080/00913847.2022.2083458).
- Coursol A, Wagner EE. 1986. Effect of positive findings on submission and acceptance rates: a note on meta-analysis bias. *Prof Psychol Res Pract.* 17(2):136–137. doi: [10.1037//0735-7028.17.2.136](https://doi.org/10.1037//0735-7028.17.2.136).
- Crang ZL, Duthie G, Cole MH, Weakley J, Hewitt A, Johnston RD. 2021. The validity and reliability of wearable microtechnology for intermittent team sports: a systematic review. *Sports Med.* 51(3):549–565. doi: [10.1007/s40279-020-01399-1](https://doi.org/10.1007/s40279-020-01399-1).
- Cummins C, Orr R, O'Connor H, West C. 2013. Global Positioning Systems (GPS) and microtechnology sensors in team sports: a systematic review. *Sports Med.* 43(10):1025–1042. doi: [10.1007/s40279-013-0069-2](https://doi.org/10.1007/s40279-013-0069-2).
- Dalton K, Guillon M, Naroo SA. 2015. An analysis of penalty kicks in elite football post 1997. *Int J Sports Sci Coach.* 10(5):815–827. doi: [10.1260/1747-9541.10.5.815](https://doi.org/10.1260/1747-9541.10.5.815).
- Dalton-Barron N, Whitehead S, Roe G, Cummins C, Beggs C, Jones B. 2020. Time to embrace the complexity when analysing GPS data? A systematic review of contextual factors on match running in rugby league. *J Sports Sci.* 38(10):1161–1180. doi: [10.1080/02640414.2020.1745446](https://doi.org/10.1080/02640414.2020.1745446).
- Delves RIMM, Thornton HR, Hodges J, Cupples B, Ball K, Aughey R, Duthie GM. 2022. The introduction of the six-again rule has increased acceleration intensity across all positions in the national rugby league competition. *Sci Med Footb.* 7(1):47–56. doi: [10.1080/24733938.2022.2051729](https://doi.org/10.1080/24733938.2022.2051729).
- Dickersin K. 1990. The existence of publication bias and risk factors for its occurrence. *JAMA: The J Am Med Assoc.* 263(10):1385–1389. doi: [10.1001/jama.1990.03440100097014](https://doi.org/10.1001/jama.1990.03440100097014).
- Downs SH, Black N. 1998. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health.* 52(6):377–384. doi: [10.1136/jech.52.6.377](https://doi.org/10.1136/jech.52.6.377).
- Eaves JS, Hughes DM, Lamb LK, Eaves SJ, Hughes MD, Lamb KL. 2008. Assessing the impact of the season and rule changes on specific match and tactical variables in professional rugby league football in the United Kingdom. *Int J Perform Anal Sport.* 8(3):104–118. doi: [10.1080/24748668.2008.11868452](https://doi.org/10.1080/24748668.2008.11868452).
- Eaves SJ, Lamb KL, Hughes MD, Eaves JS, Lamb LK, Hughes DM. 2008. The impact of rule and playing season changes on time variables in professional in rugby league in the United Kingdom. *Int J Perform Anal Sport.* 8(2):44–54. doi: [10.1080/24748668.2008.11868434](https://doi.org/10.1080/24748668.2008.11868434).
- Eng JJ, Teasell RW, Miller WC, Wolfe D, Townson A, Aubut J-A, Abramson C, Hsieh J, Connolly S, Konnyu K, et al. 2007. Spinal cord injury rehabilitation evidence: method of the SCIRE systematic review. *Top Spinal Cord Inj Rehabil.* 13(1):1–10. doi: [10.1310/sci1301-1](https://doi.org/10.1310/sci1301-1).

- Farley JB, Barrett LM, Keogh JWL, Woods CT, Milne N. 2020. The relationship between physical fitness attributes and sports injury in female, team ball sport players: a systematic review. *Sports Med Open*. 6(1):45. doi: [10.1186/s40798-020-00264-9](https://doi.org/10.1186/s40798-020-00264-9).
- Franco A, Malhotra N, Simonovits G. 2014. Publication bias in the social sciences: unlocking the file drawer. *Sci*. 345(6203):1502–1505. doi: [10.1126/science.1255484](https://doi.org/10.1126/science.1255484).
- Fuller CW, Raftery M, Readhead C, Sgrr T, Molloy MG. 2009. Impact of the International Rugby Board's experimental law variations on the incidence and nature of match injuries in southern hemisphere professional rugby union. *S Afr Med J*. 99(4):232–237.
- Gabbett TJ. 2005. Influence of the limited interchange rule on injury rates in sub-elite Rugby league players. *J Sci Med Sport*. 8(1):111–115. doi: [10.1016/s1440-2440\(05\)80031-3](https://doi.org/10.1016/s1440-2440(05)80031-3).
- García-Aliaga A, Martín-Castellanos A, Marquina Nieto M, Muriarte Solana D, Resta R, López Del Campo R, Mon-López D, Refoyo I. 2023. Effect of increasing the number of substitutions on physical performance during periods of congested fixtures in football. *Sports*. 11(2):1–14. doi: [10.3390/sports11020025](https://doi.org/10.3390/sports11020025).
- Gerber AS, Malhotra N. 2008. Publication bias in empirical sociological research: do arbitrary significance levels distort published results? *Sociol Methods Res*. 37(1):3–30. doi: [10.1177/0049124108318973](https://doi.org/10.1177/0049124108318973).
- Guedes JC, Machado FS. 2002. Changing rewards in contests: has the three-point rule brought more offense to soccer? *Empir Econ*. 27(4):607–630. doi: [10.1007/s001810100106](https://doi.org/10.1007/s001810100106).
- Hendricks S, Lambert MI, Brown JC, Readhead C, Viljoen W. 2014. An evidence-driven approach to scrum law modifications in amateur rugby played in South Africa. *Br J Sports Med*. 48(14):1115–1119. doi: [10.1136/bjsports-2013-092877](https://doi.org/10.1136/bjsports-2013-092877).
- Higgins JPT, Altman DG, Gotzsche PC, Juni P, Moher D, Oxman AD, Savovic J, Schulz KF, Weeks L, Sterne JAC, et al. 2011. The cochrane collaboration's tool for assessing risk of bias in randomised trials. *BMJ*. 343(Oct 18 2):d5928–d5928. doi: [10.1136/bmj.d5928](https://doi.org/10.1136/bmj.d5928).
- Impellizzeri FM, McCall A, Meyer T. 2019. Registered reports coming soon: our contribution to better science in football research. *Sci Med Footb*. 3(2):87–88. doi: [10.1080/24733938.2019.1603659](https://doi.org/10.1080/24733938.2019.1603659).
- John LK, Loewenstein G, Prelec D. 2012. Measuring the prevalence of questionable research practices with incentives for truth telling. *Psychol Sci*. 23(5):524–532. doi: [10.1177/0956797611430953](https://doi.org/10.1177/0956797611430953).
- Johnston RD, Black GM, Harrison PW, Murray NB, Austin DJ. 2018. Applied sport science of Australian Football: a systematic review. *Sports Med*. 48(7):1673–1694. doi: [10.1007/s40279-018-0919-z](https://doi.org/10.1007/s40279-018-0919-z).
- Kenttä G, Hassmén P. 1998. Overtraining and recovery. *Sports Med*. 26(1):1–16. doi: [10.2165/00007256-199826010-00001](https://doi.org/10.2165/00007256-199826010-00001).
- Kew F. 1987. Contested rules: an explanation of how games change. *Int Rev Sociol Sport*. 22(2):125–135. doi: [10.1177/101269028702200205](https://doi.org/10.1177/101269028702200205).
- Kew F. 1990. The development of games: an endogenous explanation. *Int Rev Sociol Sport*. 25(4):251–267. doi: [10.1177/101269029002500401](https://doi.org/10.1177/101269029002500401).
- Kobal R, Aquino R, Carvalho L, Serra A, Sander R, Gomes N, Concon V, Ramos GP, Barroso R. 2022. Does the number of substitutions used during the matches affect the recovery status and the physical and technical performance of elite women's soccer? *Int J Environ Res And Public Health*. 19(18):11541. doi: [10.3390/ijerph191811541](https://doi.org/10.3390/ijerph191811541).
- Kraak W, Coetzee F, Venter R. 2017. Analysis of the general match profile of international rugby union between 2007–2013. *Int J Perform Anal Sport*. 17(3):303–318. doi: [10.1080/24748668.2017.1336689](https://doi.org/10.1080/24748668.2017.1336689).
- Kraak W, Venter R, Coetzee F. 2016. Scoring and general match profile of super Rugby between 2008 and 2013. *Int J Perform Anal Sport*. 16(2):786–805. doi: [10.1080/24748668.2016.11868923](https://doi.org/10.1080/24748668.2016.11868923).
- Kraak W, Welman K, Carreras D, Vaz L. 2017. Modifying scoring system at South African University rugby level changes game dynamics. *South Afr J Res Sport Phys Educ Recreat*. 39(2):89–100.
- Kula H, Kula F, Kacay Z. 2022. Futbolda Üç Puan Kuralı, Gol Sayısı ve Öngörülebilirlik: Markov-Rejim Değişim Modeli ile Uzun Dönemli Bir Analiz. *Akdeniz Spor Bilimleri Dergisi*. 5(Özel Sayı 2):1032–1040. doi: [10.38021/asbid.1209634](https://doi.org/10.38021/asbid.1209634).
- Lo M, Aughey RJ, Hopkins WG, Gill N, Stewart AM. 2019. The longest journeys in super Rugby: 11 years of travel and performance indicators. *J Sports Sci*. 37(18):2045–2050. doi: [10.1080/02640414.2019.1618533](https://doi.org/10.1080/02640414.2019.1618533).
- Lyons K, Radburn C, Orr R, Pope R. 2017. A profile of injuries sustained by law enforcement officers: A critical review. *Int J Environ Res Public Health*. 14(2):142. doi: [10.3390/ijerph14020142](https://doi.org/10.3390/ijerph14020142).
- Major League Rugby. Major league rugby homegrown player policy. 2020. Published. <https://www.majorleague.rugby/major-league-rugby-home-grown-player-policy/>.
- McKay AKA, Stellingwerff T, Smith ES. 2022. Defining training and performance Caliber: a participant classification framework. *Int J Sports Physiol Perform*. 17(2):317–331. doi: [10.1123/ijsp.2021-0451](https://doi.org/10.1123/ijsp.2021-0451).
- Mesquida C, Murphy J, Lakens D, Warne J. 2023. Publication bias, statistical power and reporting practices in the journal of sports sciences: potential barriers to replicability. *J Sports Sci*. 41(16):1507–1517. doi: [10.1080/02640414.2023.2269357](https://doi.org/10.1080/02640414.2023.2269357).
- Meyer J, Klatt S. 2021. Impact of one additional substitution on player load and coaching tactics in elite football. *Appl Sci (Switz)*. 11(16):7676. doi: [10.3390/app11167676](https://doi.org/10.3390/app11167676).
- Meyer J, Klatt S. 2024. Additional substitutions in elite European football. *Int J Sports Sci Coach*. 19(2):769–778. doi: [10.1177/17479541231164090](https://doi.org/10.1177/17479541231164090).
- Moher D, Liberati A, Tetzlaff J, Altman DG. 2009. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ (Online)*. 339(7716):b2535–b2535. doi: [10.1136/bmj.b2535](https://doi.org/10.1136/bmj.b2535).
- Naughton M, Jones B, Hendricks S, King D, Murphy A, Cummins C. 2020. Quantifying the collision dose in rugby league: a systematic review, meta-analysis, and critical analysis. *Sports Med Open*. 6(1):6. doi: [10.1186/s40798-019-0233-9](https://doi.org/10.1186/s40798-019-0233-9).
- Okholm Kryger K, Wang A, Mehta R, Impellizzeri FM, Massey A, McCall A. 2022. Research on women's football: a scoping review. *Sci Med Footb*. 6(5):549–558. doi: [10.1080/24733938.2020.1868560](https://doi.org/10.1080/24733938.2020.1868560).
- Oliveira MAC, Dambroz F, Santos R, Moniz F. 2021. VAR implementation and soccer team performance: a comparison between the 2014 and 2018 World Cups. *J Phys Educ Sport*. 21(6):3208–3213. doi: [10.7752/jpes.2021.s6426](https://doi.org/10.7752/jpes.2021.s6426).
- Olive SA, Macedo LG, Gadotti IC, Fuentes J, Stanton T, Magee DJ. 2008. Scales to assess the quality of randomized controlled trials: a systematic review. *Phys Ther*. 88(2):156–175. doi: [10.2522/ptj.20070147](https://doi.org/10.2522/ptj.20070147).
- Orchard JW, McCrory P, Makdissi M, Seward H, Finch CF. 2014. Use of rule changes to reduce injury in the Australian football league. *Minerva Ortopedica e Traumatologica*. 65(6):355–364.
- Orchard JW, Seward H, Seward H, Orchard JW. 2009. Decreased incidence of knee posterior cruciate ligament injury in Australian Football League after ruck rule change. *Br J Sports Med*. 43(13):1026–1030. doi: [10.1136/bjism.2009.063123](https://doi.org/10.1136/bjism.2009.063123).
- Paul DJ, Bradley PS, Nassis GP. 2015. Factors affecting match running performance of elite soccer players: shedding some light on the complexity. *Int J Sports Physiol Perform*. 10(4):516–519. doi: [10.1123/ijsp.2015-0029](https://doi.org/10.1123/ijsp.2015-0029).
- Putukian M, Echemendia RJ, Chiampas G, Dvorak J, Mandelbaum B, Lemak LJ, Kirkendall D. 2019. Head injury in soccer: from science to the field; summary of the head injury summit held in April 2017 in New York City, New York. *Br J Sports Med*. 53(21):1332–1332. doi: [10.1136/bjsports-2018-100232](https://doi.org/10.1136/bjsports-2018-100232).
- Rennie G, Hart B, Dalton-Barron N, Weaving D, Williams S, Jones B. 2021. Longitudinal changes in super league match locomotor and event characteristics: A league-wide investigation over three seasons in rugby league. *Sunderland C, ed. PLOS ONE*. 16(12):e0260711. doi: [10.1371/journal.pone.0260711](https://doi.org/10.1371/journal.pone.0260711).
- Rennie G, Weaving D, Hart B, Dalton-Barron N, Jones B. 2022. Tackle and ball carrier demands of rugby league: a seven-year league-wide study including over 1,000,000 tackle events. *J Sci Med Sport*. 25(10):850–854. doi: [10.1016/j.jsams.2022.07.002](https://doi.org/10.1016/j.jsams.2022.07.002).
- Ribeiro CFB, Siqueira LDS, Pinto DP, Da SC. 2020. The three and six-substitution rules in football: A preliminary comparative analysis in quantitative replacing, game statistics, win rate and winning probability. *Motriz Revista de Educacao Fis*. 26(2). doi: [10.1590/s1980-6574202000020188](https://doi.org/10.1590/s1980-6574202000020188).
- Savage J, Winter M, Orchard J, Schenberg M. 2012. Incidence of facial fractures in the Australian Football League. *ANZ J Surg*. 82(10):724–728. doi: [10.1111/j.1445-2197.2012.06181.x](https://doi.org/10.1111/j.1445-2197.2012.06181.x).
- Shibukawa K, Hoshikawa Y. Decrease in aerial challenges after revision of goal kick rules in Japan professional soccer league: explorative study of the possibility of a risk reduction for head injury, concussion, and brain

- damage by a rule revision. *Sci Med Footb.* 2022:1–6. doi: [10.1080/24733938.2022.2142274](https://doi.org/10.1080/24733938.2022.2142274).
- Silverman SR, Schertz LA, Yuen HK, Lowman JD, Bickel CS. 2012. Systematic review of the methodological quality and outcome measures utilized in exercise interventions for adults with spinal cord injury. *Spinal Cord.* 50(10):718–727. doi: [10.1038/sc.2012.78](https://doi.org/10.1038/sc.2012.78).
- Song F, Parekh S, Hooper L, Loke YK, Ryder J, Sutton AJ, Hing C, Kwok CS, Pang C, Harvey I, et al. 2010. Dissemination and publication of research findings: An updated review of related biases. *Health Technol Assess (Rockv).* 14(8):1–220. doi: [10.3310/hta14080](https://doi.org/10.3310/hta14080).
- Spencer K, Brady H. 2015. Examining the effects of a variation to the ruck law in Rugby Union. *J Hum Sport Exercise.* 10(2):550–562. doi: [10.14198/jhse.2015.102.02](https://doi.org/10.14198/jhse.2015.102.02).
- Stean D, Barnes A, Churchill SM. 2015. Effect of the ‘Crouch, Bind, Set’ engagement routine on scrum performance in english premiership rugby. *Int J Perform Anal Sport.* 15(3):1202–1212. doi: [10.1080/24748668.2015.11868862](https://doi.org/10.1080/24748668.2015.11868862).
- Stokes KA, Locke D, Roberts S, Henderson L, Tucker R, Ryan D, Kemp S. 2021. Does reducing the height of the tackle through law change in elite men’s rugby union (The Championship, England) reduce the incidence of concussion? A controlled study in 126 games. *Br J Sports Med.* 55(4):220–225. doi: [10.1136/bjsports-2019-101557](https://doi.org/10.1136/bjsports-2019-101557).
- Tarzi G, Tarzi C, Mirsu D, Patel J, Dadashi E, El-Sabbagh J, Gerhart A, Cusimano MD. 2022. Effect of a new concussion substitute rule on medical assessment of head collision events in Premier League football. *Inj Prev.* 28(6):521–525. doi: [10.1136/ip-2022-044580](https://doi.org/10.1136/ip-2022-044580).
- Tok MI, Tunar M, Cetinkaya C, Tatlibal P, Kayatekin M, Arkan A. 2017. A comparison of match analysis in soccer within the context of offside rule revision. *Pamukkale J Sport Sci.* 8(2):65–72.
- Torres-Ronda L, Beanland E, Whitehead S, Sweeting A, Clubb J. 2022. Tracking systems in team sports: a narrative review of applications of the data and sport specific analysis. *Sports Med Open.* 8(1):15. doi: [10.1186/s40798-022-00408-z](https://doi.org/10.1186/s40798-022-00408-z).
- Toth AA, Banks GC, Mellor D, O’Boyle EH, Dickson A, Davis DJ, DeHaven A, Bochantin J, Borns J. 2021. Study preregistration: an evaluation of a method for transparent reporting. *J Bus Psychol.* 36(4):553–571. doi: [10.1007/s10869-020-09695-3](https://doi.org/10.1007/s10869-020-09695-3).
- Twomey R, Yingling V, Warne J, Schneider C, McCrum C, Atkins W, Murphy J, Romero Medina C, Harley S, Caldwell A, et al. 2021. Nature of our literature. *Commun Kines.* 1(3). doi: [10.51224/cik.v1i3.43](https://doi.org/10.51224/cik.v1i3.43).
- UEFA. UEFA Homegrown Rule.Pdf. [accessed 2023 Aug 31]. <https://www.uefa.com/insideuefa/protecting-the-game/protection-young-players/>.
- Vaeyens R, Coutts A, Philippaerts RM. 2005. Evaluation of the “under-21 rule”: do young adult soccer players benefit? *J Sports Sci.* 23(10):1003–1012. doi: [10.1080/02640410400023266](https://doi.org/10.1080/02640410400023266).
- Vahed Y, Kraak W, Venter R. 2014. The effect of the law changes on time variables of the South African Currie cup tournament during 2007 and 2013. *Int J Perform Anal Sport.* 14(3):866–883. doi: [10.1080/24748668.2014.11868764](https://doi.org/10.1080/24748668.2014.11868764).
- Vahed Y, Kraak W, Venter R. 2016. Changes on the match profile of the South African Currie Cup tournament during 2007 and 2013. *Int J Sports Sci Coach.* 11(1):85–97. doi: [10.1177/1747954115624826](https://doi.org/10.1177/1747954115624826).
- van den Berg P, Malan DDJ. 2012. The effect of experimental law variations on the Super 14 Rugby Union Tournaments. *Afr J Phys Health Educ Recreat Dance.* 18(3):476–486.
- van Tonder R, Starling L, Surmon S, Viviers P, Kraak W, Boer P-H, Jordaan E, Hendricks S, Stokes KA, Derman W, et al. 2022. Tackling sport-related concussion: effectiveness of lowering the maximum legal height of the tackle in amateur male rugby – a cross-sectional analytical study. *Inj Prev.* 29(1):56–61. doi: [10.1136/ip-2022-044714](https://doi.org/10.1136/ip-2022-044714).
- Vriend I, Valkenberg H, Schoots W, Goudswaard GJ, van der Meulen WJ, Backx FJGG. 2015. Shinguards effective in preventing lower leg injuries in football: population-based trend analyses over 25 years. *J Sci Med Sport.* 18(5):518–522. doi: [10.1016/j.jsams.2014.07.002](https://doi.org/10.1016/j.jsams.2014.07.002).
- Whitehead S, Till K, Weaving D, Jones B. 2018. The use of microtechnology to quantify the peak match demands of the football codes: a systematic review. *Sports Med.* 48(11):2549–2575. doi: [10.1007/s40279-018-0965-6](https://doi.org/10.1007/s40279-018-0965-6).
- Williams J. 2011. The effect of law changes on the lineout in rugby union with regards to the six nations, tri nations, european cup and super 12 competitions from 1999 to 2003. *J Appl Sports Sci.* 1(2):44–56.
- Williams J, Hughes M, O’Donoghue P. 2005. The effect of rule changes on match and ball in play time in rugby union. *Int J Perform Anal Sport.* 5(3):1–11. doi: [10.1080/24748668.2005.11868333](https://doi.org/10.1080/24748668.2005.11868333).
- Wing C, Hart NH, Ma’ayah F, Nosaka K, Ma’ayah F, Nosaka K. 2022. Impact of sudden rule changes on player injuries and performance: insights from Australian Football. *J Sports Sci Med.* 21(3):458–464. doi: [10.52082/jssm.2022.458](https://doi.org/10.52082/jssm.2022.458).
- Young W, Rayner R, Talpey S. 2021. It’s time to change direction on agility research: a call to action. *Sports Med Open.* 7(1):12. doi: [10.1186/s40798-021-00304-y](https://doi.org/10.1186/s40798-021-00304-y).
- Zanin M, Ranaweera J, Darrall-Jones J, Weaving D, Till K, Roe G. 2021. A systematic review of small sided games within rugby: acute and chronic effects of constraints manipulation. *J Sports Sci.* 39(14):1633–1660. doi: [10.1080/02640414.2021.1891723](https://doi.org/10.1080/02640414.2021.1891723).