Tackle and ruck technical proficiency in rugby union and rugby league: A systematic scoping review

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Abstract
The aim of this review was to consolidate and synthesise rugby union (RU) and rugby league (RL) studies on tackle and RU studies on ruck technique for rugby stakeholders. Forty-nine studies were identified (20 in RL and 29 in RU). RL studies primarily focussed on identifying factors that impact tackling ability. Leaner, fitter players, with greater lower body strength, tended to have more proficient tackle technique. Experience and level of play were positively associated with tackling ability. These findings highlight the importance of developing tackle technique and physical qualities to allow players to progress to higher levels. Research in RU mostly focussed on identifying tackle and ruck techniques associated with performance measures and injury outcomes. Eleven tackle techniques and five ball-carrier techniques were associated with both performance measures and injury outcomes. These findings support national injury prevention programmes that advocate that safe contact technique is also effective technique. (152 words)

Keywords
Injury prevention, performance analysis, rugby football, skill

Introduction
In rugby union (RU) and rugby league (RL) players physically engage each other to compete for territory and ball possession.1,2 The most frequent form of physical engagement is the tackle3,4 – defined as an event where a player carrying the ball (the ball-carrier) is physically impeded by another player (the tackler).4,5 In an average professional 80-minute game, 160 tackles are made in RU and 590 in RL.6,7 In both RU and RL, success is determined, in part, by the ability to win these tackle contests.2,8 The tackle also has the highest injury frequency in both RU and RL, with tackle related injuries accounting for 54% of all injuries in professional RU,9 and 47% in professional RL.10 While the ball-carrier and tackler(s) actions before and during the tackle are largely similar in RU and RL, the actions of players after the tackle are different. In RL, the contest for ball possession discontinues after a completed tackle, with the attacking team maintaining ball possession for 6 tackles before handing over the ball, if still in possession (e.g., not scored a try or kicked the ball). In RU, the contest for ball possession continues until one or more players from each team are on their feet and physically contesting each other over the ball – this is known as a ruck. Once the ruck is formed, players are no longer allowed to play the ball and must...
drive over’ it to make it available for their teammates
to play. In professional RU, ruck related injuries
accounted for 10% of all injuries9 and like the tackle,
the ability to dominate the ruck contest is associated
with overall player performance and team success.11

Proficient contact technique, for both the ball-
carrier and tackler, is recognised as a leading factor
in reducing tackle injury risk,12–14 while also increasing
a player’s chances of tackle success.15–17 As such, inter-
national (World Rugby and the Rugby League
International Federation) and national (for example,
South African Rugby Union, New Zealand Rugby
Union, Rugby Football League (UK)) governing
bodies have invested substantial funding and resources
into developing programmes that educate players,
coaches and referees on the importance of proper tech-
nique during contact events.10–13 To assist these educa-
tional programmes, and in general, to optimise contact
training, research on technical proficiency in RU (spe-
cifically for the tackle and ruck) and RL (tackle only)
has also grown in recent years. Through analysing the
patterns of movement of players immediately before,
during and after contact, studies have identified specific
techniques related to injury and performance, and what
player qualities and contextual factors influence tech-
nical proficiency. For example, in RL, players with
better physical characteristics, such as aerobic fitness
and lower body strength, have better tackle contact
technique.2,22,58

With that said, to date, research on tackle and ruck
contact technique in RU and RL has not been consol-
idated and synthesised in a manner for stakeholders to
assimilate. As this research is heterogenous (various
outcomes, player qualities and contextual factors relat-
ed to contact technique), a scoping review format is
well suited for this purpose.23 A scoping review is a
type of knowledge synthesis that follows a systematic
approach to map the existing literature on a field of
interest.24 They are commonly undertaken to deter-
mine the extent and range of studies on a topic; sum-
marise and disseminate research findings; identify gaps
in the existing literature; and determine the value and
scope of undertaking a full systematic review.23 The
purpose of this scoping review was to systematically
review studies on tackle contact technique in RU and
RL, and ruck contact technique in RU, to determine
the extent of research on this topic, and summarise and
disseminate the findings.

Method

A systematic review of the scientific literature was con-
ducted with the Preferred Reporting Items for
Systematic reviews and Meta-Analyses extension for
Scoping Reviews (PRISMA-ScR) guidelines.25

Data sources and search strategy

Two reviewers (SdH and CP) independently searched
three databases (SCOPUS, PubMed and Web of
Knowledge) for eligible studies published up until 31
May 2020. The search strategy used consisted of a com-
bination of the word ‘rugby’ connected through the
Boolean term AND with either tackl*, ball-carr*,
ruck, technique, contact skill, characteristic or mecha-
nism. The papers were screened for eligibility at the
title, abstract and full-text level. The reference lists of
papers that met the eligibility criteria were searched,
and any relevant papers were screened for eligibility
at the title, abstract and full-text level. When disagree-
ments on eligibility occurred, the eligibility criteria and
the study were revisited for clarity and any disagree-
ments resolved reaching consensus.

Eligibility criteria

The eligibility criteria for the review were as follows:

- An original research study published in a peer-
reviewed journal.
- The study was published in the English language.
- The study was on either RU or RL; including rugby
  sevens (included in RU total).
- The study analysed any technical movement pattern
  of a player in the tackle, ball-carry into contact, or
  ruck in the phases immediately before (preparation),
  during (execution) or immediately after (follow-
  through) contact.
- The study related the analysed technical variables to
  either a factor (physical measurements, age, experi-
  ence, fatigue, context) or an outcome measure (per-
  formance, injury, level of play).

The following studies were excluded from the
review:

- Studies on wheelchair rugby.
- The study assessed tackles or rucks but did not
  include the involved players’ technical movement
  patterns in the analysis.
- The study analysed players’ technical movement pat-
  terns but did not relate the results to a factor or
  outcome measure.

Data extraction

The following data were recorded and extracted onto
an Excel spreadsheet: publication details (title, author,
year of publication), details of the sample (RU or RL,
country, playing level, age group, sex, size, assessment
environment), the techniques analysed, the factor(s)
analysed, the outcome(s) measured, the statistics
used, the level of significance and, if reported, the effect size (ES), and lastly the key findings.

**Results**

Forty-nine studies were included in the review. An overview of the search process can be seen in Figure 1. Twenty of the studies were in RL, 28 in RU and 1 study in rugby sevens.

Tables 1 and 2 provide an overview of the studies in RU and RL, respectively. Ninety percent of RL studies (n = 18) only analysed the tackler’s technique, 10% (n = 2) analysed both the tackler and ball-carrier’s technique. Thirty-two percent of RU studies (n = 9) only analysed the tackler’s technique, 11% (n = 3) only the ball-carrier’s technique, 50% (n = 14) both the tackler and ball-carrier’s technique, and 7% (n = 2) the tackler’s technique, ball-carrier’s technique and the technique of a player in the ruck.

The majority of RU studies assessed the effect of contact technique on injury outcomes (n = 14; 50%) and performance outcomes (n = 8; 29%). In RL, 55% of studies assessed the effect of physical qualities on contact technique (n = 11). Other variables commonly compared to contact technique in RL included match performance (n = 6; 30%) and level of play (n = 6; 30%).

**Techniques**

Tables 3 and 4 provide a summary of the tackle and ball-carry techniques analysed in RU. Eleven tackle techniques and five ball-carry techniques were associated with both a reduced risk of injury and a higher likelihood of tackle success.

Twelve of the 29 RU studies used technical criteria in their assessment of the tackle, ball-carry and/or ruck (41%). Nine of the 12 studies (75%) used the same standardised technical criteria consisting of 16 tackle techniques, 14 ball-carry techniques and 15 ruck techniques. The technical criteria were categorised into three phases of movement: pre-contact (preparation phase), contact (execution phase) and post contact (follow-through phase). Five of the nine studies reported a total score for the number of techniques performed, and three of the studies reported totals for each phase of movement. Three of the 12 studies developed their own technical criteria for the tackle,

![Figure 1. PRISMA flow diagram of literature search.](attachment:image.png)
| Author(s) (year) | Sample size | Age group | Level | Analysis environment | Technique analysed | Analysis model | Outcome(s) or factor(s) variables | Key findings |
|-----------------|-------------|-----------|-------|----------------------|-------------------|---------------|----------------------------------|--------------|
| Burger et al. (2016) | 297 tackles U18 Elite Match | Tackle Ball-carry | Technical Criteria | Injury | Higher total technique scores were associated with non-injury tackle events. |
| Burger et al. (2017) | 297 tackles U18 Elite Match | Tackle Ball-carry | Technical Descriptors | Injury | Awareness of contact and fending were likely to reduce the risk of injury for the ball-carrier. Shoulder tacklers were likely to reduce the risk of injury for the tackler. |
| Chiwaridzo et al. (2019) | 87 players U19 Educational Training | Tackle | Technical Criteria | Level of play | Tackling proficiency did not discriminate between levels of play. |
| Chiwaridzo et al. (2019) | 71 players U16 Educational Training | Tackle | Technical Criteria | Level of play | Players who competed at a higher level of play had higher tackle technique scores, compared to players who competed at a lower level. U19 players scored better in tackle technique assessment than U16 players. Players who competed at a higher level of play had higher tackle technique scores, compared to players who competed at a lower level. |
| Chiwaridzo et al. (2020) | 158 players U16 U19 Educational Training | Tackle | Technical Criteria | Age group & level of play | |
| Davidow et al. (2018) | 327 tackles Senior Amateur Match | Tackle Ball-carry | Technical Criteria | Injury | Higher total technique scores were associated with non-injury tackle events. |
| Davidow et al. (2020) | 19 players Senior Amateur Training | Tackle | Technical Criteria | Fatigue | For both shoulders (dominant & non-dominant), fatigue had an overall decremental effect on tackling proficiency. |
| den Hollander et al. (2019) | 131 players U21 Senior Amateur Training | Tackle Ball-carry Ruck | Technical Criteria | Level of play | Senior level players scored significantly higher than the academy level players in the tackle, ball-carry and ruck technique assessments. |
| Fuller et al. (2010) | 6219 tackles Senior Elite Match | Tackle Ball-carry | Technical Descriptors | Injury | Head placement in front had a higher risk of injury to tackler than head to the side or above the ball-carrier. |
| Author(s) (year) | Sample size | Age group | Level | Analysis environment | Technique analysed | Analysis model | Outcome(s) or factor(s) variables | Key findings |
|-----------------|-------------|-----------|-------|----------------------|-------------------|---------------|----------------------------------|--------------|
| Hendricks et al. (2014) | 2092 tackles | Senior | Elite | Match | Tackle Ball-carry | Technical Descriptors | Performance | Head up and forward, counteracting the fend, shoulder tackles targeted at ball-carriers mid-torso, using arms to wrap or pull, and leg drive were associated with successful tackles. |
| Hendricks et al. (2015) | 24 tackles | U18 | Elite | Match | Tackle Ball-carry | Technical Criteria | Injury | Higher total technique scores were associated with non-injury tackle and ruck events. |
| Hendricks et al. (2016) | 24 tackles | U18 | Elite | Match | Tackle Ball-carry | Technical Descriptors | Injury | In 72% of tackles that lead to concussions the tacklers head was not 'up and forward. |
| Hendricks et al. (2018) | 4479 tackles | Senior | Elite | Match | Tackle Ball-carry | Technical Descriptors | Performance | Fending increased chances of off-loading and breaking tackle. Actively placing ball increased probability of maintaining possession after the ruck. |
| Hendricks et al. (2019) | 135 matches | Senior | International (Sevens) | Match | Tackle Ball-carry | Technical Descriptors | Performance | Strong leg drive was associated with tackle success for both the ball-carrier and tackler. Fending increased the prospect of breaking the tackle. Actively placing the ball increased the likelihood of maintaining possession after the ruck. |
| Maki et al. (2017) | 11 tackles | Senior | Elite | Match | Tackle | Technical Descriptors | Injury | There was no significant correlation between tackler characteristics and injury. |
| McIntosh et al. (2010) | 6618 tackles | U15 U18 U20 | Educational Amateur Elite | Match | Tackle Ball-carry | Technical Descriptors | Injury | No specific tackle technique was observed to be associated with a significantly increased risk of injury. |
| Sayers & Washington -King (2005) | 48 matches | Senior | Elite | Match | Ball-carry | Technical Descriptors | Performance | Effective running patterns and evasive movements were associated with successful ball-carries. |
| Sewry et al. (2015) | 763 tackles | Senior | Elite | Match | Tackle Ball-carry | Technical Descriptors | Performance | Evasive movements, tacklers' head position, contact with shoulder, leg drive, arm and shoulder usage were associated with success. |

(continued)
| Author(s) (year) | Sample size | Age group | Level | Analysis environment | Technique analysed | Analysis model | Outcome(s) or factor(s) variables | Key findings |
|------------------|-------------|-----------|-------|----------------------|-------------------|---------------|--------------------------------|----------------|
| Sobue et al. (2018)<sup>99</sup> | 3970 tackles | U21 | International | Match | Tackle | Technical Descriptors | Injury | The injury incidence for head incorrectly positioned was 69.4/1000 tacklers, compared to 2.7/1000 tackles for correct head positioning. |
| Suzuki et al. (2020)<sup>90</sup> | 34 matches | Senior | Educational | Match | Tackle | Technical Descriptors | Injury | Head placement in front had a higher risk of injury to tackler than head to the side or above ball-carrier |
| Tierney et al. (2016)<sup>41</sup> | 48 tackles | Senior | International | Match | Tackle | Technical Descriptors | Injury | Tacklers’ head placement, and ball-carrier change of direction had significance for causing tackle related head impacts. |
| Tierney et al. (2017)<sup>17</sup> | 233 tackles | Senior | Elite | Match | Tackle | Technical Criteria | Performance | Explosiveness and leg drive were associated with positive tackle outcomes for both ball-carrier and tackler. |
| Tierney et al. (2018)<sup>42</sup> | 307 tackles | Senior | Elite | Match | Ball-carry | Technical Criteria | Injury | Explosiveness and fending by ball-carrier was associated with head impact (HI) assessments for tackler. |
| Tierney et al. (2018)<sup>43</sup> | 307 tackles | Senior | Elite | Match | Tackle | Technical Criteria | Injury | Head up and forward, and head placement reduced risk of a HI assessment for the tackler. |
| Tierney et al. (2018)<sup>43</sup> | 233 tackles | Senior | Elite | Match | Tackle | Technical Criteria | Fatigue | Player time in game does not affect tackle technique proficiency. |
| van Rooyen et al. (2014)<sup>45</sup> | 211 carries | Senior | International | Match | Tackle | Ball-carry | Technical Descriptors | Performance | Leaning forward, with centre of gravity ahead of base of support, was associated with effective tackles. |
| Wheeler and Sayers (2009)<sup>16</sup> | 1372 carries | Senior | Elite | Match | Ball-carry | Technical Descriptors | Performance | Active fend strategies, leg drive and low body position were associated with successful carries. |
| Wheeler et al. (2010)<sup>91</sup> | 1372 carries | Senior | Elite | Match | Tackle | Ball-carry | Technical Descriptors | Performance | Evasive movements were associated with successful carries. |
| Wilson et al. (1999)<sup>46</sup> | 28 tackles | Senior | Elite | International | Match | Tackle | Ball-carry | Technical Descriptors | Injury | Most tackle injuries resulted from front on tackles. |
| Author(s)                          | Sample size | Age group | Level          | Analysis environment | Technique analysed | Analysis model | Outcome(s) or factor(s) | Key findings                                                          |
|-----------------------------------|-------------|-----------|----------------|----------------------|--------------------|----------------|------------------------|-----------------------------------------------------------------------|
| Cummins and Orr (2015)<sup>47</sup> | 201 matches | Senior    | Elite Match    | Tackle Technical Descriptors | Performance        |                |                        | Transferring centre of gravity over front foot and driving right shoulder in contact was associated with effective shoulder charge tackles. |
| Gabbett and Kelly (2007)<sup>49</sup> | 11 players  | Senior    | Professional Training | Tackle Technical Criteria | Line speed        |                |                        | Fast line speed reduced total tackle proficiency scores.             |
| Gabbett et al. (2007)<sup>48</sup>  | 86 players  | Senior    | Professional Training | Tackle Ball-carry Technical Criteria | Physical measures |                |                        | Total ball-carry technique scores were positively associated with body mass and 40 m sprint speed. |
| Gabbett (2008)                     | 8 players   | Senior    | Professional Training | Tackle Technical Criteria | Fatigue & physical measures |                |                        | Fatigue resulted in progressive reductions in tackle technique. Players with greater VO<sub>2</sub> max and agility had lower reductions in tackle technique under fatigue. |
| Gabbett and Ryan (2009)<sup>51</sup> | 39 players  | Senior    | Elite Training  | Tackle Technical Criteria | Experience, level of play, performance & injury |                |                        | Tackle technique was positively associated with playing level, experience, and successful and positive tackles in matches. |
| Gabbett (2009)<sup>50</sup>        | 12 players  | Senior    | Elite Training  | Tackle Technical Criteria | Physical measures |                |                        | Tackling ability was associated with age, skinfolds, mass, and waist and gluteal girths. |
| Gabbett et al. (2010)<sup>52</sup>  | 41 players  | Amateur Elite | U15 Training | Tackle Technical Criteria | Level of play & physical measures |                |                        | Fast acceleration and lower body power contributed positively to effective tackling ability. |
| Gabbett et al. (2011)<sup>53</sup> | 37 players  | Senior    | Amateur Elite Training | Tackle Technical Criteria | Experience, level of play & physical measures |                |                        | Level of play, age, experience, skinfold thickness, acceleration, and lower body power were correlated with tackle technique scores. |
| Gabbett et al. (2011)<sup>53</sup> | 58 players  | Senior    | Elite Match Training | Tackle Technical Descriptors & Criteria | Performance        |                |                        | Greater tackler proficiency was associated with the number of tackle attempts. |
| Gabbett et al. (2011)<sup>54</sup> | 86 players  | Senior    | Elite Training  | Tackle Technical Criteria | Team selection      |                |                        | Tackle ability did not influence team selection.                      |
| Gabbett et al. (2012)<sup>55</sup> | 66 players  | Senior    | Elite Training  | Tackle Technical Criteria | Injuries            |                |                        | There were no significant correlations between tackling ability and tackle related injuries. |

(continued)
| Author(s) | Sample size | Age group | Level | Analysis environment | Technique analysed | Analysis model | Outcome(s) or factor(s) | Key findings |
|-----------|-------------|-----------|-------|----------------------|-------------------|---------------|------------------------|--------------|
| Gabbett (2016) | 11 players | Senior | Amateur | Training | Tackle | Technical Criteria | Fatigue & physical measures | Fatigue resulted in progressive reductions in tackle technique. Players with greater lower body strength had the highest tackle technique scores under fatigue conditions. |
| Pearce et al. (2019) | 88 players | U18 U20 | Senior | Amateur | Training | Tackle | Technical Criteria | Level of play | Senior level players demonstrated greater tackle proficiency, compared to u18 & u20 level players |
| Speranza et al. (2015) | 36 players | U20 Senior | Amateur | Training | Tackle | Technical Criteria | Level of play & physical measures | Tackling ability was associated with squats, bench press, relative squats, and plyometric push ups. |
| Speranza et al. (2015) | 16 players | Senior | Amateur | Training | Tackle | Technical Criteria | Performance & physical measures | Higher total tackle technique proficiency scores were associated with positive tackles. |
| Speranza et al. (2016) | 24 players | Senior | Amateur | Training | Tackle | Technical Criteria | Physical training | Tackling ability significantly increased after an 8-week physical training programme. |
| Speranza et al. (2017) | 16 players | Senior | Amateur | Training | Tackle | Technical Descriptors & Criteria | Performance & physical measures | Tackling ability was associated with tacklers making front-on tackles, with a medium body height, in matches, which lowered the odds of a missed tackles in matches. |
| Speranza et al. (2017) | 12 players | Senior | Amateur | Training | Tackle | Technical Criteria | Change over season | There was no significant change in tackling ability over the course of season. |
| Speranza et al. (2018) | 31 players | Senior | Amateur | Training | Tackle | Technical Criteria | Level of play & physical measures | Level of play was associated with tackle technique, |
| Speranza et al. (2018) | 18 players | Senior | Amateur | Training | Tackle | Technical Criteria | Performance & physical measures | Tackle technique was positively associated with dominant tackles and negatively associated with missed tackles. |
consisting of 10 tackle techniques (25%). The 10 technical criteria were consistent with the 16 tackle techniques described in the aforementioned studies. No additional techniques (to the technical criteria) were identified in the other 17 RU studies. Total tackle technique score was associated with contact related injuries in 2 out of 3 studies ($p < 0.01; \text{ES} > 0.6$). No performance related studies reported total tackle technique scores in the results. Similarly, total ball-carry technique score was associated with contact related injuries in 2 out of 3 studies ($p < 0.01; \text{ES} > 0.6$) and no performance related studies reported total ball-carry technique scores in the results. Total ruck technique was not associated with ruck injuries ($p > 0.05; \text{ES} < 0.6$), however making contact with the opponent’s centre of gravity, and wrapping arms around opponent post contact when rucking were negatively associated with injury outcomes in the ruck ($p < 0.05; \text{ES} > 1.2$).

Table 5 provides an overview of the relationships between total tackle technique scores and various player qualities and contextual factors. Body composition, lower body strength, experience and match performance were positively associated with tackling ability in at least 50% of the RL studies that included these variables in their analyses.

Nineteen of the 20 RL studies (95%) used standardised technical criteria to assess tackle technique (criteria shown in online Appendix 3). The technical criteria were not grouped or categorised into phases, but all the studies reported a total score for the techniques performed. Five of the 19 studies (26%) included additional tackle techniques to the list of criteria (explosiveness on contact, lower body position, approach from front, head placement) and two included ball-carrier techniques (evasive movement, fend, side-on in contact, explosive, leg drive). No additional techniques were identified in the RL study that did not use the standardised technical criteria. Only six studies reported on the relationships between the individual tackle techniques and the study outcome (30%), in which four of the studies, 20%, showed the relationship between tackle technique and level of play (online Appendix 3). Contact with shoulder was the only technique not associated with level of play.

### Discussion

The aim of this scoping review was to consolidate and synthesise RU and RL studies on tackle technique and RU studies on ruck contact technique for rugby stakeholders. Forty-nine studies were identified. These studies were similarly distributed between RU (59%) and RL (41%). Eighty-three percent of tackle contact technique studies in RU were based on video analysis studies during matches, and for most of them, both the ball-carrier and tackler were studied. Only two studies analysed ruck contact technique; one in matches and one in training. The studies in RU aimed to
understand the relationship between contact technique and injury or contact technique and performance. In contrast, studies in RL analysed contact technique during controlled field sessions and focussed on the tackler. Also, the aim of most of the studies in RL was to identify factors that may affect tackle technique. The contrast in research studies between RU and RL highlights questions for future research on contact technique within the respective rugby code and potential collaboration opportunities.

Tackle and ruck contact technique has been studied by associating technical determinants with an outcome (deterministic model) or using a set of criteria that represents the ‘ideal’ form of the movement (diagnostic prescriptive model). In addition, tackle contact technique is typically divided into three phases, pre-contact (preparation phase), contact (action phase) and post-contact (follow-through phase), to focus the observation and interpretation.

Technical proficiency scores – i.e. scoring ball-carrier, tackler and ruck technique using set criteria – have been particularly useful for both RU and RL. The scoring is straightforward, a player is awarded either one point or zero depending on whether a particular technical criterion is met or not. The sum of these points is subsequently used to represent the technical proficiency of the player, which is easy to interpret. The criteria have been shown to have good validity in training and matches, and therefore can be potentially considered as a diagnostic and monitoring tool.

Tables 3 and 4 summarise the techniques that are significantly associated with a reduction in tackle injury risk and an increased likelihood of tackle success in RU. This provides clear support for National and International Injury Prevention programmes that advocate that safe tackle technique is also effective technique. It is worth noting that if a technique was not significantly associated with an outcome, it should not be interpreted as inconsequential and not worthy of coaching. From a practical perspective, an over-reliance on identifying statistically significant relationships can lead to false-negative findings, as a technique performed in both positive and negative outcomes would not be associated with either outcome, but may still have a decremental effect on performance or injury if not performed. Techniques not significantly

| Table 4. Ball-carry techniques associated with injury prevention and performance in rugby union. |
| Ball-carry technique | Studies (n) | Injury prevention | Performance |
| Pre-contact technique | | | |
| Focus on tackler | 7 | ✓ | – |
| Body position – upright to low (dipping) | 4 | ✓ | ✓ |
| Back straight, centre of gravity ahead of support base | 4 | ✓ | – |
| Shift ball away from contact to correct arm | 4 | – | – |
| Head up, face forward | 4 | ✓ | – |
| Shuffle or evasive manoeuvre | 5 | – | ✓ |
| Contact | | | |
| Fend into contact | 6 | ✓ | ✓ |
| Side-on into contact | 4 | ✓ | – |
| Explosiveness on contact | 4 | ✓ | ✓ |
| Body position – from low up into contact | 4 | ✓ | – |
| Ball in correct arm and protected | 4 | – | ✓ |
| Post contact | | | |
| Use of arm and/or shoulder to push tackler | 4 | ✓ | – |
| Leg drive upon contact | 4 | ✓ | ✓ |
| Go to ground and present ball | 5 | ✓ | ✓ |

The reported levels of significance and effect sizes for each technique can be found in online Appendix 2.

| Table 5. Factors associated with tackling ability in rugby league. |
| Factors | Studies (n) | Tackling ability |
| Physical measurements | | |
| Body composition | 8 | ✓ |
| Lower body strength | 4 | ✓ |
| Upper body strength | 5 | ✓ |
| Lower body power | 9 | ✓ |
| Upper body power | 5 | ✓ |
| Agility | 7 | ✓ |
| Speed and acceleration | 7 | ✓ |
| Endurance | 2 | ✓ |
| Experience | 5 | ✓ |
| Match performance | 5 | ✓ |
| Injury risk | 2 | – |
| Level of play | 5 | ✓ |
| Fatigue | 2 | ✓ |

The reported levels of significance and effect sizes for each factor can be found in online Appendix 4.
associated with an outcome should still be coached and executed, while the significant techniques can be stressed and emphasised during training.

Experience and level of play were positively associated with tackling ability in RL.\textsuperscript{48,51,55} These findings highlight the importance of tackling technique for player development. The findings also suggest that players may need considerable exposure to executing the skill within the appropriate context demands to optimise technique development. Furthermore, aerobically fitter players with greater lower body strength tended to have more proficient tackle technique.\textsuperscript{2,22,58} Similarly, players with greater aerobic fitness and greater lower body strength had the best tackling ability under fatigued conditions.\textsuperscript{57} This points out the importance of physical conditioning for enhancing tackle technique.

We identified 11 tackle techniques and five ball-carry techniques associated with both reduced injury risks and effective performance outcomes in RU (Tables 3 and 4). These findings show that safe techniques are also effective in winning the tackle contest. Four injury related tackle technique studies\textsuperscript{12,13,26,44} and four injury related ball-carry technique studies\textsuperscript{12,13,26,42} used the same diagnostic prescriptive model in their analyses. There is, therefore, scope for a systematic review on the relationship between the standardised technical criteria list used in these studies and tackle related injury events, to assess the quality of the individual studies, and the weighting of the relationship of the techniques and injury outcomes.

Currently, the diagnostic prescriptive model has been applied to three contact skills in RU (the front-on shoulder tackle, carrying the ball into contact and ruck clearing) and two contact skills in RL (under-the-ball and over-the-ball shoulder tackles). For future work in the area, we recommend that criteria for other types of tackles (smother, chop, double tackles) and ball-carrier actions (offload), ruck skills (sealing, poaching), and other contact events (scrum, maul) be developed. Only five of the studies (12%) provided sample size power calculations.\textsuperscript{14,32,39,55,56} There were similar findings in a review of video analysis studies in RU (3%).\textsuperscript{69} Therefore, the question of whether studies were adequately powered can be raised. This is a limitation of the current body of literature, and, as such, we recommend future studies conduct and report sample size power calculations. Additionally, further research on the effect of ruck technique on injury risks and performance outcomes in RU is warranted.

**Practical applications**

- Safe and effective techniques provide a framework of key techniques to emphasize during contact technique training.
- Exposure to contact training and physical conditioning are important to optimise contact technique development.

**Conclusion**

The aim of this paper was to consolidate and synthesise RU and RL research on tackle and ruck technique. We identified 29 studies in RU and 20 in RL. Studies in RU analysed tackles and rucks in matches, to understand the relationship between contact technique and injury risks or performance outcomes. Studies in RL analysed tackles in controlled field sessions, to identify factors that may affect tackle technique. The contrast in research aims highlight opportunities for future research within the respective codes of rugby.

In RU, 11 tackle techniques and 5 five ball-carry techniques were associated with reduced injury risks and positive performance outcomes. These findings support national injury prevention programmes that advocate that safe contact technique is also effective technique. The techniques identified by these studies also provide a framework of key techniques to emphasize during contact training.

In RL, aerobically fitter players with greater lower body strength had more proficient tackle technique. These findings highlight the importance of physical conditioning to develop tackle technique.

Deterministic models and diagnostic prescriptive models were used to analyse contact technique in RU and RL. Diagnostic prescriptive models were particularly useful to describe and compare contact technique within and between studies. However, these models have only been applied to three contact skills in RU, and two in RL. We, therefore, recommend additional diagnostic prescriptive models are developed for other contact skills in RU and RL. Furthermore, research on the effect of ruck technique on injury risks and measures of performance are recommended.

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