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A systematic review of small sided games within rugby: Acute and chronic effects of constraints manipulation

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ABSTRACT
Small-sided games is a commonly used training method to develop technical, tactical and physical qualities concurrently. However, a review of small-sided games in rugby football codes (e.g. rugby union, rugby league) is not available. This systematic review aims to investigate the acute responses and chronic adaptations of small-sided games within rugby football codes considering the constraints applied. Four electronical databases were systematically searched until August 2020. Acute and chronic studies investigating rugby football codes small-sided games, with healthy amateur and professional athletes were included. Twenty studies were eventually included: 4 acute and 1 chronic in rugby union, 13 acute and 2 chronic in rugby league. Acute studies investigated task and individual constraints. Chronic studies showed that small-sided games would be an effective training method to improve physical performance. Current research in rugby football codes is heavily biased towards investigating how manipulating constraints can affect the physical characteristics of small-sided games, with limited literature investigating the effect on technical skills, and no studies investigating tactical behaviour. Future research is needed to evidence the effects of constraint manipulation on technical and tactical behaviour of rugby football players in small-sided games, in addition to physical characteristics.

ARTICLE HISTORY
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KEYWORDS
Small-sided game; rugby; constraints; technical tactical; performance

1. Introduction

Team sport athletes need to develop multiple qualities (e.g., technical skills, speed, cardiovascular capacity) to excel in their sport (Duthie, 2006). For instance, in rugby union, cardiovascular capacity has been shown to be correlated with the number of tackles made, passes made, effective rucks, and total possession in forwards international players (r = 0.52–0.72) (Cunningham et al., 2018). In addition, technical (i.e. passing, tackling, ball-carrying) and tactical (i.e. defensive, evasion skills) abilities have been shown to be substantially different between elite and sub-elite rugby league players (Gabbett, Kelly et al., 2007). Technical skills refer to the specific sport skills executed (e.g., pass, kick, tackle), whilst tactical characteristics correspond to the behaviour of a group of players or a team during a game directed to achieve a specific objective (e.g., distribution of a team on the pitch) (Folgado et al., 2014; Hendricks et al., 2020; Rein & Memmert, 2016). Consequently, both technical/tactical abilities and physical qualities should be developed to ultimately improve sport performance.

Each performance component could be trained in isolation, but proponents of tactical periodization (Tamarit et al., 2015; Tee et al., 2018) suggest that every physical or technical action on the pitch should have a tactical intention (Tamarit et al., 2015). Therefore, the development of each component in isolation would not be representative of official competitions, whereby technical/tactical abilities and physical qualities are expressed concurrently to achieve a common team objective (e.g., scoring a try in rugby union).

A commonly used training method to simultaneously target technical/tactical skills and physical qualities in team sports athletes is small-sided game (SSG) training (Davids et al., 2013, 2003; Dellal et al., 2011; Fanchini et al., 2011; Ometto et al., 2018; Pizarro et al., 2019; Rampinini et al., 2007). Small-sided games are identified as `open drills`, meaning that they are characterized by considerable unpredictability and decision-making demands, thus being more representative of official competitions (Farrow et al., 2008). Therefore, if the objective of the SSG is to foster specific technical/tactical skills alongside physical qualities, a pedagogical approach (e.g., non-linear pedagogy), that fosters skill development and decision-making, should be utilized in the design process (MCY Lee et al., 2014; Pizarro et al., 2019; Renshaw et al., 2016; Renshaw & Chow, 2019; Roberts et al., 2020).

One pedagogical approach for designing SSG training is the constraints-led approach (Correia et al., 2011; Davids et al., 2013, 2003; Machado et al., 2019; Passos et al., 2008; Renshaw et al., 2016; Renshaw & Chow, 2019; Renshaw et al., 2010), whereby the objective of the SSG is first determined, and constraints (e.g., playing rules, pitch dimensions) are then applied to the game to achieve this objective (Ramos et al., 2020; Renshaw & Chow, 2019). Constraints have been defined as the `*information to shape or guide the (re)organization of*

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a complex adaptive system` [Renshaw et al., 2019, p.14]; and they have been divided into three categories: individual (e.g., morphological characteristics, fitness level), environmental (e.g., playing surface, weather conditions), and task constraints (e.g., rules of the game, field dimensions) (Corbett et al., 2018; Davids et al., 2013; Passos et al., 2008; Renshaw et al., 2010; Williams & Hodges, 2005).

Based on this approach, the selection and manipulation of constraints during training activities should aim to provide a learning environment that is ecologically valid, thus reproducing situations that occur during competition and maintaining a high degree of similarity between practice and competition cues (Renshaw et al., 2010). Ecological validity in this context refers to the similarity between cues that the performer can detect from the environment, and the extent to which they represent a competitive scenario (Araujo et al., 2007; Pinder et al., 2011).

The application of different constraints to SSGs may substantially alter the technical (e.g., number of shots, passes, pressure moments), tactical (e.g., team distribution on the pitch, offensive sequences) and physical (external and internal loads) characteristics on athletes (Folgado et al., 2014; Hodgson et al., 2014; Rampinini et al., 2007; Roe et al., 2017). External load has been defined as activities prescribed to and completed by players (e.g., distance covered, speed, acceleration, collisions), and internal load has been considered as the resulting psycho-physiological and neuromuscular response of the individual to the external load (e.g., rating of perceived exertion, heart rate) (Impellizzeri et al., 2005; McLaren et al., 2018; Phibbs et al., 2018; Wallace et al., 2014; Weaving et al., 2017). Therefore, in order to design SSGs to provide an optimal learning and physical stimulus concurrently, the key constraints relevant to specific aspects of match-play, in conjunction with specific tactics that coaches wish to adopt, would need to be identified (Práxedes et al., 2019; Ramos et al., 2020; Renshaw & Chow, 2019). These can then be applied to specific training activities, of which the physical characteristics can subsequently be quantified. This would allow the identification of the most appropriate training activities to develop technical/tactical and physical attributes of players concurrently (Tee et al., 2018).

Acute studies demonstrate that technical (e.g., number of shots, passes, pressure moments), tactical characteristics (e.g., team distribution on the pitch, offensive sequences) and external (e.g., total distance, average speed)/internal (e.g., heart rate, rating of perceived exertion) loads are acutely influenced during SSGs by the manipulation of playing rules, pitch dimensions, number of players, work-to-rest ratio (i.e. task constraints), training experience, chronological age (i.e. individual constraints), and environmental conditions (e.g., playing surface) (i.e. environmental constraints) (Almeida et al., 2013; Dellal et al., 2011; Fanchini et al., 2011; Folgado et al., 2014; Gabbett, Minbashian et al., 2007; Gains et al., 2010; Hodgson et al., 2014; Machado et al., 2019; Owen et al., 2011; Timmerman et al., 2017, 2019; Yücesoy et al., 2019). Chronic studies show that small-sided games enhance the development of tactical performance (e.g., team synchronization), speed, cardiovascular capacity, repeated sprint ability, and running economy over time (Bujalance-Moreno et al., 2019; Folgado et al., 2018; Owen et al., 2012; Sampaio & Maçãs, 2012). Throughout the review, `acute` refers to an investigation of technical/tactical characteristics and external/internal loads experienced by players following a single application of a training intervention (Geracitano et al., 2002; Mazzeo et al., 1991; Wang et al., 2020) whilst `chronic` refers to the investigation of technical/tactical and physical development of players following multiple applications of a training intervention over a period of time (Geracitano et al., 2002; Mazzeo et al., 1991; Wang et al., 2020).

Whilst a plethora of research exists in other field-based team sports (Bonney et al., 2020; Davies et al., 2013; Duthie et al., 2019; Fleay et al., 2018; Halouani et al., 2019; Hill-Haas et al., 2011; Piggott et al., 2019; Timmerman et al., 2017, 2019; Young & Rogers, 2014), based on the concept of ecological validity, findings from these studies have little applicability to the rugby football codes (i.e. rugby union, rugby league, rugby sevens). This is because SSGs designed for soccer or Australian rules football allow the ball to be passed in any direction, which is permitted during official competitions, thus enhancing the ecological validity of the drill. Conversely, in rugby football codes official games, the ball is not allowed to be passed forward, and the implementation of this rule during SSGs would compromise the ecological validity of the drill. Furthermore, another peculiarity of rugby football codes is the formation of rucks (i.e. `*when at least one player from each team is in contact, on their feet and over the ball, which is on the ground*` [Hendricks et al., 2020, p.4]) in open play where players from opposite teams can contest ball possession (Van Rooyen et al., 2010; Wheeler et al., 2013). Consequently, these characteristics should be taken into account if the goal is to achieve a specific technical/tactical objective or to improve training efficiency, thus targeting technical, tactical and physical components concurrently.

In rugby football codes, no systematic review has been conducted on the acute effects of constraints manipulation on technical/tactical characteristics and external/internal loads, and on the chronic effects of SSGs on technical/tactical and physical performance. Consequently, a systematic review of the literature on SSGs in rugby football codes is necessary to determine the current state of knowledge on the topic. The aims of this systematic review are to 1) systematically review and present the existing research examining SSGs within the rugby football codes; 2) evaluate the acute technical, tactical and physical responses of SSGs within rugby football codes considering the constraints applied; and 3) evaluate the chronic adaptations in technical, tactical and physical performance following SSG training.

2. METHODS

2.1. Selection criteria

This systematic review followed the PRISMA (i.e. Preferred Reporting Items for Systematic Reviews and Meta-analysis) (Moher et al., 2009) and SWiM (i.e. Synthesis Without Meta-analysis) (Campbell et al., 2020) guidelines. The inclusion criteria for the studies to be part of this systematic review were: studies evaluating the acute technical, tactical or physical outcomes of SSGs or the chronic adaptations in technical, tactical or physical performance following SSGs; SSGs performed in rugby football codes (e.g., rugby union, rugby league, rugby sevens); healthy young athletes, male and female amateur and professional athletes; articles published in English language in peer-reviewed scientific journals. The exclusion criteria included: disabled, sedentary, obese subjects; review papers, case studies, and conference presentations.

The decision to include a wide range of participants (i.e. young athletes, male and female amateur and professional athletes) is supported by the aim of this systematic review which is to investigate the existing research examining SSGs in rugby football codes. The restriction of chronological age (e.g., > 18 years old) as inclusion criteria would result in the exclusion of certain constraints from this systematic review. In this scenario, certain individual constraints, such as chronological age and training experience, which play an important role in the process of training drill design, would be overlooked (Ramos et al., 2020; Renshaw & Chow, 2019). Furthermore, as no previous review has been conducted on rugby football codes, a systematic review of all the constraints previously reported in the literature to improve rugby football codes performance is necessary. In addition, the exclusion of obese, sedentary, and disabled subjects is due to the specific morphological and physiological characteristics of these groups (Driss et al., 2001; Schairer et al., 1992; Thorstensson et al., 1977), and because of the different objective of the SSGs implemented in these studies (i.e. skill acquisition/performance improvement in rugby football codes versus health and quality of life improvement in sedentary or obese subjects) (Kennett et al., 2012; Mendham et al., 2015).

2.2. Literature search

A preliminary reading of previous research on SSGs was used to identify the current understanding and limitations of SSGs research in rugby football codes, and to define the key words that were used in scientific databases to systematically search the literature.

Key words were divided into two main categories, words related to SSGs (e.g., small-sided games, skill-based conditioning) and words that referred to rugby football codes (e.g., rugby union) (Table 1). Multiple words were linked together by the Boolean operator OR, and the two categories were combined by the Boolean operator AND. This Boolean search strategy was implemented by the first author (MZ) in MEDLINE, SPORTDiscus, ScienceDirect, and Scopus on 2 August 2020 with no temporal limits imposed, but limiting the findings to peer-reviewed academic journals in English language (Hammami et al., 2017; Hill-Haas et al., 2011; Kunz et al., 2019; McLaren et al., 2018; Moran et al., 2019; Sarmento et al., 2018). The complete search strategy can be found in (Appendix A).

The studies resulting from the database search were imported into EndNote (Thompson Reuters, version X9) where duplicates were automatically detected and removed. Articles were first assessed by their title, abstract, and then main body. When articles met all the inclusion criteria, they were considered for this review. The inclusion/exclusion assessment of the papers was carried out by two independent researchers (MZ, JR), and the agreement between reviewers was assessed with Kappa coefficient and percentage agreement (Cohen, 1960) which were calculated using R (4.0.3, R Core Team, 2020). Kappa coefficient was interpreted based on Landis & Koch (Landis & Koch, 1977): k < 0 “poor” agreement, 0.01–0.20 “slight” agreement, 0.21–0.40 “fair” agreement”, 0.41–0.60 “moderate” agreement, 0.61–0.80 “substantial” agreement, 0.-81–1.00 “almost perfect” agreement. After the first assessment, conflicts in terms of inclusion/exclusion of a certain article between the two independent reviewers were resolved by meetings between researchers and by consultation with a third researcher (GR). Furthermore, the reference list of significant studies was analysed to find other possible research papers that would fit the inclusion criteria.

Table 1. Boolean search strategy.

Variable	Search Terms
Small-sided games	“small-sided games” OR “game training” OR “skill-based conditioning” OR “skill conditioning” OR “skill training” OR “skill-based games” OR “game-based training” OR “conditioned games” OR \`skill-based training\`
Rugby football codes	“rugby sevens” OR “rugby football” OR “rugby union” OR “rugby league” OR “rugby” OR \`rugby 7s\` OR \`rugby football union\` OR \`rugby football league\`
Small-sided games AND field team sports	“1 AND 2”

2.3. Data extraction

For each included study, the following data were extracted: first author, publication year, title, study design, sport (e.g., rugby union, rugby league), aims of the study, pedagogical approach used to design the SSGs, number and characteristics of the participants, use of encouragement during small-sided games, number and duration of work and rest intervals, work-to-rest ratio, number of players per each team, pitch dimensions, relative playing area ($meters^2 \cdot player^{-1}$), field ratio (length-to-width), playing rules, playing conditions (e.g., time, temperature, playing surface). In addition, methods used for data collection (e.g., GPS, video camera), outcome measures (e.g., total distance, average speed [$m \cdot min^{-1}$]), and study findings were extracted from the studies included. The first author (MZ) extracted the data, and two authors (JR and GR) verified that the collected data were correct.

2.4. Quality assessment

The quality of the studies included in this systematic review was assessed with the Quality Index proposed by Downs and Black (SH Downs & Black, 1998) for randomized and non-randomized studies (Appendix B). The Quality Index has been used frequently in the sport science literature (Cummins et al., 2013; Emery et al., 2015; Freckleton & Pizzari, 2013; Johnston et al., 2018; Ramos et al., 2020), and applied specifically to SSG research in soccer (Bujalance-Moreno et al., 2019). The Quality Index is the sum of scores from the twenty-seven items of the checklist – higher scores indicate higher quality – which were grouped into four sections: reporting, external validity, internal validity, and power of the study (SH Downs & Black, 1998). The Quality Index showed a high test-retest reliability (r = 0.88), internal consistency (k = 0.89), and good inter-rater reliability (r = 0.75) (SH Downs & Black, 1998). Furthermore, the performance of the checklist was similar between randomized and non-randomized studies (SH Downs & Black, 1998). In addition, a comparison of multiple quality assessment scales (e.g., PEDro scale, Delphi list, Jadad scale) through a systematic review of the literature showed that the Quality Index was the only scale characterized by internal consistency (Olivo et al., 2008).

In this systematic review, the checklist was utilized in its original form as alterations may not guarantee the maintenance of its psychometric properties, and its validity and reliability would need to be reassessed (Olivo et al., 2008). Furthermore, this review is a synthesis without meta-analysis, consequently the Quality Index was not utilized as a weighting factor or as a covariate in a quantitative analysis, instead the presence/absence of single items of the scale was considered in the synthesis and discussion, thus overcoming the limitation of assigning the same relevance to each item of the scale (Greenland, 1994; Greenland & O'rourke, 2001; Whiting et al., 2005).

3 RESULTS

3.1. Study selection

Study selection is presented in Figure 1. A total of 1,261 research papers were collected from the literature search of four databases, and they were imported into EndNoteX9. After removing all the duplicates, 1,020 unique papers remained for inclusion/exclusion assessment. Following title and abstract screening, 988 articles were removed. The full text of 32 articles was thoroughly investigated, and 20 studies were included in this review. Percentage agreement was 98.82% whilst kappa coefficient was 0.76, indicating a substantial agreement between the two authors in terms of inclusion/exclusion of the papers before contacting the third researcher. The R script for calculating Kappa coefficient and percentage agreements can be found in (Appendix C).

3.2. Study characteristics

A summary of the characteristics of the studies included in this systematic review are presented in Table 2. Quality assessment scores are reported in Table 3, and a summary of the results of the studies are shown in Table 4. Seventeen studies (Bennett et al., 2016; Foster et al., 2010; Gabbett, Abernethy et al., 2012; Gabbett et al., 2010; Gabbett, Jenkins et al., 2012; Gabbett et al., 2015; Johnston, Gabbett, Jenkins et al., 2015; Johnston et al., 2016, 2014a, 2014b; Johnston, Gabbett, Walker et al., 2015, 2015; LMT Vaz et al., 2016; Morley et al., 2016; Sampson et al., 2015; L Vaz et al., 2012; Weakley et al., 2019) investigated the acute effects, and three studies (Gabbett, 2006; Gamble, 2004; Seitz et al., 2014) investigated the chronic effects of constraints on SSGs. Five studies were carried out in rugby union, four acute (Kennett et al., 2012; LMT Vaz et al., 2016; L Vaz et al., 2012; Weakley et al., 2019) and one chronic (Gamble, 2004), and 15 studies in rugby league, 13 acute (Bennett et al., 2016; Foster et al., 2010; Gabbett, Abernethy et al., 2012; Gabbett et al., 2010; Gabbett, Jenkins et al., 2012; Gabbett et al., 2015; Johnston, Gabbett, Jenkins et al., 2015; Johnston et al., 2016, 2014a, 2014b; Johnston, Gabbett, Walker et al., 2015; Morley et al., 2016; Sampson et al., 2015) and two chronic (Gabbett, 2006; Seitz et al., 2014). No study reported the pedagogical approach utilized to design the small-sided games.

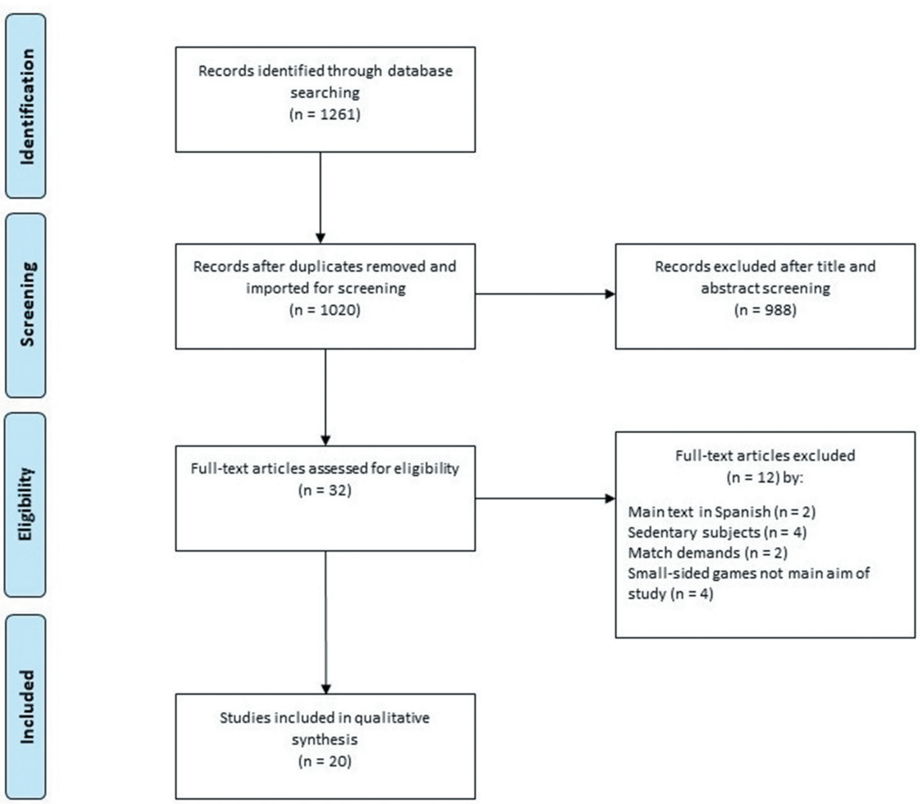

Figure 1. PRISMA flow diagram showing the overall process for study selection.

Table 2. Constraints applied to acute and chronic rugby football codes studies.

			Individual Constraints				Task Constraints				Environmental Constraints
Study	A/C	Interv Duration	Constraints Investigated	Participants	Encouragement	W:R Ratio	Nº of Players	Pitch Dimensions & Relative Playing Area	Field Ratio	Playing Rules	Playing Conditions
Bennett et al., (2016)	A	NA	Task Constraints:- Playing rules- Pitch dimensions- Number of players	15 junior male players(median [IQR], age: 15.9 [15.7–16.1], playing level: Harold Matthews U16 competition, NRL club talent identification programme).	Yes	WI: 3 minRI: NANº of WI: NA	10v10 SSG13v13 Match-play	SSG: 68 × 40 m = 136 m2·pl^{-1}Match-play: 100 × 68 = 261 m2·pl^{-1}	SSG 1.7:1Match-play 1.5: 1	SSG: onside, 6 plays per team, front-on body contact counted as a completed tackle;Match-play: official U16 rugby league rules.	Week 6 of in-season
Foster et al., (2010)	A	NA	Task Constraints: - Pitch size- Number of Players	22 junior male playersGroup 12–13 (n: 8, age: 12.6 ± 0.5 years, height: 160.2 ± 8.4 cm, weight: 52.3 ± 7.9 kg, VO2 peak: 55.4 ± 5.6 mL·kg^{-1}·min^{-1}, HR max: 201.4 ± 3.5 bpm)Group 15–16 (n: 14, age: 15.5 ± 0.5 years, height: 179.6 ± 5.1 cm, weight: 76.7 ± 10.2 kg, VO2 peak: 52.2 ± 5.5 mL·kg^{-1}·min^{-1}, HR max: 196.1 ± 8.9 bpm).	Yes	WI: 4 minRI: 3 min (active)Nº of WI: 3	4v46v6	4v4 S: 15 × 25 m = 46 m2·pl^{-1}4v4 M: 20 × 30 m = 75 m2·pl^{-1}4v4 L: 25 × 35 m = 109 m2·pl^{-1}6v6 S: 15 × 25 m = 31 m2·pl^{-1}6v6 M: 20 × 30 m = 50 m2·pl^{-1}6v6 L: 25 × 35 m = 73 m2·pl^{-1}	NA	Off-side game; attacking team possession until touched by a defender, a try was scored, dropped ball, ball out of play; running with ball permitted; tackle is a 2 handed touch by defender, attacking players allowed 5 m offside, play was restarted after each touch by tapping the ball with the foot to recommence play.	Outside grass rugby pitch
Gabbett et al., (2010)	A	NA	Task Constraints: - Playing rules	16 male players(age: 17.3 ± 0.9 years, playing level: National Rugby League club development squad).	Yes	WI: 8 minRI: 3 minNº of WI: 2	8v8	40 x 40 m = 100 m2·pl^{-1}	1:1	Offside: ball can be passed forward and backward, 3 plays per team;Onside: ball can be passed only backward, 3 plays per team;A play ended when a defender touched the ball carrier with two hands.	In-season
Gabbett, Jenkins et al., (2012)	A	NA	Task Constraints:- Playing rules	28 elite male players(age: 21.6 ± 0.5 years, playing level: NRL).	Yes (no feedback)	WI: 8 minRI: 90 secNº of WI: 2	7v7	40 x 70 m = 200 m2·pl^{-1}	1.75:1	Off-side game, 2 plays per team, touch with 2 handswrestling 5 sec in every minute, wrestling partner to the ground.	Pre-competitive phase
Gabbett, Abernethy et al., (2012)	A	NA	Task Constraint:- Pitch	dimensionsIndividual constraint:- Training experience- Chronological age	16 senior elite male players (age: 23.6 ± 0.5 years, NRL team)16 junior elite male players (age: 17.3 ± 0.3 years, NRL club high performance junior development squad).	Yes	WI: 8 min	8v8	S: 10 × 40 m = 25 m2·pl^{-1}L: 40 × 70 m = 175 m2·pl^{-1}	S: 4:1L: 1.75:1	Offside, 2 plays per team, touch with two hands.
Pre-competitive phaseWarm and dry conditions											
Gabbett et al., (2015)	A	NA	Individual Constraints:- Knowledge of game duration	12 semi-professional male players (age: 22.8 ± 2.1 years, weight: 89.7 ± 8.9 kg, height: 183.7 ± 7.7 cm, estimated maximal aerobic power: 54.3 ± 3.2 mL·kg^{-1}·min^{-1}, playing level: Queensland Cup competition)	Yes	WI: 12 minNº of WI: 1	6v6	20 x 40 m = 66 m2·pl^{-1}	2:1	Off-side, 3 plays per team; a play ended when the player in possession of the ball was tagged by a defender with two hands, or when an error was committed.	NA

(*Continued*)

Table 2. (Continued).

				Individual Constraints				Task Constraints			Environmental Constraints
Study	A/C	Interv Duration	Constraints Investigated	Participants	Encouragement	W:R Ratio	Nº of Players	Pitch Dimensions & Relative Playing Area	Field Ratio	Playing Rules	Playing Conditions
Johnston et al., (2014a)	A	NA	Task Constraints:- Playing rules	23 elite junior male players (age:19.1 ± 0.8 years, height: 178.3 ± 22.9 cm, weight: 93.7 ± 9.2 kg, playing level: NRL club)	Yes	WI: 8 minRI: 90 secNº of WI: 2	6v6	30 x 70 m = 175 m2·pl^{-1}	NA	Offside, 3 plays per team, a play ends when touched with two hands by a defender;If contact: 5 sec shoulder pummels & 5 sec wrestling partner to the ground on every minute	Penultimate week of pre-seasonGrass rugby pitch
Johnston et al., (2014b)	A	NA	Task Constraints:- Playing rules	23 elite junior male players (age:19.1 ± 0.8 years, height: 178.3 ± 22.9 cm, weight: 93.7 ± 9.2 kg, playing level: National Youth Competition U20)	Yes	WI: 8 minRI: 90 secNº of WI: 2	6v6	30 x 70 m = 175 m2·pl^{-1}	NA	Offside, 3 plays per team, a play ends when touched with two hands by a defender;If contact: 5 sec shoulder pummels & 5 sec wrestling partner to the ground every 50 sec.	Penultimate week of pre-seasonGrass rugby pitch
Johnston, Gabbett, Jenkins et al., (2015)	A	NA	Task Constraints:- Playing rules	18 semi-professional male players (age: 23.6 ± 2.8 years, weight: 91.2 ± 8.8 kg, vIFT: 19.1 ± 1.2 km·h^{-1}, 1RM back squat: 154.0 ± 21.5 kg, 1RM bench press: 124.0 ± 15.0 kg)	Yes	WI: 10 minRI: 2 minNº of WI: 2	9v9	50 x 80 m = 222 m2·pl^{-1}	NA	Off-side, 3 plays per team; a play ended when the player in possession of the ball was tagged by a defender with two hands, or when an error was committed. Every 2 minutes performed a contact bout:SSG1: 1 contact effort each bout (8 in total, 5 sec wrestling partner onto his back)SSG2: 2 contact efforts each bout (16 in total, 5 sec wrestling, 2 sec rest, 5 sec wrestling).SSG3: 3 contact efforts each bout (24 in total, 5 sec wrestling, 2 sec rest, 5 sec wrestling, 2 sec rest, 5 sec wrestling).	Grass outdoorWeek 6–7 of pre-season
Johnston, Gabbett, Walker et al., (2015)	A	NA	Task Constraints:- Playing rules	12 semi-professional male players (age: 24.5 ± 2.9 years, weight: 90.4 ± 7.2 kg)	NA	WI: 10 minRI: 2 minNº of WI: 2	6v6	30 x 70 m = 175 m2·pl^{-1}	NA	Off-side, 3 plays per team; a play ended when the player in possession of the ball was tagged by a defender with two hands, or when an error was committed. Every 2 minutes performed a contact bout:SSG1: 1 contact effort each bout (8 in total, 5 sec wrestling partner onto his back)SSG2: 2 contact efforts each bout (16 in total, 5 sec wrestling, 2 sec rest, 5 sec wrestling).SSG3: 3 contact efforts each bout (24 in total, 5 sec wrestling, 2 sec rest, 5 sec wrestling, 2 sec rest, 5 sec wrestling).	Week 4–5 of pre-seasonGrass rugby pitch

(*Continued*)

Table 2. (Continued).

				Individual Constraints				Task Constraints			Environmental Constraints
Study	A/C	Interv Duration	Constraints Investigated	Participants	Encouragement	W:R Ratio	Nº of Players	Pitch Dimensions & Relative Playing Area	Field Ratio	Playing Rules	Playing Conditions
Johnston et al., (2016)	A	NA	Task Constraints:- Playing rules	22 semi-professional male players (age: 24.0 ± 1.8 years, weight: 95.6 ± 7.4 kg, playing level: Queensland Cup)	NA	WI RHIE: 1 min x 6RI RHIE: 30 secWI SSG: 5 min x 2RI SSG: 1 min	9v9	68 x 40 m = 151 m2·pl^{-1}	NA	RHIE: 6 efforts in each bout, 3 bouts before each SSG; RHIE contact (6 contact efforts); RHIE running (6 20-m sprint); RHIE mainly contact (4 contacts, 2 sprints); RHIE mainly running (2 contact, 4 sprints); contact: wrestling partner to the ground; sprint: all-out 20-m sprint; SSG: offside, 3 plays whilst in possession, a play ends when touched with two hands by a defender.	Week 9–11 of pre-seasonGrass rugby pitch
Kennett et al.(2012)	A	NA	Task Constraints: - Pitch size- Number of Players	20 semi-professional males (age: 21.3 ± 1.2 years, weight: 89 ± 8 kg, height: 183 ± 5 cm, YOYOIRL1: 1679 ± 302 m)	Yes	WI: 9 minRI: 2 minNº of WI: 2	4v46v68v8	4S: 32 × 24 m = 96 m2·pl^{-1}4 L: 64 × 48 m = 384 m2·pl^{-1}6S: 32 × 24 m = 64 m2·pl^{-1}6 L: 64 × 48 m = 256 m2·pl^{-1}8S: 32 × 24 m = 48 m2·pl^{-1}8 L: 64 × 48 m = 192 m2·pl^{-1}	1.33:1	Onside, 6 plays per team, one hand touch, after tackle defensive line set back 5 m then play the ball.	4pm-5pmJune-July
Morley et al., (2016)	A	NA	Task Constraints:- Pitch dimensions- Number of players- Playing rules	475 junior players(n U7s: 108, n U8s: 223, n U9s: 144)	NA	U7s 4v4: WI 5 min x 8U8s 5v5: WI 5 min x 8U9s 6v6: WI 6 min x 89v9: WI 15 min x 2	4v4 SSG5v5 SSG6v6 SSG9v9 Match-play	4v4: 20 × 12 m = 30 m2·pl^{-1}5v5: 20 × 15 m = 30 m2·pl^{-1}6v6: 25 × 18 m = 37 m2·pl^{-1}9v9: 60 × 40 m = 133 m2·pl^{-1}	NA	On-side, six tackles or touches per ball possession, further specific rules for different age groups	In-season
Sampson et al., (2015)	A	NA	Task Constraints:- W: R ratio	16 amateur junior male players (age: 14.9 ± 0.5 years, height: 171.7 ± 4.4 cm, weight: 65.3 ± 7.5 kg, HR max: 198 ± 8 bpm, max velocity: 7.66 ± 0.60 m·s^{-1})	NA	1 x 24 min W, 2 × 12 min W, 3 × 8 min W, 4 × 6 min W, 6 × 4 min W, 8 × 3 min W, 12 × 2 min W, 24 × 1 min W; RI = 2 min passive	4v4	20 x 40 m = 100 m2·pl^{-1}	2:1	Off-side touch game; 3 plays per team, turnover after try, dropped ball, or 3 plays.	NA
L Vaz et al., (2012)	A	NA	Individual Constraint:- Training experience	40 male players (age: 21.6 ± 3.6 years, height: 177.7 ± 7.4 cm, weight: 81.2 ± 10.2 kg):20 exp (>5 years national/ international competitions) 20 nov (≤1 year rugby experience).	Yes (no feedback)	WI: 12 minRI: 0 secNº of WI: 1	6v6	60 x 40 m = 200 m2·pl^{-1}	NA	2011 IRB laws.	Natural turf rugby pitch
LMT Vaz et al., (2016)	A	NA	Task Constraints: - Pitch size- Number of Players	14 male players(age: 22.4 ± 3.2 years, playing level: elite national championship, training: 5 times per week 10–12 h·week^{-1}).	Yes (no feedback)	WI: 15 minRI: 0 secN of WI: 17s WI: 7 min x 2 (1 min rest)	SSG1: 1v1SSG2: 2v1SSG3: 7v7 (SSG)SSG4: 7v7 (Match 7s)	1: 30 × 30 m = 450 m2·pl^{-1}2: 30 × 30 m = 300 m2·pl^{-1}7: 50 × 35 m = 125 m2·pl^{-1}7s: 100 × 70 m = 500 m2·pl^{-1}	1:11.43:11.43:1	1v1: beat defender2v1: beat defender and support7 SSG: in attack goals: gain/retain possession, create/ penetrating space, supporting, scoring; in defence goals: contest/regain possession, deny space, tackle carrier;7s: sevens rules.	October 2012 – March 201318.30–21 hNatural turf rugby pitchTemperature: 17–19°CRelative humidity: 58–69%

(*Continued*)

Table 2. (Continued).

			Individual Constraints			Task Constraints					Environmental Constraints
Study	A/C	Interv Duration	Constraints Investigated	Participants	Encouragement	W:R Ratio	Nº of Players	Pitch Dimensions & Relative Playing Area	Field Ratio	Playing Rules	Playing Conditions
Weakley et al., (2019)	A	NA	Individual Constraints:- Knowledge of result	20 male players (age: 19.8 ± 0.8 years, height: 181 ± 5 cm, weight: 96.8 ± 15.8 kg, playing level: BUCS Super Rugby UK).	NA	WI: 4 minRI: 2 minNº of WI: 6	5v5	40 x 20 m = 80 m2·pl^{-1}	2:1	Off-side; six plays per team; first pass backward then free; turnover after a try, end of plays, error; after being touched by a defender, defenders had to return to on-side position, attackers behind the line of the ball.	Pre-season, SeptemberMonday-Thursday 9amGrass rugby pitch
Gabbett, (2006)	C	2 x 9	weeks (2d/w) in-seasonStudy duration: 29 weeks	NA	69 subelite rugby league playersTraditional group (n: 37, age: 22.3 ± 0.8 years)SSG group (n: 32, age: 22.1 ± 0.9 years)Gold Coast group 18 (NSW Country Rugby League, AUS).	NA	Various formats implemented, no specific details reported	Various formats implemented; no specific details reported	NA	NA	NA
Gamble, (2004)	C	9	weekspre-season	NA	35 professional male players(playing level: Premiership Rugby, UK; age: 27.61 ± 4.20 years; height: 185.42 ± 7.27 cm; weight: 98.61 ± 13.74 kg; HR max: 190.37 ± 9.55 bpm; resting HR: 50.77 ± 6.41 bpm).	NA	Various formats implemented; no specific details reported	Various formats implemented; no specific details reported	NA	NA	Various formats, no specific details reported
Seitz et al., (2014)	C	8 weeks in-	season2 d/w	NA	10 male players (age: 20.9 ± 1.4 years, weight: 94.4 ± 8.6 kg, height: 184.7 ± 7.4 cm, rugby experience: 11.4 ± 3.8 years)Stobart Super League academy	Yes	WI: 10 minRI: 3 min passiveNº of WI: 4	16 SSGs, 7 formats: 2 for forwards, 2 for backs, 3 for forwards & backs	NA	NA	NA
Rugby pitch											

A acute, *C* chronic, *Interv* intervention, *W* work, *R* rest, *Nº* number, *NA* not available, *[IQR]* interquartile range, *NRL* National Rugby League, *VO2* maximal oxygen uptake, *WI* work interval, *RI* rest interval, *SSG* small-sided games, *m2·pl*$^{-1}$ squared metres per player, *min* minutes, *sec* seconds, *S* small, *L* large, *vIFT* final velocity Intermittent Fitness test, *RHIE* repeated high intensity effort, *YOYOIRL1* Yo-Yo intermittent recovery level 1, *U* under, *HR* heart rate, *exp* experienced, *nov* novice, *IRB* International Rugby Board, *h* hours, *NSW* New South Wales, *bpm* beats per minute.

Table 3. Quality assessment of acute and chronic rugby football codes studies.

Study	A/C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	Quality Index
Bennett et al., (2016)	A	1	1	1	1	0	1	1	0	1	0	1	0	1	0	0	1	0	1	0	1	1	0	0	0	1	0	0	14
Foster et al., (2010)	A	1	1	1	1	1	1	1	0	1	0	1	0	1	0	0	1	0	1	0	1	0	0	0	0	1	0	0	14
Gabbett et al., (2010)	A	1	1	1	1	0	1	1	0	1	0	1	0	1	0	0	1	0	1	0	1	1	0	0	0	0	0	0	13
Gabbett, Jenkins et al., (2012)	A	1	1	1	1	0	1	1	0	1	0	1	0	1	0	0	1	0	1	0	1	1	0	0	0	0	0	0	13
Gabbett, Abernethy et al., (2012)	A	1	1	1	1	0	1	1	0	1	0	1	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	12
Gabbett et al., (2015)	A	1	1	1	1	0	0	1	0	1	0	1	0	1	0	0	1	0	1	0	1	1	0	0	0	0	0	0	12
Johnston et al., (2014a)	A	1	1	1	1	0	1	1	0	1	1	1	0	1	0	0	1	1	1	0	1	1	0	1	0	0	0	0	16
Johnston et al., (2014b)	A	1	1	1	1	0	1	1	0	1	1	1	0	1	0	0	1	0	1	0	1	1	0	0	0	0	0	0	14
Johnston, Gabbett, Jenkins et al., (2015)	A	1	1	1	1	0	0	1	0	1	0	1	0	1	0	0	1	0	1	0	1	1	0	1	0	0	0	0	13
Johnston, Gabbett, Walker et al., (2015)	A	1	1	1	1	0	0	0	0	1	0	1	0	1	0	0	1	0	1	0	1	1	0	1	0	0	0	0	12
Johnston et al. Gabbett et al., (2015)	A	1	1	1	1	0	0	1	0	1	0	1	0	1	0	0	1	0	1	0	1	1	0	0	0	0	1	0	13
Kennett et al. (2015)	A	1	1	1	1	1	1	1	0	1	0	1	0	1	0	0	1	0	1	0	1	1	0	0	0	0	0	0	14
Morley et al., (2016)	A	1	1	0	1	1	1	1	0	1	0	1	0	1	0	1	1	0	1	0	1	1	0	0	0	0	0	0	14
Sampson et al., (2015)	A	1	1	1	1	1	1	1	0	1	1	1	0	1	0	0	1	0	1	0	1	1	0	0	0	1	1	0	17
L Vaz et al., (2012)	A	1	1	1	1	0	1	1	0	1	1	1	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	13
Vaz et al., (2016)	A	1	1	1	1	0	0	0	0	1	1	1	0	1	0	0	1	0	1	0	1	1	1	0	0	0	0	0	13
Weakley et al., (2019)	A	1	1	1	1	1	1	1	0	1	0	1	0	1	0	0	1	0	1	0	1	1	0	0	0	1	0	0	15
Gabbett, (2006)	C	1	1	1	0	1	1	1	0	1	0	1	0	1	0	0	1	1	1	0	1	1	0	0	0	1	0	0	15
Gamble, (2004)	C	1	1	1	0	1	0	1	1	1	0	1	0	1	0	0	1	0	1	0	1	1	0	0	0	1	1	0	15
Seitz et al., (2014)	C	1	1	1	0	0	1	1	0	1	1	1	0	1	0	0	1	0	1	0	1	1	0	0	0	0	0	0	13

A acute, *C* chronic

3.3. Acute studies

Quality assessment of the studies investigating acute effects of constraints in SSGs (Table 3) showed a mean and standard deviation of 13.65 ± 1.37 points out of 32 possible points (range: 12–17). No study reported a list of possible adverse events (i.e. harmful or detrimental outcome that occurs during or after the intervention, for instance, a certain injury) (question 8), assessed the distribution of the main confounding factors between sample and population (question 12), blinded participants to the intervention (question 14) or those measuring the main outcomes of the intervention (question 15), concealed the randomization process to participants and staff members (question 24), reported a power calculation (question 29); and for all studies included, the reliability of compliance with the intervention (question 19) was unable to be determined.

Among the acute studies (Table 2, 4), 13 investigated the influence of task constraints (Bennett et al., 2016; Foster et al., 2010; Gabbett, Abernethy et al., 2012; Gabbett et al., 2010; Gabbett, Jenkins et al., 2012; Gabbett et al., 2015; Johnston, Gabbett, Jenkins et al., 2015; Johnston et al., 2016, 2014a, 2014b; Johnston, Gabbett, Walker et al., 2015; Kennett et al., 2012; LMT Vaz et al., 2016; Morley et al., 2016; Sampson et al., 2015; L Vaz et al., 2012; Weakley et al., 2019), three investigated the effect of individual constraints (Gabbett et al., 2015; L Vaz et al., 2012; Weakley et al., 2019), and one investigated both task and individual constraints (Gabbett, Abernethy et al., 2012) on SSGs. The task constraints investigated were pitch dimensions (Bennett et al., 2016; Foster et al., 2010; Gabbett, Abernethy et al., 2012; Kennett et al., 2012; LMT Vaz et al., 2016; Morley et al., 2016), number of players (Bennett et al., 2016; Foster et al., 2010; Kennett et al., 2012; LMT Vaz et al., 2016; Morley et al., 2016), playing rules (Bennett et al., 2016; Gabbett et al., 2010; Gabbett, Jenkins et al., 2012; Johnston, Gabbett, Jenkins et al., 2015; Johnston et al., 2016, 2014a, 2014b; Johnston, Gabbett, Walker et al., 2015; Morley et al., 2016), and work-to-rest ratio (Sampson et al., 2015). Individual constraints investigated were training experience and chronological age (Gabbett, Abernethy et al., 2012; L Vaz et al., 2012), knowledge of results (Weakley et al., 2019), and knowledge of SSG duration (Gabbett et al., 2015). No environmental constraint was investigated. Nine studies analysed the effects of constraints on external/internal loads (Foster et al., 2010; Johnston, Gabbett, Jenkins et al., 2015; Johnston et al., 2014a, 2014b; Johnston, Gabbett, Walker et al., 2015; Kennett et al., 2012; LMT Vaz et al., 2016; Sampson et al., 2015; Weakley et al., 2019). Two studies exclusively looked at technical characteristics (Bennett et al., 2016; Morley et al., 2016), and six studies investigated both external/internal loads and technical characteristics (Gabbett, Abernethy et al., 2012; Gabbett et al., 2010; Gabbett, Jenkins et al., 2012; Gabbett et al., 2015; Johnston et al., 2016; L Vaz et al., 2012).

3.3.1 Task constraints: Playing rules

No study in rugby union investigated the effect of playing rules on technical/tactical characteristics and/or external/internal loads. In rugby league, Gabbett et al. (Gabbett et al., 2010) compared `off-side` and `on-side` rules (Table 2), and reported that `off-side` rule led to more technical skills executed (e.g.,

Table 4. Description and results of acute and chronic rugby football codes studies.

Study	A/C	Study Design	Sport	Study Aim	Pedagogical Approach	Methods	Outcome Measures	Results
Bennett et al., (2016)	A	Within subjects – repeated measures design	RL	Influence of on-side SSG and match-play on technical demands	NR	Video camera	Offensive involvement: ball carry, support run, line break, line break assist; Defensive involvement: body in front, tackles made	Defensive involvements, total technical involvements per min of play: SSG > match-play ($p < 0.01$);Correlation offensive technical skills in SSG and match-play ($r = 0.80$ [0.50–0.93], $p < 0.01$);No correlation for defensive technical skills in SSG and match-play.
Foster et al., (2010)	A	Within subjects – repeated measures design	RL	Effects of pitch dimensions and number of players on HR response and reproducibility of this response over two repeated trials	NR	HR monitor	%HR max	Range %HRmax: 85–91% HRmax;15–16 yo mean %HRmax: 4v4 > 6v6 ($p < 0.001$);12–13 yo similar HR between 4v4 and 6v6;Pitch area does not influence %HR max;Variability from trials not significant in 15–16 yo and 12–13 yo;The 4v4 in medium pitch most reliable in 15–16 yo (ICC = 0.91; LoA = 0.4 ± 0.5% HR max).
Gabbett et al., (2010)	A	Within subjects crossover design	RL	Influence of On-side v Off-side rules on physical/physiological and technical demands	NR	Video cameraGPS 5 HzAccelerometer 100 HzHR monitorPhysical and Cognitive RPE	Video: total involvements, receives, catching errors, effective passes, ineffective passes, total passes, disposal efficiency;GPS: total distance, $m \cdot min^{-1}$, distance in absolute speed and accel zones;HR: mean HR	Offside: ↑ contacts with ball, effective passes, total passes; greater total distance, $m \cdot min^{-1}$, distance covered in moderate (3–5 $m \cdot s^{-1}$) and high (5–7 $m \cdot s^{-1}$) speed, and distance covered in mild (0.55–1.11 m·s¯2) and moderate (1.12–2.78 m·s¯2) accelerations ($p < 0.05$);Onside: ↑ cognitive RPE ($p < 0.05$); Similar HR and physical RPE.
Gabbett, Jenkins et al., (2012)	A	Within subjects crossover design	RL	Influence of Contact and No-Contact SSGs on physical and technical demands	NR	GPS 5 HzAccelerometer 100 HzVideo Camera	Video: total involvements, receives, catching errors, effective passes, ineffective passes, total passes, disposal efficiency;GPS: total distance, $m \cdot min^{-1}$, distance in absolute speed and accel zones, RHIE, recovery between efforts;	No-wrestling: ↑ total distance covered, average speed, distance covered at high (5–7 $m \cdot s^{-1}$) and very high (>7 $m \cdot s^{-1}$) speed ($p < 0.05$);Wrestling: ↑ maximal (>2.79 m·s¯2) accelerations, number of RHIE ($p < 0.05$);Similar total involvements, receives, catching errors, total passes, effective passes, ineffective passes, disposal efficiency.
Gabbett, Abernethy et al., (2012)	A	Within subjects crossover design	RL	Influence of pitch size and training experience on technical and physical demands	NR	Video cameraGPS 5 HzAccelerometer 100 Hz	Video: total involvements, receives, catching errors, effective passes, ineffective passes, total passes, disposal efficiency;GPS: total distance, $m \cdot min^{-1}$, distance in absolute speed zones, RHIE, recovery between efforts;	Junior: total distance, $m \cdot min^{-1}$, high speed (5–7 $m \cdot s^{-1}$), and very high speed (>7 $m \cdot s^{-1}$) distance: L pitch > S pitch ($p < 0.05$);Senior: total distance, $m \cdot min^{-1}$, and high speed (5–7 $m \cdot s^{-1}$) distance, number of recoveries between efforts: L pitch > S pitch ($p < 0.05$);Physical demands: senior > junior in both S and L pitches; Technical demands (e.g., receives, catching errors, total passes) similar between junior-elite and S pitch-L pitch.

(Continued)

Table 4. (Continued).

Study	A/C	Study Design	Sport	Study Aim	Pedagogical Approach	Methods	Outcome Measures	Results
Gabbett et al., (2015)	A	Within subjects – repeated measures design	RL	Influence of knowledge of game duration on physical/physiological and technical demands	NR	GPS 10 HzAccelerometer 100 HzRPE 1–10Video camera	Video: total passes, effective passes, ineffective passes, receives, errors, total involvements, disposal efficiency;GPS: m·min^{-1}, LSR, HSR	Similar time spent attacking/defending in each condition; m·min^{-1}: partial-knowledge (ES = 0.63 ± 0.68, 91%, likely) and no-knowledge (ES = 1.24 ± 0.55, 100%, almost certainly) > knowledge; High-speed (>5.1 m·s^{-1}) running distance: partial-knowledge (ES = 0.76 ± 0.66, 92%, likely) > control;RPE: partial-knowledge > no-knowledge (ES = 0.59 ± 0.69, 83%, likely) and knowledge (ES = 0.56 ± 0.69, 81%, likely);Total involvements (sum of receives, passes, errors): no-knowledge > knowledge (ES = 0.59 ± 0.68, 89%, likely).
Johnston et al., (2014a)	A	Counterbalanced crossover design	RL	Influence of contact and no-contact on physical/physiological demands	NR	Force platform: CMJ, plyometric push-up[CK] GPS 10 HzAccelerometer 100 HzOverall Wellbeing ScoreRPE 1–10	[CK]: fingertip;GPS: total distance, m·min^{-1}, LSR, HSR, RHIE;CMJ & PP: peak power, force;	No-contact > contact: total distance (p = 0.001, ES = 2.48 ± 1.14, 100%, almost certain), m·min^{-1} (p = 0.001; ES = 2.45 ± 1.09, 100%, almost certain), and high-speed (>5.1 m·s^{-1}) distance (p = 0.003; ES = 0.78 ± 1.05, 95%, very likely); Wellbeing score: ↓ lower after contact (ES = −048 ± 1.0) than no-contact (ES = −0.28 ± 0.97) (p = 0.03);RPE: contact > no-contact (p = 0.05, ES = 0.41 ± 0.85, 8%, unlikely);Similar creatine kinase concentrations;CMJ ↓ more following the no-contact (ES = −1.42 ± 0.93) than contact (ES = −0.88 ± 0.82) (75%, likely); PP ↓ only after contact (p = 0.003, ES = −1.08 ± 0.73, 97%, very likely).
Johnston et al., (2014b)	A	Counterbalanced crossover design	RL	Influence of contact and no-contact on physical/physiological demands	NR	GPS 10 HzAccelerometer 100 HzRPE 0–10	GPS: total distance, m·min^{-1}, LSR, HSR, RHIE; Accelerometer: PlayerLoad™ 2D;	m·min^{-1}: no-contact > contact (p = 0.076, ES = 0.45 [−0.55, 1.50], 87%, likely); Similar high-speed (>5.1 m·s^{-1}) running (p = 0.417, ES = 0.24 [−0.76, 1.20], 56%, possibly);Playerload™ 2D: contact > no-contact (p = 0.001, ES = 2.69 [2.4, 5.0], 100%, almost certain);RPE: contact > no-contact (p = 0.05, ES = 0.41 ± 0.85, 8%, unlikely).
Johnston, Gabbett, Jenkins et al., (2015)	A	Counter-balanced cross-over design	RL	Influence of number of contact bouts on physical demands	NR	GPS 10 HzAccelerometer 100 Hz	GPS: m·min^{-1}, distance in absolute speed zones;Accelerometer: PlayerLoad™ Slow	Similar m·min^{-1} between games (ES = 0.21 to −0.57);Last 5 min of game-play, m·min^{-1} ↓ more in SSG2 (ES = 1.93 ± 1.0, 100%, almost certain) and SSG3 (ES = −1.28 ± 1.0, 100%, almost certain) than in SSG1 (ES = −0.73 ± 1.0, 96%, likely);PlayerLoad™ Slow ↑ with contact demands of each game;More contacts limit HSR (>5 m·s^{-1});IFT score: high-speed (>5 m·s^{-1}) running on SSG1 ($r = 0.72$, $p < 0.01$) and SSG2 ($r = 0.75$, $p < 0.05$);As the number of contact efforts ↑, correlation IFT-m·min^{-1} ↓.

(Continued)

Table 4. (Continued).

Study	A/C	Study Design	Sport	Study Aim	Pedagogical Approach	Methods	Outcome Measures	Results
Johnston, Gabbett, Walker et al., (2015)	A	Counterbalanced crossover design	RL	Influence of number of contact bouts on physical demands	NR	GPS 10 HzAccelerometer 100 Hz	GPS: $m\cdot min^{-1}$, distance in absolute speed zones;Accelerometer: PlayerLoad^{TM} Slow	$m\cdot min^{-1}$ ↓ first to second half in SSG2 (ES = −0.47 ± 0.24, 82%, likely) and SSG3 (ES = −0.74 ± 0.27, 88%, likely);High-speed (>5.1 $m\cdot s^{-1}$) running ($m\cdot min^{-1}$) ↓ more from first to second half in SSG1 (ES = −0.78 ± 0.32, 91%, likely) than in SSG2 (ES = −0.16 ± 0.72, 51%, possibly) and SSG3 (Es = −0.09 ± 0.61, 39%, possibly); Playerload^{TM} Slow: SSG3 > SSG1 (ES = 0.72 ± 0.38, 27%, possibly).
Johnston et al., (2016)	A	Counterbalanced crossover design	RL	Influence of running and contact on physical/ physiological and technical demands	NR	GPS 10 Hz Accelerometer 100 HzRPE 1–10 Video camera Force platform: CMJ, plyometric push-up	GPS: $m\cdot min^{-1}$, distance covered in absolute speed zones; Accelerometer: PlayerLoad^{TM} SlowVideo: number of possessions, errors, number and quality of disposal;	RHIE $m\cdot min^{-1}$: ↓ in contact-only (43 ± 2 $m\cdot min^{-1}$), ↑ in running-only (105 ± 7 $m\cdot min^{-1}$) (ES = 3.00–12.97);RHIE PlayerLoad^{TM} Slow ($AU\cdot min^{-1}$): ↑ in contact-only (7.6 ± 1.7 $AU\cdot min^{-1}$), ↓ in running-only (2.6 ± 0.5 $AU\cdot min^{-1}$) (ES = 1.77–3.99);1st SSG: $m\cdot min^{-1}$ and high-speed (>5.1 $m\cdot s^{-1}$) running ($m\cdot min^{-1}$) ↓ following running-only RHIE than contact-only (ES = −0.69 ± 0.22; 93%, likely) and mainly-contact (ES = −0.69 ± 0.43, 89%, likely)From 1st to 2nd SSG: contact-only (ES = −0.96 ± 0.42, 94% likely) and mainly contact (ES = −1.07 ± 0.34, 94%, likely) ↓ in $m\cdot min^{-1}$;Similar technical demands;From 1st to 2nd SSG: effective passes ↓ only in contact-only (ES = −0.30 ± 0.22, 77%, likely);CMJ: greatest ↓ in running-only (ES = −1.36 ± 0.20, 85%, likely), and lowest in contact-only (ES = −0.01 ± 0.11, 29%, possibly not);PP: greatest ↓ in contact-only (ES = −1.55 ± 0.44, 100%, almost certain), and lowest in running-only (ES = −0.07 ± 0.09, 36%, possibly);RPE highest in mainly-contact.
Kennett et al. (2012)	A	Within subjects – repeated measures design	RU	Influence of Pitch Size and Number of players on physical and physiological demands	NR	GPS 1 HzHR monitorRPE 6–20[La]	GPS: $m\cdot min^{-1}$, HSR, Nº of sprints, peak speed;HR: %HR max, t@>85% HR max;[La]: fingertip;	$m\cdot min^{-1}$: 4 > 6 > 8 ($p < 0.05$), L > S ($p < 0.05$);Nº sprints: 4 > 8 ($p < 0.05$), L > S ($p < 0.05$);HSR distance (> 14.5 $km\cdot h^{-1}$): 4 > 6 > 8 ($p < 0.05$), L > S ($p < 0.05$);[La]: 4 > 6 and 8 ($p < 0.05$), L > S ($p < 0.05$);RPE 6–20: 4 > 6 > 8 ($p < 0.05$), L > S ($p < 0.05$); Similar %HRmax and t@>85%HRmax between pitches and numbers;High reproducibility of SSG for total distance (ICC = 0.90 [0.82, 0.95]), HSR (ICC = 0.90 [0.82, 0.95]), average speed (ICC = 0.87 [0.76, 0.93]).

(*Continued*)

Table 4. (Continued).

Study	A/C	Study Design	Sport	Study Aim	Pedagogical Approach	Methods	Outcome Measures	Results
Morley et al., (2016)	A	Within subjects – repeated measures design	RL	Influence of SSG and match-play on technical demands	NR	Video camera	Passes, catches, kicks, tackles, `around the world` runs; crossing advantage/ defensive line, line breaks, tries scored; total plays, completed sets; total skill opportunities;	In U7s: total plays (ES = 2.44, p < 0.001), total technical skills opportunities (ES = 1.44, p < 0.001), total passes (ES = 1.92, p < 0.001), total catches (ES = 1.71, p < 0.001), crossed advantage (ES = 2.58, p < 0.001) and defensive (ES = 2.18, p < 0.001): SSGs > match-play; In U8s: total plays (ES = 1.36, p < 0.001), total technical skills (ES = 1.58, p < 0.001), total passes (ES = 1.21, p < 0.01), total catches (ES = 1.20, p < 0.01), crossed advantage (ES = 0.96, p < 0.01) and defensive (ES = 0.58, p < 0.05), tries scored (ES = 1.27, p < 0.001): SSG > match;In U9s: total technical skills opportunities (ES = 0.77, p < 0.05), total tackles (ES = 0.80, p < 0.05), line breaks (ES = 0.89, p < 0.05), and tries scored (ES = 1.32, p < 0.001): SSGs > match-play;In U8s: touch-ball carrier rule highest number of total plays (v match-play ES = 2.03, p < 0.001), total technical skills opportunities (v match-play ES = 1.79, p < 0.001), total passes (v match-play ES = 1.79, p < 0.01), and crossed advantage (v match-play ES = 1.17, p < 0.01) and defensive (v match-play ES = 0.68, p < 0.05) lines in comparison with tackle-ball carrier rule and match-play.
Sampson et al., (2015)	A	Within subjects – repeated measures design	RL	Influence of work/rest interval duration on physical/physiological demands	NR	GPS 10 HzHR monitorRPE 1–15	GPS: total distance, distance in relative speed and accel zones;HR: time in HR zones	similar total distance between conditions; High speed (50–70% Vmax) running ↓ in multiple bouts, greatest decrease in 24 × 1 (ES = 0.75 [0.14, 1.36]);WI >2 min even distribution of speed/acceleration events across bouts;1 x 24, 3 x 8, 4 × 6 highest t@>90%HR max;RPE: ↑ 1 × 24 and 2 × 12 than in the other conditions (p < 0.05).
L Vaz et al., (2012)	A	Within subjects – repeated measures design	RU	Influence of training experience, exp v nov players, on physical and game performance	NR	GPS 5 HzHR monitorVideo camera	GPS: total distance, distance in absolute speed zones, number of collisions in impact zones;HR: time in HR zones; Video: passes, forward passes, balls out, tackles, tries, free kicks;	Similar total distance, distance covered in speed zones, number of collisions in impact zones, time spent in each HR zone between nov and exp;Players spent approximately 8 min @ >90%HR max; Tackles made: exp > nov (ES = 1.0, p < 0.001);Passes made: exp > nov (ES = 0.5, p < 0.001); Tries: exp > nov (ES = 0.5, p < 0.001).
LMT Vaz et al., (2016)	A	Within subjects – repeated measures design	RU	Influence of Number of players and Pitch dimensions on physical and physiological demands	NR	GPS 5 Hz Accelerometer 100 HzHR monitor	GPS: total distance, m·min^{-1}, distance in absolute speed zones, number of collisions in impact zones;HR: time in HR zones;	%HR max similar between formats (p = 0.085; 2 = 0.07);Players spent majority of time >90%HR max;No difference in m·min^{-1} between formats (p = 0.197; 2 = 0.06);Nº impacts: SSG4 > SSG1 (p < 0.05; 2 = 0.10);SSG4: highest distance covered ≥18 km·h^{-1}.

(*Continued*)

Table 4. (Continued).

Study	A/C	Study Design	Sport	Study Aim	Pedagogical Approach	Methods	Outcome Measures	Results
Weakley et al., (2019)	A	Reverse counterbalanced experimental design	RU	Influence of verbal feedback on physical/ physiological demands	NR	GPS 10 HzAccelerometer 100 HzHR monitorRPE 1–100 Leg muscle exertion and Breathlessness	GPS: total distance, individual low/high speed running distance, average accel/ decelHR: Stagno's TRIMP	Similar physical/physiological demands providing knowledge of results (i.e. total distance) between bouts.
Gabbett, (2006)	C	Longitudinal Within subjects – crossover design	RL	Compare chronic effects of SSGs and traditional conditioning to improve speed, agility, muscular power, maximal aerobic power	NR	Speed 10–20-40 mVertical JumpCOD L-runMulti-stage fitness test (VO2max)Game Win/ Loss RatioPoints scored/ concededPoints Differential	Vertical Jump: height	Similar average RPE for sessions between groups;Similar overall training loads (sRPE) between groups;Pre-post: SSGs ↑ 10 m (−5.2%), 20 m (−3.2%), 40 m (−3.0%), VO2max (+4.7%) ($p < 0.05$);Pre-post: TRD ↑ 10 m (−2.7%) and VO2max (+5.2%) ($p < 0.05$);Between groups post: 20 m, 40 m, VJ SSG > TRD ($p < 0.05$); Season outcome: points in attack, points differential SSG > TRD ($p < 0.05$); similar win-loss ratio, points conceded.
Gamble, (2004)	C	Longitudinal Within subjects – repeated measures design	RU	Chronic Cardiovascular adaptations following SSG training	NR	HR monitor	%HR max%HR recovery	Pre-post: ↑ %HR recovery score ($p < 0.01$); Week-5 to post: ↑ %HR recovery score ($p < 0.01$);Pre-post: ↓ %HRmax final stage incremental test ($p < 0.01$);Week-5 to post: ↓ %HRmax final stage incremental test ($p < 0.01$).
Seitz et al., (2014)	C	Longitudinal Within subjects – repeated measures design	RL	Chronic Effects of SSGs on RSA, Speed, 30–15 IFT	NR	30–15 IFTSpeed 10–20-40 mRSA test	RSA: mean sprint time, total sprint time, % decrement	Pre-post: ↑ vIFT (+1.29%, p = 0.05, ES = 1.01), 10 m (−3.17%, p = 0.003, ES = 12.99), 20 m (−1.37%, p = 0.002, ES = 10.08), 40 m (−0.96%, p = 0.001, ES = 6.33), mean sprint time (−2.11%, p = 0.001, ES = 6.48), total sprint time (−2.11%, p = 0.001, ES = 0.81), % decrement (7.10 v 5.93%, p = 0.05, ES = 0.27).

A acute, *C* chronic, *RL* rugby league, *RU* rugby union, *SSG* small-sided game, *NR* not reported, *HR* heart rate, *yo* years old, *ICC* intraclass correlation coefficient, *LoA* level of agreement, *RPE* rating of perceived exertion, *GPS* global positioning system, *LSR* low speed running, *HSR* high speed running, *CMJ* counter movement jump, *[CK]* creatine kinase concentration, *RHIE* repeated high intensity effort, *PP* plyometric push-up, *AU* arbitrary units, *[La]* blood lactate concentration, *COD* change of direction, *VO2* oxygen uptake, *VJ* vertical jump, *TRD* traditional, *RSA* repeated sprint ability, *IFT* Intermittent Fitness Test, *accel* acceleration, *decel* deceleration.

total passes) and greater external loads (e.g., total distance covered) than `on-side` rule ($p < 0.05$) (Gabbett et al., 2010) (Table 4).

The manipulation of contact (i.e. `wrestling`, `touch`, `tackle`) was investigated exclusively in rugby league (Table 2, 4) (Bennett et al., 2016; Gabbett, Jenkins et al., 2012; Johnston, Gabbett, Jenkins et al., 2015; Johnston et al., 2016, 2014a, 2014b; Johnston, Gabbett, Walker et al., 2015). Gabbett et al. (Gabbett, Jenkins et al., 2012) found that the introduction of `wrestling` led to SSGs characterized by more accelerations (e.g., distance covered in maximal [>2.79 $m \cdot s^{-2}$] accelerations) whilst no `wrestling` showed a greater running component (e.g., total distance covered) ($p < 0.05$) (Table 4) (Gabbett, Jenkins et al., 2012). However, technical characteristics (e.g., receives, catching errors, total passes) were similar between rules (Table 4).

Johnston et al. (Johnston et al., 2014a) and Johnston et al. (Johnston et al., 2014b) also investigated the effect of `wrestling`, and they both found that internal load (i.e. rating of perceived exertion) was higher in the `wrestling` condition ($p = 0.05$, ES = 0.41 ± 0.85, 8%, unlikely) (Johnston et al., 2014a, 2014b) (Table 4). However, Johnston et al. (Johnston et al., 2014a) found that external load (e.g., total distance, average speed [$m \cdot min^{-1}$]) was greater in no `wrestling` than `wrestling` ($p = 0.001$–0.003); whilst Johnston et al. (Johnston et al., 2014b) found that external load (e.g., average speed [$m \cdot min^{-1}$]) was similar between conditions ($p = 0.076$–0.417) (Table 4).

Johnston et al. (Johnston, Gabbett, Jenkins et al., 2015) and Johnston et al. (Johnston, Gabbett, Walker et al., 2015) investigated the external loads of three contact SSGs (Table 2). The authors found (Table 4) that whole-game average speed ($m \cdot min^{-1}$) was similar between conditions (ES = 0.21 to −0.57; (Johnston, Gabbett, Jenkins et al., 2015)), but PlayerLoad^{TM} Slow increased with increases in the number of `wrestling` bouts (for every 5-minute period: SSG3 v SSG1: ES = 0.68–1.00, 88–100%, almost certain; (Johnston, Gabbett, Jenkins et al., 2015)) (SSG3 v SSG1: first half ES = 0.98 ± 1.00, 36%, possibly; second half ES = 0.72 ± 0.38, 27%, possibly; (Johnston, Gabbett, Walker et al., 2015)) (Table 4).

Johnston et al. (Johnston et al., 2016) investigated the effect of introducing four formats of repeated high-intensity efforts (i.e. `only contact`, `mainly contact`, `mainly running`, `only running`) between SSGs, and reported that `only contact` (ES = −0.96 ± 0.42, 94% likely) and `mainly contact` (ES = −1.07 ± 0.34, 94%, likely) efforts between games led to greater reductions in average speed ($m \cdot min^{-1}$) from first to second SSG in comparison with the other conditions (Table 4). In terms of internal loads, rating of perceived exertion was highest in `mainly contact` condition (ES = −0.78 ± 0.18 [92%, likely] to −1.41 ± 0.28 [100%, almost certain]) (Table 4). Technical characteristics were similar among conditions (Table 4).

Bennett et al. (Bennett et al., 2016) compared a full contact `tackle` with a `touch` (Table 2), and found (Table 4) that defensive involvements (i.e. `body in front` tackle, tackles made) and total technical skills (i.e. sum of ball carries, support runs, line breaks, line break assists, `body in front` tackles, tackles) per minute were higher in the `touch` rule ($p < 0.01$).

3.3.2 Task constraints: Pitch dimensions

In rugby union, Kennett et al. (Kennett et al., 2012) found that external load (e.g., average speed [$m \cdot min^{-1}$]) was higher in a large pitch (length x width: 64 × 48 m) in comparison with a small pitch (32 x 24 m) ($p < 0.05$) (Table 2, 4). In contrast, Vaz et al. (LMT Vaz et al., 2016) reported external load to be similar across pitch dimensions (small: 30 × 30 m; medium: 50 × 35 m; large: 100 × 70 m) (average speed [$m \cdot min^{-1}$]: $p = 0.197$; Ƞ2 = 0.06). Considering internal loads, Kennett et al. (Kennett et al., 2012) observed higher loads (e.g., rating of perceived exertion) in a large pitch (64 x 48 m) ($p < 0.05$) whereas Vaz et al. (LMT Vaz et al., 2016) found similar loads percentage of maximal heart rate ($p = 0.085$; Ƞ2 = 0.07) across multiple pitch dimensions (small: 30 × 30 m; medium: 50 × 35 m; large: 100 × 70 m) (percentage of maximal heart rate: $p = 0.085$; Ƞ2 = 0.07). No research study investigated pitch dimensions manipulation and technical/tactical characteristics in rugby union.

In rugby league (Table 2, 4), Gabbett et al. (Gabbett, Abernethy et al., 2012) reported higher external loads in larger pitches (e.g., total distance) (large: 70 × 40 m; small: 40 × 10 m) ($p < 0.05$). In terms of internal loads, Foster et al. (Foster et al., 2010) reported that percentage of maximal heart rate was similar among small (25 x 15 m), medium (30 x 20 m), and large pitches (35 x 25 m) (Table 2, 4). Considering technical characteristics, Bennett et al. (Bennett et al., 2016) observed that these (e.g., line breaks) increased following a reduction in pitch dimensions from an official game (100 x 68 m) to a small-sided game (68 x 40 m) ($p < 0.01$) (Table 4). Similarly, Morley et al. (Morley et al., 2016) reported more technical skills (e.g., total passes) in smaller pitches when comparing SSGs (under 7-years old [U7s]: 20 × 12 m; under 8-years old [U8s]: 20 × 15 m; under 9-years old [U9s]: 25 × 18 m) to official games (60 x 40 m) (ES = 0.58–2.58, $p < 0.05$) (Table 4). Conversely, Gabbett et al. (Gabbett, Abernethy et al., 2012) found similar technical characteristics (e.g., total passes) between a small pitch (40 x 10 m) and a large pitch (70 x 40 m) (Table 4). No study in rugby league assessed the effect of pitch dimensions on tactical characteristics.

3.3.3 Task constraints: Player number

In rugby union (Table 2, 4), Kennett et al. (Kennett et al., 2012) found that a reduced number of players (i.e. 4v4) led to greater external loads (e.g., average speed [$m \cdot min^{-1}$]) in comparison with more players on the pitch (i.e. 8v8) ($p < 0.05$). In contrast, Vaz et al. (LMT Vaz et al., 2016) observed similar external load (e.g., average speed [$m \cdot min^{-1}$]) between small (i.e. 1v1, 2v1) and large (i.e. 7v7) number of players. Taking into account internal loads, blood lactate concentrations, and ratings of perceived exertion were higher in 4v4 than in 8v8 in Kennett et al. (Kennett et al., 2012) ($p < 0.05$). However, Vaz et al. (LMT Vaz et al., 2016) reported similar percentage of maximal heart rate between conditions. No research study investigated player number manipulation on technical/tactical characteristics in rugby union.

In rugby league (Table 2, 4), there was a lack of studies investigating player number manipulation on external loads. Considering internal loads, Foster et al. (Foster et al., 2010) found that in a group of young players (i.e. 15–16 years old) percentage of maximal heart rate was higher with a reduced number of players on the pitch (4v4 versus 6v6; $p < 0.001$). However, in a younger group (i.e. 12–13 years old), number of players did not affect internal response (Foster et al., 2010). In terms of technical demands, these increased with a reduction in the number of players on the pitch (Bennett et al., 2016; Morley et al., 2016). Bennett et al. (Bennett et al., 2016) found greater technical skills (e.g., support runs, tackles, line breaks) performed per minute of play in 10v10 in comparison with 13v13 ($p < 0.01$) (Table 4). Similarly, Morley et al. (Morley et al., 2016) found greater technical characteristics (e.g., total passes) in 4v4, 5v5, 6v6 in comparison with 9v9 (ES = 0.58–2.58, $p < 0.05$) (Table 4). No rugby league study assessed the influence of number of players on tactical characteristics.

3.3.4 Task constraints: Work-to-rest ratio

In rugby league, Sampson et al. (Sampson et al., 2015) investigated the effect of various work-to-rest ratios (Table 2), and reported that external load (e.g., total distance) was similar between conditions ($p > 0.05$) (Table 4). In terms of internal loads, highest time spent above 90% of maximal heart rate was found in the continuous game, in three games of 8 min, and in four games of 6 min ($p < 0.05$); while rating of perceived exertion was higher in continuous game and two games of 12 min in comparison with the other formats ($p < 0.05$) (Table 4).

3.3.5 Individual constraints: Training experience and chronological age

In rugby union, Vaz et al. (L Vaz et al., 2012) investigated the influence of training experience (i.e. experienced players: more than 5 years of national and international rugby experience, and novice players: less than 1 year of rugby experience) and observed similar external (e.g., total distance)/internal (e.g., time spent in heart rate zones) loads between groups ($p > 0.05$) (Table 2). However, technical characteristics were substantially higher in experienced players, with more tackles, passes made and tries scored ($p < 0.001$) (Vaz et al., 2012) (Table 4). In rugby league, Gabbett et al. (Gabbett, Abernethy et al., 2012) compared junior (age: 17.3 ± 0.3 years) and senior (age: 23.6 ± 0.5 years) players and found that technical characteristics were similar between groups (Table 2, 4). However, external loads (e.g., total distance, average speed [$m{\cdot}min^{-1}$]) were greater in the senior group ($p < 0.05$) (Gabbett, Abernethy et al., 2012).

3.3.6 Individual constraints: Knowledge of small-sided game duration

In rugby league, Gabbett et al. (Gabbett et al., 2015) studied the effects of knowledge of SSG duration, and found that average speed ($m{\cdot}min^{-1}$) was higher in partial knowledge (ES = 0.63 ± 0.68, 91%, likely) and no knowledge (ES = 1.24 ± 0.55, 100%, almost certainly) in comparison with knowledge condition (Table 2, 4). Similarly, rating of perceived exertion was greater in partial knowledge than no knowledge (ES = 0.59 ± 0.69, 83%, likely) and knowledge (ES = 0.56 ± 0.69, 81%, likely) (Gabbett et al., 2015) (Table 4). In terms of technical characteristics, players showed a similar time spent attacking and defending in each condition, however, total involvements (i.e. sum of receives, passes, errors) was greater in the no knowledge condition in comparison with knowledge condition (ES = 0.59 ± 0.68, 89%, likely) (Gabbett et al., 2015).

3.3.7 Individual constraints: Knowledge of result

In rugby union, Weakley et al. (Weakley et al., 2019) investigated the influence of knowledge of result (i.e. total distance covered) between bouts of SSGs on external/internal loads (Table 2). The authors found that providing knowledge of results between bouts did not affect external (e.g., ES[90%CI]: total distance: ES = 0.15 [−0.03, 0.34])/internal (e.g., ES[90%CI]: training impulse (AU): ES = −0.05 [−0.17, 0.06]) loads in small-sided games (Weakley et al., 2019) (Table 4).

3.3.8 Environmental constraints

No study in rugby football codes investigated the influence of environmental constraints (e.g., playing surface) on technical/tactical characteristics and/or external/internal loads in SSGs.

3.4. Chronic studies

Quality assessment of the studies investigating chronic effects of constraints in SSGs (Table 3) showed a mean and standard deviation of 14.33 ± 1.15 points out of 32 possible points (n = 3; range: 13–15). None of the three studies included (rugby union (Gamble, 2004), rugby league (Gabbett, 2006; Seitz et al., 2014)) reported a clear description of the intervention of interest (question 4), assessed the distribution of the main confounding factors between sample and population (question 12), blinded participants to intervention (question 14) and those measuring the main outcomes of the intervention (question 15), concealed the randomization process to participants and staff members (question 24), randomized subjects to intervention groups (question 23), and reported a power calculation (question 27). In addition, for all studies included, the reliability of compliance with the intervention (question 19), and the recruitment of the subjects over the same period of time for different intervention groups (question 22) were unable to be determined. Descriptions of the small-sided games implemented as the training intervention were incomplete in all studies, and there was a lack of information about task constraints (e.g., playing rules, number of players, pitch dimensions) and environmental constraints (e.g., playing surface) utilized.

In rugby union, Gamble (Gamble, 2004) studied the effect of SSGs as the only physical conditioning method over a 9-week pre-season (Table 2). Percentage of heart rate recovery after an incremental running test and percentage of maximal heart rate at the final stage of the same test substantially improved from pre- to post-intervention and between the fifth week of training and post-intervention ($p < 0.01$) (Gamble, 2004) (Table 4).

In rugby league, Gabbett (Gabbett, 2006) compared a traditional conditioning programme (e.g., running without a rugby ball) and a SSG training intervention over a 9-week in-season period, 2 days per week (Table 2). Session rating of perceived exertion were similar between groups. Pre- to post-changes showed that SSG training group improved speed over ten, twenty, and forty metres, and maximal cardiac output ($p < 0.05$); whilst traditional conditioning improved speed over exclusively ten metres and maximal cardiac output ($p < 0.05$) (Table 4). Similar results were found in Seitz et al. (Seitz et al., 2014) who investigated the chronic effects of SSG training on speed, repeated sprint ability, and cardiovascular performance over an 8-week pre-season, 2 days per week of training (Table

2). Final velocity achieved during the 30–15 intermittent fitness test, speed over ten, twenty, and forty metres, and repeated sprint ability (i.e. mean sprint time, total sprint time, percentage decrement) all substantially improved following the training intervention ($p \leq 0.05$, ES = 0.27–12.99) (Seitz et al., 2014) (Table 4).

4.DISCUSSION

Findings from this systematic review showed that most of the SSGs research in rugby football codes was carried out in rugby league (15 out of 20 papers included, 75%). The acute effects of task (i.e. playing rules, pitch dimensions, number of players, work-to-rest ratio) and individual (i.e. training experience, chronological age, knowledge of game duration, knowledge of result) constraints were investigated, with playing rules (i.e. task constraint) being the constraint most commonly examined (9 out of 17 acute papers, 53%). Different playing rules led to different external/internal loads and technical characteristics, with `off-side` `touch` rules being the most frequently utilized and resulting in greater technical opportunities, but lower ecological validity in comparison with `on-side` rule. Pitch dimensions showed contrasting findings in terms of external/internal loads and technical characteristics. Number of players resulted in similar external/internal loads, but a lower number of players (e.g., 4v4) led to greater technical characteristics than larger numbers (e.g., 8v8). Limited research was conducted on work-to-rest ratios and individual constraints. However, these findings should not be considered as definitive due to the limited amount of research on the topic and the heterogeneity of the studies.

Although only three chronic studies were available, they demonstrated that SSGs were an effective training method for developing physical (i.e. speed and cardiovascular capacity) qualities in rugby football codes. No study investigated the acute and chronic effects of environmental constraints (e.g., playing surface), and the influence of constraints manipulation (e.g., playing rules) on tactical characteristics and adaptations. Most of the papers included in this systematic review focused on the physical characteristics of the SSGs (12 out of 20 papers included, 60%). In addition, no study provided the pedagogical approach used to design the SSGs.

4.1. Acute studies

4.1.1. Task constraints: Playing rules

Nine out of seventeen acute papers (53%) included in this systematic review examined the effect of playing rules manipulation on technical characteristics and external/internal loads. Playing rules is a task constraint that can be easily modified by coaches and could be used to design ecologically valid SSGs based on a technical and/or tactical objective (Ramos et al., 2020; Renshaw & Chow, 2019).

An investigation of `on-side` (i.e. ball can be passed only backwards to players in an `on-side` position, which means behind an imaginary line passing through the ball and parallel to the try line) and `off-side` (i.e. the ball can be passed in any direction) rules showed that internal loads (e.g., heart rate) were similar between conditions, but `off-side` reported greater technical component and external load in comparison with `on-side` ($p < 0.05$) – possibly as a result of greater opportunities for action (i.e. players can move everywhere on the pitch and pass in any direction) (Gabbett et al., 2010). However, `on-side` rule led to a higher cognitive rating of perceived exertion ($p < 0.05$) (Gabbett et al., 2010). This is particularly important from a learning perspective as a high cognitive demand has been proposed as a potential stimulus for skill acquisition (TD Lee et al., 1994). Therefore, both rules could have practical applications. `Off-side` rule might be used in early pre-season, where training is more general, as a tool to increase opportunities for actions, involvements with the ball, and increase external loads. Conversely, `on-side` rule might be used when approaching the in-season as a tool to improve specific technical/tactical objectives and increase the ecological validity of the SSG, thus allowing players to get exposed to game-like scenarios (Davids et al., 2003; Tee et al., 2018).

As in rugby football codes, physical contact is allowed to contest for ball possession (e.g., rucks, tackle), the utilization of a `tackle` (i.e. full-body contact to stop the opponent moving forward; (Hendricks et al., 2020)), its replacement with a `touch` (i.e. touching the ball carrier with two hands represents a tackle), and the introduction of `wrestling` bouts (i.e. contact bouts consisting of 5 s of shoulder pummels followed immediately by 5 s of wrestling a partner to the ground) between SSGs have been investigated (Gabbett, Jenkins et al., 2012; Johnston, Gabbett, Jenkins et al., 2015; Johnston et al., 2014a; Morley et al., 2016). Morley et al. (Morley et al., 2016) demonstrated that a `touch` instead of a `tackle` resulted in substantially greater technical characteristics (e.g., total passes) in seven-nine years old rugby league players ($p < 0.05$). A `touch` might have provided a quicker pace to the game, thus offering more opportunities for technical actions (Morley et al., 2016). However, external/internal loads and tactical component were not assessed in this study, thus providing limited information about the SSGs utilized. Furthermore, the age of the participants should be taken into account when interpreting these findings as their technical/tactical abilities and physical characteristics will differ from elite junior or professional rugby players (Gabbett, Kelly et al., 2007; Hansen et al., 2011). Therefore, future research should investigate how `touch` and `tackle` influence technical, tactical and physical characteristics in different populations.

A number of studies demonstrated that in elite junior and semi-professional (age: 19–23 years) rugby league players, introduction of `wrestling` on every minute of a SSG showed a greater acceleration demand (e.g., PlayerLoad^{TM} Slow [<2 $m \cdot s^{-1}$], distance covered in maximal acceleration [>2.79 $m \cdot s^{-2}$]) and internal load (i.e. rating of perceived exertion) in comparison with no `wrestling`, which instead showed higher running characteristics (Gabbett, Abernethy et al., 2012; Johnston, Gabbett, Jenkins et al., 2015; Johnston et al., 2016, 2014a, 2014b; Johnston, Gabbett, Walker et al., 2015). The higher internal load experienced during SSGs with `wrestling` bouts might be the result of a greater upper-body recruitment in addition to lower-body, thus resulting in superior fatigue and impaired running performance (Rampinini et al., 2009). This might have implications for the implementation of SSGs throughout the training week. Following the tactical periodization principles (Tee et al., 2018), the SSGs with contact (e.g., `wrestling`) might be introduced early in the training week leading to an official competition as the internal load and fatigue would be higher following this type of SSG (Johnston et al., 2016; Tee et al., 2018). Conversely, small-sided games without contact might be implemented closer to official competitions as they would result in greater opportunities for actions and less fatigue (Johnston et al., 2016; Morley et al., 2016; Tee et al., 2018).

No research study investigated the effect of playing rules on tactical characteristics. Consequently, in rugby football codes literature, there is no information available about how playing rules can be utilized to manipulate a team tactical behaviour which might be of interest in applied settings when the goal is to develop technical/tactical abilities and physical performance concurrently.

4.1.2. Task constraints: Pitch dimensions

Pitch dimension manipulation has previously been extensively investigated in the SSGs literature of other field-based team sports (Bujalance-Moreno et al., 2019; Fleay et al., 2018; Hodgson et al., 2014; Malone & Collins, 2017; Pantelić et al., 2019; Rampinini et al., 2007; Timmerman et al., 2017). Six out of 17 acute papers (35%) included in this systematic review examined the effects of pitch dimensions on technical demands and external/internal loads. In terms of external load, two studies (Gabbett, Abernethy et al., 2012; Kennett et al., 2012) showed that larger pitches (length x width: > 60 × 40 m) led to greater external loads (e.g., average speed), when number of players was maintained constant. This is in line with research in sports where the ball can be passed in any direction (e.g., soccer, Australian rules football) (Fleay et al., 2018; Hodgson et al., 2014; Malone & Collins, 2017; Pantelić et al., 2019). This finding might be the result of an enhanced relative playing area (i.e. pitch surface area divided by number of players; $meters^2 \cdot player^{-1}$) which would lead to greater running demands and more opportunities to experience high running velocities due to the greater space available to accelerate (e.g., during a line break in rugby football codes). Conversely, one study included in this systematic review (LMT Vaz et al., 2016) observed similar external loads with different pitch dimensions. However, the results of this study might be explained by the fact that multiple constraints (i.e. playing rules, number of players, pitch dimensions) were concurrently modified across conditions, thus introducing multiple confounding factors in the investigation of pitch dimensions.

Contrasting results emerged regarding the influence of pitch dimensions on internal loads in rugby football codes. Rating of perceived exertion and blood lactate concentrations were higher in larger pitches (64 x 48 m) ($p < 0.05$), whilst heart rate (i.e. and time spent above 85% of maximal heart rate) was similar between pitch dimensions (e.g., 64 × 48 m versus 32 × 24 m) (Foster et al., 2010; Kennett et al., 2012; LMT Vaz et al., 2016). Similarly, in other sports (i.e. soccer, hurling), different studies have reported contrasting findings, with larger pitches (e.g., 50 × 40 m) showing greater, similar, or lower internal loads (e.g., rating of perceived exertion, percentage of maximal heart rate) in comparison with smaller pitches (e.g., 28 × 20 m) (Hodgson et al., 2014; Malone & Collins, 2017; Owen et al., 2011; Rampinini et al., 2007). These contrasting findings might be the result of different methods used to establish individuals' maximal heart rate values, for instance, laboratory incremental test (Foster et al., 2010), Yo-Yo intermittent recovery level 1 (Kennett et al., 2012), and Yo-Yo intermittent recovery level 2 (LMT Vaz et al., 2016). Field tests (e.g., Yo-Yo intermittent recovery level 1) have been reported to produce higher maximal heart rate values in comparison with laboratory tests (Jamnick et al., 2020). Furthermore, a single field test might not elicit maximal heart rate values for the whole sample, thus preventing between subjects interpretations of the results as the same percentage of maximal heart rate might elicit different homoeostatic responses (e.g., maximal lactate steady state, ventilatory threshold) (Jamnick et al., 2020; Sca et al., 2019). In addition, when comparing internal loads from different studies, it is important to consider the external loads that produced the internal response and the individual characteristics of the participants (e.g., fitness [individual constraint]). For instance, two studies, utilizing the same environmental and task constraints and producing similar external loads, might report different internal loads (e.g., heart rate) because the cardiovascular capacity of one sample substantially differed from the other (i.e. individual constraints) (Baggish et al., 2010; Mikulić, 2008).

With respect to technical characteristics, in rugby football codes, decreasing pitch dimensions, and relative playing area concurrently (from an official game to a SSG), increased the technical component (e.g., total passes) in young rugby league players (age: 7–16 years) ($p < 0.05$) (Bennett et al., 2016; Morley et al., 2016). These findings agree with soccer and Australian rules football research which showed that a smaller pitch increased the technical component of the SSGs (Fleay et al., 2018; Hodgson et al., 2014; Owen et al., 2011). A smaller pitch in conjunction with a smaller relative playing area may require athletes to perform more technical skills (e.g., passes) to maintain ball possession as performers would be closer to each other, thus having less time to keep the ball without pressure from an opponent. However, when comparing pitch dimensions between SSGs formats, technical characteristics were reported to be similar between a small (40 x 10 m) and a large (70 x 40 m) pitch (Gabbett, Abernethy et al., 2012). This might be the result of different constraints applied to the studies. Specifically, Gabbett et al. (Gabbett, Abernethy et al., 2012) utilized the \`off-side\` rule for the SSGs, whilst Bennett et al. (Bennett et al., 2016) and Morley et al. (Morley et al., 2016) used the \`on-side\` rule which showed different technical characteristics (Gabbett et al., 2010).

No study investigated how tactical characteristics might be affected by pitch dimension manipulation. Conversely, research in soccer SSGs reported that pitch dimensions influenced the distribution of players on the pitch, with bigger pitches showing a greater distribution of the players around the width rather than the length of the pitch (Folgado et al., 2014). Consequently, due to the limited amount of research available and the substantial role of technical/tactical skills in team sports performance, further research is needed to investigate how pitch dimensions can be manipulated to foster these skills in rugby football codes.

4.1.3. Task constraints: Number of players

The number of players on each team is a task constraint often investigated concurrently with pitch dimensions, as these two constraints together create the relative playing area ($m^2 \cdot pl^{-1}$) (Dellal et al., 2011; Folgado et al., 2014; Kennett et al., 2012; Rampinini et al., 2007). Five out of seventeen acute papers (29%) included in this systematic review examined the effects of number of players on technical characteristics and external/internal loads. Looking firstly at external loads, contrasting results were observed. When holding pitch dimensions constant and reducing the number of players, less players (i.e. 4v4 rather than 6v6) led to a higher external load (e.g., average speed), possibly as a result of a greater relative playing area and higher running demands (4v4: 384 $m^2 \cdot pl^{-1}$; 6v6: 256 $m^2 \cdot pl^{-1}$; 8v8: 192 $m^2 \cdot pl^{-1}$) (Kennett et al., 2012). This is supported by previous research on the effect of pitch dimensions manipulation while maintaining number of players constant in soccer, hurling, Australian rules football (Fleay et al., 2018; Hodgson et al., 2014; Malone & Collins, 2017; Pantelić et al., 2019), and by research in field hockey where a reduction in number of players – while maintaining pitch dimensions stable – increased external loads (Timmerman et al., 2019). Conversely, when multiple constraints were manipulated across conditions (i.e. number of players, playing rules, pitch dimensions), the number of players (i.e. 1v1: 450 $m^2 \cdot pl^{-1}$, 2v1: 300 $m^2 \cdot pl^{-1}$, 7v7: 125 $m^2 \cdot pl^{-1}$) showed similar external loads (LMT Vaz et al., 2016). This might be explained by the different nature of the games, and by the fact that concurrently manipulating multiple constraints prevents the identification of the effect of number of players only.

Research investigating internal loads in rugby football codes showed that a reduction in number of players on the pitch led to higher blood lactate concentrations, rating of perceived exertion (i.e. from 6v6 to 4v4; $p < 0.05$) (Kennett et al., 2012), and percentage of maximal heart rate (i.e. from 6v6 to 4v4; $p < 0.001$) (Foster et al., 2010). Conversely, comparisons of 1v1, 2v1, 7v7 showed similar percentages of maximal heart rate (LMT Vaz et al., 2016). These findings may be the result of the extreme differences (i.e. rules, number of players, pitch dimensions) among the SSGs investigated. Although limited research has been conducted in rugby football codes, the findings are in line with soccer studies in which a higher percentage of maximal heart rate, rating of perceived exertion, and blood lactate concentrations were observed with a reduced number of players (e.g., 3v3 versus 6v6) on the pitch – possibly as a result of increased external loads (e.g., high speed [>5.6 $m \cdot s^{-1}$] running demand) (Dellal et al., 2011; Hill-Haas et al., 2011; Rampinini et al., 2007).

In terms of technical component, reducing the number of players (i.e. 13v13 and 10v10 versus 10v10 and 6v6, respectively) led to a greater number of technical skills performed in young rugby league players (age: 7–16 years) (i.e. more passes, and line breaks; $p < 0.05$) (Bennett et al., 2016; Morley et al., 2016), thus offering players more opportunities to develop their technical abilities. Similar results were observed in soccer and field hockey, where a reduced number of players (i.e. 3v3 versus 5v5, 3v3 versus 6v6, respectively) led to a higher number of specific technical skills (e.g., dribbling, crosses, shots at goal, successful passes, interceptions) (Da Silva et al., 2011; Timmerman et al., 2019). No study investigated the influence of number of players on tactical performance in rugby football codes SSGs.

4.1.4. Task constraints: Work-to-rest ratio

One out of seventeen acute papers (6%) included in this systematic review examined the effects of work-to-rest ratios on external/internal loads (Sampson et al., 2015). Similar external loads (e.g., total distance) emerged from multiple work-to-rest ratios, ranging from a continuous condition to a highly intermittent condition (Sampson et al., 2015). Conversely, internal loads (i.e. rating of perceived exertion, time spent above 90% maximal heart rate) were greater in higher work-to-rest ratios (i.e. 1:0, 6:1, 4:1) (Sampson et al., 2015). These findings agree with research in soccer and hurling, where greater work-to-rest ratios (i.e., 2:1, 1:0) resulted in similar external loads (Christopher et al., 2016), but in higher rating of perceived exertion and percentage of maximal heart rate (i.e. internal loads) in comparison with smaller work-to-rest ratios (i.e. 1:1, 1:2) ($p < 0.05$) (Christopher et al., 2016; Köklü et al., 2015; Malone et al., 2019). Greater ratios (e.g., 2:1 versus 1:1) might elicit a higher cardiopulmonary response (e.g., mean heart rate, mean minute ventilation, blood lactate concentration), thus leading to higher internal loads; possibly as a result of an incomplete recovery due to the shorter rest period (Bogdanis et al., 1998; Nicolò et al., 2014).

Although, the effect of work-to-rest ratios on technical/tactical characteristics was not investigated in rugby football codes; greater ratios might impair the restorage of energy substrates (i.e. adenine triphosphate, creatine kinase) (Bogdanis et al., 1998; Buchheit & Laursen, 2013), which could ultimately compromise technical/tactical abilities due to the onset of fatigue (Rampinini et al., 2009; Russell et al., 2011). Consequently, further research is needed to better understand how the manipulation of work-to-rest ratios can affect performance in rugby football codes SSGs.

4.1.5. Individual constraints: Training experience & chronological age

Four out of seventeen acute studies (23%) included in this systematic review investigated the effect of individual constraints manipulation on rugby football codes SSGs (Gabbett, Abernethy et al., 2012; Gabbett et al., 2015; L Vaz et al., 2012; Weakley et al., 2019). In rugby union, training experience (i.e. more than five years of national/international experience versus less than one year of rugby experience) did not influence external/internal loads, when chronological age was similar between groups (age: 21.6 ± 3.6 years) (L Vaz et al., 2012). However, experienced players performed more tackles, passes, and scored more tries ($p < 0.001$) (i.e. higher technical component than novice players) (L Vaz et al., 2012). Conversely, in rugby league, when chronological age (23.6 ± 0.5 years versus 17.3 ± 0.3 years) and training experience (i.e. National Rugby League club: first team versus academy players) were manipulated concurrently, technical characteristics were similar between groups, but substantially higher external load was reported in the older, more experienced group ($p < 0.05$) (Gabbett, Abernethy et al., 2012). In soccer, training experience influenced both technical/tactical characteristics and external/internal loads (Almeida et al., 2013; Dellal et al., 2011).

Training experience and chronological age may reflect differences in multiple individual constraints, for instance, grey-towhite matter ratio, due to an increased number of myelinated axons throughout childhood and adolescence, maximal strength, and cardiovascular capacity (Baggish et al., 2010; Hansen et al., 2011; Jernigan & Tallal, 1990). Consequently, individual constraints should be taken into consideration in the process of training drill design in order to offer players appropriate learning environments and physical stimuli. Due to the limited number of studies on the effect of training experience and chronological age in rugby football codes SSGs, further research is needed.

4.1.6. Individual constraints: Knowledge of result & knowledge of duration of small-sided games

Information conveyed to the athletes is an individual constraint that coaches can manipulate to alter the demand of the SSGs (Gabbett et al., 2015; Renshaw et al., 2010). In rugby league, manipulation of knowledge of the duration of SSGs affected technical characteristics and external/internal loads (Gabbett et al., 2015). Conversely, knowledge of result did not affect external/internal loads in rugby union (Weakley et al., 2019). However, no study investigated the effect of coach encouragement which has been shown to increase external loads (i.e. total distance) in tennis conditioning drills (Kilit et al., 2019), and internal loads (i.e. percentage of maximal heart rate, blood lactate concentration, rating of perceived exertion) and physical enjoyment (i.e. individual constraint) in soccer SSGs (Balagué et al., 2019; Los Arcos et al., 2015; Rampinini et al., 2007). Information provided to players and encouragement are individual constraints that can be easily modified by coaches during training. Consequently, further research is necessary to better inform coaching practice, SSGs design, and the resultant technical/tactical components and external/internal loads experienced by players in rugby football codes.

4.1.7. Environmental constraints

No study investigated the effects of environmental constraints on technical, tactical and physical characteristics in rugby football codes SSGs. However, environmental constraints (e.g., pitch surface, weather conditions, temperature) can influence movement strategies adopted by players, reasoning, learning, and risk of injury (Baker et al., 1998; Fernandez et al., 2006; Lee & Garraway, 2000; Pilcher et al., 2002; Spencer et al., 2004; Stiles et al., 2009). In addition, studies included in this systematic review showed limitations when reporting environmental constraints. Specifically, there was a lack of details related to natural or artificial grass status, frequency of use, temperature, weather conditions, and humidity, which might all lead to specific movement strategies in the players (Renshaw & Chow, 2019). In contrast, the reporting of environmental constraints is well established in other disciplines, such as biology and microbiology (Geracitano et al., 2002; Lowe et al., 1993).

4.2. Chronic studies

Three out of 20 included studies (15%) examined the chronic effects of SSGs on physical performance, and found that SSGs were an effective training method to develop speed over ten, 20, and forty metres, cardiovascular capacity, and repeated sprint ability (Gabbett, 2006; Gamble, 2004; Seitz et al., 2014). These findings are in agreement with research in volleyball (Gabbett, 2008; Trajkovic et al., 2012), handball (Iacono et al., 2016, 2015), and soccer (Fransson et al., 2018; Owen et al., 2012).

However, caution should be observed when interpreting findings from rugby football codes research as no study clearly described the intervention of interest (i.e. question 4 in Downs & Black, (SH Downs & Black, 1998)). Gamble (Gamble, 2004) reported that the small-sided games implemented were designed with a combination of elements from gridiron, netball, and soccer, with multiple games characterized by different playing rules. Gabbett (Gabbett, 2006) did not report information about the design of the small-sided games implemented. Seitz et al. (Seitz et al., 2014) specified that they used seven different SSGs, two designed exclusively for forwards, two designed exclusively for backs, and three designed for both forwards and backs; however, their design was not reported.

In addition, the contribution of other training methods implemented throughout the intervention (e.g., technical/tactical rugby training, resistance training, speed training) needs to be taken into consideration to account for the physical adaptations (e.g., as a confounding variable in data analysis). However, Gabbett (Gabbett, 2006) and Seitz et al. (Seitz et al., 2014) did not consider other training modalities, whilst Gamble (Gamble, 2004) simply reported that heart rate data from other training methods showed lower intensities in comparison with SSGs. Consequently, findings from these studies might be questioned due to poor reporting, lack of consideration of confounding variables, and lack of a control group to compare against.

5. Limitations and future directions

The results of this systematic review were narratively reported. A meta-analysis was not conducted due to the limited body of research on constraints manipulation in rugby football codes SSGs, and the high heterogeneity of constraints investigated across studies (Ramos et al., 2020). In addition, a specific population was not selected, for instance, professional athletes instead of young athletes. As a result, the specific constraints applied to a certain population were not investigated, thus offering a more general overview of the constraints implemented in rugby football codes SSGs. Furthermore, this review mainly analysed limitations in the overall process of design and investigation of SSGs as a training method to improve training efficiency and to develop both technical/tactical skills and physical qualities.

At present, limited evidence is available for designing SSGs in rugby football codes, and in particular in rugby union. This systematic review should represent the starting point for further research on rugby football codes SSGs where the interactions among constraints, teams and individuals are taken into account, thus also investigating the tactical characteristics of the games. In addition, the reporting of the pedagogical approach used to design the SSGs may provide practical information about how coaches and sport scientists may collaborate to create SSGs to achieve specific objectives.

6. Conclusions

Small-sided games training is one method that is applied within field-based team sport training to develop technical, tactical and physical qualities (Buchheit & Laursen, 2013; Helgerud et al., 2007; Impellizzeri et al., 2006). This systematic review found limited research with which to guide the design of SSGs in rugby football codes. The majority of available research was conducted in rugby league (15 out of 20 papers included, 75%). Acute studies investigated task (i.e. playing rules, pitch dimensions, number of players, work-to-rest ratio) and individual (i.e. training experience, chronological age, knowledge of game duration, knowledge of result) constraints, but no study analysed the manipulation of environmental constraints (e.g., playing surface). Chronic studies showed that SSGs would be an effective training method to improve physical performance. However, this systematic review has shown that current research in rugby football codes is heavily biased towards investigating how manipulating constraints can affect the physical characteristics of SSGs (i.e. external/internal loads), with limited literature investigating the effect on technical skills, and no studies investigating tactical behaviour. Additionally, no study reported the pedagogical approach used to design the SSGs.

Future research is needed to evidence the effects of constraint manipulation on technical and tactical behaviour of rugby football players in SSGs, in addition to physical characteristics. Such research would broaden the evidence-based usefulness of SSGs and help guide practitioners in designing SSGs games to target multiple qualities concurrently (i.e. technical, tactical, physical) if either needed or desired.

Disclosure statement

No potential conflict of interest was reported by the authors.

Declarations

The authors declare that there is no conflict of interest.

Availability of data and material

Comprehensive literature search strategy provided in (Appendix A).

Code availability

Custom code for percentage agreement and Kappa coefficient is provided in (Appendix C).

Authors' contributions

MZ and JR selected the included studies and extracted the data with support of GR. MZ, GR, JDJ, DW, KT collaborated to the writing of this paper.

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Appendix A. Full literature search strategy (performed on 02.08.2020 by first author).

Database	Kay Words and Boolean Operators
MEDLINE via EBSCO: 105 (from 106, including only Peer Reviewed Journals 105)	((small-sided games) OR (game training) OR (skill-based conditioning) OR (skill conditioning) OR (skill training) OR (skill-based games) OR (game-based training) OR (conditioned games) OR (skill-based training)) AND ((rugby sevens) OR (rugby football) OR (rugby union) OR (rugby league) OR (rugby) OR (rugby 7s) OR (rugby football union) OR (rugby football league))
SPORTDiscus: 131 (from 252, including only academic journals 131) (excluded 102 magazines, 10 reports, 2 non-print resources, 1 book, 1 dissertation)	((small-sided games) OR (game training) OR (skill-based conditioning) OR (skill conditioning) OR (skill training) OR (skill-based games) OR (game-based training) OR (conditioned games) OR (skill-based training)) AND ((rugby sevens) OR (rugby football) OR (rugby union) OR (rugby league) OR (rugby) OR (rugby 7s) OR (rugby football union) OR (rugby football league))
Science Direct: 168 (it requires a maximum of 8 Boolean operators) I: 48 (from 76, excluding 5 review articles, 7 book chapters, 8 conference abstracts, 2 Editorials, 5 short communications, 1 other) II: 10 (from 11, excluding 1 book chapter) III: 102 (from 185, excluding 15 review articles, 1 encyclopaedia, 32 book chapters, 9 conference abstracts, 2 discussions, 4 editorials, 3 mini reviews, 6 short communications, 11 other) IV: 8 (no exclusions)	I. ("small-sided games" OR "game training" OR "skill-based conditioning" OR "skill conditioning" OR "skill training") AND ("rugby sevens" OR "rugby football" OR "rugby union" OR "rugby league") II. ("skill-based games" OR "game-based training" OR "conditioned games" OR "skill-based training") AND ("rugby" OR "rugby 7s" OR "rugby football union" OR "rugby football league") III. ("small-sided games" OR "game training" OR "skill-based conditioning" OR "skill conditioning" OR "skill training") AND ("rugby" OR "rugby 7s" OR "rugby football union" OR "rugby football league") IV. ("skill-based games" OR "game-based training" OR "conditioned games" OR "skill-based training") AND ("rugby sevens" OR "rugby football" OR "rugby union" OR "rugby league")
Scopus: 857 (from 1205, excluding 58 Spanish, 8 Portuguese, 3 French, 2 Catalan, 1 German, 1 Italian = 1122; excluding then 163 review, 71 book chapters, 29 books, 16 conference papers, 6 note, 2 letter, 1 conference review, 1 editorial, 1 short survey, 1 undefined)	("small-sided games" OR "game training" OR "skill-based conditioning" OR "skill conditioning" OR "skill training" OR "skill-based games" OR "game-based training" OR "conditioned games" OR "skill-based training") AND ("rugby sevens" OR "rugby football" OR "rugby union" OR "rugby league" OR "rugby" OR "rugby 7s" OR "rugby football union" OR "rugby football league")

Appendix B. Quality Index (Downs & Black, 1998)

Reporting

1. Is the hypothesis/aim/objective of the study clearly described?

yes	1
no	0

2. Are the main outcomes to be measured clearly described in the Introduction or Methods section? If the main outcomes are first mentioned in the Results section, the question should be answered no.

yes	1
no	0

3. Are the characteristics of the patients included in the study clearly described? In cohort studies and trials, inclusion and/or exclusion criteria should be given. In case-control studies, a case-definition and the source for controls should be given.

yes	1
no	0

4. Are the interventions of interest clearly described? Treatments and placebo (where relevant) that are to be compared should be clearly described.

yes	1
no	0

5. Are the distributions of principal confounders in each group of subjects to be compared clearly described?A list of principal confounders is provided.

yes	2
partially	1
no	0

6. Are the main findings of the study clearly described? Simple outcome data (including denominators and numerators) should be reported for all major findings so that the reader can check the major analyses and conclusions. (This question does not cover statistical tests which are considered below).

yes	1
no	0

7. *Does the study provide estimates of the random variability in the data for the main outcomes?* In non normally distributed data the inter-quartile range of results should be reported. In normally distributed data the standard error, standard deviation or confidence intervals should be reported. If the distribution of the data is not described, it must be assumed that the estimates used were appropriate and the question should be answered yes.

yes	1
no	0

8. Have all important adverse events that may be a consequence of the intervention been reported? This should be answered yes if the study demonstrates that there was a comprehensive attempt to measure adverse events. (A list of possible adverse events is provided).

yes	1
no	0

9. Have the characteristics of patients lost to follow-up been described? This should be answered yes where there were no losses to follow-up or where losses to follow-up were so small that findings would be unaffected by their inclusion. This should be answered no where a study does not report the number of patients lost to follow-up.

yes	1
no	0

10. Have actual probability values been reported (e.g.0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?

yes	1
no	0

All the following criteria attempt to address the representativeness of the findings of the study and whether they may be generalized to the population from which the study subjects were derived.

11. Were the subjects asked to participate in the study representative of the entire population from which they were recruited? The study must identify the source population for patients and describe how the patients were selected. Patients would be representative if they comprised the entire source population, an unselected sample of consecutive patients, or a random sample. Random sampling is only feasible where a list of all members of the relevant population exists. Where a study does not report the proportion of the source population from which the patients are derived, the question should be answered as unable to determine.

yes	1
no	0
unable to determine	0

12. Were those subjects who were prepared to participate representative of the entire population from which they were recruited? The proportion of those asked who agreed should be stated. Validation that the sample was representative would include demonstrating that the distribution of the main confounding factors was the same in the study sample and the source population.

yes	1
no	0
unable to determine	0

13. Were the staff, places, and facilities where the patients were treated, representative of the treatment the majority of patients receive? For the question to be answered yes the study should demonstrate that the intervention was representative of that in use in the source population. The question should be answered no if, for example, the intervention was undertaken in a specialist centre unrepresentative of the hospitals most of the source population would attend.

yes	1
no	0
unable to determine	0

Internal Validity – bias

14. Was an attempt made to blind study subjects to the intervention they have received? For studies where the patients would have no way of knowing which intervention they received, this should be answered yes.

yes	1
no	0
unable to determine	0

15. Was an attempt made to blind those measuring the main outcomes of the intervention?

yes	1
no	0
unable to determine	0

16. If any of the results of the study were based on "data dredging", was this made clear? Any analyses that had not been planned at the outset of the study should be clearly indicated. If no retrospective unplanned subgroup analyses were reported, then answer yes.

yes	1
no	0
unable to determine	0

(1) In trials and cohort studies, do the analyses adjust for different lengths of follow-up of patients, or in case-control studies, is the time period between the intervention and outcome the same for cases and controls? Where follow-up was the same for all study patients the answer should yes. If different lengths of follow-up were adjusted for by, for example, survival analysis the answer should be yes. Studies where differences in follow-up are ignored should be answered no.

yes	1
no	0
unable to determine	0

(1) Were the statistical tests used to assess the main outcomes appropriate? The statistical techniques used must be appropriate to the data. For example, nonparametric methods should be used for small sample sizes. Where little statistical analysis has been undertaken but where there is no evidence of bias, the question should be answered yes. If the distribution of the data (normal or not) is not described it must be assumed that the estimates used were appropriate and the question should be answered yes.

yes	1
no	0
unable to determine	0

(1) Was compliance with the intervention/s reliable? Where there was non compliance with the allocated treatment or where there was contamination of one group, the question should be answered no. For studies where the effect of any misclassification was likely to bias any association to the null, the question should be answered yes.

yes	1
no	0
unable to determine	0

(1) Were the main outcome measures used accurate (valid and reliable)? For studies where the outcome measures are clearly described, the question should be answered yes. For studies which refer to other work or that demonstrates the outcome measures are accurate, the question should be answered as yes.

yes	1
no	0
unable to determine	0

(1) *Internal Validity – Confounding (selection bias)*
(2) Were the patients in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited from the same population? For example, patients for all comparison groups should be selected from the same hospital. The question should be answered unable to determine for cohort and case control studies where there is no information concerning the source of patients included in the study.

yes	1
no	0
unable to determine	0

(1) Were study subjects in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited over the same period of time? For a study which does not specify the time period over which patients were recruited, the question should be answered as unable to determine.

yes	1
no	0
unable to determine	0

(1) Were study subjects randomized to intervention groups? Studies which state that subjects were randomized should be answered yes except where method of randomization would not ensure random allocation. For example, alternate allocation would score no because it is predictable.

yes	1
no	0
unable to determine	0

(1) Was the randomized intervention assignment concealed from both patients and health care staff until recruitment was complete and irrevocable? All non-randomized studies should be answered no. If assignment was concealed from patients but not from staff, it should be answered no.

yes	1
no	0
unable to determine	0

(1) Was there adequate adjustment for confounding in the analyses from which the main findings were drawn? This question should be answered no for trials if: the main conclusions of the study were based on analyses of treatment rather than intention to treat; the distribution of known confounders in the different treatment groups was not described; or the distribution of known confounders differed between the treatment groups but was not taken into account in the analyses. In nonrandomised studies if the effect of the main confounders was not investigated or confounding was demonstrated but no adjustment was made in the final analyses the question should be answered as no.

yes	1
no	0
unable to determine	0

(1) Were losses of patients to follow-up taken into account? If the numbers of patients lost to follow-up are not reported, the question should be answered as unable to determine. If the proportion lost to follow-up was too small to affect the main findings, the question should be answered yes.

yes	1
no	0
unable to determine	0

Power

(1) Did the study have sufficient power to detect a clinically important effect where the probability value for a difference being due to chance is less than 5%?Sample sizes have been calculated to detect a difference of x% and y%.

	Size of *smallest* intervention group	
A	$<n_1$	0
B	n1–n2	1
C	n3–n4	2
D	n_5-n_6	3
E	n_7-n_8	4
F	n_9+	5

References

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Appendix C. R Script for Cohen's Kappa coefficient and percentage agreement

```
# Kappa coefficient (Cohen, 1960)
  # Contingency table
  # It is a table like this
  # Yes No
  #Yes x y
  #No w z
  xtab <- as.table(rbind(c(20, 2), c(10, 988)))
  # Descriptive statistics
  diagonal.counts <- diag(xtab)
  N <- sum(xtab)
  row.marginal.props <- rowSums(xtab)/N
  col.marginal.props <- colSums(xtab)/N
  # Compute kappa (k)
  Po <- sum(diagonal.counts)/N
  Pe <- sum(row.marginal.props*col.marginal.props)
  k <- (Po – Pe)/(1 – Pe)
  k
  # Percentage agreement:
  # “Number of agreements in observations divided by the total number of observations”
  # (Cohen, 1960; Hallgren, 2012)
  per_agreement <- sum(diag(xtab))/N
  per_agreement
  #References
  # Cohen, Jacob. 1960. “A Coefficient of Agreement for Nominal Scales.” Educational and Psychological Measurement 20 (1): 37–46. doi:10.1177/001316446002000104.
  # Landis JR, Koch GG. 1977. “The Measurement of Observer Agreement for Categorical Data” 1 (33). Biometrics: 159–74.
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```