Title: Match demands, anthropometric characteristics, and physical qualities of female rugby sevens athletes: A systematic review

Running head: Female rugby sevens

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Abstract

Since the inclusion of rugby sevens in the 2016 Olympic Games, the popularity of women's rugby sevens has grown rapidly worldwide. This systematic review aimed to summarize the scientific literature addressing the match demands, anthropometric characteristics, and physical qualities of female rugby sevens athletes, and to highlight differences between competition levels and playing positions. Four electronic databases were searched, as were the reference lists and key journals. Hedges' g effect sizes with 95% Confidence Intervals were calculated to evaluate differences between Elite and Non-Elite athletes, and backs and forwards. 27 studies met inclusion criteria, and scored 68 ± 13% upon quality assessment. Comparisons between groups were restricted to variables where data was available. Greater running demands and intensities, number of sprints and accelerations, but lower physiological responses characterized International matches compared to Nationals. At International level, backs demonstrated greater running demands and intensities, number of sprints, and physiological responses than forwards. Elite athletes were leaner, taller, and displayed superior physical qualities (e.g., maximal speed, power, upper-body strength, and aerobic capacity) compared to Non-Elite athletes. At Elite level, forwards were heavier and displayed greater upper-body strength, whereas backs showed greater acceleration and maximal speed abilities. The specific match demands and physical requirements of female rugby sevens athletes competing at different playing levels and playing positions must be considered for developing effective training programs.

Key Words: Rugby 7s, women, training

INTRODUCTION

Rugby sevens is an intermittent field-based team sport characterized by high intensity activities and collisions (49). Although played under similar rules and field dimensions as rugby union, rugby sevens consists of two teams of 7 on-field players playing two 7-minute halves separated by a 2-minute halftime, as opposed to 15 players playing two 40-minute halves separated by 10-15 minutes in rugby union. Rugby sevens matches are played in a tournament style, with 5 to 6 matches played over 2 or 3 days. The top teams in the world compete annually in the Men's and Women's Sevens World Series, which are comprised of 10 and 6 International tournaments, respectively (1). Of note, from the start of the 2016-2017 World Series, the duration of Cup finals matches has changed from two 10-minute halves to two 7-minute halves for player welfare (2).

Since the inclusion of rugby sevens in the 2016 Olympic Games, the popularity of the game has grown rapidly worldwide (18, 22, 25, 26, 28, 47, 61), resulting in a number of countries creating national rugby sevens programs (61). The growth of rugby sevens has also led to an increase in scientific interest, as reflected by the emergence of rugby sevens research (7, 33). However, a greater number of studies have addressed the men's rugby sevens game compared to the women's game. Since differences between male and female rugby sevens athletes have been observed in terms of anthropometric characteristics (15), physical qualities (15), match demands (15), and technical and tactical skills associated with success (7), specific considerations are needed for female rugby sevens athletes. Furthermore, it is well known that the menstrual or contraceptive profiles of female athletes can impact sporting performance (54), warranting specific research on the female athlete.

A number of recent investigations have described the match demands (12, 15, 26, 38, 41, 45, 47, 57, 61), anthropometric characteristics (3, 15, 25, 43), and physical qualities of female rugby sevens athletes (3, 15, 25, 36, 43, 61). Given the differences found between athletes competing at an International and National level (15, 45, 61), understanding the match demands and the physical requirements for each competition level is fundamental for developing effective training programs (52, 57). This understanding is also useful for informing coaches and support staff of the requirements needed to dominate at the highest level (55) and transition between competition levels. Furthermore, as rugby sevens athletes can be categorized as backs and forwards, knowledge of the position-specific demands may have important implications to further enhance athletes' preparation (11). The aim of this systematic review is therefore to summarize the current body of female rugby sevens literature, addressing the match demands, anthropometric characteristics, and physical qualities of athletes, and to highlight differences between competition levels and playing positions.

METHODS

Procedures

Search Strategy

This systematic review adheres to the structure and reporting guidelines of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (42). Four electronic databases (PubMed, SciVerse Scopus®, SPORTDiscus™, Web of Science®) were searched systematically on 21 June 2018 using the following keywords and Boolean operators: ‘‘football AND seven* AND female AND NOT/NOT soccer". The reference lists of all articles meeting inclusion were searched manually for additional articles of relevance. The electronic databases and key journals in the field (e.g., The Journal of Strength and Conditioning Research, International Journal of Sports Physiology and Performance) were monitored until 30 September 2018.

Inclusion Criteria

Only original peer-reviewed research articles written in English reporting match demands, anthropometric characteristics, or physical qualities of senior (> 18 years) female rugby sevens athletes were included. Conference abstracts, letters to the Editor, book chapters, and thesis publications were excluded.

Study Selection Process

One author (FSS) completed the study screening and selection process. Duplicate articles identified through the electronic database search were removed first. Thereafter, all titles, abstracts, and full texts were sequentially screened for inclusion criteria. The study selection process was replicated for articles that were included through the manual search (Figure 1).

FIGURE 1

Study Quality Assessment

The methodological quality of the included articles was assessed using a modified version of the Downs and Black Quality Assessment Checklist (21). Modified versions of the checklist have been used to assess the quality of sport-related articles (29, 31, 32) based on reporting, external validity, internal validity (bias and confounding), and power. The specific modifications and scoring criteria implemented for our systematic review are outlined in the Supplemental Digital Content 1 (Study Quality Assessment). A final Quality Index score for each study was computed as follows, where a higher percentage reflects a superior methodological quality:

$$Quality\ Index\ (\%) = \frac{Total\ number\ of\ points}{Total\ number\ of\ applicable\ points} \times 100$$

Studies were categorized as strong, moderate, or limited quality when reaching thresholds of 75%, 50%, 25%, and poor when < 25% (34, 53). The design of each study was classified first as experimental or observational, and then as randomized controlled trial, cross-sectional (measures taken single occasion or multiple occasions without comparisons), or cohort (measures taken multiple occasions with comparisons) (40, 60, 62). No articles were excluded from this review based on quality score or study design. Two authors (FSS and KHL) assessed the quality and classified the design of studies independently. Results were subsequently compared. In case of disagreement between authors without reaching a consensus rating, a third author was available to resolve differences in opinion, but was not needed.

Data Extraction

Data were extracted by one author (FSS), with the completeness of extraction verified by a second author (KHL). All data were organized and analysed using Microsoft Excel® 2016 (Microsoft Corporation, Redmont, WA, USA).

Measures of external and internal load collected with the use of Global Positioning System (GPS) and heart rate (HR) monitors were extracted as match demand metrics. Total (m) and relative ($m\cdot min^{-1}$) match distance; total (m) and relative ($m\cdot min^{-1}$) distance covered at different intensities; maximal speed ($m\cdot s^{-1}$), number of sprints, and number of accelerations were considered external load metrics. Maximal and mean HR ($beats\cdot min^{-1}$), and percentage time (%) spent in different heart zones were extracted as internal load metrics. Only GPS data of full games (14 min) were used to describe total match distance, total distance covered at different intensities, number of sprints, and number of accelerations. GPS and HR files of athletes who played ≥ 7 min of a full game were used to describe relative match distance, relative distance covered at different intensities, maximal speed, maximal and mean HR, and percentage time spent in different heart zones. The analysis did not consider Cup finals when matches were 20 minutes long (i.e., previous regulations).

All speed variables were expressed in $m \cdot s^{-1}$, with speed zones of 5.5 and 5.6 $m \cdot s^{-1}$ pooled together. Sprints were defined as running efforts above 5.5 $m \cdot s^{-1}$, whereas accelerations were defined as efforts above 1.5 $m \cdot s^{-2}$. No metabolic power measures or collision data were considered as their validity in rugby sevens has not yet been established (17, 61). Height, body mass, and body composition data were extracted as anthropometric characteristics. Results from physical tests assessing acceleration, maximal speed, power, strength, and aerobic capacities were extracted to represent physical quality metrics.

Data were grouped in categories based on competition level (Elite and Non-Elite) and playing position (backs and forwards). Elite athletes were those defined as competing in International (I) tournaments as part of a National team. Non-Elite athletes were those defined as competing domestically or in National (N) tournaments. Across studies, mean and standard deviation values (mean ± SD) specific to each competition level and playing position were computed and weighted by sample size, with the exception of match demand data where weighting was based on the number of GPS and HR files analyzed.

Statistical Analyses

To evaluate differences between competition levels and playing positions, Hedges' g effect sizes (ES) with 95% Confidence Intervals (CI) were calculated, with the reference group for comparison being Elite or International, and backs. ES magnitudes were interpreted as trivial < 0.20, small 0.20 – 0.59, moderate 0.60 – 1.19, large 1.20 – 1.99, very large 2.00 – 3.99, and extremely large ≥ 4.00 (35). Where the 95% CI overlapped small positive and negative effects (± 0.20), the difference was deemed unclear (25). For clarity in the tables, clear effects and their magnitudes were reported using superscript letters: ^{T} trivial, ^{S} small, ^{M} moderate, ^{L} large, ^{V} very large, and ^{X} extremely large (30).

RESULTS

Search Strategy, Study Characteristics, and Quality Scores

The initial electronic database search generated 326 hits, with a total of 27 articles meeting inclusion (Figure 1). A summary of the research design, Quality Index, participants, and variables of interest for each study are reported in Table 1. Of the 27 studies reviewed, 18 (67%) had an observational cross-sectional design (3, 12, 15, 17, 18, 25-28, 36, 38, 41, 43, 45, 47, 57, 59, 61), 7 (26%) had an observational cohort design (13, 14, 16, 23, 24, 37, 48), and 2 (7%) were experimental randomized controlled trials (20, 44). The average Quality Index of the studies reviewed was 68 ± 13% (range 42–91). Ten studies (37%) were categorized as being of strong (20, 23, 26, 28, 37, 38, 41, 44, 45, 48), 15 (56%) as moderate (3, 12, 14-18, 25, 27, 36, 43, 47, 57, 59, 61), and 2 (7%) as limited quality (13, 24). The average Quality Index for studies reporting match demands was 73 ± 11% (range 56–90), anthropometric characteristics 69 ± 13% (range 42–91), and physical qualities 64 ± 8% (range 48–79). The complete quality assessment for each study can be found in the Supplemental Digital Content 1 (Table 6). The inability to determine the participants' source population, lack of menstrual or contraceptive phase data, and lack of adequate adjustments for confounding variables were the main quality issues.

Participants and Themes

The Elite group was the most researched, with 19 studies (3, 12, 13, 17, 18, 20, 23-28, 38, 41, 43, 44, 47, 57, 59), followed by 6 studies addressing Elite and Non-Elite (14-16, 37, 45, 61), and 2 studies on Non-Elite only (36, 48). A total of 1139 female rugby sevens athletes were considered across the 27 studies, comprised of 976 Elite (86%) and 163 Non-Elite (14%) athletes. Data specific on playing positions were clearly reported in 5 studies (3, 26, 37, 41, 43) (Table 1). The average number of participants in each study was 42 ± 106; however, due to the range (7 to 566 participants) and since 25 of the 27 studies had less than 42 participants, the median value (*n* = 22) may be more representative (39).

The weighted mean age of participants across the studies was 24.5 ± 1.2 years. One study did not report age (61), and another only indicated that participants were > 18 years (15). A total of 14 studies (12-16, 18, 20, 23, 37, 43-45, 48, 61) explicitly indicated the country of origin of participants. Among the countries considered, Australia was the most represented (12-16, 18, 23), followed by Spain (20, 23, 44, 45). Only one study specified involving athletes from multiple countries (23). When considering the variables of interest, 10 studies reported match demands data with playing time information (15, 18, 20, 26, 38, 41, 45, 47, 57, 61); 26 reported anthropometric characteristics (3, 12-18, 20, 23-28, 36-38, 41, 43-45, 47, 48, 57, 59); and 14 reported physical qualities of female rugby sevens athletes (3, 12, 15, 16, 18, 20, 24, 25, 36, 41, 43, 57, 59, 61) (Table 1).

TABLE 1

Match Demands

Ten studies reported GPS match demand data (15, 18, 20, 26, 38, 41, 45, 47, 57, 61) (see Table 7, Supplemental Digital Content 2). Six of these studies (20, 26, 38, 45, 57, 61) also reported HR responses (see Table 8, Supplemental Digital Content 2).

During matches, Elite athletes covered greater total distances (1623 ± 17 vs 1363 ± 222 m, ES = 4.46) and relative distances (98 ± 12 vs 94 ± 4 $m \cdot min^{-1}$, ES = 0.36) in comparison to their Non-Elite counterparts. Elite athletes also completed more sprints (3.9 ± 1.2 vs 1.9 ± 1.4 sprints, ES = 1.65) and accelerations (12.4 ± 1.5 vs 10.5 ± 3.1 accelerations, ES = 1.15) per match, and reached greater maximal speeds (7.3 ± 0.4 vs 7.0 ± 0.5 $m \cdot s^{-1}$, ES = 0.71). Elite athletes covered more total distance in each of the speed thresholds analyzed (ES = 0.62 to 5.52) and more relative distance above 5.5 $m \cdot s^{-1}$ (ES = 1.64) and between 4.4 and 5.5 $m \cdot s^{-1}$ (ES = 2.44). In contrast, Non-Elite athletes covered more relative distance between 2.2 and 4.4 $m \cdot s^{-1}$ (ES = -0.24), and more distance below 2.2 $m \cdot s^{-1}$ (ES = -0.76) (Table 2).

Lower maximal (187 ± 1 vs 190 ± 7 $beats \cdot min^{-1}$, ES = -0.97) and mean (170 ± 2 vs 174 ± 11 $beats \cdot min^{-1}$, ES = -0.82) HR values were registered in International matches compared to National-level. When considering time spent in different HR zones, Elite athletes spent more time between 80 and 90% HR max (ES = 1.18), between 60 and 70% HR max (ES = 0.43), and below 60% HR max (ES = 2.05). On the other hand, Non-Elite athletes spent more time between 90 and 100% HR max (ES = -1.24) and between 70 and 80% HR max (ES = -0.92) and (Table 3).

During International matches, backs covered on average 1728 m, completed 4.5 sprints, and performed 14.0 accelerations per game, whereas forwards covered 1422 m, completed 2.5 sprints, and performed 11.0 accelerations. However, no comparisons were possible as no SD values were reported (Table 2). Backs reached greater maximal speeds than forwards (7.4 ± 0.3 vs 7.1 ± 0.4 $m \cdot s^{-1}$, ES = 0.86) during matches; in contrast, total relative distance was similar between playing positions. When considering distance covered in different speed zones, no comparisons were possible for total distance covered between 4.4 and 5.5 $m \cdot s^{-1}$ and above 5.5 $m \cdot s^{-1}$. Backs covered more relative distance above 5.0 $m \cdot s^{-1}$ (ES = 0.25), and forwards between 3.5 and 5.0 $m \cdot s^{-1}$ (ES = -0.55) (Table 2).

In International matches, backs registered a higher mean HR (172 ± 2 vs 170 ± 1 beats·min^{-1}, ES = 1.83) compared to forwards. On average, International backs and forwards had maximal HR of 188 and 186; however, no comparisons were possible (Table 3). When considering time spent in different HR zones, backs spent more time between 90 and 100% HR max (ES = 0.30), between 80 and 90% HR max (ES = 0.90), and below 60% HR max (ES = 1.00). In contrast, forwards spent more time between 70 and 80% HR max (ES = -0.66) and between 60 and 70% HR max (ES = -0.98) (Table 3).

TABLE 2

TABLE 3

Anthropometric Characteristics

Height and body mass of athletes were reported in all of the studies reviewed except for one (61). In addition, measures of body composition were reported in 11 studies (3, 12, 15, 18, 20, 25, 36, 43-45, 59) (see Table 9, Supplemental Digital Content 2). Across the studies, sum of 7 skinfolds (mm) (3, 12, 15, 18, 25), sum of 3 skinfolds (mm) (36), body fat (%) (20, 43-45), and Body Mass Index (BMI) (kg·m^{-2}) (59) were employed to describe the body composition of athletes.

Elite athletes were taller (1.68 ± 0.01 vs 1.66 ± 0.02 m, ES = 1.69) and heavier (67.4 ± 1.5 vs 66.8 ± 5.0 kg, ES = 0.26) compared to Non-Elite. Furthermore, Elite athletes were leaner, as highlighted by the lower body fat (17.0 ± 1.3 vs 21.5 ± 5.1%, ES = -1.91) and lower sum of 7 skinfolds (83.8 ± 8.3 vs 89.0 ± 20.0 mm, ES = -0.46) (Table 4).

At Elite level, backs were shorter (1.66 ± 0.02 vs 1.67 ± 0.03 m, ES = -0.40), lighter (63.7 ± 2.4 vs 69.9 ± 2.2 kg, ES = -2.68) and leaner (body fat: 15.4 ± 3.1 vs 18.1 ± 3.5%, ES = -0.82;

sum of 7 skinfolds: 84.4 ± 26.1 vs 95.0 ±12.3 mm, ES = -0.51) compared to forwards. Within Non-Elite athletes, similar height characterized backs and forwards; however, backs were lighter than forwards (66.0 ± 9.5 vs 71.7 ± 13.9 kg, ES = -0.49) (Table 4). No information about body composition of Non-Elite backs and forwards were reported.

TABLE 4

Physical Qualities

Acceleration and Speed

Information on acceleration and speed abilities were reported in 6 studies (3, 15, 25, 41, 43, 61) (see Table 10, Supplemental Digital Content 2). Across studies, distances ranging between 10 and 50 m were employed to assess sprint performance qualities.

Elite athletes had greater maximal sprinting speeds (7.96 ± 0.26 vs 7.53 ± 0.27 $m \cdot s^{-1}$, ES = 1.64) and faster 40 m sprint times (5.63 ± 0.07 vs 5.79 ± 0.17 s, ES = -1.50) compared to Non-Elite; whereas 10 m sprint time was similar between Elite and Non-Elite athletes. At Elite level, backs had greater maximal sprinting speeds (8.06 ± 0.20 vs 7.86 ± 0.25 $m \cdot s^{-1}$, ES = 0.89) and faster 10 m (1.81 ± 0.03 vs 1.84 ± 0.04 s, ES = -0.85) and 40 m sprint times (5.60 ± 0.14 vs 5.72 ± 0.12 s, ES = -0.92). Sprint times over 30 and 50 m were similar between backs and forwards (Table 5).

Power

A total of 9 studies reported the power abilities of athletes or proxy measures of power (e.g., distance, velocity) (3, 15, 16, 20, 24, 25, 36, 43, 59) (see Table 11, Supplemental Digital Content 2). A variety of horizontal (3, 25) and vertical jumps (15, 16, 20, 24, 43) as well as cyclical movements (59) were employed to assess the lower-body power abilities of athletes; whereas the bench press exercise was employed as an indicator upper-body power (36).

During a countermovement jump, Elite athletes produced greater relative mean power (39 ± 4 vs 33 ± 7 $W \cdot kg^{-1}$, ES = 1.08), relative peak power (60 ± 4 vs 56 ± 10 $W \cdot kg^{-1}$, ES = 0.69), and peak velocity (3.2 ± 0.2 vs 3.0 ± 0.3 $m \cdot s^{-1}$, ES = 0.80) compared to Non-Elite. Vertical jump height was similar between Elite and Non-Elite athletes. In Elite athletes, standing long jump and standing triple jump distance, countermovement jump and squat jump height were similar between backs and forwards (Table 5).

Strength

Strength qualities were reported in 3 studies (3, 25, 36) (see Table 12, Supplemental Digital Content 2). Across the studies, absolute and relative maximum strength (1RM) were assessed for lower (front squat, power clean) (3, 25) and upper (bench press, neutral grip pull-up) body (3, 25, 36).

In the bench press exercise, Elite athletes displayed greater absolute 1RM (65.2 ± 3.3 vs 40.3 ± 7.3 kg, ES = 6.19) compared to Non-Elite. At Elite level, backs had lower absolute 1RM in neutral grip pull-up (78.1 ± 6.7 vs 86.3 ± 5.2 kg, ES = -1.34), in bench press (61.8 ± 7.1 vs 68.8 ± 7.1 kg, ES = -0.99), and in power clean (68.2 ± 6.2 vs 73.5 ± 4.5 kg, ES = -0.97) compared to forwards. Absolute and relative 1RM in the front squat, and relative 1RM in the power clean, bench press and neutral grip pull-up were similar between backs and forwards (Table 5).

Aerobic Capacities

Seven studies addressed the aerobic capacities of athletes (3, 12, 15, 18, 25, 57, 61) (see Table 13, Supplemental Digital Content 2). Across studies, a range of field-based and laboratory tests were used, such as the Yo-Yo Intermittent Recovery test Level 1 (Yo-Yo IR1) (15, 18, 61), 1600 m time trial (3, 25), critical velocity test (18), and VO_2 max incremental treadmill test (12, 18, 57).

During the Yo-Yo IR1 test, Elite athletes covered greater distance compared to Non-Elite (1300 ± 219 vs 955 ± 136 m, ES = 1.82). In Elite athletes, 1600 m running time was similar between backs and forwards (Table 5).

TABLE 5

DISCUSSION

Across the studies reviewed, the majority of the research focused on Elite female rugby sevens athletes playing at International level, whereas a limited number of studies focused on Non-Elite athletes. Most of the studies pooled the results of athletes together, without differentiating between backs and forwards. Based on the available data, differences between competition levels and playing positions were observed in match demands, anthropometric characteristics, and physical qualities that can have implications in athlete development, coaching, and training.

Match Demands

International matches had greater running demands, running intensities, a higher number of sprints and accelerations in comparison to National matches; but were characterized by lower physiological responses (i.e. lower heart rates values). The superior physical qualities of Elite female rugby sevens athletes are likely to explain these findings. Well-developed aerobic capacities have shown moderate to large correlations with on-field running performance in female rugby sevens (12, 15, 18, 61). In addition, possessing greater aerobic capacities seems to be advantageous to minimize fatigue and facilitate recovery between repeated high-intensity bouts (49, 56, 58). Moderate to large correlations have been observed between acceleration abilities (i.e., 10 m time) and match sprint performance in female rugby sevens' matches (18). Furthermore, since female rugby sevens athletes repeatedly reach running speeds above 90% of their maximal sprinting speed during matches (41, 61), superior sprinting abilities possessed by Elite athletes likely accounts for and contributes to the increased running demands and performances during International matches.

In International matches, backs demonstrated greater maximal speeds, running intensities, and physiological responses than forwards. Furthermore, although we could not undertake comparisons as no SD values were clearly reported, greater total distance (ES = 0.77, $p \leq 0.05$), number of sprints ($p \leq 0.05$), and sprint distance ($p \leq 0.05$) have been shown to differentiate Elite backs to forwards (38). The specific positional role of backs to carry the ball in wider areas of the field (38), combined with their superior sprinting ability likely explain these increased running and physiological demands. In contrast, the total workload of forwards could be underestimated when only considering GPS running load data; as this does not account for rugby-specific demands such as rucking, line outs, and scrummaging where the objective is to gain and secure ball possession (38). The different physiological responses between backs and forwards during match-play further highlight the specific demands of the positional roles that should be addressed in training.

In addition to the running (GPS) and physiological (HR) match demands, considering the specific technical-tactical demands of the game becomes essential to gain a more comprehensive understanding of the overall on-field demands. To date, four studies (7, 8, 44, 47) have reported information on the technical-tactical demands of female rugby sevens matches. However, since all four studies addressed International matches, without differentiating between playing positions, further research is required to investigate the rugby-specific demands of backs and forwards during International and National-level matches.

Anthropometric Characteristics

Elite female rugby sevens athletes were found to be leaner, taller, and slightly heavier compared to their Non-Elite counterparts. The increased running demands observed at the International level, along with the greater level of organized training and nutritional support provided to Elite-level athletes, may explain some of these differences (51). Furthermore, it is possible that specific anthropometric characteristics could be beneficial for specific technical demands of the game.

At Elite level, body mass discriminated between forwards and backs, with small to moderate differences also observed in height and body fat. In rugby sevens, forwards are required to engage in scrums and participate in lineouts; as a result, being heavier and taller is likely to be advantageous for performing these tasks successfully (3, 51). Whereas, only small differences in body mass were observed between Non-Elite backs and forwards with no clear difference in height. These findings are based on the results of a single study (37), therefore, generalization across Non-Elite players is challenging. Another study (15), found that Non-Elite and Junior female rugby sevens forwards to be heavier and taller, and possess higher skinfolds and greater lean mass compared to backs, agreeing with Elite findings. However, given the paucity of data and lack of clear reporting, further research is required to determine if any positional differences exist in the anthropometric characteristics of Non-Elite female rugby sevens athletes.

Physical Qualities

Overall, Elite female rugby sevens athletes were characterized by superior physical qualities compared to Non-Elite, and differences were observed between playing positions. Greater maximal speeds discriminated Elite compared to Non-Elite athletes; whereas unclear differences in acceleration abilities were observed. Although correlated, acceleration and maximal speed represent two distinct components of sprint running (5, 10). Therefore, prioritizing training interventions which aim at improving the mechanisms associated with maximal speed may be of further benefit for playing at the highest level. During International matches, Elite athletes were found to cover ~15 m per sprint (38, 57); however, athletes are also required to sprint over 30 m at times (38, 57), indicating that working on maximal speed and speed-maintenance abilities is also important. Elite backs attained higher maximal speeds and faster times over 10 and 40 m than forwards. As previously discussed, superior sprinting abilities would be advantageous for backs given their positional role.

In collisions sports, assessing sprint momentum (sprint velocity multiplied by body mass) in addition to sprinting speed can interest practitioners (6, 9). In fact, in male rugby sevens, 10 m sprint momentum was found to be a greater indicator of on-field performance in contact situations (e.g., defensive rucks, dominant tackles) than 10 m sprinting time alone (50). In the only study comparing sprint momentum between Elite and Non-Elite female rugby sevens athletes, no differences were observed between groups (15). However, given the differences in body mass and sprinting abilities highlighted in this review, it is likely that greater sprint momentum would characterize Elite compared to Non-Elite athletes in presence of a larger sample size. In Elite female rugby sevens athletes, greater sprinting momentum differentiated forwards compared to backs (ES = 1.33 to 1.53) (3), despite their lower sprinting abilities, indicating that both sprinting qualities and body mass could be useful metrics to consider when assessing athletic qualities in rugby sevens.

Comparisons between jumping abilities highlighted that Elite female rugby sevens athletes are able to express greater relative power and produce higher velocities during the CMJ. Despite differences in sprinting abilities, similar vertical and horizontal jumping abilities were observed between playing positions at the Elite level. In female rugby athletes (both sevens and fifteens), horizontal jumping ability has been found to be largely to very largely correlated with measures of sprint running (4). However, when grouping athletes based on sprint performance, the relationship between horizontal jumping ability and sprinting speed decreases in faster athletes (4). These findings suggest that horizontal jump tests may be a better proxy measure of sprint performance in lower-level athletes; whereas more detailed mechanistic performance tests may be required for assessing faster athletes (4).

Greater absolute upper-body (bench press) strength also discriminated between Elite and Non-Elite athletes. One study also demonstrated that superior upper-body strength discriminated between athletes who played high-minutes and low-minutes across a full International season within a squad of Elite female sevens athletes (25). Given the contact nature of rugby sevens, it is clear that possessing well-developed upper-body strength qualities is advantageous to perform a number of rugby-specific tasks, such as tackling, rucking, scrummaging, fending, and wrestling (25, 49); as well as physical resiliency to tolerate the physical stress associated with collisions (25). No information on the lower-body strength abilities of Non-Elite female rugby sevens athletes were found, so it is unknown if differences exist in the lower-body maximum strength between playing levels. Our review showed that greater absolute upper-body (bench press and pull-up) strength was observed in Elite forwards compared to backs; however, when strength was expressed in relation to body mass, differences between playing positions were no longer present. Indeed, absolute upper-body strength rather than relative strength might be advantageous for forwards during match play in scrum, lineout, and ruck situations (3, 25). Contrasting results were observed in lower-body maximal strength between playing positions in Elite athletes. The current results are based on data reported in single study using a relatively small sample size (3), warranting further research in lower-body strength qualities between backs and forwards to inform practice.

Superior aerobic capacities were observed in Elite than Non-Elite athletes. Furthermore, better aerobic capacities were found to differentiate between athletes that played high and low minutes during a full International season (25). Given the HR responses and high physiological demands (i.e., majority of the match > 80% of HR max) observed during matches, a well-developed aerobic system is advantageous for tolerating the demands and optimizing performance in rugby sevens. As previously discussed, possessing a well-developed aerobic system has been shown to be beneficial for on-field running performance in female rugby sevens athletes (12, 15, 18, 61), and to minimize fatigue during match play (49, 56, 58). Furthermore, given the specific format of rugby sevens with multiple matches per day, well-developed aerobic capacities could be advantageous to facilitate recovery between matches (49, 56, 58). Despite the differences in the running demands and positional roles, similar aerobic capacities were observed between playing positions; thus, suggesting the importance of well-developed aerobic capacities for performance for both backs and forwards.

Limitations

No comparisons between match demands and physical qualities of Non-Elite backs and forwards were possible due to a lack of literature. A variety of tests, protocols, and equipment were used to assess specific match, anthropometric, and physical metrics, which further reduced the possible comparisons between groups. Standardization of tests and protocols across research groups and governing bodies would allow better comparisons and a greater understanding of female rugby sevens. Furthermore, matches can last more than 14 minutes due to the specific laws of the game. A limited number of research studies report or account for the exact playing time when coding match data, which would provide a more accurate representation of the on-field demands.

None of the studies reviewed addressed sample size considerations. The number of participants across most of the studies (median, $n = 22$) reflects the average number of athletes comprising a rugby sevens team. However, due to the relatively small sample size, the results may not represent the female rugby sevens population as a whole. Since multiple studies addressed Elite athletes from specific countries, the same athletes might have been sampled multiple times and bias the current review findings. Furthermore, despite the biphasic responses of oestrogen and progesterone across the menstrual cycle and their effects on different body systems and functions (19), and the increasing number of athletes using oral contraceptive (46), no studies reported information regarding the type (menstrual or contraceptive) and phase (high or low hormones) of the cycle of participants at the moment of testing.

To describe the percentage time spent at different physiological intensities (HR zones), data from slightly different HR categories were pooled together. The speed zones across studies were not consistent, thus making comparisons between studies challenging. For example, 3.5 (26), 4.4 (38, 61), or 5.0 $m{\cdot}s^{-1}$ (20, 45, 57) have been used as threshold for high-intensity running even though findings support that 3.5 is a more appropriate threshold in female rugby sevens athletes than 5.0 $m{\cdot}s^{-1}$ to avoid underestimating high-intensity workloads (12). Similarly, despite 5.5 $m{\cdot}s^{-1}$ being used as a threshold for quantifying sprinting (38, 41, 45, 57), 4.7 $m{\cdot}s^{-1}$ has been suggested as a more specific threshold adjusted for female rugby sevens athletes (41). That said, given the average maximal speed values registered during female rugby sevens matches range from 7.0 to 7.3 $m{\cdot}s^{-1}$ (Table 2), the most appropriate threshold to capture the sprinting demands of games is debatable.

PRACTICAL APPLICATIONS

This systematic review provides useful information for coaches and strength and conditioning practitioners regarding the match demands, anthropometric characteristics, and physical qualities of the female rugby sevens athlete. Female sevens athletes aiming to compete at the highest level should focus on developing maximal speed, lower-body power, upper-body strength, aerobic capacity, and lean muscle mass with relatively low amounts of body fat. At the Elite level, given the specific positional roles, well-developed acceleration and maximal speed abilities would be advantageous for backs, whereas forwards would benefit by possessing well-developed upper-body strength and greater body mass. The specific requirements of female rugby sevens athletes competing at different playing levels and playing positions must be taken into account when developing training programs to maximize athletes' preparation.

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Supplemental Digital Content 1.pdf - Complete Quality Assessment of the studies reviewed

Supplemental Digital Content 2.pdf - Tables reporting match demands, anthropometric, and physical qualities data of the studies reviewed

Figure

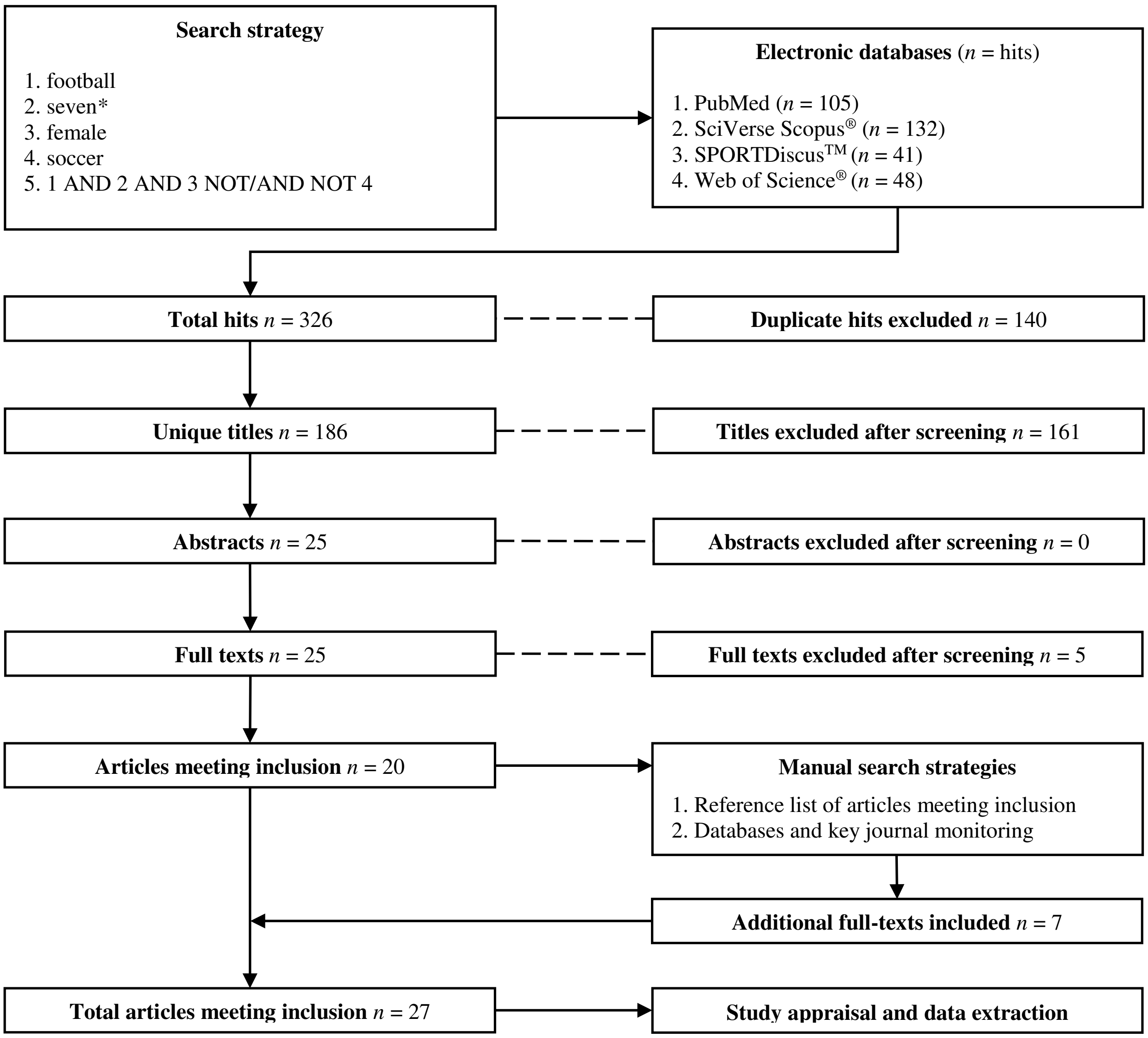

Figure 1. Flow diagram of the search strategy and article selection process

Table 1. Summary of the studies reviewed

Article	Study Design	Quality Index	Participants				Variables of Interest
			n	Level	Age (y)	Country	
Agar-Newman et al. (3),	Observational	70% (16/23)	13	Elite – WS (B)	21.3 ± 3.5	NS	Anthropometric characteristics
2017	Cross-sectional		11	Elite – WS (F)	24.5 ± 3.9	NS	Physical qualities (speed, power, strength, aerobic)
Clarke et al. (18), 2014	Observational	73% (16/22)	22	Elite – WS	25.0 ± 5.0	Australia	Match demands (GPS)
	Cross-sectional						Anthropometric characteristics
							Physical qualities (aerobic)
Clarke et al. (16), 2015	Observational	67% (16/24)	12	Elite – WS	22.3 ± 2.5	Australia	Anthropometric characteristics
	Cohort		10	Non-Elite	24.4 ± 4.3	Australia	Physical qualities (power)
Clarke et al (12), 2015	Observational	64% (14/22)	12	Elite – WS	23.5 ± 4.9	Australia	Anthropometric characteristics
	Cross-sectional						Physical characteristics (aerobic)
Clarke et al. (14), 2015	Observational	54% (13/24)	12	Elite – WS	22.3 ± 2.5	Australia	Anthropometric characteristics
	Cohort		10	Non-Elite	24.4 ± 4.3	Australia	
Clarke et al. (15), 2017	Observational	56% (13/23)	11	Elite – WS	> 18	Australia	Match demands (GPS)
	Cross-sectional		22	Non-Elite	> 18	Australia	Anthropometric characteristics
							Physical qualities (speed, power, aerobic)
Clarke et al. (13), 2017	Observational	42% (10/24)	23	Elite – WS	24.0 ± 5.0	Australia	Anthropometric characteristics
	Cohort						
Clarke et al. (17), 2017	Observational	53% (10/19)	12	Elite – WS	22.8 ± 3.6	NS	Anthropometric characteristics
	Cross-sectional						
Del Coso et al. (20),	Experimental	79% (22/28)	16	Elite	23.0 ± 2.0	Spain	Match demands (GPS, HR)
2013	Randomized Controlled						Anthropometric characteristics
							Physical qualities (power)

Table 1. Continued

Article	Study Design	Quality Index	Participants				Variables of Interest
			n	Level	Age (y)	Country	
Fuller et al. (23), 2017	Observational Cohort	91% (20/22)	197	Elite – WS	24.3 ± 3.6	Multiple[a]	Anthropometric characteristics
			221	Elite – WS	24.6 ± 4.0	Multiple[b]	
			148	Elite – Oly	26.2 ± 4.0	Multiple[c]	
Gathercole et al. (24), 2015	Observational Cohort	48% (11/23)	12	Elite	23.6 ± 4.3	NS	Anthropometric characteristics Physical qualities (power)
Goodale et al. (25), 2016	Observational Cross-sectional	61% (14/23)	12	Elite – WS (HM)	24.3 ± 3.1	NS	Anthropometric characteristics
			12	Elite – WS (LM)	21.2 ± 4.3	NS	Physical qualities (speed, power, strength, aerobic)
Goodale et al. (26), 2017	Observational Cross-sectional	86% (18/21)	11	Elite – WS (B)	24.0 ± 3.6	NS	Match demands (GPS, HR)
			9	Elite – WS (F)		NS	Anthropometric characteristics
Griffin et al. (28), 2017	Observational Cross-sectional	78% (17/22)	24	Elite – WS	24.0 ± 5.0	NS	Anthropometric characteristics
Griffin et al. (27), 2017	Observational Cross-sectional	68% (15/22)	24	Elite – WS	24.0 ± 5.0	NS	Anthropometric characteristics
Leite et al. (36), 2016	Observational Cross-sectional	57% (12/21)	7	Non-Elite	21.3 ± 1.5	NS	Anthropometric characteristics Physical qualities (power, strength)
Ma et al. (37), 2016	Observational Cohort	86% (19/22)	10	Elite (B)	24.1 ± 3.4	USA	Anthropometric characteristics
			7	Elite (F)	23.8 ± 8.3	USA	
			44	Non-Elite (B)	23.5 ± 5.0	USA	
			33	Non-Elite (F)	23.7 ± 5.6	USA	
Malone et al. (38), 2018	Observational Cross-sectional	90% (19/21)	27	Elite – WS	24.4 ± 2.1	NS	Match demands (GPS, HR) Anthropometric characteristics

Table 1. Continued

Article	Study Design	Quality Index	Participants				Variables of Interest
			n	Level	Age (y)	Country	
Misseldine et al. (41), 2018	Observational Cross-sectional	76% (16/21)	7	Elite (B)	24.6 ± 4.7	NS	Match demands (GPS)
			5	Elite (F)	27.0 ± 2.5	NS	Anthropometric characteristics
							Physical qualities (speed)
Ohya et al. (43), 2015	Observational Cross-sectional	64% (14/22)	12	Elite (B)	23.1 ± 4.1	Japan	Anthropometric characteristics
			11	Elite (F)		Japan	Physical qualities (speed, power)
Portillo et al. (45), 2014	Observational Cross-sectional	76% (16/21)	10	Elite	26.3 ± 4.0	Spain	Match demands (GPS, HR)
			10	Non-Elite	32.1 ± 6.4	Spain	Anthropometric characteristics
Portillo et al. (44), 2017	Experimental Randomized Controlled	86% (24/28)	16	Elite	23.0 ± 2.0	Spain	Anthropometric characteristics
Reyneke et al. (47), 2018	Observational Cross-sectional	71% (15/21)	15	Elite – WS	24.3 ± 3.9	NS	Match demands (GPS)
							Anthropometric characteristics
Rizi et al. (48), 2017	Observational Cohort	78% (18/23)	14	Non-Elite	20.3 ± 1.2	Hong Kong	Anthropometric characteristics
Suárez-Arrones et al. (57), 2012	Observational Cross-sectional	64% (14/22)	12	Elite	27.8 ± 4.0	NS	Match demands (GPS, HR)
							Anthropometric characteristics
							Physical qualities (aerobic)
Valenzuela et al. (59), 2018	Observational Cross-sectional	65% (15/23)	7	Elite – Oly (HP)	27.0 ± 5.0	NS	Anthropometric characteristics
			7	Elite – Oly (LP)	28.0 ± 5.0	NS	Physical qualities (power)
Vescovi et al. (61), 2015	Observational Cross-sectional	57% (13/23)	16	Elite	NS	Canada	Match demands (GPS, HR)
			13	Non-Elite	NS	Canada	Physical qualities (speed, aerobic)

B Backs, *F* Forwards, *GPS* Global Positioning System, *HM* High playing minutes, *HP* High-power, *HR* Heart rate, *LM* Low playing minutes, *LP* Low-power, *NS* Not specified, *Oly* Olympic Games, *WS* World Series.

[a] Australia, Canada, China, England, Fiji, France, New Zealand, Russia, South Africa, Spain, USA, [b] Australia, Canada, England, Fiji, France, Ireland, Japan, New Zealand, Russia, Spain, USA, [c] Australia, Brazil, Canada, Colombia, Fiji, France, Great Britain, Japan, Kenya, New Zealand, Spain, USA.

Table 2. Summary of GPS match data of female rugby sevens athletes

Competition Level		Total Distance (m)	Relative Distance (m·min^{-1})	Sprints, > 5.5 m·s^{-1} (*n*)	Accelerations, > 1.5 m·s^{-2} (*n*)	Max Speed (m·s^{-1})	Speed Zones (m·s^{-1})							
							< 3.5	3.5-5.0	5.0-5.5	> 5.5	< 2.2	2.2-4.4	4.4-5.5	> 5.5
I	Pooled Mean	1623 ± 17	98 ± 12	3.9 ± 1.2	12.4 ± 1.5	7.3 ± 0.4	1021 ± 32 m	439 ± 1 m	86 ± 22 m	116 ± 8 m	36 ± 2 m·min^{-1}	36 ± 5 m·min^{-1}	14 ± 0 m·min^{-1}	7 ± 1 m·min^{-1}
	(no. files)	(296)	(845)	(296)	(279)	(741)	(46)	(46)	(46)	(296)	(134)	(134)	(384)	(190)
N	Pooled Mean	1363 ± 222	94 ± 4	1.9 ± 1.4	10.5 ± 3.1	7.0 ± 0.5	961 ± 168 m	356 ± 94 m	46 ± 33 m	47 ± 39 m	39 ± 6 m·min^{-1}	38 ± 12 m·min^{-1}	10 ± 4 m·min^{-1}	4 ± 3 m·min^{-1}
	(no. files)	(21)	(192)	(21)	(21)	(189)	(21)	(21)	(21)	(21)	(78)	(78)	(78)	(78)
ES [95% CI]		4.46^{X}	0.36^{S}	1.65^{L}	1.15^{M}	0.71^{M}	0.62^{M}	1.59^{L}	1.55^{L}	5.52^{X}	-0.76^{M}	-0.24^{S}	2.44^{V}	1.64^{L}
		[3.89,5.01]	[0.21,0.52]	[1.18,2.10]	[0.69,1.60]	[0.55,0.87]	[0.09,1.14]	[0.99,2.15]	[0.95,2.10]	[4.89,6.12]	[-1.04,-0.47]	[-0.52,0.04]	[2.15,2.73]	[1.34,1.94]

Playing Position (International Level)		Total Distance (m)	Relative Distance (m·min^{-1})	Sprints, > 5.5 m·s^{-1} (*n*)	Accelerations, > 1.5 m·s^{-2} (*n*)	Max Speed (m·s^{-1})	Speed Zones (m·s^{-1})				
							4.4-5.5	≥ 5.5	< 3.5	3.5-5.0	> 5.0
B	Pooled Mean	1728	88 ± 4	4.5	14.0	7.4 ± 0.3	223 m	133 m	61 ± 7 m·min^{-1}	15 ± 5 m·min^{-1}	10 ± 4 m·min^{-1}
	(no. files)	(131)	(122)	(131)	(131)	(253)	(131)	(131)	(103)	(103)	(103)
F	Pooled Mean	1422	88 ± 3	2.5	11.0	7.1 ± 0.4	174 m	102 m	61 ± 8 m·min^{-1}	18 ± 6 m·min^{-1}	9 ± 4 m·min^{-1}
	(no. files)	(119)	(100)	(119)	(119)	(219)	(119)	(119)	(88)	(88)	(88)
ES [95% CI]		NA	0.00	NA	NA	0.86^{M}	NA	NA	0.00	-0.55^{S}	0.25^{S}
			[-0.26,0.26]			[0.67,1.04]			[-0.28,0.28]	[-0.83,-0.26]	[-0.04,0.53]

Data are presented as mean or mean ± SD. Pooled based on number of GPS files analysed.

B Backs, *CI* Confidence interval, *ES* Effect size, *F* Forwards, *I* International, *Max* Maximal, *N* National, *NA* Data not available.

^{T} trivial, ^{S} small, ^{M} moderate, ^{L} large, ^{V} very large, ^{X} extremely large.

Table 3. Summary of HR match responses of female rugby sevens athletes

Competition Level		Max HR (beats·min^{-1})	Mean HR (beats·min^{-1})	HR Zones (% time)				
				< 60% HR max	60-70% HR max	70-80% HR max	80-90% HR max	90-100% HR max
I	Pooled Mean	187 ± 1	170 ± 2	1.0 ± 0.3	7.6 ± 6.6	13.9 ± 4.8	40.1 ± 6.6	36.0 ± 15.2
	(no. files)	(480)	(671)	(487)	(487)	(487)	(621)	(487)
N	Pooled Mean	190 ± 7	174 ± 11	0.4 ± 0.2	4.9 ± 1.4	18.1 ± 0.2	32.5 ± 5.7	54.6 ± 14.2
	(no. files)	(104)	(104)	(52)	(52)	(52)	(130)	(130)
ES [95% CI]		-0.97^{M} [-1.19,-0.75]	-0.82^{M} [-1.03,-0.61]	2.05^{V} [1.74,2.36]	0.43^{S} [0.14,0.72]	-0.92^{M} [-1.21,-0.63]	1.18^{M} [0.98,1.37]	-1.24^{L} [-1.44,-1.03]
Playing Positions (International Level)								
B	Pooled Mean	188	172 ± 2	1.2 ± 0.1	5.5 ± 3.1	13.2 ± 1.9	44.9 ± 6.1	35.7 ± 11.8
	(no. files)	(131)	(234)	(234)	(234)	(234)	(234)	(234)
F	Pooled Mean	186	170 ± 1	1.1 ± 0.1	11.4 ± 8.1	16.1 ± 6.1	40.8 ± 1.5	31.5 ± 16.0
	(no. files)	(119)	(207)	(207)	(207)	(207)	(207)	(207)
ES [95% CI]		NA	1.83^{L} [1.61,2.05]	1.00^{M} [0.80,1.20]	-0.98^{M} [-1.18,-0.79]	-0.66^{M} [-0.85,-0.47]	0.90^{M} [0.70,1.09]	0.30^{S} [0.11,0.49]

Data are presented as mean or mean ± SD. Pooled based on number of HR files analysed.

B Backs, *CI* Confidence interval, *ES* Effect size, *F* Forwards, *HR* Heart rate, *I* International, *Max* Maximal, *N* National, *NA* Data not available.

^{T} trivial, ^{S} small, ^{M} moderate, ^{L} large, ^{V} very large, ^{X} extremely large.

Table 4. Summary of anthropometric characteristics of female rugby sevens athletes

Competition Level		Height (m)	Body Mass (kg)	Sum of 7 SF (mm)	Body Fat (%)
E	Pooled Mean	1.68 ± 0.01	67.4 ± 1.5	83.8 ± 8.3	17.0 ± 1.3
	(n)	(960)	(960)	(93)	(49)
NE	Pooled Mean	1.66 ± 0.02	66.8 ± 5.0	89.0 ± 20.0	21.5 ± 5.1
	(n)	(150)	(150)	(22)	(10)
	ES [95% CI]	1.69[L]	0.26[S]	-0.46[S]	-1.91[L]
		[1.50,1.87]	[0.09,0.43]	[-0.92,0.02]	[-2.65,-1.13]
Playing Position (Elite)					
B	Pooled Mean	1.66 ± 0.02	63.7 ± 2.4	84.4 ± 26.1	15.4 ± 3.1
	(n)	(42)	(42)	(13)	(12)
F	Pooled Mean	1.67 ± 0.03	69.9 ± 2.2	95.0 ± 12.3	18.1 ± 3.5
	(n)	(34)	(34)	(11)	(11)
	ES [95% CI]	-0.40[S]	-2.68[V]	-0.51	-0.82[M]
		[-0.85,0.06]	[-3.27,-2.03]	[-1.30,0.33]	[-1.64,0.06]
Playing Position (Non-Elite)					
B	Pooled Mean	1.65 ± 0.06	66.0 ± 9.5		
	(n)	(44)	(44)		
F	Pooled Mean	1.65 ± 0.06	71.7 ± 13.9		
	(n)	(33)	(33)		
	ES [95% CI]	0.00	-0.49[S]		
		[-0.45,0.45]	[-0.94,-0.03]		

Data are presented as mean ± SD. Pooled based on sample size.

7 SF Sum of 7 skinfolds, *B* Backs, *CI* Confidence interval, *E* Elite. *ES* Effect size, *F* Forwards, *NE* Non-Elite.

[T] trivial, [S] small, [M] moderate, [L] large, [V] very large, [X] extremely large.

Table 5. Summary of physical qualities of female rugby sevens athletes

Competition Level		Speed			Power				Strength	Aerobic
		0-10 m (s)	0-40 m (s)	Max Speed (m·s^{-1})	VJ Height (cm)	CMJ RPP (W·kg^{-1})	CMJ RMP (W·kg^{-1})	CMJ PV (m·s^{-1})	Bench Press 1 RM (kg)	Yo-Yo IR1 (m)
E	Pooled Mean	1.81 ± 0.03	5.63 ± 0.07	7.96 ± 0.26	49.6 ± 3.8	60 ± 4	39 ± 4	3.2 ± 0.2	65.2 ± 3.3	1300 ± 219
	(n)	(58)	(58)	(86)	(11)	(24)	(12)	(12)	(43)	(49)
NE	Pooled Mean	1.82 ± 0.06	5.79 ± 0.17	7.53 ± 0.27	47.4 ± 5.5	56 ± 10	33 ± 7	3.0 ± 0.3	40.3 ± 7.3	955 ± 136
	(n)	(22)	(22)	(35)	(22)	(10)	(10)	(10)	(7)	(35)
ES [95% CI]		-0.25	-1.50^{L}	1.64^{L}	0.44	0.69^{M}	1.08^{M}	0.80^{M}	6.19^{X}	1.82^{L}
		[-0.74,0.25]	[-2.03,-0.94]	[1.18,2.07]	[-0.30,1.16]	[-0.08,1.43]	[0.15,1.93]	[-0.10,1.64]	[4.65,7.53]	[1.29,2.32]

Playing Position (Elite)		Speed					Power				Strength				Aerobic
		0-10 m (s)	0-30 m (s)	0-40 m (s)	0-50 m (s)	Max Speed (m·s^{-1})	SLJ (m)	STJ (m)	CMJ Height (m)	SJ Height (m)	Front Squat 1 RM (kg, kg·kg^{-1})	Power Clean 1 RM (kg, kg·kg^{-1})	Bench Press 1 RM (kg, kg·kg^{-1})	Pull-up 1 RM (kg, kg·kg^{-1})	1600 m (s)
B	Pooled Mean	1.81 ± 0.03	4.64 ± 0.19	5.60 ± 0.14	7.26 ± 0.29	8.06 ± 0.20	229 ± 11	705 ± 32	38.4 ± 4.2	33.0 ± 3.5	82.5 ± 11.3,	68.2 ± 6.2,	61.8 ± 7.1,	78.1 ± 6.7,	390 ± 28
	(n)	(12)	(9)	(12)	(9)	(19)	(12)	(12)	(10)	(10)	1.2 ± 0.2	1.0 ± 0.1	0.9 ± 0.1	1.2 ± 0.1	(13)
											(8)	(8)	(11)	(12)	
F	Pooled Mean	1.84 ± 0.04	4.74 ± 0.11	5.72 ± 0.12	7.39 ± 0.16	7.86 ± 0.25	228 ± 9	691 ± 28	37.5 ± 4.0	32.9 ± 3.6	84.5 ± 5.8,	73.5 ± 4.5,	68.8 ± 7.1,	86.3 ± 5.2,	377 ± 25
	(n)	(11)	(9)	(11)	(9)	(16)	(11)	(11)	(10)	(10)	1.1 ± 0.1	1.0 ± 0.0	0.9 ± 0.1	1.2 ± 0.1	(10)
											(9)	(7)	(10)	(9)	
ES [95% CI]		-0.85^{M}	-0.64	-0.92^{M}	-0.56	0.89^{M}	0.10	0.46	0.22	0.03	-0.23	-0.97^{M}	-0.99^{M}	-1.34^{L}	0.49
		[-1.68,0.03]	[-1.56,0.33]	[-1.74,-0.03]	[-1.47,0.41]	[0.18,1.57]	[-0.72,0.91]	[-0.38,1.28]	[-0.67,1.09]	[-0.85,0.90]	[-1.17,0.74],	[-1.98,0.16],	[-1.85,-0.04],	[-2.22,-0.34],	[-0.37,1.30]
											0.65	0.00	0.00	0.00	
											[-0.36,1.59]	[-1.01,1.01]	[-0.86,0.86]	[-0.86,0.86]	

Data are presented as mean ± SD. Pooled based on sample size.

B Backs, *CI* Confidence interval, *CMJ* Countermovement jump, *E* Elite, *ES* Effect size, *F* Forwards, *NE* Non-Elite, *PV* Peak velocity, *RM* Repetition Maximum, *RMP* Relative mean power, *RPP* Relative peak power, *SJ* Squat jump, *SLJ* Standing long jump, *STJ* Standing triple jump, *VJ* Vertical jump, *Yo-Yo IR1* Yo-Yo Intermittent Recovery Test Level 1.

^{T} trivial, ^{S} small, ^{M} moderate, ^{L} large, ^{V} very large, ^{X} extremely large.

Study Quality Assessment

For the purpose of this review, the following modifications to the original 27-items Downs and Black Quality Assessment Checklist were applied. The term "patient" was replaced with "participant", and "treatment" with "testing". On questions 8, 10, 14, 15, 17, 19, 23, 24, 26, and 27, ''Not applicable'' was added as a scoring option. For questions 5 and 25, country of origin, playing level, playing position (backs and forwards), and information regarding the type (menstrual or contraceptive) and phase (high or low hormones) of the cycle of participants at the moment of testing were considered as confounding variables. To receive two points on question 5, all four confounders had to be reported. For one point, two or three confounders had to be addressed. A score of zero was given when one or no confounder was given. When no participants were lost to follow-up, when losses to follow-up were < 10%, or when at least 90 % of the total cohort completed all assessments, questions 9 and 26 were scored "Yes". Question 11 was answered "Yes" if all the athletes of a given team were invited to participate, whereas question 12 was answered "Yes" when all the athletes of a given team participated in the study. When an article reported or provided a reference to the accuracy of a measurement system, question 20 was scored ''Yes''. Question 27 was scored "Yes" when statistical significance was reached or the effect size was clear, "No" when statistical significance was not reached or the effect size was unclear, and "Not applicable" when no statistical analysis was performed (e.g., observational study with no comparisons).

Table 6. Modified Downs and Black Quality Assessment Checklist and Quality Score

	Agar-Newman et al. (3)	Clarke et al. (18)	Clarke et al. (16)	Clarke et al. (12)	Clarke et al. (14)	Clarke et al. (15)	Clarke et al. (13)	Clarke et al. (17)	Del Coso et al. (20)
Reporting									
1. Aims clearly described	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Main outcomes to be measured clearly described	✓	✓	✓	✓	✓	✓	✓	✓	✓
3. Participants characteristics clearly described	✓	✓	✓	✓	✓	✓	✓	✓	✓
4. Interventions of interest clearly described	✓	✓	✓	✓	✓	✓	✓	✓	✓
5. Principal confounders clearly described	✓	✓	✓	✓	✓	✓	✓	X	✓
6. Main findings clearly described	✓	✓	✓	✓	✓	✓	X	✓	✓
7. Estimates of random variability provided	✓	✓	✓	✓	✓	✓	✓	X	✓
8. Important adverse events of the intervention reported	X	X	X	X	X	X	X	NA	✓
9. Characteristics of participants lost to follow-up described	X	✓	X	X	X	X	X	✓	✓
10. Probability values reported	✓	X	X	X	X	X	X	NA	X
External Validity									
11. Subjects asked to participate representative of population	U	U	U	U	U	U	U	U	U
12. Subjects prepared to participate representative of population	U	U	U	U	U	U	U	U	U
13. Location and delivery of testing representative of population	✓	✓	✓	✓	✓	U	U	✓	U
Internal Validity – Bias									
14. Participants blinded to intervention	NA	NA	NA	NA	NA	NA	NA	NA	✓
15. Investigators blinded to intervention	U	NA	U	NA	U	U	U	U	✓
16. Any "data dredging" clearly described	✓	✓	✓	✓	✓	✓	X	✓	✓
17. Analyses adjusted for different lengths of follow-up	NA	NA	✓	NA	X	NA	✓	NA	✓
18. Appropriate statistical tests performed	✓	✓	✓	✓	✓	✓	✓	✓	✓
19. Compliance with the interventions reliable	NA	NA	NA	NA	NA	NA	NA	NA	✓
20. Outcome measures valid and reliable	✓	✓	✓	✓	U	✓	✓	✓	✓
Internal Validity – Confounding									
21. Participants recruited from the same population	✓	✓	✓	✓	✓	✓	U	U	✓
22. Participants recruited over the same time period	✓	✓	✓	✓	✓	U	U	U	✓
23. Participants randomised to intervention	NA	NA	NA	NA	NA	NA	NA	NA	✓
24. Assignment concealed from investigators and participants	NA	NA	NA	NA	NA	NA	NA	NA	✓
25. Adequate adjustment for confounding	✓	X	✓	X	X	✓	X	X	X
26. Losses to follow-up taken into account	X	✓	X	X	X	X	X	NA	✓
Power									
27. Sufficient power to detect a significant and/or clear effect	✓	✓	✓	✓	✓	✓	✓	NA	✓
Overall score (*n*/*n* applicable)	16/23	16/22	16/24	14/22	13/24	13/23	10/24	10/19	22/28
Quality Index	70%	73%	67%	64%	54%	56%	42%	53%	79%
	M	M	M	M	M	M	L	M	S

✓✓ two points, ✓ one point, *L* Limited, *M* Moderate, *NA* Not applicable, *S* Strong, *U* Unable to determine, *X* zero points.

Table 6. Continued

	Fuller et al. (23)	Gathercole et al. (24)	Goodale et al. (25)	Goodale et al. (26)	Griffin et al. (28)	Griffin et al. (27)	Leite et al. (36)	Ma et al. (37)	Malone et al. (38)
Reporting									
1. Aims clearly described	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Main outcomes to be measured clearly described	✓	✓	✓	✓	✓	✓	✓	✓	✓
3. Participants characteristics clearly described	✓	✓	✓	✓	✓	✓	✓	X	✓
4. Interventions of interest clearly described	✓	✓	✓	✓	✓	✓	✓	✓	✓
5. Principal confounders clearly described	✓	X	X	✓	X	X	X	✓	✓
6. Main findings clearly described	✓	X	✓	✓	✓	✓	✓	✓	✓
7. Estimates of random variability provided	✓	✓	✓	✓	✓	✓	✓	✓	✓
8. Important adverse events of the intervention reported	NA	X	X	NA	NA	NA	X	NA	NA
9. Characteristics of participants lost to follow-up described	✓	X	X	✓	✓	X	✓	✓	✓
10. Probability values reported	✓	X	✓	✓	✓	✓	✓	✓	✓
External Validity									
11. Subjects asked to participate representative of population	✓	U	U	U	U	U	U	✓	✓
12. Subjects prepared to participate representative of population	✓	U	U	U	U	U	U	U	U
13. Location and delivery of testing representative of population	✓	U	✓	✓	✓	✓	U	✓	✓
Internal Validity – Bias									
14. Participants blinded to intervention	NA	NA	NA	NA	NA	NA	NA	NA	NA
15. Investigators blinded to intervention	NA	NA	NA	NA	NA	NA	NA	NA	NA
16. Any "data dredging" clearly described	✓	✓	✓	✓	✓	✓	✓	✓	✓
17. Analyses adjusted for different lengths of follow-up	✓	✓	U	NA	✓	✓	NA	✓	NA
18. Appropriate statistical tests performed	✓	✓	✓	✓	✓	✓	✓	✓	✓
19. Compliance with the interventions reliable	NA	NA	NA	NA	NA	NA	NA	NA	NA
20. Outcome measures valid and reliable	✓	U	✓	✓	✓	✓	U	✓	✓
Internal Validity – Confounding									
21. Participants recruited from the same population	✓	✓	✓	✓	✓	✓	✓	✓	✓
22. Participants recruited over the same time period	✓	✓	✓	✓	✓	✓	U	✓	✓
23. Participants randomised to intervention	NA	NA	NA	NA	NA	NA	NA	NA	NA
24. Assignment concealed from investigators and participants	NA	NA	NA	NA	NA	NA	NA	NA	NA
25. Adequate adjustment for confounding	X	X	X	✓	X	X	X	✓	✓
26. Losses to follow-up taken into account	✓	X	X	✓	✓	X	NA	✓	✓
Power									
27. Sufficient power to detect a significant and/or clear effect	✓	✓	✓	✓	✓	✓	✓	✓	✓
Overall score (*n*/*n* applicable)	20/22	11/23	14/23	18/21	17/22	15/22	12/21	19/22	19/21
Quality Index	91%	48%	61%	86%	78%	68%	57%	86%	90%
	S	L	M	S	S	M	M	S	S

✓✓ two points, ✓ one point, *L* Limited, *M* Moderate, *NA* Not applicable, *S* Strong, *U* Unable to determine, *X* zero points.

Table 6. Continued

	Misseldine et al. (41)	Ohya et al. (43)	Portillo et al. (45)	Portillo et al. (44)	Reyneke et al. (47)	Rizi et al. (48)	Suárez-Arrones et al. (57)	Valenzuela et al. (59)	Vescovi et al. (61)
Reporting									
1. Aims clearly described	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Main outcomes to be measured clearly described	✓	✓	✓	✓	✓	✓	✓	✓	✓
3. Participants characteristics clearly described	✓	✓	✓	✓	✓	✓	✓	✓	X
4. Interventions of interest clearly described	✓	✓	✓	✓	✓	✓	✓	✓	✓
5. Principal confounders clearly described	✓	✓	✓	✓	X	✓	X	X	✓
6. Main findings clearly described	✓	✓	✓	✓	✓	✓	✓	✓	✓
7. Estimates of random variability provided	✓	✓	✓	✓	✓	✓	✓	✓	✓
8. Important adverse events of the intervention reported	NA	X	NA	✓	NA	X	X	X	X
9. Characteristics of participants lost to follow-up described	✓	X	✓	✓	✓	✓	✓	✓	X
10. Probability values reported	X	X	X	✓	X	✓	X	X	✓
External Validity									
11. Subjects asked to participate representative of population	U	U	U	U	U	U	U	✓	U
12. Subjects prepared to participate representative of population	U	U	U	U	U	U	U	✓	U
13. Location and delivery of testing representative of population	✓	✓	✓	✓	✓	✓	U	U	U
Internal Validity – Bias									
14. Participants blinded to intervention	NA	NA	NA	✓	NA	NA	NA	NA	NA
15. Investigators blinded to intervention	NA	NA	NA	✓	U	NA	NA	U	U
16. Any "data dredging" clearly described	✓	✓	✓	✓	✓	✓	✓	X	✓
17. Analyses adjusted for different lengths of follow-up	NA	NA	NA	✓	NA	✓	NA	NA	NA
18. Appropriate statistical tests performed	✓	✓	✓	✓	✓	✓	✓	✓	✓
19. Compliance with the interventions reliable	NA	NA	NA	✓	NA	NA	NA	NA	NA
20. Outcome measures valid and reliable	✓	U	✓	✓	✓	✓	✓	✓	✓
Internal Validity – Confounding									
21. Participants recruited from the same population	✓	✓	✓	✓	✓	✓	✓	✓	✓
22. Participants recruited over the same time period	✓	✓	✓	✓	✓	✓	✓	✓	✓
23. Participants randomised to intervention	NA	NA	NA	✓	NA	NA	NA	NA	NA
24. Assignment concealed from investigators and participants	NA	NA	NA	✓	NA	NA	NA	NA	NA
25. Adequate adjustment for confounding	✓	✓	X	X	X	X	X	X	X
26. Losses to follow-up taken into account	U	X	✓	✓	✓	✓	✓	✓	X
Power									
27. Sufficient power to detect a significant and/or clear effect	✓	✓	✓	✓	✓	✓	✓	✓	✓
Overall score (*n*/*n* applicable)	16/21	14/22	16/21	24/28	15/21	18/23	14/22	15/23	13/23
Quality Index	76%	64%	76%	86%	71%	78%	64%	65%	57%
	S	M	S	S	M	S	M	M	M

✓✓ two points, ✓ one point, *L* Limited, *M* Moderate, *NA* Not applicable, *S* Strong, *U* Unable to determine, *X* zero points.

Table 7. GPS match data of female rugby sevens athletes

Article	Comp	Device, no. files	Total Match Distance (m)	Relative Match Distance (m·min^{-1})	Sprints/ Accel (n)	Max Speed (m·s^{-1})	Speed Zones (m·s^{-1})				
							0	2.2	3.5	5.0	5.5
Clarke et al. (15)	Int (WS)	GPS[a] 5 Hz, 89 T		T: 86 ± 4		T: 8.1 ± 0.6					
Del Coso et al. (20)	Int	GPS[b] 5 Hz, 28 P 28 ED		P: 88 ± 8 ED: 95 ± 13						*5.0-5.5 m·s^{-1}* P: 3.7 ± 1.4 m·min^{-1} ED: 4.4 ± 1.4 m·min^{-1}	*> 5.5 m·s^{-1}* P: 4.6 ± 3.3 m·min^{-1} ED: 6.1 ± 3.4 m·min^{-1}
Goodale et al. (26)	Int (WS)	GPS[c] 10 Hz, 191 T 103 B 88 F 193 FH 216 SH		T: 87 ± 11 B: 86 ± 9 F: 87 ± 12		T: 6.9 ± 0.8 B: 7.1 ± 0.7 F: 6.7 ± 0.7 FH: 6.6 ± 0.9 SH: 6.5 ± 0.8	*0-0.2 m·s^{-1}* T: 2 ± 1 m·min^{-1} B: 2 ± 1 m·min^{-1} F: 2 ± 1 m·min^{-1}	*0.2-3.5 m·s^{-1}* T: 59 ± 7 m·min^{-1} B: 59 ± 7 m·min^{-1} F: 59 ± 8 m·min^{-1}	*3.5-5.0 m·s^{-1}* T: 16 ± 5 m·min^{-1} B: 15 ± 5 m·min^{-1} F: 18 ± 6 m·min^{-1}	*5.0-6.5 m·s^{-1}* T: 7 ± 3 m·min^{-1} B: 8 ± 3 m·min^{-1} F: 7 ± 3 m·min^{-1}	*≥ 6.5 m·s^{-1}* T: 2 ± 2 m·min^{-1} B: 2 ± 2 m·min^{-1} F: 2 ± 2 m·min^{-1}
Malone et al. (38)	Int (WS)	GPS[d] 10 Hz, 250 T 131 B 119 F	T: 1625 ± 132 B: 1728 (1422-1865) F: 1422 (1123-1468) FH: 865 SH: 765	T: 116 ± 9	*Sprints* B: 4.5 (1.4-5.1) F: 2.5 (1.0-3.1) *Accel* B: 14 (10-16) F: 11 (9-13)	T: 7.5 ± 1.4 B: 7.7 (7.3-8.2) F: 7.5 (7.0-8.0) FH: 7.6 SH: 7.5				*4.4-5.5 m·s^{-1}* T: 199 ± 44 m, 14.2 ± 3.1 m·min^{-1} B: 223 m (195-254) F: 174 m (104-200) FH: 107 m SH: 93 m	*≥ 5.5 m·s^{-1}* T: 118 ± 45 m B: 133 m (130-143) F: 102 m (98-111) FH: 63 m SH: 55 m
Misseldine et al. (41)	Int	GPS[e] 5 Hz, 31 T 19 B 12 F		T: 98 ± 8 B: 98 ± 8 F: 97 ± 6		T: 7.0 ± 0.7 B: 7.5 ± 0.7 F: 6.7 ± 0.5					

Table 7. Continued

Article	Comp	Device, no. files	Total Match Distance (m)	Relative Match Distance (m·min^{-1})	Sprints/ Accel (n)	Max Speed (m·s^{-1})	Speed Zones (m·s^{-1})					
							0	2.2	3.5		5.0	5.5
Portillo et al. (45)	Int	GPS[b] 15 Hz, 29 T 36 FH 30 SH	T: 1642 ± 171 FH: 883 ± 122 SH: 725 ± 157		*Sprints* T: 6.1 ± 3.1 *Accel* FH: 6.0 ± 2.7 SH: 4.9 ± 2.4	T: 6.9 ± 0.5 FH: 6.8 ± 0.6 SH: 6.9 ± 0.4	*0-1.7 m·s^{-1}* T: 496 ± 69 m FH: 238 ± 34 m SH: 261 ± 46 m	*1.7-3.5 m·s^{-1}* T: 549 ± 74 m FH: 306 ± 48 m SH: 241 ± 63 m	*3.5-3.9 m·s^{-1}* T: 165 ± 44 m FH: 91 ± 29 m SH: 73 ± 22 m	*3.9-5.0 m·s^{-1}* T: 275 ± 88 m FH: 135 ± 45 m SH: 114 ± 50 m	*5.0-5.5 m·s^{-1}* T: 103 ± 48 m FH: 52 ± 24 m SH: 46 ± 19 m	*> 5.5 m·s^{-1}* T: 119 ± 61 m FH: 62 ± 38 m SH: 62 ± 38 m
Suárez-Arrones et al. (57)	Int	GPS[f] 1 Hz, 17 T 17 FH 17 SH	T: 1556 ± 189		*Sprints* FH: 2.5 ± 1.6 SH: 2.8 ± 1.6	T: 6.4 ± 0.5 FH: 6.4 ± 0.6 SH: 6.4 ± 0.4	*0-1.7 m·s^{-1}* T: 463 ± 95 m	*1.7-3.5 m·s^{-1}* T: 516 ± 89 m	*3.5-3.9 m·s^{-1}* T: 181 ± 61 m	*3.9-5.0 m·s^{-1}* T: 256 ± 88 m	*5.0-5.5 m·s^{-1}* T: 57 ± 41 m	*> 5.5 m·s^{-1}* T: 84 ± 65 m
Reyneke et al. (47)	Int (WS)	GPS[g] 4 Hz, 40 L 54 H		L: 88 ± 9 H: 92 ± 10			*0-2.0 m·s^{-1}* L: 32.5 ± 4.2 m·min^{-1} H: 33.1 ± 4.0 m·min^{-1}	*2.0-3.5 m·s^{-1}* L: 28.5 ± 6.5 m·min^{-1} H: 29.8 ± 5.8 m·min^{-1}	*3.5-5.0 m·s^{-1}* L: 18.5 ± 6.0 m·min^{-1} H: 18.3 ± 4.5 m·min^{-1}		*5.0-6.0 m·s^{-1}* L: 5.5 ± 2.0 m·min^{-1} H: 6.3 ± 2.6 m·min^{-1}	*≥ 6.0 m·s^{-1}* L: 2.9 ± 3.6 m·min^{-1} H: 4.2 ± 2.4 m·min^{-1}
Vescovi et al. (61)	Int	GPS[h] 5 Hz, 134 T		T: 95 ± 5 (92-98)		T: 7.4 ± 0.5 (7.1-7.6)	*0-2.2 m·s^{-1}* T: 36 ± 2 m·min^{-1} (35-38)	*2.2-4.4 m·s^{-1}* T: 36 ± 5 m·min^{-1} (33-39)		*4.4-5.5 m·s^{-1}* T: 14 ± 3 m·min^{-1} (13-16)		*> 5.5 m·s^{-1}* T: 8 ± 4 m·min^{-1} (6-11)

Table 7. Continued

Article	Comp	Device, no. files	Total Match Distance (m)	Relative Match Distance (m·min⁻¹)	Sprints/ Accel (n)	Max Speed (m·s⁻¹)	Speed Zones (m·s⁻¹)					
							0	2.2	3.5		5.0	5.5
Clarke et al. (18)	Nat, E	GPS[b] 5 Hz, 24 T		T: 86 ± 7								
Clarke et al. (15)	Nat	GPS[a] 5 Hz, 90 T		T: 98 ± 12		T: 7.4 ± 0.5						
Portillo et al. (45)	Nat	GPS[b] 15 Hz, 21 T 27 FH 22 SH	T: 1363 ± 222 FH: 719 ± 148 SH: 615 ± 146		*Sprints* T: 1.9 ± 1.4 *Accel* FH: 6.0 ± 2.2 SH: 4.5 ± 2.2	T: 6.0 ± 0.7 FH: 5.8 ± 0.7 SH: 6.2 ± 0.7	*0-1.7 m·s⁻¹* T: 524 ± 137 m FH: 259 ± 63 m SH: 251 ± 78 m	*1.7-3.5 m·s⁻¹* T: 437 ± 97 m FH: 237 ± 67 m SH: 213 ± 52 m	*3.5-3.9 m·s⁻¹* T: 157 ± 51 m FH: 86 ± 34 m SH: 71 ± 25 m	*3.9-5.0 m·s⁻¹* T: 199 ± 79 m FH: 106 ± 45 m SH: 88 ± 46 m	*5.0-5.5 m·s⁻¹* T: 46 ± 33 m FH: 26 ± 24 m SH: 19 ± 15 m	*> 5.5 m·s⁻¹* T: 47 ± 39 m FH: 15 ± 21 m SH: 27 ± 28 m
Vescovi et al. (61)	Nat	GPS[h] 5 Hz, 78 T		T: 91 ± 11 (84-97)		T: 6.8 ± 0.8 (6.4-7.3)	*0-2.2 m·s⁻¹* T: 39 ± 6 m·min⁻¹ (36-42)	*2.2-4.4 m·s⁻¹* T: 38 ± 12 m·min⁻¹ (31-45)		*4.4-5.5 m·s⁻¹* T: 10 ± 4 m·min⁻¹ (7-12)		*> 5.5 m·s⁻¹* T: 4 ± 3 m·min⁻¹ (2-6)

Data are presented as mean, mean ± SD, or range.

Accel Accelerations, *B* Backs, *Comp* Competition, *E* Elite athletes, *ED* Energy drink, *F* Forwards, *FH* First half, *H* High score differential, *Int* International tournament, *L* Low score differential, *Nat* National tournament, *P* Placebo, *SH* Second half, *T* Total, *WS* World Series.

[a] SPI HPU, GPSports Systems, Australia, [b] SPI Pro X, GPSports, Australia, [c] Minimax S4, Catapult Innovations, Australia, [d] STATSports Viper, STATSports, UK, [e] JOHAN trackers, JOHAN Sports, the Netherlands, [f] SPI Elite, GPSports, Australia, [g] VX sport 220, Visuallex Sport International, New Zealand, [h] SPI Pro, GPSports, Australia.

Table 8. HR match responses of female rugby sevens athletes

Article	Comp	Device, no. files	Max HR (beats·min^{-1})	Mean HR (beats·min^{-1})	HR Zones (% time)						
					< 60% HR max	60% HR max	70% HR max	80% HR max	90% HR max	95% HR max	100% HR max
Del Coso et al. (20)	Int	HR monitor[a] 5 Hz, 28 ED 28 P	ED: 189 ± 10 P: 188 ± 9	ED: 168 ± 7 P: 164 ± 6							
Goodale et al. (26)	Int (WS)	HR monitor[a] 1 Hz, 191 T 103 B 88 F		T: 170 ± 8 B: 170 ± 7 F: 169 ± 8	*50-59%* T: 1.0 ± 1.0 B: 1.0 ± 1.0 F: 1.0 ± 1.0	*60-69%* T: 2.0 ± 3.0 B: 2.0 ± 3.0 F: 2.0 ± 4.0	*70-79%* T: 10.0 ± 7.0 B: 11.0 ± 7.0 F: 9.0 ± 8.0	*80-89%* T: 40.0 ± 16.0 B: 38.0 ± 14.0 F: 39.0 ± 18.0	*≥ 90%* T: 49.0 ± 21.0 B: 49.0 ± 18.0 F: 50.0 ± 24.0		
Malone et al. (38)	Int (WS)	HR monitor[b], 250 T 131 B 119 F	T: 187 ± 12 B: 188 (184-190) F: 186 (182-189)	T: 171 ± 9 B: 173 (167-178) F: 170 (165-176)	*≤ 60%* B: 1.3 (0.8-2.1) F: 1.2 (0.6-2.0)	*61-70%* B: 8.3 (4.2-10.5) F: 18.3 (11.3-20.5)	*71-80%* B: 14.9 (12.3-17.2) F: 21.4 (19.2-23.5)	*81-90%* B: 50.3 (42.3-52.6) F: 42.1 (42.6-51.3)	*91-95%* B: 19.1 (15.4-21.3) F: 15.7 (13.4-17.3)	*≥ 95%* B: 6.1 (3.1-8.3) F: 2.1 (1.3-3.1)	
Portillo et al. (45)	Int	HR monitor[c], 23 T 36 FH 30 SH	T: 186 ± 9	T: 164 ± 9	*< 60%* FH: 0.3 ± 0.8 SH: 0.0 ± 0.0	*61-70%* FH: 2.3 ± 3.2 SH: 0.9 ± 1.4	*71-80%* FH: 8.6 ± 7.3 SH: 7.4 ± 6.4	*81-90%* FH: 29.4 ± 12.7 SH: 31.7 ± 13.0	*91-95%* FH: 33.8 ± 10.9 SH: 31.6 ± 7.4	*> 95%* FH: 25.0 ± 14.8 SH: 28.3 ± 17.8	
Suárez-Arrones et al. (57)	Int	HR monitor[b], 17 FH 17 SH	FH: 188 ± 12 SH: 190 ± 10	FH: 167 ± 9 SH: 169 ± 10							
Vescovi et al. (61)	Int	HR monitor[c], 134 T	T: 187 ± 6 (184-190)	T: 172 ± 7 (167-178)	*< 80%* T: 13.3 ± 19.3			*80-90%* T: 32.0 ± 17.3	*> 90%* T: 54.7 ± 31.4		

Table 8. Continued

Article	Comp	Device, no. files	Max HR (beats·min^{-1})	Mean HR (beats·min^{-1})	HR Zones (% time)						
					< 60% HR max	60% HR max	70% HR max	80% HR max	90% HR max	95% HR max	100% HR max
Portillo et al. (45)	Nat	HR monitor[c], 26 T 27 FH 22 SH	T: 178 ± 12	T: 155 ± 14	*< 60%* FH: 0.2 ± 0.9 SH: 0.5 ± 2.4	*61-70%* FH: 6.2 ± 7.6 SH: 3.5 ± 7.0	*71-80%* FH: 18.2 ± 12.6 SH: 17.9 ± 13.5	*81-90%* FH: 41.6 ± 13.1 SH: 36.9 ± 16.7	*91-95%* FH: 22.9 ± 11.9 SH: 26.3 ± 16.0	*> 95%* FH: 10.7 ± 9.4 SH: 15.3 ± 11.8	
Vescovi et al. (61)	Nat	HR monitor[c], 78	T: 194 ± 5 (191-198)	T: 180 ± 9 (174-186)	*< 80%* T: 6.6 ± 5.9			*80-90%* T: 27.7 ± 18.2	*> 90%* T: 65.7 ± 22.6		

Data are presented as mean, mean ± SD, or range.

B Backs, *Comp* Competition, *F* Forwards, *ED* Energy drink, *FH* First half, *HR* Heart rate, *Int* International tournament, *Nat* National tournament, *P* Placebo, *SH* Second half, *T* Total, *WS* World Series.

[a] T31, Polar Electro Oy, Finland, [b] Polar Team Sport System; Polar Electro Oy, Kempele, Finland, [c] Polar Electro, Kempele, Finland.

Table 9. Anthropometric characteristics of female rugby sevens athletes

Article	Participants		Height (m)	Body Mass (kg)	Body Composition
	n	Level			
Agar-Newman et al. (3)	13	Elite – WS (B)	1.66 ± 0.06	66.4 ± 3.5	7 SF: 84.4 ± 26.1 mm
	11	Elite – WS (F)	1.70 ± 0.04	72.9 ± 4.8	7 SF: 95.0 ± 12.3 mm
Clarke et al. (18)	22	Elite – WS	1.68 ± 0.06	69.0 ± 7.0	7 SF: 85.0 ± 15.0 mm
Clarke et al. (16)	12	Elite – WS	1.67 ± 0.04	65.8 ± 4.6	
Clarke et al. (12)	12	Elite – WS	1.68 ± 0.04	68.2 ± 7.7	7 SF: 75.0 ± 10.7 mm
Clarke et al. (14)	12	Elite – WS	1.67 ± 0.04	65.8 ± 4.6	
Clarke et al. (15)	11	Elite – WS	1.69 ± 0.02	68.6 ± 4.4	7 SF: 67.0 ± 14.0 mm
Clarke et al. (13)	23	Elite – WS	1.72 ± 0.05	69.1 ± 6.3	
Clarke et al. (17)	12	Elite – WS	1.69 ± 0.02	68.6 ± 4.4	
Del Coso et al. (20)	16	Elite	1.66 ± 0.07	66.0 ± 7.0	BF: 16.6 ± 2.8%[a]
Fuller et al. (23)	197	Elite – WS	1.69 ± 0.06*	67.4 ± 6.1*	
	221	Elite – WS	1.68 ± 0.06*	67.8 ± 6.0*	
	148	Elite – Oly	1.67 ± 0.06*	66.4 ± 6.7*	
Gathercole et al. (24)	12	Elite	1.69 ± 0.06	69.5 ± 4.9	
Goodale et al. (25)	12	Elite – WS (HM)	1.68 ± 0.07	70.0 ± 4.9	7 SF: 86.8 ± 11.2 mm
	12	Elite – WS (LM)	1.69 ± 0.04	68.7 ± 5.7	7 SF: 91.6 ± 28.4 mm
Goodale et al. (26)	20	Elite – WS	1.68 ± 0.06	69.0 ± 5.0	
Griffin et al. (28)	24	Elite – WS	1.68 ± 0.05	68.0 ± 6.0	
Griffin et al. (27)	24	Elite – WS	1.68 ± 0.05	68.0 ± 6.0	
Ma et al. (37)	10	Elite (B)	1.69 ± 0.02	64.7 ± 11.2	
	7	Elite (F)	1.63 ± 0.10	68.0 ± 8.1	
Malone et al. (38)	27	Elite – WS	1.68 ± 0.07	67.9 ± 4.3	
Misseldine et al. (41)	7	Elite (B)	1.67 ± 0.05	62.4 ± 4.4	
	5	Elite (F)	1.70 ± 0.03	69.8 ± 2.0	
Ohya et al. (43)	12	Elite (B)	1.64 ± 0.05	60.6 ± 3.6	BF: 15.4 ± 3.1%[b]
	11	Elite (F)	1.66 ± 0.03	68.2 ± 8.4	BF: 18.1 ± 3.5%[b]
Portillo et al. (45)	10	Elite	1.67 ± 0.07	65.4 ± 5.0	BF: 19.3 ± 4.1%[c]
Portillo et al. (44)	16	Elite	1.66 ± 0.07	66.0 ± 7.0	BF: 16.6 ± 2.8%[a]
Reyneke et al. (47)	15	Elite – WS	1.68 ± 0.07	67.5 ± 6.3	
Suárez-Arrones et al. (57)	12	Elite	1.65 ± 0.06	63.7 ± 4.8	
Valenzuela et al. (59)	7	Elite – Oly (HP)	1.67 ± 0.05	66.7 ± 3.7	BMI: 24.0 ± 0.8 $kg \cdot m^{-2}$
	7	Elite – Oly (LP)	1.71 ± 0.05	69.1 ± 5.1	BMI: 23.5 ± 0.9 $kg \cdot m^{-2}$
Clarke et al. (16)	10	Non-Elite	1.67 ± 0.03	66.1 ± 7.9	
Clarke et al. (14)	10	Non-Elite	1.67 ± 0.03	66.1 ± 7.9	
Clarke et al. (15)	22	Non-Elite	1.70 ± 0.07	70.4 ± 9.3	7 SF: 89.0 ± 20.0 mm
Leite et al. (36)	7	Non-Elite	1.63 ± 0.07	67.1 ± 11.4	3 SF: 172.0 ± 56.0 mm
Ma et al. (37)	44	Non-Elite (B)	1.65 ± 0.06	66.0 ± 9.5	
	33	Non-Elite (F)	1.65 ± 0.06	71.7 ± 13.9	
Portillo et al. (45)	10	Non-Elite	1.67 ± 0.03	66.5 ± 5.4	BF: 21.5 ± 5.1%[c]
Rizi et al. (48)	14	Non-Elite	1.61 ± 0.04	53.3 ± 5.1	

Data are presented as mean ± SD.

3 SF Sum of 3 skinfolds, *7 SF* Sum of 7 skinfolds, *B* Backs, *BF* Body fat, *BMI* Body Mass Index, *F* Forwards, *HM* High playing minutes, *HP* High-power, *LM* Low playing minutes, *LP* Low-power, *Oly* Olympic Games, WS World Series.

[a] calculated using 6 skinfolds, [b] measured with air displacement plethysmography, [c] not specified.

* data relies on reports to World Rugby.

Table 10. Acceleration and speed qualities of female rugby sevens athletes

Article	Participants		Time (s)				Maximal Speed ($m \cdot s^{-1}$)
	n	level	0-10 m	0-30 m	0-40 m	0-50 m	Up to 50 m
Agar-Newman et al. (3)	12	Elite – WS (B)	1.81 ± 0.03[a,d]		5.60 ± 0.14[a,d]		8.21 ± 0.26[a,d]
	11	Elite – WS (F)	1.84 ± 0.04[a,d]		5.72 ± 0.12[a,d]		8.02 ± 0.25[a,d]
Clarke et al. (15)	11	Elite – WS	1.76 ± 0.05[b]		5.50 ± 0.16[b]		8.23 ± 0.34[b]
Goodale et al. (25)	12	Elite – WS (HM)	1.83 ± 0.05[a,d]	4.41 ± 0.13[a,d]	5.66 ± 0.16[a,d]		8.13 ± 0.26[a,d]
	12	Elite – WS (LM)	1.82 ± 0.03[a,d]	4.39 ± 0.07[a,d]	5.66 ± 0.11[a,d]		8.06 ± 0.26[a,d]
Misseldine et al. (41)	7	Elite (B)					7.80 ± 0.30[c,d]
	5	Elite (F)					7.50 ± 0.40[c,d]
Ohya et al. (43)	9	Elite (B)		4.64 ± 0.19[a]		7.26 ± 0.29[a]	
	9	Elite (F)		4.74 ± 0.11[a]		7.39 ± 0.16[a]	
Vescovi et al. (61)	16	Elite					7.58 ± 0.19[a,e]
Clarke et al. (15)	22	Non-Elite	1.82 ± 0.06[b]		5.79 ± 0.17[b]		7.77 ± 0.26[b]
Vescovi et al. (61)	13	Non-Elite					7.22 ± 0.42[a,e]

Data are presented as mean ± SD.

B Backs, *F* Forwards, *HM* High playing minutes, *LM* Low playing minutes, *WS* World Series.

[a] measured with timing lights (Brower Timing System, Utah, USA), [b] measured with timing lights (Fusion Sport, Brisbane, Australia), [c] measured with GPS units (JOHAN Sports, Noordwijk, the Netherlands), [d] performed on artificial turf, [e] performed indoor.

Table 11. Power characteristics of female rugby sevens athletes

Article	Participants		VJ	CMJ				SLJ	STJ	Other
	n	level	Height (cm)	Height (cm)	RPP (W·kg^{-1})	RMP (W·kg^{-1})	PV (m·s^{-1})	Distance (cm)	Distance (cm)	
Agar-Newman et al. (3)	12	Elite – WS (B)						229 ± 11	705 ± 32	
	11	Elite – WS (F)						228 ± 9	691 ± 28	
Clarke et al. (15)	11	Elite – WS	49.6 ± 3.8[a]							
Clarke et al. (16)	12	Elite			64 ± 9[b]	39 ± 4[b]	3.2 ± 0.2[b]			
Del Coso et al. (20)	16	Elite (ED)								15-s RJ, TP: 25.6 ± 11.8 kW[c]
	16	Elite (P)								15-s RJ, TP: 23.5 ± 10.1 kW[c]
Gathercole et al. (24)	12	Elite			57 ± 5[d]					
Goodale et al. (25)	12	Elite – WS (HM)						227 ± 9	692 ± 25	
	12	Elite – WS (LM)						230 ± 11	705 ± 35	
Ohya et al. (43)	10	Elite – B		38.4 ± 4.2[e]						SJ, Height: 33.0 ± 3.5 cm[e]
	10	Elite – F		37.5 ± 4.0[e]						SJ, Height: 32.9 ± 3.6 cm[e]
Valenzuela et al. (59)	7	Elite – Oly (HP)								WAnT, RPP: 9.80 ± 0.25 W·kg^{-1}[f]
	7	Elite – Oly (LP)								WAnT, RPP: 8.94 ± 0.45 W·kg^{-1}[f]
Clarke et al. (15)	22	Non-Elite	47.4 ± 5.5[a]							
Clarke et al. (16)	10	Non-Elite			56 ± 10[b]	33 ± 7[b]	3.0 ± 0.3[b]			
Leite et al. (36)	7	Non-Elite								Bench Press (Concentric) MP: 195.0 ± 48.7 W[g], 30% 1RM, PP: 201.6 ± 70.8 W[g], 40% 1RM, PP: 204.7 ± 49.0 W[g], 50% 1RM, PP: 200.3 ± 40.6 W[g], 60% 1RM, PP: 173.4 ± 40.2 W[g]

Data are presented as mean ± SD.

15-s RJ 15 seconds rebound jump, *B* Backs, , *CMJ* Countermovement jump, *ED* Energy drink, *F* Forwards, *HM* High playing minutes, *HP* High-power, *LM* Low playing minutes, *LP* Low-power, *MP* Mean power, *Oly* Olympic Games, *P* Placebo, *PV* Peak velocity, *RM* Repetition Maximum, *RMP* Relative mean power, *RPP* Relative peak power, *PP* Peak power, *SJ* Squat jump, *SLJ* Standing long jump, *STJ* Standing triple jump, *TP* Total power, *VJ* Vertical jump, *WAnT* Wingate Anaerobic test, *WS* World Series.

[a] measured with Vertec (Swift Performance Equipment, Queensland, Australia), [b] measured with linear position transducer (GymAware, Kinetic Performance, Australia), [c] measured with force plate (Quattrojump, Kistler, Switzerland), [d] measured with force plate (400 series, Fitness Technology, Australia) and position transducer (Celesco, Chatsworth, USA), [e] measured with a switch mat system (Multi jump tester, DKH CO., Tokyo, Japan), [f] measured with magnetically braked stationary cycle ergometer (SNT Medical, Cardgirus, Spain, [g] measured with triaxial accelerometer (Myotest S4P, Sion, Switzerland).

Table 12. Strength qualities of female rugby sevens athletes

Article	Participants	Front Squat		Power Clean		Bench Press		Neutral Grip Pull-Up	
	level	1 RM (kg)	Rel 1 RM (kg·kg^{-1})	1 RM (kg)	Rel 1 RM (kg·kg^{-1})	1 RM (kg)	Rel 1 RM (kg·kg^{-1})	1 RM (kg)	Rel 1 RM (kg·kg^{-1})
Agar-Newman et al. (3)	Elite – WS (B) (*n*)	82.5 ± 11.3 (8)	1.2 ± 0.2 (8)	68.2 ± 6.2 (8)	1.0 ± 0.1 (8)	61.8 ± 7.1 (11)	0.9 ± 0.1 (11)	78.1 ± 6.7 (12)	1.2 ± 0.1 (12)
	Elite – WS (F) (*n*)	84.5 ± 5.8 (9)	1.1 ± 0.1 (9)	73.5 ± 4.5 (7)	1.0 ± 0.0 (7)	68.8 ± 7.1 (10)	0.9 ± 0.1 (10)	86.3 ± 5.2 (9)	1.2 ± 0.1 (9)
Goodale et al. (25)	Elite – WS (HM) (*n*)	84.2 ± 7.9 (8)	1.2 ± 0.2 (8)	71.8 ± 4.8 (7)	1.0 ± 0.1 (7)	68.4 ± 6.3 (11)	1.0 ± 0.1 (11)	84.0 ± 8.2 (10)	1.2 ± 0.1 (10)
	Elite – WS (LM) (*n*)	83.0 ± 9.6 (8)	1.2 ± 0.2 (8)	69.4 ± 7.2 (7)	1.0 ± 0.1 (7)	62.2 ± 8.1 (11)	0.9 ± 0.1 (11)	79.1 ± 5.4 (10)	1.2 ± 0.1 (10)
Leite et al. (36)	Non-Elite (*n*)					40.3 ± 7.3[a] (7)			

Data are presented as mean ± SD.

B Backs, *F* Forwards, *HM* High playing minutes, *LM* Low playing minutes, *Rel* Relative, *RM* Repetition Maximum, *WS* World Series.

[a] Performed on a guided bar bench.

Table 13. Aerobic capacities of female rugby sevens athletes

Article	Participants		Yo-Yo IR1	VO_2 max	Other
	n	level			
Agar-Newman et al. (3)	13	Elite – WS (B)			1600 m, time: 390 ± 28 s[a]
	10	Elite – WS (F)			1600 m, time: 377 ± 25 s[a]
Clarke et al. (18)	22	Elite – WS	TD: 1200 ± 320 m[b] Lev: 16.3 ± 1.0[b]	VO_2 max: 46.5 ± 5.2 $ml\cdot kg^{-1}\cdot min^{-1}$[c] vVO_2 max: 3.7 ± 0.3 $m\cdot s^{-1}$[c]	Critical v: 3.2 ± 0.3 $m\cdot s^{-1}$[d]
Clarke et al. (15)	11	Elite – WS	TD: 1702 ± 329 m		
Clarke et al. (12)	7	Elite – WS		VO_2 max: 51.0 ± 4.0 $ml\cdot kg^{-1}\cdot min^{-1}$[c] vVO_2 max: 4.1 ± 0.6 $m\cdot s^{-1}$[c] vVT_2: 3.5 ± 0.3 $m\cdot s^{-1}$[c]	
Goodale et al. (25)	12	Elite – WS (HM)			1600 m, time: 374 ± 20 s[e]
	12	Elite – WS (LM)			1600 m, time: 393 ± 30 s[e]
Suárez-Arrones et al. (57)	12	Elite		VO_2 max: 51.1 ± 3.6 $ml\cdot kg^{-1}\cdot min^{-1}$[f]	
Vescovi et al. (61)	16	Elite	TD: 1160 ± 191 m[g]		
Clarke et al. (15)	22	Non-Elite	TD: 1058 ± 249 m		
Vescovi et al. (61)	13	Non-Elite	TD: 781 ± 129 m[g]		

Data are presented as mean ± SD.

B Backs, *F* Forwards, *HM* High playing minutes, *Lev* Last level completed, *LM* Low playing minutes, *TD* Total distance, *v* Velocity, *VO_2 max* Maximal oxygen uptake, *VT_2* Second ventilatory threshold, *WS* World Series, *Yo-Yo IR1* Yo-Yo Intermittent Recovery Test Level 1.

[a] performed on a 400 m gravel track, [b] performed indoor, [c] performed on a custom-built motorised treadmill (Australian Institute of Sport), [d] performed on grass, [e] performed on a 400 m running track, [f] performed on a treadmill and measured with Oxycon Delta de Jaeger, Hoechberg, Germany, [g] performed indoor.