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- 1 **VARIANCES IN STRENGTH AND CONDITIONING PRACTICE IN ELITE RUGBY**
- 2 **UNION BETWEEN THE NORTHERN AND SOUTHERN HEMISPHERES**

1 **ABSTRACT**

2 The strength and conditioning (S&C) practices in elite Rugby Union (RU) have
3 previously been detailed. There is also research which indicates playing styles can
4 differ between Northern hemisphere (NH) and Southern hemisphere (SH) teams. It is
5 not presently known if these variances in playing styles are reflected in the S&C
6 practices of those supporting NH and SH teams. As such, the present study
7 examines any variances in S&C practices between those supporting NH and SH elite
8 level teams. A validated questionnaire was employed that comprised 7 sections;
9 personal details, physical testing, strength and power development, concurrent
10 training, unique aspects of the programme and any further relevant information
11 regarding prescribed training programmes. Forty (20 NH, 20 SH, 38 male, 2 female;
12 33.0 ± 5.5 y) of 52 (77%) coaches responded to the questionnaire. All practitioners
13 worked with international level and/or professional RU athletes. The primary
14 variances in S&C practice between NH and SH coaches included; utilization of
15 differing tests of anaerobic capacity and cardiovascular endurance and differing
16 prescription of compound and Olympic lifts. Also, NH coaches placed a greater
17 emphasis on strength and power training while SH coaches had a more objective
18 approach to determining strength training loads. Furthermore SH practitioners placed
19 more emphasis on integration when compared with NH practitioners. Other aspects
20 of S&C practice detailed in this article appear to be similar between Northern and
21 Southern hemisphere practitioners. This research represents the only published
22 survey to date of differing S&C practices in Northern and Southern hemisphere RU.

23
24 **KEY WORDS** Elite sport, training prescription, physical preparation, programme
25 design, questionnaire

INTRODUCTION

Rugby Union (RU) is a multi-directional, intermittent, invasion game incorporating multiple high intensity efforts (3,13). These efforts vary in nature and consist of sprinting, accelerations and sport specific activities including tackling, rucking, mauling and scrummaging (2,3,10,13). A 15-player side consists of forwards ($n = 8$) and backs ($n = 7$), the forwards are further subcategorised into; “front row”, “second row” and “back row” positions. Backs also are subcategorised into “half backs”, “centres” and “outside backs”.

RU is popular worldwide, at the time of publication the top 10 ranked teams in the world were (1 – 10); New Zealand, England, South Africa, Australia, Wales, Ireland, Argentina, France, Scotland, and Fiji (worldrugby.org, 06/10/2016). Five of these nations are from the Northern hemisphere (NH) and 5 are from the Southern hemisphere (SH). Although NH and SH international teams compete against each other in World Cups and test series, international teams compete annually in separate NH and SH international tournaments. These tournaments are “The 6 Nations” in which England, France Ireland, Italy, Scotland and Wales compete and “The Rugby Championship” in which Argentina, Australia, New Zealand and South Africa compete. Additionally, there are separate competitions for NH and SH elite level club/province/franchise sides and due to the distances between nations and logistical constraints NH and SH club sides do not play against each other.

Few aspects of RU playing style and performance between NH and SH teams have been quantified in peer reviewed literature. A recent doctoral dissertation has examined tackling performance between NH and SH players (8). It was reported that

NH teams made more tackles, had greater tackle completion and missed fewer tackles than their SH counterparts. It also was reported that SH players made more “positive tackles” (i.e. a tackle which result in the attacking player not gaining territorial or tactical advantage) but NH players made more effective tackles (i.e. a tackle which stopped an attacking player and caused a ruck or maul to occur). Separate work examined differences in offloads between NH and SH teams (12). It was observed that SH teams performed more offloads and scored more tries following offloads than NH teams. Additionally, anecdotal observations have indicated some variances in playing styles between NH and SH clubs/provinces/franchises and international teams. These differences in playing style have implications for training prescription from both technical/tactical and strength and conditioning (S&C) perspectives.

We have detailed previously the S&C practices that practitioners working with elite level RU teams and athletes employ (9). However, in our previous analysis we did not examine any variances in practice between coaches working with NH or SH international or elite level clubs/provinces/franchises. Due to the indicated differences in playing style, this type of analysis may provide insightful and impact the practices and strategies of sports scientists and S&C coaches working in RU. This information also may inform training programme design for future studies seeking to examine the influence of conditioning interventions in elite RU athletes. Consequently, the aim of this study was to survey and examine training and monitoring strategies of practitioners responsible for the S&C of RU athletes and examine any variances in practice between NH and SH based sports scientists and S&C coaches.

METHODS

Experimental Approach to the Problem

The survey titled “Strength and Conditioning Questionnaire” was adapted from that employed by Ebben and Blackard (4). The questionnaire was made specific to RU and pilot tested on a group of 7 S&C coaches. The survey contained 6 sections; personal details, physical testing, strength and power development, concurrent training, unique aspects of the programme and any further relevant information regarding prescribed training programmes. The survey was distributed to S&C coaches and sport scientists working with either professional rugby clubs/franchises/provinces or national teams in both the Northern and Southern hemispheres. It was hypothesised that this study would provide a comprehensive view of S&C practices in elite RU and highlight any variances in S&C practices between NH and SH S&C coaches.

Subjects

Prior to all experimental procedures the Northumbria University research ethics committee approved the study. All subjects were informed of the risks and benefits of taking part in the investigation prior providing informed written consent. Surveys were sent out electronically via email and a survey collating website. Data were collected between September 2014 and February 2015.

Statistical analysis

The survey contained fixed-response and open-ended questions. Answers to open-ended questions were content analysed according to methods described by Patton

(11), which have previously been used in other surveys of S&C practices in elite and professional sport (including RU) (1,5–7,9,14). Researchers had experience with qualitative methods of sports science and S&C research. When analysing data, investigators generated raw result data and higher-order themes *via* inductive content analysis and compared individually generated themes until agreement was reached at all levels of analysis. When higher-order themes were developed, deductive analysis was used to confirm that all raw data themes were represented.

RESULTS

Personal Details

Forty (38 male, 2 female; 33.0 ± 5.5 y) of 52 (77%) coaches responded to the questionnaire. Twenty respondents were based and practicing in the NH and 20 were based and practicing in the SH. The NH practitioners supported teams in competitions including; The English Premiership and Championship, PRO12, French Top 14 and Japanese Top League. The SH practitioners supported teams in competitions including the Super 18, New Zealand's National Provincial Championship and South Africa's Currie Cup. The respondents consisted of 18 S&C Coaches, 14 Head S&C Coaches, 3 Senior S&C Coaches, 3 Academy S&C Coaches, 1 Performance Manager and 1 Sport Scientist. All 40 practitioners reported having fellow coaching and support staff. Examples of fellow coaching staff given by respondents were; "Assistants", "Interns", and other S&C staff such as Performance Managers and "Travelling S&C Coach" (text in double quotes are direct quotations taken from questionnaires). Of the NH practitioners 14 were based in the United Kingdom, 3 in France, 1 in Ireland, 1 in Hong Kong and 1 in Japan. Of the SH practitioners 12 were based in New Zealand, 5 in Australia, 2 in South Africa, 1 in

Samoa. Information on the types of athlete that the respondents coached is presented in Table 1.

Table 1 about here

Formal Education

Seventy-seven and 85% of NH and SH respondents had an undergraduate degree in Sport and Exercise Science or a related subject, respectively. Sixty and 51% NH and SH respondents also held a master's degree in a Sport Science related field, respectively. In addition, 2 NH coaches held post graduate certificates in Education and 1 SH coach had a "Post Grad in Psychology". Furthermore, 1 NH coach stated they were completing a PhD in S&C.

Certification

The most commonly held professional certification of the NH practitioners was United Kingdom Strength and Conditioning Association Accreditation (n = 9). Four NH respondents were Certified Strength and Conditioning Specialists with the National Strength and Conditioning Association (USA), there was 1 was Australian Strength and Conditioning Association accredited respondent and 6 were British Amateur Weightlifting Association certified. Other qualifications the NH practitioners held included; "British Association of Sport and Exercise Sciences High Performance Sport Accreditation", "International Society for the Advancement of Kinanthropometry Accreditation" and "United Kingdom Athletics Coaching Qualification". The most commonly held professional certification of the SH practitioners was Australian Strength and Conditioning Association Accreditation (at various levels) (n = 8). Four

SH respondents were Certified Strength and Conditioning Specialists with the National Strength and Conditioning Association (USA), there were 2 were United Kingdom Strength and Conditioning Association accredited respondents.

Physical Testing

All 40 respondents (20 NH and 20 SH) indicated they performed physical testing. Participants were asked when during the year testing was performed (Figure 1) and what aspects of physical performance were tested (Figure 2). The most commonly employed test of acceleration was 10m sprint time ($n = 27$, NH = 14, SH = 13). Tests of agility included; pro agility test, “reactive agility”, Illinois agility run, T-test, 5-0-5 test, change of direction and acceleration test (CODAT) and “in depth lateral jumps”. Measures of anaerobic capacity detailed by NH practitioners included; Rugby Football Union (RFU) anaerobic test, Welsh Rugby Union (WRU) WAT test, “repeat sprint ability”, “Watt-Bike repeat sprints (10 x 6s in at 30s intervals)”, “3 x 60s running test” and “150m Shuttle Test”. SH practitioners measured anaerobic capacity using; Yo-Yo test, “3 x 60s running test”, “500 rowing”, phosphate decrement test, “Bronco shuttle test”, “GPS work capacity”, “repeat sprint ability”, “Wattbike 6min test”, “rugby specific testing”, “anaerobic training threshold zone (ATTZ) runs” and “30/90 Wattbike efforts”.

Figure 1 about here

The most commonly employed measure of body composition by both NH and SH practitioners was sum of 8 skinfold site ($n = 20$, NH = 7, SH = 13) with 7 ($n = 2$, NH = 1, SH = 1) and 3 ($n = 1$ (NH)) skinfold sites also were utilised. Other measures of

body composition included; body mass, height, dual-energy X-ray absorptiometry (DEXA), body fat% and one NH respondent designed their own method of assessing body composition, although no other details were given.

Eleven NH respondents stated that the Yo-Yo incremental test was utilised as a measure of cardiovascular (CV) endurance, NH practitioners included other tests of CV endurance such as; 1500m run, “30-15 aerobic test”, “a 4min shuttle test”, 1km run, “MAS test TUB 2”, “1km repeat”, “3min Watt-Bike test”, “incremental treadmill test” and “1.6km time trial”. Fourteen SH practitioners report using the Yo-Yo incremental test as a measure of CV endurance, SH practitioners included; 2.4km time trial, “7min test”, “modified bleep test”, “Watt-Bike 20min test”, “GPS work capacity”, “ATTZ test”, “1.6km time trial” and “Bronco” as other tests of CV endurance.

Figure 2 about here

The most commonly employed test of muscular power was maximum countermovement jump (CMJ) height ($n = 21$, NH = 12, SH = 9), 16 practitioners assessed 1-3 repetition maximum (RM) in Olympic lifts (clean or snatch) or their variations (*i.e.*, from hang position) (NH = 7, SH = 9), additionally 17 (NH = 10, SH = 7) assessed reactive strength index (RSI) or other jump variations including; broad jumps, drop jumps, squat jumps, “triple response jumps” *etc.* Respondents used a variety of other measures of muscular power including; “velocity test”, velocities of movements via “GymAware” and “Attacker” systems, 10 and 30m sprints, tendon stiffness, 1RM in bench press, back squat and half squat, “bench throw and pull”,

1 peak power output in 6s on Watt-Bike and medicine ball throw. Thirty-four (NH = 18,
2 SH = 16) practitioners utilised 1-3RM testing to assess muscular strength, with
3 bench press (n = 33, NH = 18, SH = 15) and back squat (n = 32, NH = 17, SH = 15)
4 the most common lifts. Other methods of assessing muscular strength included mid-
5 thigh isometric pulls on a force plate and “predicted RMs taken from strength training
6 performance”. All 37 (NH = 18, SH = 19) respondents who stated they tested speed
7 phenotypes examined sprint times with distances ranging from 10-80m, additional
8 speed tests employed included; “speed bounce”, “force plates test” and GPS
9 maximum velocity (all SH only).

11 **Strength and Power Development**

12 The initial question in the section asked if practitioners believed that strength training
13 benefits RU performance, all 40 respondents answered yes. Eight (1 NH, 7 SH)
14 practitioners left additional comments, the NH comments was; “Being stronger allows
15 them to be more dominant on the field, strength is also correlated with power which
16 will then improve their breakdown and speed. Mentally being strong makes the
17 players feel better and confident about themselves”. The SH comments included;
18 “Yes. But a focus on quality of lifting through a full range if safe for the athlete is
19 critical as well as the combination of movement skills, awareness and integration
20 with the rest of the rugby programme is critical to maximise carryover into
21 performance.”, “Yes, being able to create and withstand high loads is essential for
22 any professional athlete” and “Absolutely yes **to a certain point** some athletes get
23 squatted to the point that they lose speed!”. All 40 respondents also stated that their
24 athletes regularly performed strength training.

In-Season Training

The current section was divided into 2 subsections, the first of which focused on in-season strength and power training practices. The first question in this subsection asked how many days of the week that in-season strength and power training was performed. Of the NH respondents one practitioner reported 1d·wk⁻¹, five reported 2d·wk⁻¹, thirteen reported 3d·wk⁻¹ and one reported 4d·wk⁻¹. Of the SH respondents six practitioners reported 2d·wk⁻¹ and fourteen reported 3d·wk⁻¹.

The second question within this subsection asked coaches to detail the days of the week in which strength and power training is performed in relation to the next scheduled match day (MD). Of the NH respondents two practitioners reported MD-6, fifteen MD-5, sixteen reported MD-4, seven reported MD-3, sixteen reported MD-2, three reported MD-1 and one reported strength and power training was conducted on MD. Of the SH respondents three practitioners reported MD-6, seventeen MD-5, sixteen reported MD-4, five reported MD-3, fifteen reported MD-2 and two reported MD-1 (many practitioners gave more than one response). The third question in this section asked practitioners the typical duration of an in-season strength and power session. Of the NH practitioners one practitioner reported 15-30min, five reported 30-45min, eleven reported 45-60min and three 60-75min. Of the SH practitioners five reported 30-45min and fifteen reported 45-60min. The final question in the subsection asked practitioners to indicate the number of sets and repetitions typically used for strength training exercises in-season. Responses were content analysed and resulted in the creation of 5 higher-order themes, including; a) set range of 3-5, b) set range including >5 sets, c) rep range of 3-5, d) rep range including >5 reps

and e) miscellaneous. Further information on higher-order themes, practitioner responses and representative raw data is presented in Table 2.

Table 2 about here

Off-Season Training

The first question in the off-season subsection asked practitioners the number of d·wk⁻¹ their players engage in strength training. Of the NH practitioners two practitioners reported 2d·wk⁻¹, six reported 3d·wk⁻¹, twelve reported 4d·wk⁻¹, six reported 5d·wk⁻¹ and three reported 6d·wk⁻¹. Of the SH practitioners one practitioner reported 2d·wk⁻¹, eight reported 3d·wk⁻¹, ten reported 4d·wk⁻¹, five reported 5d·wk⁻¹ and two reported 6d·wk⁻¹ (many practitioners gave more than one response). The following question addressed the average length of an off-season strength/power session. Of the NH practitioners ten reported 45-60min, nine reported 60-75min and one reported >75min. Of the SH practitioners nine reported 45-60min, nine reported 60-75min and two reported >75min.

The final question in the off-season training subsection asked practitioners to indicate the number of sets and repetitions typically used for strength training exercises during the off-season. Content analysis resulted in the creation of 5 higher-order themes including; a) set range of 3-6, b) set range including >6 sets, c) rep range of 3-8, d) rep range including >8 reps and e) miscellaneous. Further information on higher-order themes, practitioner responses and representative raw data is presented in Table 3.

Table 3 about here

Programme Design

The initial question in this subsection asked whether practitioners included Olympic style weightlifting exercises in their prescribed training programme. All 40 respondents (20 NH and 20 SH) indicated that Olympic style weightlifting exercises were included in conditioning programmes.

The next questions within this subsection were related to recovery time prescribed between; a) an Olympic weightlifting style strength session and a high-quality rugby training session, b) a general strength training session and a high-quality rugby training session, c) an Olympic weightlifting style strength session and a competitive rugby match and d) a general strength training session and a competitive rugby match. Responses to these 4 questions are detailed in Table 4. Practitioners were then asked the extent to which they agreed that strength and power training influenced rugby performance. Of the NH coaches 15 practitioners indicated they strongly agreed and 5 agreed. Of the SH coaches 12 indicated they strongly agreed, 7 agreed and 1 was unsure. The next question asked coaches to identify and rank the top 5 weightlifting exercises that are most important in their programmes, responses to this question are detailed in Table 5.

Table 4 about here

Table 5 about here

Question 7 in this subsection asked practitioners if they used periodization strategies to structure training plans. Nineteen NH practitioners and 20 SH practitioners indicated that periodization strategies were used. Practitioners' comments in response to this question included; "To target specific outcomes in a specific period", "Better long term results, prevents stagnation", "Monitoring and assessing load and volume with intensity is vital, so you need to know when to delay and load at appropriate times of the year".

The final question in this section asked practitioners how load (weight) was determined during typical strength training sessions. Responses were content analysed into 4 categories including; a) RM and max strength testing, b) coaches subjective assessment, c) athlete led and d) periodization and phase of training. Data pertaining to higher-order themes, total number of practitioners whose responses made up the theme and selected raw data within higher-order themes are presented in Table 6.

Table 6 about here

Speed Development

All 40 respondents (20 NH and 20 SH) reported incorporating aspects of speed development in their programming. Responses were content analysed and resulted in the creation of 6 higher-order themes; a) un-resisted (free) sprinting, b) sprint mechanics and technique, c) plyometrics, d) improving max strength, e) resisted sprinting and f) Olympic lifting. Table 7 details the aforementioned higher-order

themes, the total number of coaches whose responses made up the theme, and select raw data within each higher-order theme.

Table 7 about here

Plyometrics

All 40 respondents (20 NH and 20 SH) reported using plyometrics. The subsequent question in this section asked why coaches prescribed plyometrics. Fourteen NH coaches reported prescribing plyometrics for improving rate of force development, 2 for training the stretch shortening cycle, 2 for improving stiffness and 1 for injury prevention. Eleven SH coaches reported prescribing plyometrics for improving rate of force development, 4 for training the stretch shortening cycle, 3 for improving stiffness and 2 for injury prevention (many respondents gave more than one answer). The third question in this subsection focused on the phases of the year plyometrics are used, Figure 3 illustrates the responses to this question.

Figure 3 about here

The forth question in this subsection examined integrated plyometrics. Responses were content analysed and resulted in the creation of 4 higher-order themes; a) within strength and/or power session, b) within warm up, c) dependent on individual athlete and d) part of movement skills. Table 8 lists the higher-order themes, number of practitioners whose responses make up the theme and representative raw data within each theme. The final question within this subsection asked practitioners to

identify types of plyometric exercises regularly used in their programme. Responses to this question are detailed in Figure 4.

Figure 4 about here

Concurrent strength and endurance training

The first question in the subsection asked practitioners if they considered any potential muting effect of endurance training on strength/hypertrophic development. Of the NH practitioners 14 indicated they did and 6 indicated they did not, of SH practitioners 16 indicated they did and 4 indicated they did not. Reasons for not considering any potential interference effect consisted of; "Rugby is concurrent", "Players must develop both motor qualities", "If programmed correctly can balance both into programmes" and "Our preparation period is short and hence we need to target multiple bio motor abilities simultaneously". The following question in this subsection asked practitioners how important they felt it was to consider any concurrent training effect when programming for strength/hypertrophic development (1 = not important at all and 5 = most important), the responses to this question are detailed in Figure 5. The penultimate question asked participants to rank the following programme variables in order of importance when attempting to avoid any muting effect of endurance type stimulus on strength/hypertrophic development; periodization, order of strength and endurance training, volume of endurance training, volume of strength training and time between strength and endurance training. Responses to this question are detailed in Table 9. The final question in this section asked practitioners which order of strength and endurance training they felt was more conducive to strength and/or hypertrophic development. Of the NH

respondents 16 believed strength then endurance training was more favourable and 4 believed endurance then strength. Of the SH respondents 18 believed strength then endurance training was more favourable and 2 believed endurance then strength.

Table 9 about here

Figure 5 about here

Unique aspects of the programme

The unique aspects (if any) of practitioners physical conditioning programmes were content analysed and divided into 5 higher-order themes; (a) integration, (b) individualisation, (c) miscellaneous, (d) nothing unique and (e) periodization. Table 10 details these themes and the number of practitioners' responses that make up each theme. The second question within this section asked practitioners what they would like to do differently in their conditioning programmes. Responses were content analysed and resulted in the creation of 6 higher-order themes; (a) miscellaneous, (b) greater individualisation, (c) have more time, (d) improved facilities/equipment, (e) improved monitoring and (f) more staff. Table 11 details these themes and the number of practitioners' responses that make up each theme.

Table 10 about here

Table 11 about here

DISCUSSION

The present study sought to conduct a comprehensive survey of S&C practice in elite RU and identify any variances in practice between coaches supporting NH and SH elite level teams. To the authors' knowledge this comparison is the first of Northern and Southern hemisphere S&C practices in RU. A total of 40 (20 NH and 20 SH) practitioners responded to the questionnaire. For a study examining S&C provision in a single sport, this number of responses is high. Our previous work examining S&C practices elite RU received 43 responses (9), and research in North American sports have received between 20 and 26 responses (4–6,14) and a more recent study in British Rowing received 32 responses (7). Furthermore, the response rate to our survey was high (77%), previous comparable studies have reported return rates of between 69-87%. As such, 40 responses at a return rate of 77% were deemed sufficient for analysis. Many respondents stated they worked with more than 1 level of RU athlete. The most commonly supported level of athlete for NH and SH practitioners played for either a professional club, province or franchise and/or a national team (NH = 16 and 13, SH = 13 and 11). Therefore, the data presented in this article are reflective of elite RU.

Physical testing was most commonly conducted pre (100% NH and SH) and in-season (NH = 90%, SH = 80%). Both NH and SH practitioners reported testing 11 aspects of physical fitness (additional details are presented in Figure 2). Twenty % more SH than NH practitioners reported testing agility, this difference may indicate that this quality is perceived to be more important in the SH. All other responses were similar between NH and SH practitioners. The most commonly tested aspect of physical fitness was speed which was assessed by 18 NH and 19 SH practitioners

(90 and 95%, respectively). Other commonly assessed physical qualities included; acceleration (NH = 90%, SH = 80%), body composition (NH = 90%, SH = 85%), cardiovascular endurance (NH = 80%, SH = 85%), muscular power (NH = 90%, SH = 85%) and muscular strength (NH = 90, SH = 90%). These results likely indicate that the practitioners who responded to the survey consider these physical qualities important for RU performance.

Whilst the number of NH and SH practitioners employing tests of anaerobic capacity and cardiovascular endurance were similar, there were notable differences in testing protocols. These differences in protocol may simply indicate that practitioners employ testing protocols that are developed in their country of work. For example, practitioners in the NH tended to use tests such as the RFU anaerobic test and the WRU WAT test, whereas, SH coaches employed the Bronco shuttle test. This variance in testing protocols may make comparisons between the anaerobic capacities and cardiovascular endurance of NH and SH players difficult. This potential difficulty supports our previous suggestion that there is a need for future work to construct a valid and standardized protocol for assessing anaerobic capacity in RU athletes (9).

All 40 respondents indicated that their athletes regularly performed strength training; in addition all practitioners believed strength training is beneficial for RU performance. One SH practitioner made an interesting comment, the practitioner believed that strength training benefited RU performance to a point, but some athletes may lose speed due to excessive squatting. The NH practitioners did not mention anything to this effect. One NH practitioner did, however, make a comment

1 about strength training being beneficial for athlete's confidence while no SH
2 practitioners made this point.

3
4 Every practitioner reported implementing Olympic style weightlifting exercises within
5 strength and power training. Both NH (70%) and SH (75%) practitioners believed the
6 squat is the most important exercise within players training programmes. The
7 perceived second most important weightlifting exercise differed between Northern
8 and Southern hemisphere practitioners. NH practitioners ranked the clean as the
9 second most important weightlifting exercise, whereas SH coaches ranked the
10 deadlift as the second most important weightlifting exercise. This distinction may
11 reflect differing coaching philosophies around compound and Olympic type lifting,
12 although this remains speculative.

13
14 There were slight variances in the responses of NH and SH practitioners relating to
15 the extent to which strength and power training influences RU performance.
16 Seventy-five % of NH practitioners strongly agreed that strength and power training
17 influenced RU performance, whereas only 60% of SH practitioners agreed with this
18 statement. Furthermore, 1 SH practitioner stated they were unsure if strength and
19 power training benefited RU performance, no NH practitioners gave such a
20 response. It is possible that this variance indicates that more value is placed on
21 strength and power training in the NH.

22
23 With regard to strength training frequency, NH and SH responses were largely
24 similar. The most commonly prescribed in-season training frequency of both NH and
25 SH practitioners was 3d·wk⁻¹ (NH = 13 and SH 14 responses respectively). Strength

training frequency in the off-season also was similar between NH and SH coaches with 4d-wk⁻¹ being the most frequent response (NH = 12 and SH 10 responses respectively).

The methods of determination of loads during strength training differed between NH and SH practitioners. Fifty five % of NH practitioners used RM and max strength testing to determine strength training load, whereas 75 of SH practitioners used this method. Fifty percent more NH practitioners used subjective assessments to determine strength training load than SH practitioners. Additionally, 50% more NH practitioners used athlete led methods of load determination than SH coaches. Combined, these observations may indicate a more objective approach to determining strength training loads in the SH.

Each one of the 40 respondents prescribed speed development training. Un-resisted or “free” sprinting was the most popular method of speed development in both NH and SH practitioners (60 and 55%, respectively). Fifteen % more NH practitioners reported coaching sprint mechanics and technique than SH practitioners, additionally 15% more SH practitioners reported using plyometrics for speed development than NH coaches. These variations may indicate differing methods of improving max speed between NH and SH practitioners.

Thirty respondents indicated (NH = 14 and SH = 16) indicated that the “interference effect” associated with concurrent strength and aerobic training was considered whilst programming for RU athletes, other practices related to concurrent training also appeared to be similar between NH and SH practitioners.

1

2 The unique aspects of respondents' programmes differed between Northern and
3 Southern Hemisphere practitioners. Thirty % more SH practitioners than NH
4 practitioners stated that "integration" was a unique aspect of their programme.
5 Therefore, it is possible that a greater emphasis is placed on integration with RU
6 skills and practice in SH S&C for RU athletes. It may be of value for future work to
7 employ interview based assessments to help understand the decision making
8 process being strength and conditioning practices and philosophes.

9

10 From survey data analysis, some variance in practice between Northern and
11 Southern hemisphere S&C coaches emerged. These include; utilization of differing
12 tests of anaerobic capacity and cardiovascular endurance, differing prescription of
13 compound and Olympic lifts, NH coaches placed a greater emphasis on strength and
14 power training and SH coaches had a more objective approach to determining
15 strength training loads. Other aspects of S&C practice detailed in this article appear
16 to be similar between Northern and Southern hemisphere practitioners. These
17 similarities may be due to practitioners spending time working in both the NH and SH
18 and incorporating new aspects into their practice. Additionally, it is possible that
19 practitioners simply focus on preparing the athlete for RU and not specifically a NH
20 or SH style of play.

21

22 **PRACTICAL APPLICATIONS**

23 This study describes S&C practices of practitioners supporting RU athletes in the
24 Northern and Southern hemispheres and highlights any variance in practice between
25 NH and SH practitioners. It appears the primary variances relate to the physical

1 testing protocols employed. As most respondents supported international and/or
2 professional level RU athletes, practitioners now have a source of data describing
3 S&C practices at the elite level of RU. Coaches and Sports Science practitioners
4 who work with RU athletes at all levels of the game, may use this summary of S&C
5 practice as a resource to inform and improve their practice. Information presented in
6 this article also may influence the design of experimental protocols in future studies
7 investigating differences in physical characteristics and/or playing styles between NH
8 and SH RU players and teams.

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Figure Legends

Figure 1. Times when physical performance phenotypes are assessed.

Figure 2. Physical phenotypes tested.

Figure 3. Times in which plyometrics are conducted.

Figure 4. Specific plyometric exercises prescribed.

Figure 5. Importance of considering of concurrent training effect when programming for strength/hypertrophic development (1 = not important at all, 5 = most important).