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ORIGINAL INVESTIGATION

Mind the gap! A survey comparing current strength training methods used in men's versus women's first team and academy soccer

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ABSTRACT

Purpose: Much less is known about strength and conditioning (S&C) practice in women's versus men's soccer. The aim of this study was to compare S&C practice between coaches working in men's or women's soccer, at first team or academy level, worldwide.

Methods: A total of 170 participants, who were involved with S&C support at their soccer club (in Europe, USA and South America, within men's or women's first team or academy settings) completed a comprehensive online survey, designed to evaluate (i) their academic qualifications and S&C coaching experience; and their preferred methods for (ii) physical testing; (iii) strength and power development; (iv) plyometric training; (v) speed development; and (vi) periodization.

Results: Women's academies had fewer weekly in-season S&C sessions than men's academies (1.6±0.6 *vs*. 2.3±0.9, p=0.005). Relatively, fewer women's academy S&C coaches (6%) used Olympic weightlifting movements than men's academy S&C coaches (32%, p=0.030). Relatively, more women's academy coaches (47%) used the Nordic hamstring exercise (NHE) compared to men's academy coaches (15%, p=0.006), but relatively more women's *vs*. men's first team coaches (61% *vs*. 38%, p=0.028) and women's *vs*. men's academy (61% *vs*. 38% coaches, p=0.049) utilised rating of perceived exertion-based load prescriptions.

Conclusion: Notable differences in S&C practice exist between coaches of men's and women's soccer squads, particularly at academy level. Fewer weekly S&C sessions in women academy players may have implications for physical development, while the greater use of subjective load prescriptions in both academy and first team women's squads may lead to sub-optimal performance gains.

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KEYWORDS
Strength training; soccer; youth

Introduction

Soccer is a sport played by men and women of all ages, with global participation in the women's game increasing by 32% between 2010 to 2015, reaching 30 million women players (Griffin et al. 2020) Associated with this and the increased professionalisation (Culvin 2021) there has been an increase in high-intensity movements during women's match-play, particularly high-speed running (FIFA 2020). Research into women's soccer has also grown in recent years, however, overall it is still an under-developed area compared to men's soccer (Emmonds et al. 2019a). Consequently, women's training practices may be based on evidence from men's populations, which may be inappropriate considering the sex differences in performance characteristics and injury risk (Emmonds et al. 2019a).

Strength and conditioning (S&C) methods not only improve athleticism in women soccer players (Millar et al. 2020) but may also decrease non-contact injury risk (Khayambashi et al. 2016). Women soccer players have a greater frequency of severe injuries compared to men (Mufty et al. 2015). Further, in a single season, 70% of first team (Faude et al. 2005) and 92% of academy aged (Le Gall et al. 2008) women soccer players will experience an injury. This may be due to poor landing mechanics (Sutton and Bullock 2013), increased laxity and joint instability (Rozzi et al. 1999; Faude et al. 2005) and lower levels of relative strength (Le Gall et al. 2008; Emmonds et al. 2017; Morris et al. 2018) compared to men soccer players. Injury risk in young women players may further increase due to growth-related changes associated with puberty, which may reduce movement quality and alter forces during dynamic actions (DiCesare et al. 2019). As such, it has been recommended that all athletes continually engage with an injury prevention programme to mitigate injury risk (Mufty et al. 2015).

The physiological differences between sexes, may impact the training methods S&C coaches choose to use. When observing high-school coaches, Reynolds et al. (Reynolds et al. 2012) reported that 86% coaches working with women athletes believed different approaches should be used depending on the athlete's sex, and the authors hypothesised that this was due to coaches perceiving limited benefits of resistance training (RT) on sports performance with women athletes. These differences manifested in lower training frequency, extra jump training to protect against non-contact injuries and 'female-preferred' methods, such as muscular endurance (Reynolds et al. 2012). These approaches were not based on scientific

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evidence but from coaches' own ideas (65%) and the internet (58%). However, this was a small sample (n = 14) in a multi-sport environment and may not reflect current S&C practice in academy women soccer players (Reynolds et al. 2012). Further, to the authors' knowledge, no study has investigated whether S&C practice differs between coaches working with men's first team soccer players and those working with women's first team players. This information is important, as it would inform both practice and research in this under-developed area of S&C.

The aim of this study was to investigate the practices of S&C coaches working with men soccer players compared to those working with women soccer players at both first team and academy level, worldwide. Due to limited research in elite women soccer players, we hypothesised that the training methods implemented, particularly exercise prescription, would not differ between coaches working with men players and those working with women players.

Methods

Survey design and data collection

This study was designed to compare the current practices of S&C coaches in men's and women's soccer. The original survey was entitled '*Current Practice of Strength and Conditioning Coaches in Soccer*' and was based on previous works of a similar design (Duehring et al. 2009; Jones et al. 2016). The online survey platform, 'Jisc Online Surveys' (formerly Bristol Online Surveys; *Joint Information Systems Committee, Bristol, UK*) was used to create the questionnaire and collect answers anonymously. The survey was reviewed for content validity via initial discussions within the research team and subsequently adjusted following pilot testing with S&C practitioners (n = 5). Those piloting the study had experience working with first team and/or academy soccer players in either men's or women's professional soccer clubs in the UK. Based on feedback, questions were amended/removed to improve the usability of the research tool. The survey was then translated into French, Spanish, German, Italian and Portuguese. This was initially performed using Google Translate (*Google, California, USA*), then corrected by associates of the research group, who were native speakers of these specific languages. The online questionnaire took 17 ± 7 minutes to complete and comprised six sections: (i) academic qualifications (bachelor's degree, master's degree, etc), job role (sport scientist, S&C coach, technical coach, etc.) and experience of S&C delivery; and their preferred methods for (ii) physical testing; (iii) strength and power development; (iv) plyometric training; (v) speed development; and (vi) periodization. Data were collected between 1 December 2019 and 1 July 2020. The survey was distributed both directly (via email) and indirectly (via social media). Following an extensive internet search for the websites of high-level men's and women's soccer clubs worldwide, the lead researcher noted the email addresses of relevant club personnel (e.g. physical performance/fitness/S&C/technical coach or sport scientist), where these were available online. Further, if email addresses of relevant personnel at high-level clubs were known to the research team, they were sent the survey link directly via email. The link was also posted on the social media platforms (e.g., Twitter, Linked-In) of the lead researcher on three occasions over seven months (January 2020 to July 2020). These are methods previously used when collecting data from coaches (Nosek et al. 2020). The cover page was accessed 1597 times and 205 individuals started the survey but did not finish, however, it is not possible to identify if the same individual accessed/started the survey multiple times.

Participants

To take part in the survey, participants had to be currently involved with S&C support at their soccer club within men's or women's first team or academy settings. A total of 177 participants completed the survey and all participants' responses were quality controlled prior to being included in the subsequent analysis. If key data were missing, such as whether participants worked with men's or women's, first team or academy squads, these participants were excluded from the study (n = 7). Thus, a final sample of 170 participants' responses were subsequently analysed. The global reach of this survey included responses from S&C coaches working in the UK (n = 70, 41%), Spain (n = 7, 4%), Germany (n = 6, 4%), Italy (n = 3, 2%), Portugal (n = 1, 1%), Brazil (n = 65 38%), Uruguay (n = 4, 2%), and the USA (n = 14, 8%). To help ensure that responses were reflective of current practice, participants needed to be directly involved with the delivery of S&C support in soccer at the time of responding. Participants were grouped into those who worked with men's first team, women's first team, men's academy and women's academy squads (Table 1). The age groups our participants worked with in both men's and women's academy settings ranged from under nine to under 23 years-old. All participants provided informed consent prior to completing this survey study, which was approved by Liverpool John Moores University's Research Ethics Committee (approval number: 19/SPS/046).

Table 1. Participant demographic data.

Group (n)	Job role	Years in S&C	Academic qualification (%)
Men's first team n = 48	S&C/Fitness coaches = 61% * Sport scientists = 35% * Technical coaches = 4%	<5 years = 29% 6–10 years = 19% * >10 years = 52% *	BSc: 25% MSc: 44% PhD: 21% Other: 10%
Women's first team n = 44	S&C/Fitness coaches = 84% Sport scientists = 9% Technical coaches = 7%	<5 years = 32% 6–10 years = 45% >10 years = 23%	BSc: 41% MSc: 36% PhD: 12% Other: 11%
Men's academy n = 60	S&C/Fitness coaches = 55% * Sport scientists = 40% * Technical coaches = 5%	<5 years = 38% 6–10 years = 40% >10 years = 22%	BSc: 30% MSc: 53% PhD: 14% Other: 3%
Women's academy n = 18	S&C/Fitness coaches = 88% Sport scientists = 6% Technical coaches = 6%	<5 years = 61% 6–10 years = 28% >10 years = 11%	BSc: 33% MSc: 56% PhD: 6% Other: 5%

* Different to equivalent in Women's squad (p < 0.05)

Statistical analysis

Raw data were initially exported into Microsoft Excel (*Excel 2019, Microsoft, Washington, USA*) before being transferred to SPSS (*SPSS 26, IBM, Armonk, USA*) for statistical analysis. To assess between group differences for nominal data, frequency assessment was performed via Pearson's chi-square test of independence, with results reported as percentages of the total group response. To assess between (men's vs. women's) group differences for ratio data, independent sample T-tests were used. When responses were given as a range e.g., weekly frequencies '1–3' the midpoint was used for statistical analysis. Responses to exercise selection were grouped into movement patterns for quantitative analysis. For training prescription, only responses that contained sets, repetitions and intensity were used for analysis. Statistical significance was set at $p < 0.05$.

Results

Demographics

There were no differences in academic qualifications between coaches working with men's *vs*. women's soccer at first team (χ^2 (2, N = 92) = 3.38 p = 0.337) or academy level (χ^2 (3, N = 78) = 0.97, p = 0.809; Table 1). Coaches working with men's first team squads had more years' experience as an S&C coach compared to those working with women's first team squads (χ^2 (2, N = 92) = 10.45, p = 0.005; Table 1). However, there was no difference in the number of years' S&C experience between coaches working with men's and women's academy players (χ^2 (2, N = 78) = 3.01, p = 0.222; Table 1). There were relatively more S&C coaches working with women's first team (84%) than men's first team (60%; χ^2 (2, N = 92) = 9.06, p = 0.011; Table 1) squads, and with women's academy (89%) than men's academy (55%; χ^2 (2, N = 78) = 7.67, p = 0.022; Table 1) squads. There were relatively more sport scientists delivering S&C support to men's first team (35%) than women's first team (9% respectively; χ^2 (2, N = 92) = 9.06, p = 0.011; Table 1) squads, and with men's academy (40%) than women's academy (6%; χ^2 (2, N = 78) = 7.67, p = 0.022; Table 1) squads.

Resistance training methods

There was no difference between the age boys or girls start a formal S&C programme on a global scale (boys: 13 ± 2 years; girls: 13 ± 2 years; t_{106} = 0.123, p = 0.903).

There were no differences between the proportion of coaches working with men's or women's first team squads using free-weight training (men's first team, 98% *vs*. women's first team, 95%; χ^2 (1, N = 92) = 0.51, p = 0.599), bodyweight training (men's first team, 88% *vs*. women's first team, 84%; χ^2 (1, N = 92) = 0.22, p = 0.639) or plyometrics (men's first team, 96% *vs*. women's first team, 100%; χ^2 (1, N = 92) = 1.87, p = 0.495), when aiming to develop strength and power. There were no differences between the proportion of coaches working with men's or women's academy squads using bodyweight training (men's academy, 93% *vs*. women's academy, 94%; χ^2 (1, N = 75) = 0.05, p = 1.000) or plyometrics (men's academy, 90% *vs*. women's academy, 94%; χ^2 (1, N = 75) = 0.31; p = 0.581). However, a significantly lower proportion women's academy coaches reported using free-weights (83%) compared to men's academy coaches (97%; χ^2 (1, N = 75) = 3.81; p = 0.049).

Forty-one participants (26% of all participants) provided this complete set of information. There were no differences between women's first team and men's first team S&C coaches when programming sets (t_{27} = −1.56, p = 0.129; Figure 1), repetitions (t_{27} = 0.786, p = 0.438; Figure 1), or intensity relative to the single repetition maximum (1RM; t_{27} = −0.12, p = 0.904; Figure 1).

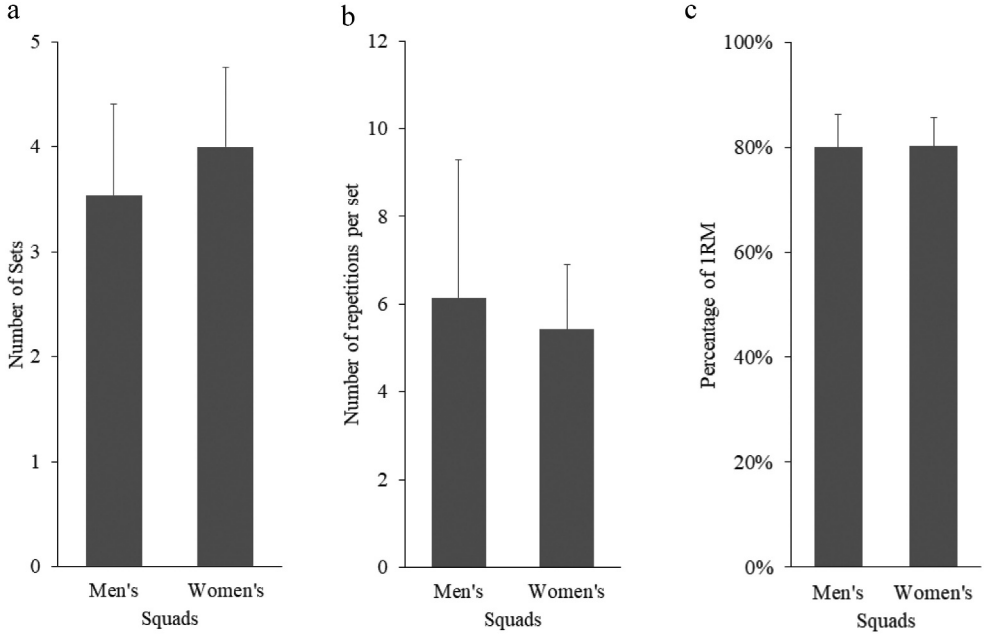

Figure 1. The sets (A), repetitions (B) and training intensity (C) first team coaches prescribe to for strength training in-season.

There were no differences in the proportion of coaches working with men or women players, who used a percentage 1RM (men's first team, 40% *vs*. women's first team, 41%; χ^2 (1, N = 91) = 0.002, p = 0.963; men's academy, 40% *vs*. women's academy, 39%; χ^2 (1, N = 78) = 0.007, p = 0.933). There were no differences in the proportion of coaches working with men or women players, who used velocity-based metrics (men's first team, 40% *vs*. women's first team, 25%; χ^2 (1, N = 91) = 2.447, p = 0.118; men's academy, 23% *vs*. women's academy, 6%; χ^2 (1, N = 78) = 2.817, p = 0.093). A greater proportion of women's coaches (both first team and academy) utilised RPE-based load prescription than those working with men (men's first team, 61% *vs*. women's first team, 38%; χ^2 (1, N = 91) = 4.84, p = 0.028; men's academy, 61% *vs*. women's academy, 38%; χ^2 (1, N = 78) = 2.922, p = 0.049).

Exercise selection

There were no differences in the proportion of men's or women's S&C coaches prescribing bilateral squat patterns (men's first team, 78% *vs*. women's first team, 85%; χ^2 (1, N = 80) = 0.74, p = 0.390; men's academy, 81% *vs*. women's academy, 100%; χ^2 (1, N = 76) = 3.71, p = 0.054; Figure 2), bilateral hinge (men's first team, 78% *vs*. women's first team, 80%; χ^2 (1, N = 80) = 0.08, p = 0.785; men's academy, 85% *vs*. women's academy, 83%; χ^2 (1, N = 76) = 0.06, p = 0.812; Figure 2), unilateral exercises (men's first team, 67% *vs*. women's first team, 70%; χ^2 (1, N = 80) = 0.06, p = 0.809; men's academy, 53% *vs*. men's academy, 77%; χ^2 (1, N = 76) = 3.10, p = 0.078; Figure 2), and plyometrics (men's first team, 40% *vs*. women's first team, 20%; χ^2 (1, N = 80) = 1.87, p = 0.495; men's academy, 34% *vs*. women's academy, 41%; χ^2 (1, N = 76) = 0.31, p = 0.581; Figure 2). There was no difference in the proportion of men's or women's S&C coaches prescribing weightlifting derivatives, such as the clean and jerk, snatch and their variations with first team players (men's, 25% *vs*. women's, 35%; χ^2 (1, N = 80) = 0.95, p = 0.329; Figure 2), however, there was a difference with academy S&C coaches (men's, 32% *vs*. women's, 6% respectively; χ^2 (1, N = 76) = 4.72, p = 0.030; Figure 2). A greater proportion of women's (47%) *vs*. men's (15%) academy coaches reported specifically using the Nordic hamstring exercise (NHE) than men's academy coaches (χ^2 (1, N = 76) = 7.69, p = 0.006; Figure 2) but this was not evident in first team coaches (women's, 35% *vs*. men's, 25%; χ^2 (1, N = 80) = 0.95, p = 0.329).

Periodisation

There were no differences between men's and women's coaches regarding the number of weekly S&C sessions during preseason at first team (t_{87} = −0.99, p = 0.324) or academy (t_{74} = 0.44, p = 0.660; Table 2) level. Mean session duration was greater in women's first team (58 ± 15 minutes) than in men's first team (48 ± 18 minutes; t_{86} = −2.565, p = 0.010; Table 2) squads. However, there were no differences in session duration at academy level (women's, 47 ± 19 minutes *vs*. men's, 50 ± 16 minutes; t_{73} = −0.07, p = 0.943; Table 2).

Overall, there was no difference between men's and women's first team coaches regarding the number of weekly S&C sessions in-season (t_{787} = −0.36, p = 0.717; Table 2). However, men's academy coaches prescribed more sessions than women's academy coaches in-season (t_{75} = 2.91, p = 0.005; Table 2). Mean session duration was greater in women's first team squads (53 ± 16 minutes) than in men's (44 ± 18 minutes; t_{84} = −2.69, p = 0.009) but not at academy level (women's, 48 ± 16 minutes *vs*. men's, 48 ± 16 minutes; t_{72} = 0.39, p = 0.698; Table 2).

Restrictions to practice

There were no differences in the proportion of men's and women's S&C coaches, who felt their S&C practice was restricted by potential muscle soreness following RT (first team, χ^2 (1, N = 92) = 1.78, p = 0.182; academy, χ^2 (1, N = 78) = 1.32, p = 0.251), time (first team, χ^2 (1, N = 92) = 0.05,

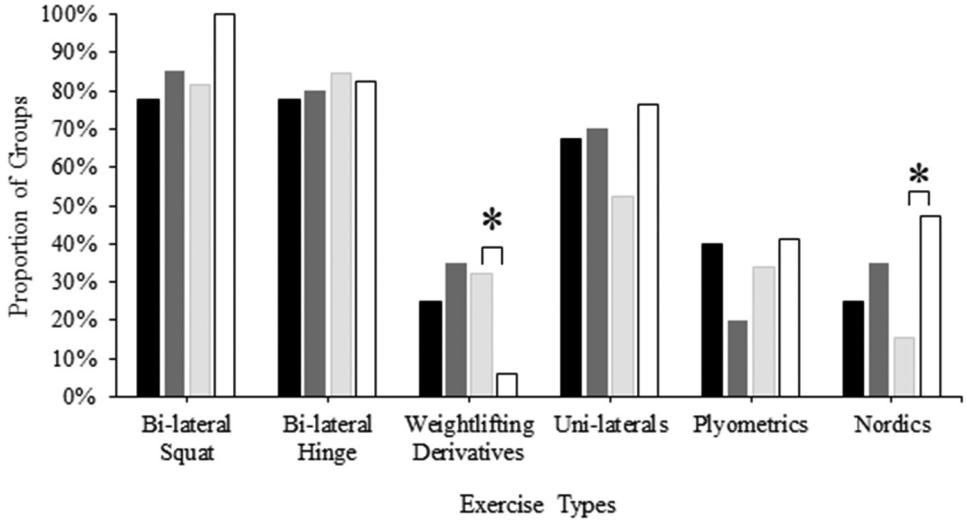

Figure 2. The proportions of men's first team (black bars), women's first team (dark grey bars), men's academy (light grey) and women's academy (white bars) coaches, who incorporated these movement patterns/exercise types into their practice to develop strength and/or power with their soccer players. * difference between men's and women's academy coaches ($p < 0.05$).

Table 2. Time spent in specific strength and conditioning sessions during pre-season and in-season.

Group	Season phase	Weekly frequency	Duration (minutes)
Men's first team	Pre-season	2.83 ± 1.14	48 ± 19
Women's first team		3.18 ± 0.98 *	58 ± 16
Men's academy		2.42 ± 0.80	48 ± 19
Women's academy		2.13 ± 0.74	47 ± 16
Men's first team	In-season	2.18 ± 0.81	44 ± 19
Women's first team		2.26 ± 1.07	54 ± 16 *
Men's academy		2.26 ± 0.90	47 ± 17
Women's academy		1.56 ± 0.63 *	16 ± 17

* Different to the equivalent men's team ($p < 0.05$)

$p = 0.828$; academy, χ^2 (1, N = 78) = 0.44, $p = 0.508$, Figure 3) or facilities/equipment (first team, χ^2 (1, N = 92) = 0.25, $p = 0.618$; academy, χ^2 (1, N = 78) = 0.07, $p = 0.796$; Figure 3).

Discussion

The aim of this study was to compare current S&C practices of coaches working with men or women soccer players (at either first team or academy level) worldwide. The main findings were: i) women's academies had fewer weekly in-season S&C sessions compared to men's academies; ii) relatively more men's academy coaches implemented weightlifting within their training programmes compared to women's academy coaches; iii) a greater proportion of women's academy coaches reported using the Nordic hamstring exercise (NHE) compared to men's academy coaches; iv) at both first team and academy level, a greater proportion of coaches working with women's squads utilised RPE-based load prescriptions; and v) the sets, repetitions and intensity relative to 1RM that S&C coaches implement were similar between men's and women's first team settings.

Demographics

As S&C coaches develop, it is fundamental to gain a combination of coaching experience and formal education. These components can help differentiate between beginner, competent and more experienced coaches (LaPlaca and Schempp 2020). According to these criteria, those working with men's first team squads are more experienced than with women's due to more years of experience (Table 1), though with a similar formal education (evidenced via academic qualifications). The latter is similar to previous findings (Weldon et al. 2020), but the differences in experience between groups is a novel finding. As a result, less experienced S&C coaches may be less effective in their programme delivery and likely to cause potential injury (Carson et al. 2021). At a youth level, S&C coaches of girls have been reported as being less experienced and qualified than those coaching boys (Reynolds et al. 2012), which may play a role in the high injury rate previously reported (Le Gall et al. 2008). However, this was not seen in this study, with similar years of experience and formal education between coaches of men and women academy soccer players globally, demonstrating greater external validity. A unique finding within this sample was that for both men's first team and academy squads, there were relatively more sport scientists and fewer S&C/fitness coaches than for women's first team and academy squads (Table 1). This may reflect different responsibilities between the roles, or the titles may be being used interchangeably due to cross-over between roles (Haff 2010; Hartshorn et al. 2016). Both sport scientists and S&C coaches implement physical training programmes based on sport science principles and therefore it may be difficult to determine if this has an impact on the training programmes implemented (Haff 2010; Hartshorn et al. 2016).

Chronological age of soccer players starting S&C

As part of an holistic youth athlete development model, both boys and girls are introduced to S&C programmes prior to peak-height velocity (PHV) to maximise long-term benefits (McQuilliam et al. 2020). As PHV coincides with the onset of puberty and tends to occur earlier in girls (11–13 years-old) compared to boys (12–15 years-old) (Iuliano-Burns et al. 2001), it was somewhat surprising that academy coaches did not start a formal S&C programme with their youth players (either boys or girls) until they were ~13 years old. While programming starts at the same chronological age, this results in women academy soccer players starting S&C programmes at a later

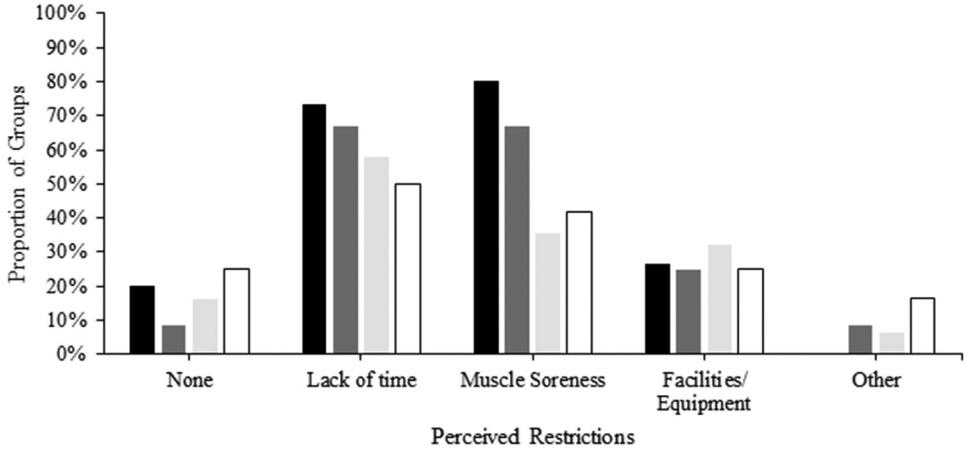

Figure 3. The proportions of men's first team (black bars), women's first team (dark grey bars), men's academy (light grey) and women's academy (white bars) coaches who perceive their S&C practice to be restricted by facilities/equipment, potential muscle soreness following training, lack of time, other or no restrictions at all. Other consisted of; technical coach/player 'preferences', 'training load' and 'fixture congestion'.

stage of maturation than in boys. Introducing S&C training early in a youth athlete's development can have long-term benefits by improving gains in strength and power and helping to prevent injury (Myer et al. 2013). However, it should be noted that strength relative to body mass shows minimal changes with increasing age groups despite the inclusion of S&C sessions in both men's (Morris et al. 2018) and women's (Emmonds et al. 2017) academies, questioning the effectiveness of methods used by coaches in these environments to develop strength.

Resistance training

Whether men and women athletes require different approaches to develop strength and power has been discussed in the literature, with studies either supporting (Roberts et al. 2020), or refuting this suggestion (Reynolds et al. 2012). The data provided here would suggest there is little difference in the S&C training methods used by coaches for men and women soccer players of similar age. When developing strength, both men's and women's coaches utilised similar sets, repetitions and relative intensity (Figure 1), as well as movement patterns (Figure 2). However, relatively fewer women's academy coaches reported using free-weights (83%) compared to men's (97%). Further differences were seen in the use of Olympic weightlifting and its derivatives, with relatively more men's academy coaches implementing them within their training programmes compared to women's academy coaches (Figure 2). This is important and should be reconsidered by S&C coaches, as women athletes show comparable improvements in strength and hypertrophy following the same externally loaded RT protocols (Roberts et al. 2020). These differences may be a result S&C coaches perceiving a limited benefit of RT in women athletes (Reynolds et al. 2012) as well as an effect of less experience (Table 1).

Exercise selection and training prescription may not have differed between S&C coaches working with men's and women's players but there were differences in the methods used to assign training load. Relatively more first team and academy women's S&C coaches used subjective measures to assign RT intensity, particularly RPE (61% and 61%, respectively), than men's coaches (38% and 38%, respectively). There are benefits with using subjective measures, such as low cost, efficiency, and not requiring a maximum strength test for prescription (Greig et al. 2020). However, self-selected loads could be sub-optimal, as exercises have been suggested to be significantly underloaded (Dias et al. 2018). The balance between ease of application and athletic benefits should be considered, as training time may limit opportunities for physical development and methods need to be effective. Conversely, there were no differences in the use of objective methods of training load prescription, such as velocity measures and percentages of 1RM. The use of velocity-based methods has gained popularity due to instant feedback, clear targets, and accounting for daily fluctuations in maximum strength and peak-power (Weakley et al. 2020). However, it appears this approach is not widely used in soccer, with only 27% of participants using it to prescribe training intensity, according to our data.

Whether using objective or subjective loading prescriptions, reducing injury risk is a key objective of S&C programming. With greater injury frequency in women soccer players (Mufty et al. 2015), this may explain why more women's academy (47%) than men's (15%) coaches included the NHE in their top five RT exercises. The NHE is purported to be an effective exercise for reducing hamstring injuries in soccer (Van Dyk et al. 2019). However, only two studies within the Van Dyk et al. (Van Dyk et al. 2019) review examined its effectiveness in women soccer players, and both showed it had no effect on injury rates (Soligard et al. 2008; Del Ama Espinosa et al. 2015). This highlights the need for more women-specific research in this area, as the assumption that what works for men will work for women athletes may lead to erroneous conclusions. Further, the rates of hamstring injuries in women soccer players are lower than in men (Cross et al. 2013). Nevertheless, the apparent importance placed on the NHE in women's soccer suggests it may be an attempt to mitigate the higher risk of soft-tissue injuries in women vs. men, such as ACL injuries, and requires further investigation (Mufty et al. 2015).

Periodisation

Irrespective of injury risk, there appears to be more time directed towards physical development in women's first team squads than in men's. Although weekly session frequency was no different, women's first team squad S&C sessions were longer in duration (Table 2), which may lead to greater differences in total time spent on S&C. This may be due to using S&C methods to prevent non-contact soft tissue injury (Talpey and Siesmaa 2017), and national governing bodies encouraging greater levels of athleticism from their women players (Emmonds et al. 2019b). In contrast, women academy soccer players received less exposure to S&C than men academy players (Table 2). This may reflect the emerging status of not only S&C support in the women's academy setting, but the development of women's academies in general, compared to women's first team and men's academy/first team. This is important to consider, as S&C practices can be effective injury prevention methods when delivered as part of a holistic training programme (Talpey and Siesmaa 2017). As discussed above, women academy soccer players have a greater frequency of non-contact soft tissue injuries (Faude et al. 2005; Le Gall et al. 2008), which may be linked to differences in S&C support as well as physiological differences between men and women (Markofski and Braun 2014). This suggests that monitoring the menstrual cycle and oral contraceptive use (as the latter may be protective against risk of anterior cruciate ligament injury risk (Herzberg et al. 2017)) of women soccer players may be important. Although not asked directly about the menstrual cycle in the current study, only 4% women's coaches reported that they considered it when planning their programmes. This should be investigated further, as its potential influence on injury risk, performance, training adaptation and athlete well-being could change S&C practice in women's soccer.

Limitations

For the findings presented here, there are some limitations that need to be considered. Firstly, data were collected between 1 December 2019 and 1 July 2020, so the transformation, professionalisation and research within women's soccer may change S&C methodology rapidly. Secondly, the larger sample sizes from the UK and South America, with no participants from continents, such as Asia or Africa, limit the generalisability of our data. Further, when comparing the programmed sets, repetitions, and intensity relative to 1RM used to develop strength in-season only 41 (26%) of the total sample provided this information. While the information provided by participants was rich with information, due to the wide variety of methods, it was not possible to convert all the information into traditional sets, repetitions, and percentage of 1RM that are universally recognised. Finally, we analysed the years of S&C coaching experience the participants had accrued, however, this may not necessarily be exclusive to the population the S&C coaches were working with at the time of participation in our study, which may influence their current practice.

Summary and conclusion

Our novel findings suggest key differences exist in S&C practice exist between coaches of men's and women's soccer squads, particularly at academy level. The fewer weekly in-season S&C sessions for women academy players may have negative implications for physical development and injury risk, which is concerning considering the higher risk of injury in women *vs*. men soccer players. However, the finding that more women's than men's academy S&C coaches use the Nordic hamstring exercise may be a direct result of the greater injury risk/frequency in women players, as this has previously been suggested to be an effective injury prevention exercise. Despite this, the greater use of subjective load prescriptions in both academy and first team women's squads (compared to academy and first team men's squads) may lead to sub-optimal adaptation to strength training, which may limit performance gains. Future research should aim to produce guidelines on S&C practice in soccer that are sex- and age-specific.

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Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article.

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