Strength and conditioning provision and practices in elite male football

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INTRODUCTION

There is limited published research on strength and conditioning (S&C) practices in elite football. Information regarding programme design and factors that impact programming would provide valuable information to applied practitioners and researchers investigating the influence of performance interventions strategies. The aim of this study was to detail the current practices of S&C coaches working in senior male football. A questionnaire was developed comprising three main sections: personnel details and staff structure; strength and power development; and current issues and barriers to practice. A total of 51 (51 men; age 32.45 ± 7.27 years) out of 74 (68.9%) coaches responded to the questionnaire, all of whom had been working in senior male football for 9.61 ± 5.65 years. All respondents believed that strength training benefits football performance and reported that their athletes regularly performed strength training. The trap bar deadlift was rated the most frequently prescribed exercise. One hundred percent of respondents reported prescribing plyometric training, and 43 (84%) indicated that periodisation strategies were used. Time availability was considered the biggest factor impacting programme delivery. Building trust, relationships and communication were seen as the biggest determinants of successful S&C practice. This survey represents new data regarding S&C practices in elite male football and serves as a review of applied information.

Introduction

Professional football is the world's most popular sport: the Federation of the International Football Association (FIFA) estimates that more than 270 million people are actively involved in the sport worldwide.[86] In recent years there has been a remarkable expansion in, and acceptance of, sport science (SS) and strength and conditioning (S&C) practices within football.[54] Strength and conditioning is a discipline that is recognized as a valid area of scientific and professional practice, with S&C practitioners increasingly becoming key members of the multidisciplinary coaching team.[54] Given the accepted importance of physical conditioning today, many teams hire S&C coaches to help prepare athletes for performance and to avoid injury.[21,38]

Football is a highly challenging sport to support. In addition to the necessary technical and tactical skills, football players must develop and maintain a high level of athleticism to be successful and can require different – and in some cases – contrasting physical qualities for successful performance.

The development of a literature base quantifying the physical demands of elite football has allowed practitioners to gain a greater understanding of the physiology of football and thus potentially programme more effectively for their athletes.[57] The required increase in the physical demand of successful performance is demonstrated with the year-on-year increase in match play intensity in English Premier League matches.[9] Here, high levels of strength, power and endurance are required to sustain the increased distance covered, number of sprints and high speed running actions performed.[7] However, despite the increased input from S&C and SS practitioners, and the potential to enhance practice, there remains a challenge in fully integrating this work into the practices of football at multiple levels. This situation is often exacerbated by a lack of understanding of the roles that S&C coaches play and the practices utilised within the game.

Over the past decade there has been a surge in football-related information in the field. This has involved the application of multiple modalities, including monitoring of on-field training practices,[57] injury prevention,[53,54,60] fatigue monitoring,[83] return to play criteria,[80,20] and training load.[49] However, although these areas have received plenty of review, there appears to be a relative dearth of research exploring the function of traditional S&C practices, and even less concerning the practices, strategies and periodisation used by S&C professionals in elite male football.

S&C practices have been examined in numerous other sports including basketball,[73] ice hockey,[24] American football,[22] rugby union,[40] rowing,[34] baseball[23] and cricket.[64] However, there are very limited available data on how S&C professionals operate in elite football. Research in football has typically focused on injury prevention methods in international Premier League clubs,[53] during international competition,[54] and during the return to play/perform process.[20] Unfortunately, there are currently no data regarding specific details on methods of application, such as session distribution, session frequency and periodisation strategies; staff structure; methodologies utilised, programming rationales, and session compliance. Similarly, there is no clear understanding of the logistical challenges facing S&C coaches, such as the impact of match schedules on programming, the impact of the coaching team and how these challenges at elite professional level impact the implementation strategy of the S&C coach. In addition, information regarding how practitioners overcome the challenges faced in day-to-day delivery of S&C programmes has never been reported. Yet without an understanding of context, the challenges of application can never be fully elucidated.

Therefore, the purpose of this survey was to examine a variety of S&C practices and to determine the common and the unique practices employed in elite male football. Information obtained from this research will allow coaches access to a serviceable source of the collective ideas of others that they can then use to compare with their own provision, and potentially incorporate into, their own practices. This information may also help inform training programme design for future studies seeking to examine the influence of S&C interventions in elite football players.

Materials and methods

EXPERIMENTAL APPROACH TO THE PROBLEM

This study utilised a quantitative research design in the form of an online survey to examine the current practices and perceptions of S&C coaches in senior male football clubs in the UK and USA. The survey, titled 'Strength and Conditioning Questionnaire', was adapted from that commonly used in other sports by Ebben and Blackard.[22] The questionnaire was adapted to be specific to football, to the demands of this research and to test the hypothesis that football S&C coaches follow contemporary and scientifically-based principles of strength and conditioning practices. It was hoped that coaches would be willing to share their ideas, practices and perceptions through this survey.

SURVEY

The questionnaire was pilot tested on a group of five S&C coaches, academics and researchers in order to determine the reliability and validity of the questions. Once feedback was received, certain questions were modified. This included changing the order of the questions, so that the logical order would be improved, changing some qualitative questions to quantitative queries and rewording questions to make them clearer. After this, the survey was reassessed by a supervisory panel before being sent to the coaches.

The survey consisted of three main sections: personnel details and staff structure; strength and power development; and

Table 1. Competition standard of respondents' clubs

PREMIER LEAGUE	CHAMPIONSHIP	LEAGUE ONE	LEAGUE TWO	NATIONAL LEAGUE PREMIERSHIP	SCOTTISH SOCCER	MAJOR LEAGUE
9	17	8	7	2	3	6

current issues and barriers to practice. The survey contained 48 questions (3 open and 45 closed) relating to the objectives and methods of S&C practices.

The online survey was distributed to S&C coaches, sports scientists and medical professionals working in professional senior male football teams in the UK and America via the website sogosurvey.com.

DATA COLLECTION

All subjects were informed of the purposes of the investigation before participating in the study. An initial email or message via social media platforms describing the study was sent to the S&C coaches at the selected football clubs. This message included a description of the broader study, and an explanation of what the survey would entail. Only those who responded to assist in the research were then contacted by an email containing an electronic link to access the survey.

The coaches were given 30 days from the time of receiving the email to complete the survey. If no responses were received after 30 days, a reminder was sent for a further 30 days. After 60 days, the questionnaires that were completed were collated for statistical analyses. All data were collected between July and August 2019, and referenced the 2018-19 football season.

STATISTICAL ANALYSIS

All data were collected using an online questionnaire (sogosurvey.com, VA, USA). The survey consisted of a combination of fixed-response and open-ended questions. Data analysis procedures were descriptive in nature with frequency counts and percentages calculated. In addition, some of the questions were scored to produce rank scores, with the frequency count of each response reported, as well as a 5-point Likert Scale set as 1 (not at all) to 5 (very important).

RESULTS

PERSONAL DETAILS

Fifty-one (51 men; age 32.45 ± 7.27 years) of 74 (68.9%) coaches responded to the questionnaire. The respondents consisted of three head S&C coaches, twelve heads of sports science, six heads of performance, eight heads of fitness and one head of medical. A further four senior S&C coaches, one senior sports scientist, three first team S&C coaches, five first team sport scientists, one first team physiotherapist, three first team rehab specialists and one assistant S&C coach also responded. Two responders were highlighted as 'other', but no further information was given.

Out of the 51 responders, 45 (88.2%) practitioners were based in the UK, and 6 (11.8%) in the USA. Information on the level of the participants' clubs is presented in Table 1. On average, the participants had been working in professional football for 9.61 ± 5.65 years, and had worked in their current role for 2.97 ± 2.79 years.

STAFF STRUCTURE

A total of 452 staff worked in the 51 clubs that responded. The greatest number of staff were physiotherapists (n=123). Sport scientists (n=69), soft tissue therapists (n=66), sports doctors (n=52), and S&C coaches (n=48) were also reported as support staff. There were 61 interns, and 33 classed as 'other', such as nutritionists.

Subjects were asked how many support staff had previously completed an internship placement, at the current club or previous club. A total of 134 staff had previously completed an internship in the 51 clubs that responded. The greatest number of internships had been carried out by sport scientists (n=48, 36%). Strength and conditioning coaches (n=36, 27%), physiotherapists and soft tissue therapists (both n=23, 17%) were also reported as staff to have completed an internship. Two (1%) sports doctors completed an internship placement.

When analysed as a percentage of those currently in a job, 36 out of the 48 (75%) who were now S&C coaches had completed an internship placement; 48 out of the 69 (70%) who were now sport scientists had done so; 35% of soft tissue therapists and 19% of physiotherapists. In total, 29% of staff who currently work in football had previously completed an internship placement.

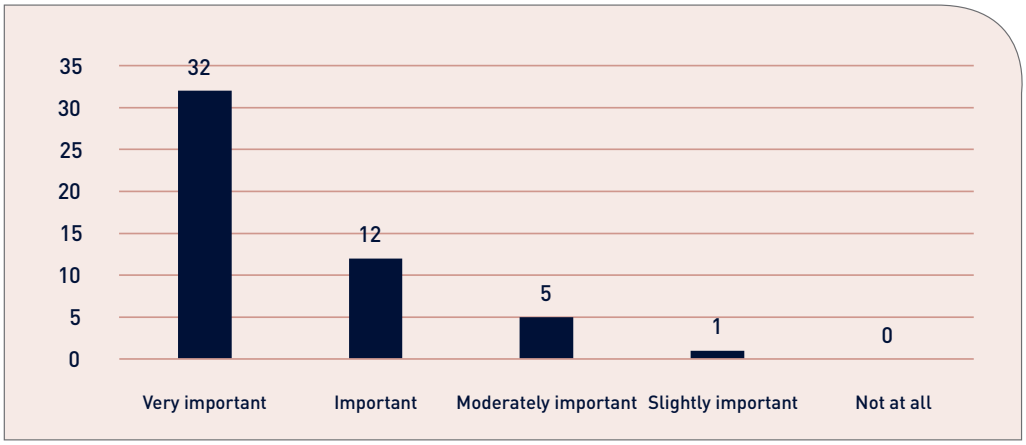

Figure 1. Perceived benefits of strength and conditioning practices on soccer performance

FORMAL EDUCATION

Fifty-two percent of total staff had an undergraduate degree in strength and conditioning, sports science or related medical subject; 31% held a master's degree in a related field; 4% held a PhD. In addition, 11% and 3% of total staff were currently studying a master's degree or a PhD respectively.

CERTIFICATION

A total of 112 staff members held an S&C related certification. The most commonly held professional certifications were the United Kingdom Strength and Conditioning Association (UKSCA) ASCC Accreditation, and also the National Strength and Conditioning Association (NSCA) CSCS certification (n = 37, 33%, and n=36, 32% respectively). Twenty-two (20%) staff held 'other S&C' certifications, and 17 (15%) participants were accredited with the British Association of Sport and Exercise Sciences (BASES). Forty members of staff were certified with a football-specific coaching certification. The most commonly held coaching certification was UEFA B licence (n = 29, 73%), with 10 (25%) holding a UEFA A and 1 (3%) with a UEFA Pro Licence.

STRENGTH AND POWER DEVELOPMENT

The initial question in the section asked if practitioners believed that S&C practices have an important benefit to improving football performance. Answers were ranked on a Likert scale of 1 – 5, with 1 = not at all, and 5 = very important. Fifty out of the 51 responders answered this question. Results on the perceived benefits of S&C on football performance are presented in Figure 1.

All 51 coaches stated that lower limb strength and conditioning was incorporated into their programmes. The top five reasons for including S&C are presented in Table 2, with answers weighted by rank score.

Forty-five (88%) out of the 51 respondents said that S&C sessions were compulsory for all players. Six coaches said that S&C sessions were not compulsory. An additional comment was: 'no punishment for not completing so can't describe as compulsory, but sessions are encouraged by management'. When asked to detail the percentage of players who regularly completed lower limb strength sessions, the most selected response was 91-100% (n=39, 76%). Six (11.7%) coaches responded 81-90%, and five (9.8%) said 71-80%. Only one coach responded 51-60%.

Coaches were asked to select what best described the S&C sessions provided; they were given the choice of more than one answer, with a total of 113 answers selected by the 51 coaches. The most common description (53%, n=27) was: 'players do the same compulsory exercises, but have specific individual extras'. Forty-nine percent (n=25)

Table 2. The top five reasons for including lower limb strength and conditioning practices

REASONS FOR INCLUDING S&C	RANK 1	2	3	WEIGHTED RANK (SCORE)
Help the players develop physical qualities needed	19	15	7	1 (94)
Make the players more robust	13	6	11	2 (62)
Stronger players are more resilient	4	11	8	3 (42)
Helps improve our injury rates	4	6	4	4 (37)
Enhance fundamental movement skills	5	4	6	5 (29)

stated that 'our S&C programmes prioritise performance enhancement strategies', and 47%, (n=24) that 'exercises are individual, based on a needs analysis of each player'. Thirty-three percent (n=17) stated that the programmes: 'prioritise injury prevention or reduction strategies'. Twenty-one percent (n=11) of coaches stated that: 'exercises are the same for all, but load and volume are individual' and 15.5% (n=8) stated that: 'the majority of the playing squad perform the same exercise'.

The final question in this sub-section asked practitioners about the typical duration of an in-season S&C session. Figure 2 presents the responses from the coaches.

STRENGTH AND POWER DEVELOPMENT: FREQUENCY OF SESSION

This sub-section asked how many, and on what days of the week, strength and conditioning sessions were performed during the in-season in relation to the next match day (MD). Figures 3 and 4 highlight the responses from coaches with regards to provision during a two-game week (eg, Saturday and Saturday); and a three-game week (eg, Saturday, mid-week and Saturday) respectively, and Figure 5 highlights when sessions were performed in relation to the next match day (MD).

During a three-game week, 16 (31%) coaches reported that all players completed at least one S&C session, 14 (27%) reported that only non-starting players completed a session, 15 (29%) reported that sessions were set on an individual basis, and 8 (16%) reported that no players completed any session. Reasons reported as to why no players completed an S&C session included: 'lack of time between matches doesn't allow full recovery', 'management want players to rest or have days off', 'a greater emphasis is placed on recovery strategies', 'not deemed appropriate', and 'no gym-based work, but extended power-based activation is performed on the pitch'.

The final question in this sub-section asked how external load (resistance) was determined during an S&C session. Practitioners could select more than one answer for this question. Thirty (58%) coaches responded that it was 'athlete-led'; 28 (55%) stated it was 'based on periodisation or phase of training'; 25 (49%) 'coach's subjective assessment'; and nine (17%) responded that load was determined by 'measures of velocity with the use of technology' and 'rep max or strength testing'. No-one suggested that load was similar for all players.

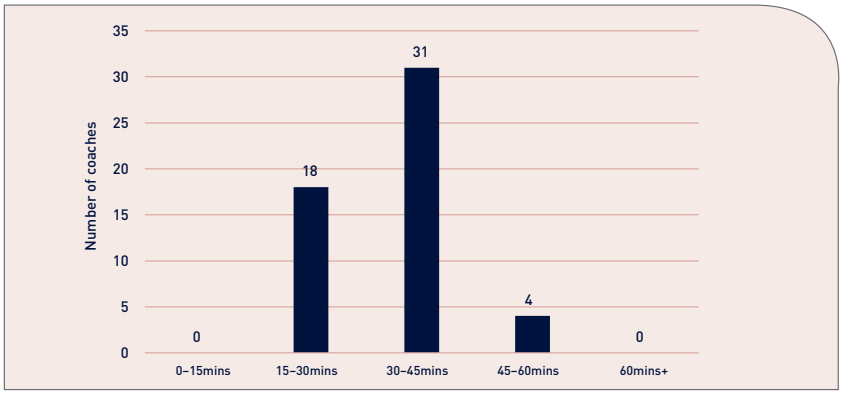

Figure 2. Average length of soccer strength and conditioning coaches' in-season S&C session

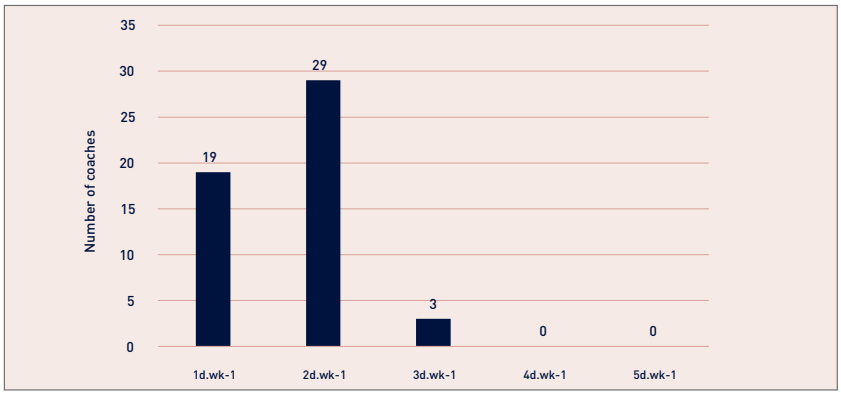

Figure 3. The number of strength and conditioning sessions provided in-season during a two-game week

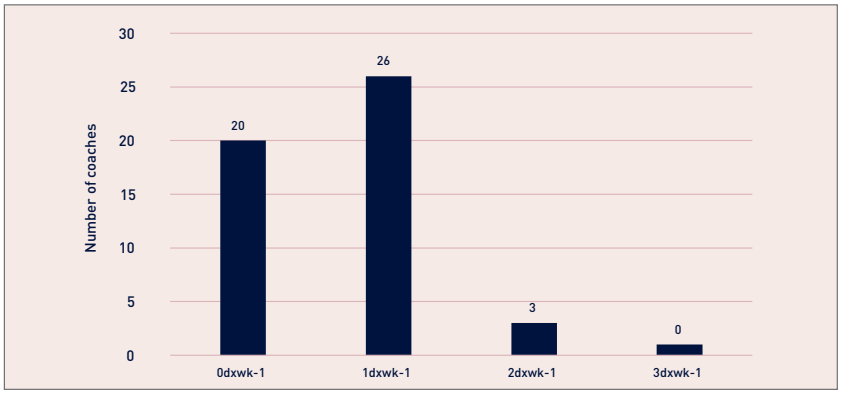

Figure 4. The number of strength and conditioning sessions provided in-season during a three-game week

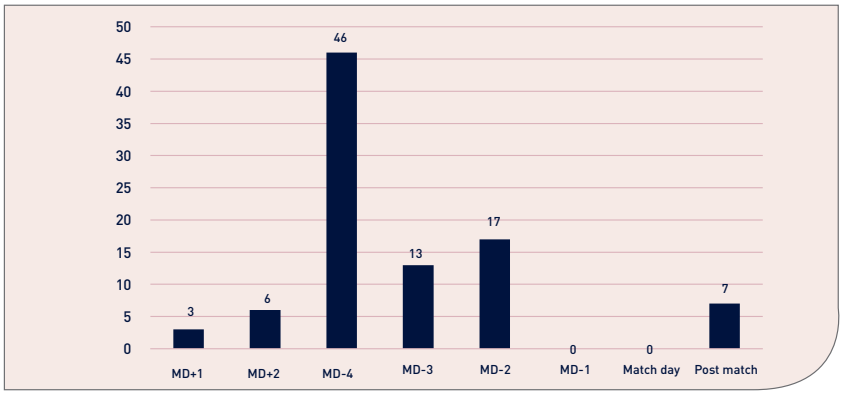

Figure 5. Days of the week strength and conditioning sessions were performed in relation to the next match day (MD)

STRENGTH AND POWER DEVELOPMENT: EXERCISE SELECTION

The next sub-section asked which exercise modalities were most commonly used in S&C practices. Answers were weighted by rank score. Thirty-seven (72.5%) coaches ranked using free weight (barbell, dumbbell or kettlebell) resistance at number one. Plyometric exercises were ranked second with Nordic hamstring curls third. Derivatives of Olympic weightlifting movements and isometric training were ranked fourth and fifth respectively. Other commonly ranked exercises modalities were eccentric slide boards, complex training, fly wheel training and velocity-based training.

Coaches were asked to detail their top five most frequently used exercises. The most selected exercise was the trap bar or hex bar deadlift with 26 (51%) out of 51 coaches incorporating this exercise into their programmes. Romanian or stiff leg deadlift variations (n=22, 43%), barbell squat (n=21, 41%), rear foot or split stance squat variations (n=20, 39%), Nordic hamstring curls (n=15, 29%) and hip thrusts (n=13, 25%) were the other most frequently used exercises. Numerous other exercises were also ranked in coaches' top five exercises, including: eccentric hamstring curls, calf raises, lunge patterns, isometric hamstring holds, step-ups, Copenhagen adductor holds, single leg jumps, and derivatives of Olympic Weightlifting, such as jump shrugs, hang cleans and drop snatches.

STRENGTH AND POWER DEVELOPMENT: PLYOMETRICS

In the following section participants were asked if they incorporated plyometric exercises into their S&C programme and, if they did, the reasons why. One hundred percent (n=50 of coaches who answered reported using plyometrics, with one coach not answering the question.

In terms of plyometric rationale, 68% (n=35) of coaches reported using plyometrics for improving rate of force development, 49% (n=25) for improving reactive strength, 43% (n=22) for training the stretch shortening cycle, 41% (n=21) for improving stiffness, and 29% (n=15) for injury prevention. Other answers were 'improving vertical jump', 'upper body power', 'speed development' and 'full body power'.

The second question in this sub-section asked coaches how they integrate plyometric training into their S&C programmes. Forty-seven percent (n=24) of coaches stated that it is 'dependent on the individual athlete'. Twenty-nine percent (n =15) of coaches reported that 'plyometrics and resistance training are done as complex training during the same session', 27% (n =14) 'only included on the grass during the warm-up', and 22% (n =11) state that plyometrics are completed 'on separate days to resistance training'. Other responses included 'depends on the phase of training as to when they are included', 'pre-training to potentiate speed drills' and 'incorporated within sprinting sessions'.

The third question in this sub-section asked coaches to identify the types of plyometric exercises regularly used in their sessions. Figure 6 highlights the responses from the coaches. Other select responses include 'proprioceptive ancillary drills for stiffness' and 'ankling warm-ups'.

STRENGTH AND POWER DEVELOPMENT: ECCENTRIC TRAINING

In the following section, participants were asked if they incorporated eccentric overload exercises into their S&C programme and, if so, the reasons why. Forty-five out of 51 (88%) coaches reported using eccentric exercises. Forty (78%) coaches reported using eccentrics for preventing injuries. Twenty-five (49%) coaches used eccentric exercises as 'they follow the recommended advice given in available literature', 15 (31%) used them as they 'can provide the exercises in environments away from the gym', 12 (24%) responded: 'we can use only a few exercises to get a significant physical adaption in our players' and 7 (14%) used eccentric exercises as 'players find it useful'.

Six (12%) coaches reported not using eccentric exercises. The main reason given was: 'we don't have time to recover from eccentric overload exercises during the season'. Other responses included: 'we don't have the equipment to test eccentric strength', 'maximal effort eccentric work provides too much DOMS', and 'players have a negative perception of the eccentric exercises, such as the Nordic'.

STRENGTH AND POWER DEVELOPMENT: PERIODISATION

The next sub-section related to periodisation strategies used to implement S&C sessions. Eighty-four percent (n=43) of coaches answered that 'yes' they do use a periodisation strategy; 16% (n =8) said 'no' they did not. Sixty percent of those who implement a periodisation strategy responded that 'periodisation helps target a specific outcome of a specific period'. Other answers were: 'periodised training offers superior developments of strength, power

and performance variables" (n=22); 'it helps prevent stagnation or boredom' (n=11); and it is 'vital to know when to add or delay changes in the programme' (n=10). The main reason as to why a periodisation strategy was not incorporated was 'too many external variables interrupt any pre-planned periodisation strategy' and 'players don't perform enough S&C to follow a true or traditional periodisation strategy' (n=4). Other responses included: 'too many matches', 'our sessions incorporate most aspects of athletic development' and 'we don't follow a traditional model of periodisation'.

STRENGTH AND POWER DEVELOPMENT: SPEED DEVELOPMENT TRAINING

In the following section participants were asked which forms of training were used for targeting speed development, when this occurred, and how often they were trained.

Information regarding the type of speed development exercises most frequently used by football S&C practitioners are highlighted in Figure 7. The second question in this sub-section asked coaches how they integrate speed development training into their S&C programmes. Information regarding how speed development training is integrated into S&C programming in relation to resistance training session is highlighted in Figure 8. The final question in this sub-section asked practitioners how often these speed development modalities were specifically targeted in the training schedule.

When specifically targeting acceleration, the most common response from practitioners was 'once a week' (n=17). Thirteen coaches specifically targeted acceleration daily, and 12 twice a week. When specifically targeting change of direction speed (CODs), the most common response from practitioners was 'twice a week' (n=17). Sixteen coaches specifically targeted CODs 'once a week', and nine daily. When specifically targeting deceleration, the most common response from practitioners was 'once a week' (n=19). Fifteen coaches specifically targeted deceleration twice a week and nine daily. When specifically targeting high speed running, the most common response from practitioners was 'twice a week' (n=24). Eighteen coaches specifically targeted high speed running once a week, and six did the same three times a week. When specifically targeting max speed, the most common response from practitioners was 'once a week' (n=35). Ten coaches specifically targeted max speed twice a week, and two fortnightly. When specifically targeting repeated sprint ability (RSA), the most common response from coaches was 'once a week' (n=24). Seven

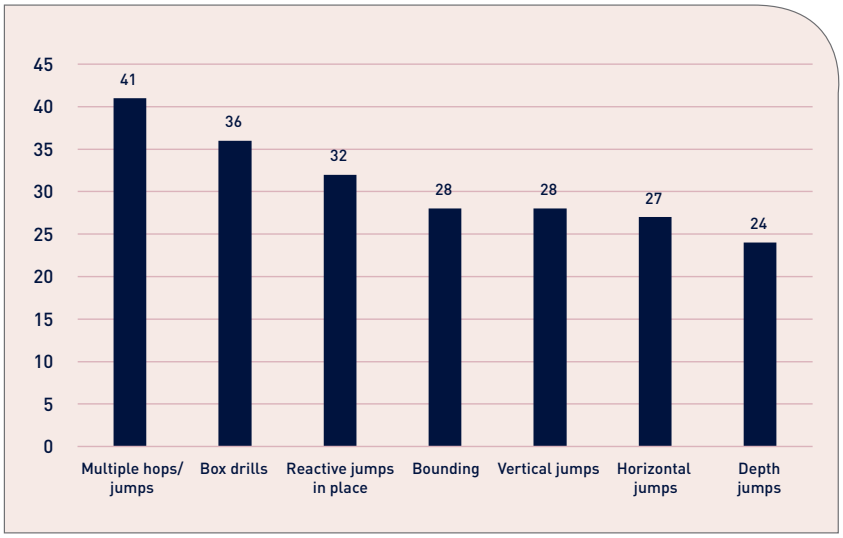

Figure 6. The type of plyometric exercises most frequently used by soccer S&C coaches

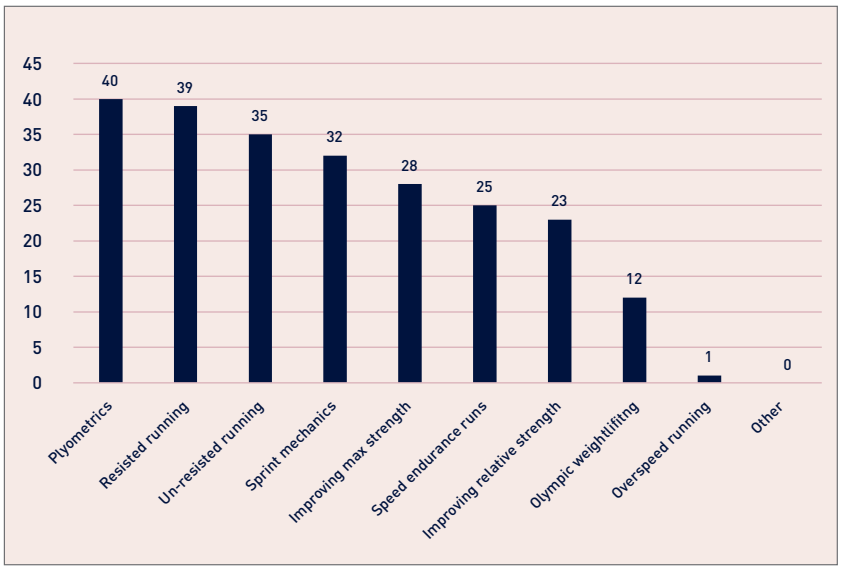

Figure 7. Exercises used by strength and conditioning coaches for speed development training

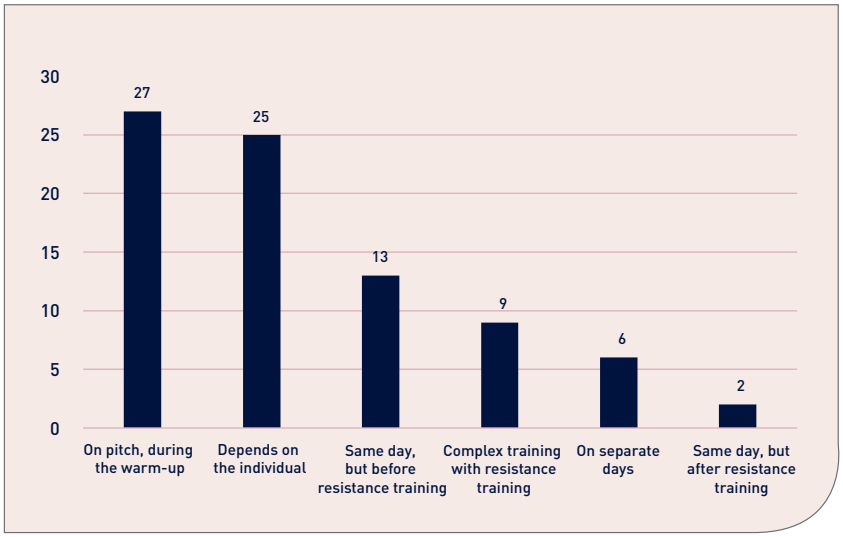

Figure 8. How coaches incorporate speed development sessions in relation to resistance training

coaches specifically targeted RSA twice a week, and six fortnightly and monthly.

CURRENT ISSUES AND BARRIERS TO PRACTICE

The fourth section of this survey elicited responses from coaches regarding attitudes, experiences and barriers facing the delivery of S&C practices in football. This aimed to address attitudes – not only of the players but also of other key people who facilitate the success of any strength and conditioning programme.

The first question in this section asked coaches if they thought there had been a positive change in attitude from players and management towards S&C practices. Forty-eight (94%) of coaches believed there has been a positive change in attitude from players towards S&C practices during their time working in football. Two (4%) coaches were 'unsure', and one coach suggested 'definitely more buy-in across the squad as a whole, but is this because the players are more conditioned to just do as they are told?'

Forty-two coaches believe there has been a positive change in attitude from senior management/staff towards S&C practices during their time working in football, with three suggesting there hasn't been, and one 'unsure'. Four coaches gave more detailed responses including: 'in my current club yes, but when working at a bigger club, senior staff did not believe there was a benefit to strength training', 'depends on the management', 'still considered behind physio as it's an older discipline. Some coaches also not interested in what we can help them with', and 'different staff have different views and expectations'.

Table 3. Challenges facing delivery of S&C practices at responders' clubs

CHALLENGES	RANK 1	2	3	4	5	WEIGHTED RANK (SCORE)
Lack of time between matches	8	7	6	5	4	1
Importance of winning	2	7	3	4	4	2
Lack of or poor facilities	6	1	4	3	5	3
Lack of staff	5	2	7	1	0	4
Players' previous negative experiences	2	5	4	3	6	5
Constant changes in management	4	2	1	5	4	6
None – we have good adherence and no challenges	6	0	3	1	3	7
Lack of appreciation and understanding of role	2	4	2	1	1	8
Lack of player understanding or buy-in	1	4	1	4	1	9
Trying to keep things fresh	3	0	4	1	3	10

Table 4. Perceived challenges facing delivery of S&C practices at other clubs

CHALLENGES	RANK 1	2	3	4	5	WEIGHTED RANK (SCORE)
Constant changes in management	12	4	1	4	1	1
Authority over implementing practice	6	6	2	1	2	2
Importance of winning	3	3	4	9	2	3
Integration with coaching staff philosophies	3	4	4	2	7	4
Lack of time between matches	1	3	10	2	3	4
Lack of or poor facilities	3	6	1	3	3	5
Lack of staff	2	6	4	0	2	6
Lack of appreciation and understanding of role	4	3	2	3	3	7
Difficulty quantifying benefits	3	2	6	0	4	8
Lack of support from management	3	3	2	4	3	9
Lack of player understanding or buy-in	2	1	4	2	1	10

The second question in this sub-section asked coaches for their experiences with the challenges they faced in delivering S&C practices, as well as their opinion on the challenges facing S&C delivery for all other S&C coaches in football. Ranked weighted order (weighted average) responses show that lack of time available between matches was deemed the biggest challenge facing coaches in providing effective S&C programmes in their own organisation. Table 3 details the top 10 challenges facing delivery of S&C practices at clubs. Other selected responses included: 'integration with coaching staff philosophies', 'authority over implementing practices' and 'too much travelling'.

Table 4 details the ranking of the top 10 perceived challenges facing delivery of S&C practices in football as a whole. Responses showed that 'constant change in management' is believed to be the main challenge facing football as a whole. Other selected responses included 'players getting input from external coaches' and 'players' previous experiences'.

The final question in this subsection related to the most valuable method for creating a positive buy-in or attitude towards strength and conditioning practices. Results show that 46 (90%) coaches believed 'building trust and effective relationships with players' to be the most valuable method for creating a positive attitude towards S&C. A total of 41 (80%) coaches reported 'effective communication with athletes' as the second most valuable method for creating a positive attitude towards S&C; in contrast, 37 (72%) coaches reported that 'showing the player how gym based exercises will translate to on-pitch improvements', 35 (69%) coaches suggested 'the ability to vary coaching style to different athletes' and 'building trust and relationships with staff' are all important factors in creating positive attitude towards strength and conditioning practices. Programme design (n=14, 27%), exercise selection (n=11, 21%), and use of the latest technology (n=4, 8%) were other factors to be considered.

DISCUSSION

The present study sought to conduct a comprehensive survey of S&C practices in senior professional male football; to the authors' knowledge, this is the first such assessment. It is also the first assessment to investigate the concerns and challenges that practitioners face when trying to implement S&C practice, although some have been reported in injury prevention studies. Seventy-four practitioners working in professional, senior male football were invited to participate and 51 responded (69%). Although this may be lower than some previous response rates within similar studies in other sports (47-87%),[22,23,40,73] this is the highest number of respondents obtained in a study examining S&C provision in a single sport to date. Previous studies examining S&C practices in various sports have received between 20 and 43 responses.[22,23,24,34,40,73] In similar reports into injury rates in professional football, response rates were 44 (53) and 32.[54] As such,[51] responses at a return rate of 69% were deemed sufficient for analysis and is the highest number of respondents to a survey of S&C practices.

All respondents supported athletes in professional, senior male football. There were nine respondents from the English Premier league, 17 from the English Championship, 8 from League One, 7 from League Two, 3 from Scottish Premiership, 6 from Major League Football (USA) and 2 from the National League. The data presented in this article are therefore truly reflective of elite, senior male football.

Respondents were also experienced in the field of S&C, with an average time working in football of 9.61 ± 5.65 years; in addition, they had worked in their current role for 2.97 ± 2.79 years. This level of experience is similar to those coaches who responded in similar research in different sports.[23,24]

Respondents were also experienced in the field of S&C, with an average time working in football of 9.61 ± 5.65 years; in addition, they had worked in their current role for 2.97 ± 2.79 years. This level of experience is similar to those coaches who responded in similar research in different sports.[23,24]

STRENGTH AND POWER DEVELOPMENT

There is great variance in the physical qualities required for successful football performance;[47,61] also, the increasing physical requirements in elite football[7,9] suggest that the inclusion of S&C practices would be beneficial to help players cope with this demand. Research indicates that football performance requires a level of contractile strength which can be improved through S&C practices. Lower limb strength training, such as sprint speed and jumps,[15,36,70] has been shown to have a positive influence on football-specific movements and is seen as an important factor in physical success.

'This is the highest number of respondents obtained in a study examining S&C provision in a single sport to date'

In this survey, 100% of coaches who responded indicated that lower limb strength training was regularly incorporated into their programmes, with 88% stating that sessions are compulsory. In addition, a total of 86% of practitioners believe strength training is very important (63%) or important (23%) for football performance. The most common reason for incorporating lower limb S&C training was to 'help develop the physical qualities needed to play the game'.

In this study, practitioners stated that the main focus of their S&C programmes was to: 'prioritise performance enhancement strategies' (n =25, 49%) rather than 'prioritising injury prevention or reduction strategies (n=17, 33.3%). Previous research in football has focused on injury prevention strategies[53,60] and the practices that are perceived to help this. This could suggest that injury reduction is the primary goal of S&C interventions in football. However, our study clearly contradicts this and provides information regarding S&C in football that has hitherto been unreported: this has implications on the types of practices deemed to be most effective in football.

Although not reported in football, well-developed lower-body strength, repeated sprint ability and speed have all been shown to be associated with a greater tolerance to higher workloads, as well as a reduced risk of injury in team-sport players.[50] Also, elite rugby league players, with greater high-intensity running ability and lower body strength, have been shown to experience smaller decrements in peak power output post-match.[39]

The role of muscle strength and muscle imbalances as risk factors for lower limb injuries has been widely discussed.[17,31,53,54] In fact, muscle imbalances have previously been ranked as the third most important intrinsic risk factor for injury in elite male football.[53,54] Adequate training to improve muscular strength has been reported as the main measure for reducing these imbalances and reducing injury risk in football players[4,82] and has been shown to reduce injuries to less than one third and over-use injuries almost halved.[44]

The physical demands of professional male football are continually increasing.[7,9] Consequently, improving the ability to not only tolerate these demands, but also to enhance performance, can bring significant benefits to the football club. Lower limb injuries represent a disconcerting cause of time lost from male professional football,[25,27,41] decreased player performance[26,35] and financial cost.[28] It should be noted that reducing a player's risk of injury could in turn be a performance-enhancement strategy in itself. If a player spends more time training and being available for match selection due to a reduction in their injury risk/increase in work capacity, then this should be seen as a performance-enhancement strategy. Moreover, 93% of coaches, staff and players questioned in a recent review[59] suggested that it was the fitness coach's responsibility to ensure 'injury prevention programmes' are put in place.

Although the reduction of injuries is an important factor in success, pushing the boundaries of physical performance to meet, for example, rowing demands, should be a key focus of S&C practitioners in any sport, including football of course. The results of this research are enlightening and suggest that the majority of coaches aim to drive physical performance.

It is clearly, therefore, a dual role of the S&C coach to not only provide effective injury reduction based training, but also to aim to improve the physical capabilities (such as RFD, speed, endurance, strength) of their players.

STRENGTH AND POWER DEVELOPMENT: SESSION DURATION AND FREQUENCY

A typical duration of an in-season S&C session was 30-45 minutes (Figure 2), which appears to be shorter than that reported in other sports. In rugby union, ice hockey and basketball, a typical session is 45-60mins+,[40,24,73] and in rowing sessions can be 60-75mins+.[34] Time available between matches and throughout the training week are reported as challenges to S&C provision, not only in this current research but also in others.[54,57] However, rugby and rowing may not provide suitable comparators. In the case of rugby union, the fixture demand is less than that in football. Often rugby union matches only occur once a week. Rowing, when considered as an Olympic sport, will have long periods out of competition during the four-year Olympic cycle and as such, may have a stronger tradition of S&C practices, and therefore an increase in S&C time and provision.

Twenty-nine (56.8%) coaches reported prescribing strength training two days a week during a two-game week (eg, Saturday and Saturday). The most frequent training day was match day-4 (MD-4), with 46 (90%) coaches reporting they perform S&C on this day. These are similar to those reported in other sports, with 2 d·wk-1 reported as the most common in basketball[73] and ice hockey,[24] but 3 d·wk-1 in rugby union.[40] The review into rugby union was the only other to ask when S&C was incorporated in relation to the next match day, with 85.7% of coaches also reporting MD-4 as the most common day for S&C provision.

In theory, incorporating lower limb S&C on a MD-4 would give the players sufficient time to recover from the previous game (>48 hours) and would give sufficient time to recover and prepare for the forthcoming game (four days later). It has been shown that hamstring strength returns to normal or above baseline at 72 hours post-match in elite youth football players.[16] In theory, in a two-game week, 72 hours post-match would be recorded as a MD-4, ie, a Tuesday, between two Saturday fixtures.

In some football-specific periodisation models, a MD-4 would be considered the biggest training day in terms of training volume. Coaches may not wish to implement strength training the day before a high volume of speed running for fear of residual fatigue increasing the risk of injury or poor performance. A MD-4 may also fall the day before a day off or rest day, so a high volume of combined pitch and gym work would be followed by an adaptation period without fear of being back on the pitch the next day. S&C practices may therefore not only be determined by fatigue and physiological responses to matches, but also by the manager's desired periodisation strategy.

During a three-game week (eg, Saturday and Tuesday and Saturday games),[26] (52%) coaches reported S&C sessions were provided 1d·wk-1, three reported 2d·wk-1, and one reported 3d·wk-1. Twenty (40%) practitioners reported that S&C sessions were not provided at all, but that they 'could be set on an individual basis'. One practitioner did not respond to this question. When asked to provide further details,[14] practitioners reported that only non-starting players completed a session and 16 reported that all players completed at least one S&C session. No other study into football or any other sports has looked at the provision of S&C during a congested fixture week, and as such comparisons are difficult to discuss. However, reasons as to why coaches reported that no players completed an S&C session included: 'lack of time between matches doesn't allow full recovery', 'management wants players to rest or have days off', 'a greater emphasis is placed on recovery strategies', 'not deemed appropriate', and 'no gym-based work, but extended power-based activation is performed on the pitch'. These results provide a useful context for practitioners where the logistical challenges faced in the game provide a limitation to the scope of S&C practice.

'Lower limb strength training, such as sprint speed and jumps, has been shown to have a positive influence on football-specific movements'

'Eccentric muscle actions involve the active lengthening of muscle tissue against an external force or load'

Hamstring injuries are frequently reported as the most common soft tissue injury in football[27] and muscle fatigue from fixture congestion could add to the issue. Despite the clear concern with high hamstring injury rates, the lack of uptake of the Nordic hamstring protocol (NHE) by Elite European teams is surprising: it has been reported that only 16.7% of teams followed the NHE protocol in part or full capacity.[4] The lack of time between matches could explain this situation. Although suggestions as to why this uptake was so low were not reported in that review, it could be suggested that answers from the current study such as 'lack of time between matches doesn't allow fully recovery' or 'not deemed appropriate' may be applicable to the lack of uptake of NHE, as teams surveyed in that review would be consistently playing three-game weeks.

It may also be of note that recent research with elite youth football players suggests that, when combined with adequate recovery, match-play may provide a suitable stimulus for posterior chain muscle strength development.[16] Coaches working on a day-to-day basis may see this as a reason for not including any further stimulus, especially in the posterior chain muscles during a congested fixture week. With time constraints and busy schedules being a factor for not incorporating S&C, it may be of interest for future research to highlight S&C strategies that can be utilised during these busy periods.

STRENGTH AND POWER DEVELOPMENT: MOST COMMON EXERCISES USED

The trap bar deadlift (TBD) or hex bar deadlift (HBD) was the most commonly used exercise reported in this study; with 26 (51%) coaches incorporating this exercise into their programmes. The TBD was used more frequently compared to a traditional barbell back squat (n=21, 43%) or deadlift. Research has demonstrated that the use of a TBD results in greater force, power and rate of force development (RFD) and has a greater correlation with vertical jump due to similar body positions when compared to traditional squat or deadlifts.[45,74] Hex bar jumps have been shown to elicit greater jump height, peak force, power and peak RFD across varying loads when compared to jump squats.[78] Also, the TBD has been shown to have a 65.8% higher concentric RFD compared to the squat[89] in recreational trained athletes. In the authors' experience, football players also struggle with hip and ankle injuries and subsequent lack of range of motion that often lead to a poor technical ability in the traditional barbell squat exercise. These limitations can often be reduced by utilising the TBD exercise.

Split stance exercises such as rear foot elevated split squats (RFESS) were frequently reported as the exercise utilised in football S&C coaches' programmes (n=20, 39%). Although split stance exercises may not allow for the use of high loads compared to bilateral movements such as the squat or TBD, they may still be valuable due to the reported high RFD and their unilateral nature.[89] Unilateral exercises such as split stance squats or step-ups have a relatively high concentric RFD[89] and as such may be useful for training athletic activates such as sprinting or single leg jumps.

In comparison, the only other study that looks at S&C provision in football reported that the leg extension exercise was the most commonly used.[67] Leg extensions have been reported to have a benefit in certain rehabilitation settings, but their benefit in aiding football performance may be limited.[62] This suggests that there has been a change in emphasis since this study as free weight, closed-chain exercises are often considered more functional and beneficial to athletic performance.[6] In support of this,[37] (72%) coaches ranked using free weight

(barbell, dumbbell or kettlebell) resistance as the number one resistance modality used in S&C practices.

The use of Olympic style weightlifting exercises was considered less important in football practices than previously reported in other sports such as rugby union (used by 90% of practitioners),[40] rowing (87%),[34] NFL (88%)[22] and NHL (91%).[24] Despite the association between Olympic lifting training and improvements in power output and acceleration,[14,84] the apparent lack of implementation in football practice may be for a number of reasons. This lower usage may also be due to some of the challenges of implementing Olympic lifts into programmes. Olympic lifting exercises such as the clean, snatch, and hang clean are highly skilled, technically difficult and time-consuming exercises to teach.[29,81] With the reported lack of time available considered a challenge to implementing S&C in football, coaches may feel that time could be spent better elsewhere with their athletes. However, it is important to note a potential difference between previous studies that may also explain some of this differential. In some previous studies in rugby union[40] and rowing practices,[34] the squat and deadlift were considered Olympic lifting exercises and as such could be a reason for the higher reported usage of these exercises than in the current study.

Other frequently used exercises included the Romanian or stiff leg deadlift variations (n=22, 43%), Nordic hamstring curls (n=15, 29%) and hip thrusts (n=13, 25%). Numerous other exercises were also ranked in the coaches' five main exercises, including eccentric hamstring curls, calf raises, lunge patterns, isometric hamstring holds, step-ups, Copenhagen adductor holds, single leg jumps, and derivatives of Olympic weightlifting, such as jump shrugs, hang cleans and drop snatches. It should also be noted that, as commented by one practitioner, 'there is a wide range of exercises used' – ie, that there are so many that they couldn't comment on which were the most frequently used. This emphasises that there appears to be a wide range of exercises used within football S&C programmes.

STRENGTH AND POWER DEVELOPMENT: ECCENTRIC EXERCISES

Eccentric muscle actions involve the active lengthening of muscle tissue against an external force or load,[46] in contrast to isometric and concentric muscle actions which involve no change in muscle length or the shortening of muscle tissue,

respectively.[77] It has been reported that skeletal muscle can produce more relative force during eccentric muscle actions compared to isometric and concentric actions[65] and as such the use of many eccentric exercises are gaining popularity during strength and conditioning sessions.

In this research, 45 out of 51 (88%) coaches reported using eccentric exercises, with 40 (78%) using eccentrics for preventing injuries. These results support those previously reported in the literature, where 85% of practitioners believe that eccentric exercises can help prevent lower limb injuries in football players.[59] Eccentric exercises have previously been ranked as the most effective way to prevent non-contact injuries in football players.[53] In addition, it was reported that hamstring eccentrics and the Nordic hamstring exercise (NHE) were ranked third and fifth accordingly. Eccentric exercises have also been ranked fifth for preventing injuries in international football squads.[54] It has been suggested that eccentric exercises may prevent injury by improving the muscles' ability to absorb more force before failing.[43]

A review into the use of eccentric exercise, and in particular the NHE, in 50 UEFA Champions League football teams, suggests that despite the growing body of evidence that promotes the use of NHE in hamstring injury prevention, not many teams actually follow the advice given.[4] A total of 49% of coaches in this current study use eccentric exercises as 'they follow the recommended advice given in the literature'. In contrast, Bahr et al[4] found that only 16.7% followed the NHE protocol in part or full capacity. The contrast in results in these studies maybe due to the lack of specific reference to the NHE exercise in this current study, and just

'In this research, 88% of coaches reported using eccentric exercises, with 78% using eccentrics for preventing injuries'

referring to eccentric exercises, whereas the Bahr et al[4] research was specific to the NHE protocol. Results in that study also suggest that clubs use a multitude of hamstring strengthening exercises, including other eccentric exercises such as eccentric leg curls in a yo-yo device, slider board eccentrics and the Askling rehabilitation exercise protocol;[3] therefore uptake of eccentric exercises overall maybe more closely related to those in the current study. In the present study, six coaches reported not using eccentric exercises. The main reason why they are not prescribed was because 'we don't have time to recover from eccentric overload exercises during the season'. Other responses included 'maximal effort eccentric work provides too much DOMS' and 'players have a negative perception of eccentric exercises, such as the Nordic'. These responses are the same as suggestions by Petersen et al[63] and responses in the Bahr et al UEFA Champions League NHE review.[4]

If the advice in the literature for protection of hamstring injuries is to utilise eccentric and in particular NHE exercises, then researchers and coaches should look at ways of incorporating it more. In that respect, a recent study by Cuthbert, Ripley, McMahon, Evans, Haff and Comfort[18] has shown that a lower than expected volume of NHE can still produce adequate strength gains and reduce the risk of HSI in football players. Maybe practitioners need to follow this advice early in pre-season to allow players to adapt to the demands of the exercise before congested season begins.

It could also be noted that S&C programmes need to include a variety of strength exercises, especially for hamstring/posterior chain strengthening. There is much debate around the muscle actions required by the hamstrings during top end running, with some believing it is an eccentric action,[72] and some believing it is more of an isometric action.[87] It is beyond the scope of this review to discuss these matters fully, but what is suggested is that it may be beneficial to include both eccentric and isometric training, as well as traditional eccentric-concentric (isotonic) strengthening and power development exercises in S&C provision for football players. Future research may look to provide further real-world case study examples of in-season strength training programmes that address these issues.

'In theory, by having the athletes perform plyometric training, they will increase power performance for specific game situations'

STRENGTH AND POWER DEVELOPMENT: PLYOMETRICS AND SPEED DEVELOPMENT TRAINING

The purpose of plyometric training is to increase the power of subsequent movements using both natural elastic components of muscle and tendon and the stretch reflex.[56] The stretch shortening cycle (SSC) enhances the ability of the neural and musculotendinous systems to produce maximal force in the shortest amount of time.[51] This has prompted the use of plyometric training as a bridge between strength and speed.[51] As football is made up of a combination of running, jumping, and change of direction movements it would seem logical to include methodologies that enhance this capacity. In principle, the more power the athletes can produce, the better athletic performance they will be able to achieve, which could lead to an increased level of football performance. In theory, by having the athletes perform plyometric training, they will increase power performance for specific game situations.

Fifty (100%) coaches who responded reported using plyometrics; there was one coach who did not answer the question. These results are similar to those in previous studies in other sports; rugby (95%), NBA (100%), MLB (95%), and NHL (91%).[23,24,40,73] The reasons given for the use of plyometrics were 'improving rate of force development' (68%), 'improving reactive strength' (49%), 'training the stretch shortening cycle' (SSC) (43%) and 'injury prevention' (29%). One key factor when considering appropriate plyometric drills is the ground contact time (GCT) involved in the activity. To this end, plyometric activities can be categorised as either slow SSC (>250 milliseconds) or fast (<250 milliseconds) SSC, depending on their GCT.

A total of 71% of coaches in this report frequently use box jumps in their programmes. According to Markovic,[52] plyometric training produces greater positive effects in slow SSC jumps, particularly the CMJ, than in the concentric-only jumps (ie, squat jump), or even fast SSC jumps (ie, drop jump).

Although there was unanimity amongst the responses as to the use of plyometrics, there was far more variance in the methodologies deployed. Plyometrics cover a wide range of jumping, hopping, and bounding-based exercises that have the fundamental aim of enhancing SSC performance. The most frequently reported plyometric exercise was multiple hops/jumps, with 80% of coaches (n = 41) using these regularly. Other exercises regularly used were box drills (eg, box jumps) (n=36; 71%), reactive jumps in place (n =32; 62%), bounding and vertical jumps (both n =28; 55%), horizontal jumps (n=27; 47%), and depth jumps (n=24; 47%). Other select responses include 'proprioceptive ancillary drills for stiffness' and 'ankling warm-ups'. These results are highly comparable to reported use of plyometrics in other sports. Box jumps, jumps in place and multiple hops were the most frequently used plyometric exercise in rugby (74.4%),[40] whereas box drills and multiple hops (85%) were second only to upper body plyometric exercises in basketball.[73]

Coaches in this study reported using both vertical jumps (55%), and horizontal movements, such as bounding (55%) and horizontal jumps (47%). Direction of force applied during plyometric or resistance exercises may be considered as a determinant factor of maximal sprint performance.[58] For example, it has been shown that horizontal force production jumps such as broad jumps, and resisted sprints have positive responses in acceleration capacities in elite young football players.[48] Conversely, vertical jumping has been shown to have positive effects on speed at longer distance (10 to 20m),[48] which would be consistent with the increased amount and importance of vertical ground reaction forces during the transition from lower to higher velocities.[52] To this end, the GCT and the type and direction of forces should guide plyometric choice.

Using plyometric exercises was also the main exercise stimulus reported to be used in speed development training (n=40, 78%). Previous studies into other sports have shown that plyometric exercises are frequently used modality in speed development. For example, in rugby union,[40] plyometric exercises were second behind un-resisted or free sprinting – which was third (68%) in the current study in football. In basketball,[743] plyometric training and speed endurance running (90%) are second only to speed or sprint training drills. In this current study, 68% of coaches used un-resisted (free) sprinting and 63% used sprint mechanics/technique running drills to develop speed in football players. Considering that all coaches incorporate strength training practices, with their main focus being performance enhancement, and 95% of coaches using plyometric exercises, it would appear that 68% is surprisingly low for using actual sprint-related drills to improve speed development and may compromise effective speed development.

The second question in this sub-section asked practitioners how they integrate plyometric training into their S&C programmes. A total of 24 coaches (47%) stated that it is 'dependent on the individual athlete'. The individualisation of plyometric programming is far greater in the results of this study compared to those previously reported in other sports. In rugby union,[40] only 13% of coaches integrate plyometrics depending on the athlete's individual needs. Similarly, in the NBA,[73] only 5% of coaches integrate plyometrics depending on the athlete's individual needs.

Fifteen (29%) coaches reported that 'plyometric exercises and resistance training are done as complex training during the same session'. In comparison to similar studies in other sports, plyometrics used as complex training with resistance exercises is a far more common practice. In rugby union, 80.6%,[40] in the NBA 60% of coaches,[73] and in the NHL 56.6%[24] of coaches integrate plyometrics as complex training within strength and power sessions. In NHL,[24] results are closer to that seen in football, with 26.9% of coaches integrating plyometrics as complex training.

In this study, 14 (27%) coaches only include plyometric exercises 'on the grass during the warm up', and 11 (22%) state that plyometrics are completed 'on separate days to resistance training'. In comparison, in rugby union, 6.5% of coaches integrate plyometrics only 'within on-field warm-ups.[40] Other responses included 'depends on the phase of training as to when they are included', 'pre-training to potentiate speed drills' and 'incorporated within sprinting sessions'.

The next question in this sub-section asked practitioners how they integrated speed development training into their S&C programmes. Twenty-seven (54%) coaches reported that 'speed development training is only included on the grass, during warm-up or conditioning drills'. Twenty-five (49%) coaches stated it was 'dependent on the individual athlete', 13 (25%) reported that 'it is done before resistance training, but on the same day', 9 (17%) reported that they included speed training 'in complex training during the same sessions as resistance training', and 6 (11%) state that it is done on 'separate days to resistance training'. Only two (4%) coaches reported that 'speed development training is done on the same day but after resistance training'.

Despite previous studies in other sports highlighting the use of speed development sessions, no data have been produced showing how they can be integrated into daily or weekly practice.

STRENGTH AND POWER DEVELOPMENT: PERIODISATION

Periodisation is a theoretical model that offers a framework for the planning and systematic variation of an athlete's training prescription.[10] Periodisation was originally developed to support the training process in track and field or similar sports in which there is a clear overall objective such as training tailored towards a major championship such as the Olympics.[66] The inclusion of variation in the prescribed training load is thought to be a fundamentally important concept in successful training programmes.[32] Sustained exposure to the same training load can fail to elicit further adaptations as an athlete adapts to the stimulus. Sustained training loads, especially if they are high, can also lead to fatigue and injury.[57] Both these outcomes would result in ineffective training sessions and a failure to benefit performance of both the individual athlete and the team.[57]

Training studies normally show that periodised training elicits improved responses when compared to groups employing a constant load.[30,76] Consensus has thus largely been reached among researchers and practitioners that periodised training offers superior development of strength, power, body composition, and other performance variables.[30,75,76]

Forty-three of the 51 respondents (84%) reported implementing periodisation strategies in their S&C programmes. This practice is lower, but similar to that of coaches in rugby union (90%), rowing (97%), NBA (91%), NHL (90%), and MLB (83%).[40,34,73,24,23] Eight (16%) answered 'no', they do not use a periodisation strategy. The main reason (n=26, 51%) given for

implementing a periodisation strategy was that 'periodisation helps target a specific outcome at a specific period'. Other answers were that 'periodised training offers superior development of strength, power and performance variables' (n=22, 43%), 'it helps prevent stagnation or boredom' (n=11, 22%), and it is 'vital to know when to add or delay chances in the programme' (n=10, 20%).

A major obstacle for coaches working in seasonal team sports is the frequent matches and extended competition period. Football players need to attain multiple physical training goals within similar time periods and a competitive fixture schedule that requires multiple (around 40-50) peaks across a 10-11 month season. This is supported by the responses provided in this research. The main reason as to why a periodisation strategy was not incorporated was 'too many external variables interrupt any pre-planned periodisation strategy' and 'players don't perform enough S&C to follow a true or traditional periodisation strategy'. Other responses included 'too many matches', 'our sessions incorporate most aspects of athletic development' and 'don't follow a traditional model of periodisation'. A potential complication here is what is considered to be periodisation. Traditional periodisation strategies often focus on a particular component of training for approximately four weeks, utilising a 3:1 loading paradigm whereby progressive loading is applied for weeks 1-3 and week 4 is a de-load. However, there is a general lack of evidence for the direct application of traditional periodisation models to team sports such as football.[32]

If coaches were to follow the classic model, training would taper considerably for the duration of the competition phase and this would be hugely counterproductive for most team sports.[5,37] Therefore, a non-linear or conjugate periodisation, which involves the variation of load and volume on a session-by-session basis, is more appropriate to team sports during the in-season.[33] It could be that this type of approach is actually deployed but was not considered as periodisation by the 16% of responders who reported not using periodisation.

Periodisation in football has previously focused on the on-pitch conditioning of players.[49] This may be due to the fact that in order to optimally prepare players to undertake the different positional match demands, specific physical and technical football drills are implemented to achieve these key physiological requirements. It may also be because coaches often see the on-pitch technical, tactical and physical work to be of greater importance than gym-based activities. Although it is clear that some general concepts associated with periodisation (for example, the division of the year into phases of training; namely pre-season, the competitive season, and the off-season) are applied within the elite professional game, there is little evidence for the wholesale application of the traditional methods of periodisation.

Therefore, relatively little information is available, either in the literature or applied professional journals, that provides a detailed outline of the longitudinal gym-based S&C training loads experienced by players in football.

CURRENT ISSUES AND BARRIERS TO PRACTICE

It is well known that football schedules are often congested, chaotic and at constant threat of changing due to several factors such as television coverage and progression in one or a number of knockout tournaments. Issues around fixture congestion are impossible to change, as the nature of the sport can require teams to play 2-3 games per week for the vast majority of the season.[2,83] This is the case for not only the elite teams playing in European competition, but also those in English domestic leagues, due to involvement in multiple cup competitions on top of a 38-46 game league season. It becomes difficult to periodise, manage training load and avoid accumulated fatigue, while ensuring that players remain at an optimal level of physical fitness during the season.[2]

It is therefore no surprise that time available between matches was reported as the biggest

'building relationships and effective communication styles to allow players to see the transfer of gym work to on-field performance would be highly advantageous'

'if the requirement in professional football is to improve performance and help prevent injuries, then organisations may need to employ more qualified staff in strict S&C roles'

challenge facing the implementation of S&C practices by practitioners in this study. It was also the second ranked perceived challenge facing those at other organisations. Reduced recovery time and congested match schedule are highly ranked perceived extrinsic risk factors for injury in top-level football.[53] Responses in this study are in line with those previously reported into injury prevention strategies and on-pitch conditioning.[8,19,49,53,54] In agreement, 33 (64.7%) coaches in this survey suggest that the increase of in-season fixtures is a cause of increased injury risk.

Additionally, the importance placed on winning matches, which was ranked second in barriers to practice, is a barrier that will prove very difficult to change. The overall aim of senior professional sport is to win, and support staff operating within these organisations should always remember that winning is often deemed more important than the process of getting there. The importance of winning matches has previously been highlighted as a barrier to physical fitness development;[49] in this current report, one practitioner suggested that S&C coaches 'need to understand that we are part of football performance, not just gym performance'.

However, 'lack of staff' or 'lack of or poor facilities', which were third and fourth ranked responses in this survey, are something that can be managed. If performance, injury rates and time lost to injury are all important factors to winning matches,[35] then employing qualified staff and providing adequate training facilities should be of high importance to senior club staff. Lack of staff has previously been highlighted as a substantial barrier to the effectiveness of any training load monitoring practices in football.[1] Hagglund et al[35] have previously described how a low incidence of injuries and team success are correlated, whereby teams with fewer injuries have better results in both UEFA tournaments and in national leagues. The results from this study should provide clear motivation for coaches and managers to work together with medical teams to help prevent injuries. Although not reported in this study, from the authors' experience, many football clubs especially in the lower tiers of English football may not have their own training facilities. Often clubs will use local leisure centres, universities or public fitness centres for their S&C sessions, which all provide barriers to the effective application of strength and conditioning.

Within the 51 clubs who responded to this study, there was a total of 452 staff employed. However, S&C coaches were the least represented out of all the professions, with only 10.6% (n=48) compared to 27.2% (n=123) physiotherapists, 15.3% (n=69) sports scientists and 14.3% (n=66) soft tissue therapists. Clearly S&C still has a long way to go before it is fully accepted as a key part of a performance team. This is further emphasised by the fact that there were less reported paid S&C coaches than interns (n=61, 13.5%) within the 51 clubs who replied, further emphasizing the potential lack of importance placed on strength and conditioning.

However, although we did not ask the question, it is always possible that some sport scientists, physiotherapists and interns take the role of S&C coaches in some organisations and therefore these numbers may not be truly representative of the landscape. Clubs in the lower tiers, or those with less finance, may utilise some staff in a dual-role capacity. Some sports scientists and S&C coaches may often have inter-changeable job titles depending on the organisation. For example, someone whose job role is primarily that of an S&C coach, may in fact have the job title of sport scientist or fitness coach. The fact that 112 members of staff hold a S&C-related certification, but only 48 (43%) are classified as S&C coaches may bear this out. However, if the requirement in professional football is to improve performance and help prevent injuries, then organisations may need to employ more qualified staff in strict S&C roles. In fact, when given the option to provide an insight into the future of S&C in football, several practitioners provided answers that support this argument. Responses included: 'the increased demands of the game and athletes will improve buy-in', 'with players becoming fitter, faster, stronger, the role

of the S&C coach will become more vital', and 'hope that S&C coaches get the same recognition in terms of salary and respect as other medical staff'.

Given that S&C has yet to be fully accepted in football, an important role for a coach is to convince key people of the potential impact S&C practices can have on football performance. Consequently, coaches were asked about their methods for creating a positive buy-in or attitude towards S&C practices. Results show that 46 (90%) coaches believe 'building trust and effective relationships with players' to be the most valuable method for creating a positive attitude towards S&C. Forty-one (80%) coaches reported 'effective communication with athletes' as the second most valuable method for creating a positive attitude towards S&C. These responses could be of interest to current and up-and-coming coaches.

On the other hand, programme design (n=14, 27%), exercise selection (n=11, 21%), and use of the latest technology (n=4, 8%), all areas that are typically associated with superior strength and conditioning programming, were actually lower ranked responses. Instead, it was communication, relationships and approach to players and staff that were deemed more important. Often, S&C professionals are encouraged to think it is the choice of exercises that make a successful programme, but coaches working in elite football suggest differently. No survey into other sports has asked this question before, and as such, the findings relating to S&C practice in football are novel to this report, and crucial if the field is to develop suitably skilled coaches.

As a result, universities, coaching organisations such as the NSCA or UKSCA, and other educational providers should be encouraged to incorporate more communication style and relationship building education into their courses rather than focusing solely on the importance of exercises per se. Interestingly, previous research with elite athletes has shown that – while instruction, technical knowledge and feedback are essential in delivery effective S&C coaching – athletes suggest that trust, respect and relationship with the coach have an important role in a successful programme.[79]

Thirty-seven (72%) coaches reported 'showing the player how gym-based exercises will translate to on-pitch improvements' as an important method for creating a positive attitude towards S&C practices. The transfer from 'gym strength' to on-field performance is supported by the training principle of specificity, which states that the closer the strength training resembles a sport movement, the greater the transfer of strength is, particularly in elite athletes.[90] Muscle recruitment patterns associated with a strength training task should be comparable when expressed during the sport movement.[13] For example, this would include the direction of force, velocity of movement and muscle contraction types[42] being similar in gym-based movements to those performed on the pitch. Research into a number of elite sports (track-cycling, kayaking, rowing and athletics) has shown that S&C coaches believe that in order to gain the biggest transfer from gym strength to performance strength, there needs to be a strong combination of non-specific strength training and resisted sport movement training, such as resisted rowing, resisted running or over-geared (increased resistance) pedalling.[11]

Taken together, it could be suggested that to create a positive buy-in from players to help develop a successful S&C programme, building relationships and effective communication styles to allow players to see the transfer of gym work to on-field performance would be highly advantageous.

Practical conclusion

This study is the first to describe the S&C practices of coaches supporting football athletes in the UK and North America. As respondents supported professional senior male level football players, practitioners now have a source of data describing S&C at the elite end of football. Coaches and sports science practitioners who work with football athletes at all levels can use this summary of S&C practices as a resource to inform and improve their practices. Information presented in this article may also influence the design of experimental protocols in future studies investigating effects of conditioning interventions on physical performance variables associated with football performance.

There are currently some recommendations regarding what exercises could be used to create an effective S&C programme, and how these can be prescribed in professional players (eg, sets, reps, frequency and progression). There is, however, no clear consensus regarding the most effective

'Coaches and sports science practitioners who work with football athletes at all levels can use this summary of S&C practices as a resource to inform and improve their practices'

approach to integrating a multidimensional S&C programme into a football season. Similarly, there are no clear guidelines regarding when the programme can be performed in relation to matches or other exercise sessions; for example, during congested schedules when three matches are played per week and recovery time is reduced. Results from this survey highlight when and how practitioners aim to incorporate strength, plyometric, eccentric and speed development sessions into their training schedule. It also reports the variables that need to be considered, and barriers to incorporating practices when trying to include S&C practices. Information in this study has shown that, despite the wide range of exercises available, many coaches use the same types of exercises with their athletes, with a dual focus on bilateral and unilateral exercises.

Interestingly, coaches have shown that communication and relationship-building skills are considered more important at creating player programme buy-in than anything else, including exercise selection. It would therefore be of interest to coaches and researchers to find ways to develop these skills to enhance the success of S&C practices to professional football players.

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