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Practices of Strength and Conditioning Coaches: A Snapshot From Different Sports, Countries, and Expertise Levels

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Abstract

Weldon, A, Duncan, MJ, Turner, A, LaPlaca, D, Sampaio, J, and Christie, CJ. Practices of strength and conditioning coaches: a snapshot from different sports, countries, and expertise levels. *J Strength Cond Res* 36(5): 1335–1344, 2022—This study describes the practices of strength and conditioning coaches (SCCs) from different sports, countries, and expertise levels. One hundred fifty-six SCCs (31.9 ± 8.9 years old) completed an online survey, consisting of 40 questions (36 fixed response and 4 open-ended), with 8 sections as follows: (a) background information, (b) muscular strength and power development, (c) speed development, (d) plyometrics, (e) flexibility development, (f) physical testing, (g) technology use, and (h) programming and any additional comments. Responses were received from 48 sports and 17 countries. This study provides exploratory evidence incorporating responses primarily in soccer (45%), track and field (30%), volleyball (23%), golf (17%), and tennis (17%). A bachelor's degree or higher were held by 99% of SCCs, of which 94% were in a sports science–related field, and 71% held a strength and conditioning related certification or accreditation. Periodization strategies and physical testing were used by 96% and 94% of SCCs respectively. The hang clean (82%), power clean (76%), and clean high pull (63%) were the most prescribed Olympic weightlifting exercises. Multiple hops/lunges (84%) were the most prescribed plyometrics exercises. For open-ended questions, 40% of SCCs wanted to integrate more technology into their programs and 30% believed technology will be the main future trend. Strength and conditioning coaches from different sports, countries, and expertise levels can use the information presented in this study to review their current practices and provide a source of new ideas for diversifying or modifying future practices.

Key Words: survey, exercise selection, physical development, programming, physical testing, technology

Introduction

A strength and conditioning coach (SCC) forms part of a multidisciplinary team and is required to have a general understanding of coaching and sports science with the primary roles of reducing injuries and improving performance (43). As strength and conditioning continues to evolve and additional responsibilities are given to SCCs, it is important to understand the current practices of SCCs in a range of sports, countries, and expertise levels. This will help identify possible gaps between theoretical models, proposed guidelines and real practice, and to further develop research and education resources in this field. Strength and conditioning practices have been examined in some sports such as National Football League (NFL) (11), National Hockey League (NHL) (12), Major League Baseball (MLB) (13), National Basketball Association (NBA) (37), rowing (17), wrestling (14), rugby union (21), and swimming (7), and populations, such as high school SCCs (10), cricket coaches (30), strongman athletes (44), sprint coaches (20), and rugby union coaches (33). Although these studies provide rich data on the practices of SCCs, there are still a number of sports, countries, and levels underrepresented, which it would be beneficial to add such data to this field of research.

The aforementioned research provides valuable insights for understanding the physical testing, exercise prescription, and programming strategies used by SCCs. Physical testing is well established within SCCs practice as an effective way to guide training for both competitive and noncompetitive sports (29). In previous surveys physical testing was reported as being commonly used in NFL (11), NHL (12), MLB (13), NBA (37), wrestling (14), rowing (17), and rugby union (21). As might be expected, there is considerable commonality in the physical constructs assessed by SCCs with body composition (11–13,17,21,37), strength (11,13,14,17,37), and power (12,14,17,21,37) being assessed regularly across sports. Acceleration (12,13), speed (11–13) and agility (11-13) was tested infrequently by less than 50% of SCCs irrespective of the importance of these physical attributes in these sports. Whereas, cardiovascular endurance was tested with regularity in the NHL (12), NBA (37), and rugby union (21), but only in rowing was it assessed by more

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than 90% of practitioners responsible for strength and conditioning. Flexibility was cited as being tested in NFL (11), MLB (13), and rowing (17), whereas the proportion of coaches testing this construct was less than 50%. Oher physical testing components such as anaerobic capacity (12,14), muscular endurance (12,14), and agility (14,37) have been used frequently in some sports but not all. Although 100% of SCCs in MLB (13) reported physically testing athletes, they regularly tested fewer constructs than other sports, such as NFL (11), NHL (12), and NBA (37). Therefore, although physical testing is commonly used by SCCs in elite sport as demonstrated in previous surveys, it is also of interest to ascertain whether such practices are also commonplace in different sports and levels of expertise.

Regarding exercise prescription, SCCs considered the squat to be the most important exercise for strength and power development in numerous sports, such as swimming (7), NFL (11), NHL (12), MLB (13), wrestling (14), rugby union (21), and NBA (37). Olympic weighlitfing and associated derivatives were also frequently prescribed in the NBA (37) (95%), NHL (12) (91%), NFL (11) (88%), rowing (17) (87%), and wrestling (14) (83%). Plyometrics was frequently prescribed for power development in NBA (37) (100%), wrestling (14) (100%), rugby union (21) (95%), MLB (13) (95%), NHL (12) (91%), and NFL (11) (73%). Whereas, speed development exercises were commonly prescribed in NFL (11) (100%), MLB (13) (100%), NBA (37) (100%), wrestling (14) (100%), NHL (12) (96%), and rugby union (21) (93%). Although there is some commonality in the types of exercises prescribed by SCCs, given a general need to train all components of fitness, there are naturally differences where SSCs must tailor the training to the demands of their sport. For example, in the MLB (13) it was deemed important to prescribe exercises particularly focussing on the development and function of the rotator cuff/shoulder stabilizer, which is logical given the importance of pitching in MLB; however, this was not an explicit focus of strength exercises prescribed by SCCs in other sports (11,14,17,21,37). The reasons for discrepancies in other sports are less clear; for example, SCCs in wrestling (14) and rowing (17) favored lower-body plyometric exercises, whereas it may be argued that upper-body plyometric exercises are just as important to develop the physical capacities specific to these sports. It is therefore acknowledged that there are some commonalities in the types of exercises prescribed by SCCs across most sports, albeit prescribed with different frequencies, whereas, to meet the physical demands in some sports (e.g., baseball), SCCs may also prescribe specific exercises.

Previous studies assessing the practices of SCCs have predominantly focused on North American sports (11–13,37) and that of the elite level (7,11–14,17,21,37). However, as the discipline of strength and conditioning continues to grow, which is evident from the National Strength and Conditioning Association (NSCA) now expanding to 45,000 members across 72 countries (27), there is a need to develop a broader understanding of the practices of SCCs. Furthermore, with the advances in strength and conditioning research and the development of technology software and hardware (25), it is also important to ascertain if SCCs are able to keep up to date with contemporary practices in strength and conditioning.

Therefore, the purpose of this study was to build on the current body of research and provide further insights and description into the practices of SCCs of different sports, countries, and expertise levels. Furthermore, this study aimed to provide information for SCCs to review their current practices and provide a source of new ideas for diversifying or modifying future practices.

Methods

Experimental Approach to the Problem

A cross-sectional explorative study was designed to survey SCCs from a range of sports, countries and expertise levels, to ascertain their current strength and conditioning practices.

Subjects

One hundred fifty-six SCCs participated in this study, comprising 143 men (92%) and 13 women (8%), mean age 32 years +/- 8 years (range, 19-65). The study was approved by the Research Ethics Committee of the Technological and Higher Education Institute of Hong Kong. Inclusion criteria were those currently employed as a SCC. All subjects were informed of the benefits and risks of the study before providing written informed consent to initiate the survey online. The survey was anonymous, and all questions required an answer; therefore, only fully completed surveys were used for analyses. The start of the survey included an explanation of the purpose, aims, time-commitment required, and the confidentiality of information. Respondents were informed that a copy of results may be sent to them on request.

Procedures

The survey was adapted from previous research (11,21) and developed using open access survey administration application Google Forms. The survey comprised of 8 sections as follows: (a) background information, (b) muscular strength and power development, (c) speed development, (d) plyometrics, (e) flexibility development, (f) physical testing, (g) technology use, and (h) programming and any additional comments (see Appendix 1, Supplemental Digital Content 1, http://links.lww.com/JSCR/A225). The first 7 sections included 36 fixed response questions and respondents had the opportunity to provide specific answers using the "other" option, and the last section included 4 open-ended questions. Some questions allowed respondents to select more than one response (e.g., which sport(s) do you currently coach), therefore some completed questions have more responses than others. Pilot testing was conducted by the 6 members of the research team, then by 6 accredited SCCs, for a total 3 rounds of pilot testing before the survey was finalized. Pilot testing led to slight modifications to the wording and structure of the survey to ensure its validity for use with this population. The survey was circulated through social media platforms, such as LinkedIn, Twitter, and Instagram, frequently used by those working in strength and conditioning. This approach was used to provide a broad overview of the perspectives of SCCs rather than capturing a specific subset of SCCs, which has been the case in previous studies.

Statistical Analyses

All responses from Google Forms were downloaded into an Excel 2016 spreadsheet (Microsoft Corporation, Redmond, WA). Fixed response questions were assessed using a frequency analysis. Whereas, a six-stage thematic analysis (5) approach was used to assess open-ended questions that included (a) familiarization with the data, (b) generating initial codes, (c) searching for themes, (d) reviewing themes, (e) defining and naming themes, and (f) producing the report. This method of thematic analysis has been previously used by studies surveying SCCs and sports coaches (7,20). Using this approach, overarching clear and identifiably distinct themes

representing the main ideas or patterns emerging from the raw data were generated for each of the open-ended questions. In some cases responses received from SCCs provided sufficient information that more than one overarching theme could be identified.

Results

Background Information

A total of 156 SCCs with a mean strength and conditioning experience of 8.35 ± 6.89 years participated in this study. Responses were received from 17 countries, with the most reported being the United States (33%), United Kingdom (21%), China (18%), and Spain (12%). A total of 48 sports were reported as being worked in (Figure 1), whereas 54% of SCCs concurrently worked in more than one sport.

Strength and conditioning related certifications were held by 71% of respondents, whereas 23% had more than one qualification. The most reported strength and conditioning certifications were NSCA-Certified Strength and Conditioning Specialist (CSCS) (70%), United Kingdom Strength and Conditioning Association (UKSCA) Accredited SCC (ASCC) (14%), Australian Strength and Conditioning Association (ASCA) SCC Accreditation (13%), Collegiate Strength and Conditioning Coaches Association (CSCCa) SCC Certified (SCCC) (11%), and United States of America Weightlifting (USAW) Certification (9%). In total, 99% of SCCs reported being educated to degree level, whereas 94% of these reported completing a degree in a sports science–related field. The most reported highest level of degree was bachelor's degree (25%), master's degree (65%), and Doctor of Philosophy (PhD) (8%). A strength and conditioning internship was completed by 69% of respondents, and the most reported times for completing an internship were before certification (69%), during certification (46%), and after certification (27%). The level of athlete(s) SCCs currently work with are presented in Figure 2.

Muscular Strength and Power Development

Off-Season. The most reported number of strength training sessions during this period per athlete/team each week was 3 sessions (39%), 2 sessions (21%), 4 sessions (17%), and 5 sessions (8%). The most reported length of sessions was 45–60 min (50%), 60–75 min (28%), 30–45 min (12%), and 75–90 min (8%). The most reported set ranges were 3–4 (60%) and 5–6 (22%). Ten (6%) SCCs provided other responses, including "dependent on the objectives" and "individualized for each athlete." The most reported repetition ranges were 4–6 (31%), 10–12 (31%), and 7–9 (21%). Eleven (7%) SCCs provided other responses, including "I use an auto-regulatory progressive resistance exercise protocol on main lifts" and "Depends on the periodization, sometimes using 1 × 20 method, but a usual rep range 10–15."

In-Season. The most reported number of strength training sessions during this period per athlete/team each week was 2 sessions (51%), 3 sessions (25%), 4 sessions (9%), and 1 session (6%). The most reported length of sessions was 45–60 min (40%), 30–45 min (32%), 60–75 min (14%), and 15–30 min (8%). The most reported set ranges used were 3–4 (76%) and 5–6 (11%). Five (3%) SCCs provided other responses, including "depends what stage of development" and "depends on sport." The most reported repetition ranges used were 4–6 (49%), 1–3 (18%), and 7–9 (18%). Seven (4%) SCCs provided other responses, including "Athlete dependent" and "2–3 reps for multijoint, explosive movements; 4–6 reps for auxiliary, strength-based movements."

Periodization, Set Loads, and Recovery. Periodization strategies were used by 96% of respondents to structure their programs. The most reported methods for determining set loads were rating of perceived exertion (RPE) (49%), repetition maximum (45%), predicted repetition maximum (42%), athlete determined (33%), velocity (e.g., accelerometer) (31%), trial and error (17%), subjective/guess (14%), and train to failure (5%). The amount of recovery time prescribed by SCCs between strength and conditioning training, sports practice, and competition is presented in Table 1.

Resistance Training. All SCCs reported using resistance type training and aside from the more traditional exercises, whereby the concentric portion of the lift is emphasized, SCCs also reported using eccentric (92%), isometric (73%), variable (e.g.,

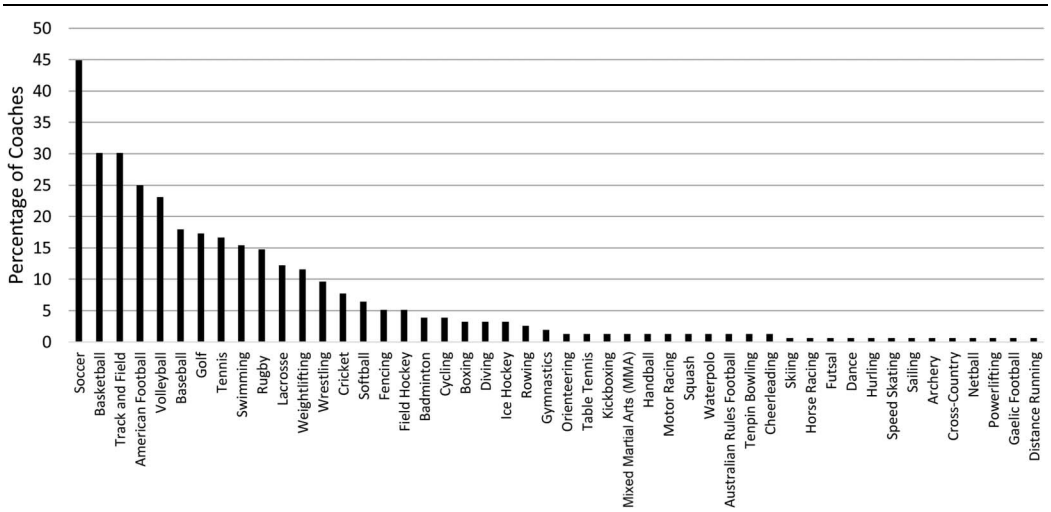

Figure 1. Sports strength and conditioning coaches surveyed reported currently working with. Some strength and conditioning coaches responded to working in more than one sport.

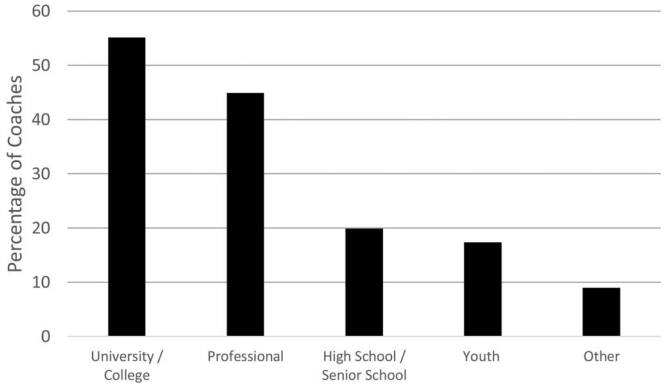

Figure 2. Level of athlete strength and conditioning coaches surveyed reported currently working with.

bands and chains) (69%), machine (19%), and isoinertial (e.g., flywheel) (10%) modes of resistance. Olympic weightlifting and associated derivative exercises were prescribed by 87% of respondents, and an overview of these exercises are presented in Figure 3.

Speed Development

Speed development exercises were prescribed by 99% of SCCs, and an overview of the exercises prescribed are presented in Figure 4.

Plyometrics

All SCCs reported using plyometric exercises, an overview of the purposes for prescribing plyometric exercises are presented in Figure 5. Eight (5%) SCCs stated "injury prevention" as another purpose for using plyometrics that was not available in the multiple choice answers for this question. The most reported times for prescribing plyometric exercises were before weights (40%), as complex training (35%), on separate days (15%), and after weights (5%). The most reported times of year for prescribing plyometric exercises were all year round (66%), preseason (26%), in-season (26%), training camp (10%), and offseason (8%). The plyometric exercises prescribed by SCCs are presented in Figure 6.

Flexibility Development

Flexibility exercises were prescribed by 99% of respondents, and an overview of the most reported times for prescribing flexibility exercises are presented in Figure 7. The most reported length of flexibility sessions was 5–10 min (41%), 10–15 min (30%), ≥20 min (30%), 0–5 min (11%), and 15–20 min (10%). An overview of the frequency that SCCs prescribe different methods of flexibility exercises are presented in Table 2. The most reported duration of holding static stretches was ≥20 sec (30%), 10–15 sec (23%), 15–20 sec (21%), and 5–10 sec (8%).

Physical Testing and Technology Use

Physically testing of athletes was reported as being administered by 94% of respondents, with the most reported times for administering physical tests being all year round (54%), pre-season (46%), off-season (30%), in-season (18%), and training camp (10%). An overview of the most of the most utilized physical tests are presented in Figure 8.

Technology-based equipment was used by 65% of respondents, and 22% of whom provided specifically which equipment was being used, such as jump mat/other jump assessment devices (55%), bar velocity trackers (41%), speed gates (23%), global positioning system (14%), force plates (14%), mobile applications (9%), heart rate monitors (4.5%), video analysis software (4.5%), crane scales for isometric midthigh pull (4.5%), and body composition analyzers (4.5%).

Athlete well-being was monitored by 84% of respondents, with the most common methods used being mobile device questionnaires (50%), verbal questionnaires (47%), and written questionnaires (32%). In total, 9% of respondents monitoring athlete well-being provided other responses, including conversation/talking with athletes (83%) and monitoring training performance (17%).

Programming and Additional Comments

Four open-ended questions were asked in the final section of the survey (see Appendix 1, Supplemental Digital Content 1, http://links.lww.com/JSCR/A225), to allow more detailed responses from SCCs. From the responses to these questions higher-order themes were created. The number of responses to each theme and exemplar responses are provided in Tables 3–5.

The final open-ended question provided SCCs the opportunity to make any additional comments, which 9% did. The responses are summarized here: "I'm in charge of both male and female squads, so it's quite crazy and hard to manage and individualize training for that number of athletes," "Time for planning and programming barely exists," "Good strength and conditioning is not about performance enhancement; it is about optimizing movement patterns while pursuing adaptation goals," "For this industry to grow, the current certification process has to be integrated within the university's sports

Table 1

Percentage of responses from strength and conditioning coaches surveyed for recovery time prescribed between different modes of training, sports training, and competition.

Question	Same day	24 h	36 h	48 h	>48 h
Recovery time between speed development and sports training session	43	37	8	10	2
Recovery time between strength/power development and sports training session	42	33	12	11	3
Recovery time between speed development and competition	3	26	25	30	16
Recovery time between strength/power development and competition	3	17	24	33	22

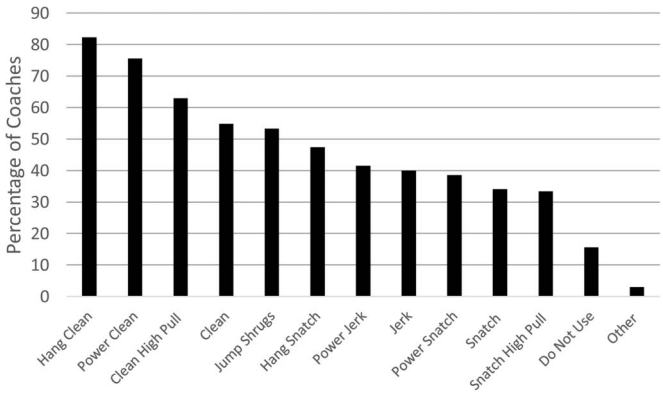

Figure 3. Percentage of different Olympic weightlifting exercises strength and conditioning coaches surveyed prescribe.

science/human movement/exercise science curriculum, and more research should be done to uncover the black box of force production," and "This survey will provide valuable cross-sectional information, but we also need to think how to obtain longitudinal or time-related information."

Discussion

This study describes the practices of SCCs from a wide range of sports, countries, and expertise levels. Unlike other studies, this survey included responses from soccer (45%), track and field (30%), volleyball (23%), golf (17%), and tennis (17%), which had similar response rates to previous research on specific sports (n = 20–43) (7,11–13,17,20,21,30,34,37). As the use of strength and conditioning is widespread in popular sports, such as soccer, and there is an expectation of SCCs to implement research informed practices, it is important the current practices of SCCs are further investigated to build upon the limited evidence and understanding we have in some sports (38,42). Results indicated 54% of SCCs worked in more than one sport, which was apparent across all experience, qualification, and expertise levels. This number is possibly inflated by the proportion of coaches working within university/college (55%) and high school/senior school (20%) populations, often requiring SCCs to work across a

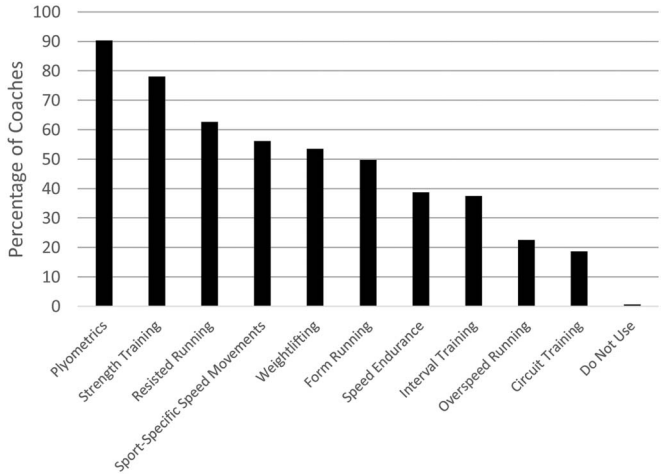

Figure 4. Percentage of different exercises strength and conditioning coaches surveyed prescribe for speed development.

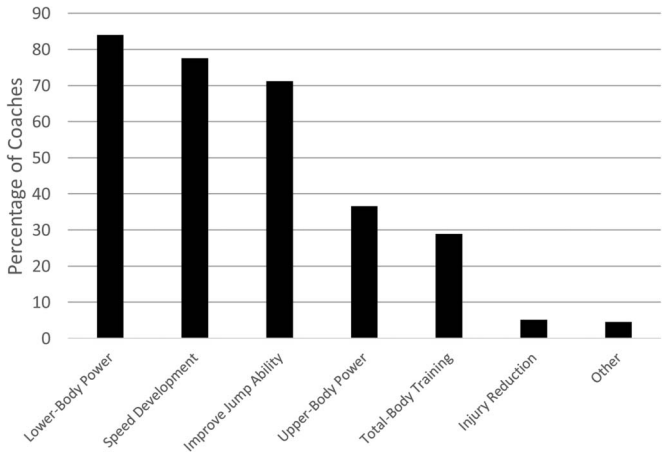

Figure 5. Different purposes for prescribing plyometric exercises and the percentage of strength and conditioning coaches surveyed who reported each purpose as their basis for using plyometrics.

range of sports. Nevertheless, this raises the importance of SCCs having a broad understanding of the application of strength and conditioning in different sports, recognizing general and specific principles of training, and possible transferences between sports.

In regards to academic qualifications, the highest qualification held by SCCs were master's degree (65%), bachelor's degree (25%), and PhD (8%). of which 94% were in a sports science–related field. Furthermore, 71% of SCCs had a strength and conditioning related certification or accreditation. This is encouraging for the profession and how associated higher education curriculums around the world are seemingly addressing areas of strength and conditioning. To note, the survey used in this study was designed to enable all expertise levels to share their practices irrespective of qualification or experience level. It has been evidenced that competent and expert SCCs share similar skills, knowledge, and experiences, whereas the main differentiating factor is that expert SCCs have built upon these foundational characteristics to develop a higher level of coaching expertise (23). Whereas, interestingly irrespective of expertise level or experience, a number of SCCs reported the most unique aspect of their strength and conditioning program was that they "focused on the basics" (Table 3).

New information is provided on strength and conditioning internships, where 69% of SCCs completed their internship before

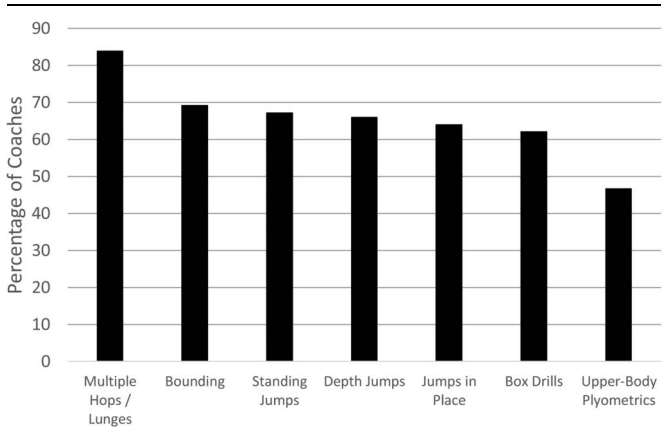

Figure 6. Percentage of different exercises strength and conditioning coaches surveyed prescribe for plyometrics.

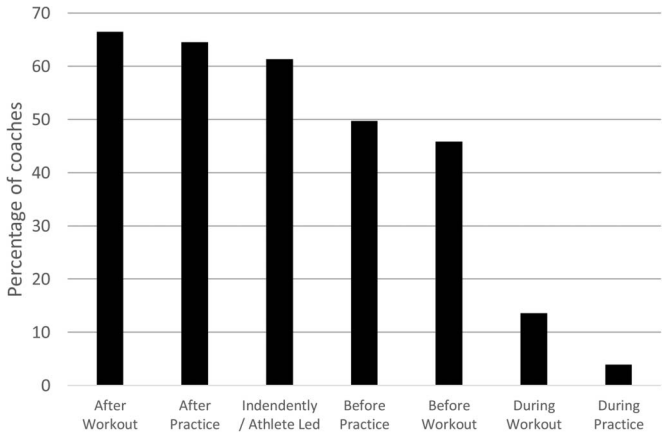

Figure 7. Different times for prescribing flexibility exercises and the percentage of strength and conditioning coaches surveyed who reported prescribing flexibility exercises at these times.

obtaining a strength and conditioning related certification, therefore it may be suggested internships were completed when SCCs had less experience. Similar findings were observed in a large survey of 600 SCC interns that showed 58% of SCCs were ≤25 years-old and had ≤2 years' experience (38). The high number of internships completed may suggest the importance SCCs place on this type of learning experience, which allows them to apply their strength and conditioning knowledge and practical skills (9). Furthermore, it has been observed that completing internships can increase the likelihood of employment, with previous surveys showing that 44% of SCC interns obtained employment with the organizations offering the internship (38).

With regard to strength and power development, results indicated a slight reduction in training load in-season as one less strength and conditioning session per week was completed, suggesting an intentional reduction. Similar findings were observed in SCCs surveyed in rugby union, which concluded the reduction was maybe associated with a maintenance approach whereas SCCs have more contact time with athletes to develop the physical qualities required in their given sports during the off-season (21). The use of maintenance sessions in-season can be beneficial in sports, such as soccer, where a single strength and conditioning maintenance session used in-season over a 12-week period was sufficient in maintaining strength and power gains achieved during a preceding developmental period (35).

Periodization strategies were used by 96% of SCCs, similar to previous surveys in wresting (14) (100%), rowing (17) (91%), NHL (12) (91%), rugby union (21) (88%), MLB (13) (86%), NBA (37) (85%), and NFL (11) (69%). This also aligns with research recommendations that have shown superior training adaptations in periodized training programs compared with those non-periodized, across different ages, training statuses, and program lengths (31). Although the most used method for determining set loads was RPE (49%), a number of SCCs still subjectively guessed (14%), meaning a load was estimated using no systematic method. This deviates from recommendations for planning resistance training programs, where it is deemed important to methodically estimate set loads and volumes to prescribe a suitable resistance and elicit the desired athlete responses and adaptations (18). It may be speculated that coaches use a method of subjectively guessing set loading due to time constraints or possibly having a strong understanding of the ability level of their athletes, which may still be suitable for athlete development.

Table 2

Percentage of responses from strength and conditioning coaches surveyed for the frequency in which different methods of flexibility training are used.

Type of stretch	Commonly	Sometimes	Never
Ballistic	20	38	42
Dynamic	83	15	2
Active	58	36	6
Passive	21	55	24
Static	38	47	15
Isometric	16	55	29
Proprioceptive Neuromuscular Facilitation	13	62	24

Regular physical testing of athletes was reported by 94% of SCCs, with an average of 5.7 aspects of fitness tested, and the most common tests used were for muscular strength (90%), similar to previous surveys in NHL (12) (100%), wrestling (14) (97%), rugby union (21) (81%), and NBA (37) (75%). It is unsurprising that muscular strength was the most reported test, as developing strength in both adolescent and adult populations is associated with reduced injury rates and is important for establishing a foundation for developing other attributes, such as speed and power (39). In addition, 84% of SCCs reported monitoring athlete well-being, with the most common methods used being self-reporting techniques, such as mobile device questionnaires (50%). The use of self-reporting techniques is a valid method for monitoring athletes' fatigue and well-being levels, and sports coaches and SCCs can use this information to modify set loads, training intensity, training volume, and provide further athlete support (36). Similarly, within training sessions SCCs primarily reported using subjective measures such as RPE (49%) for determining set loads, which has shown to also be a valid and reliable tool ($r = 0.8–0.9$) to inform SCCs whether modifications are required for exercise prescription, set load, and intensity (6). Therefore, it may be implied that the SCCs surveyed physically test and monitor athlete's well-being in line with other sports and research recommendations.

This study included questions regarding the integration of technology-based equipment into strength and conditioning

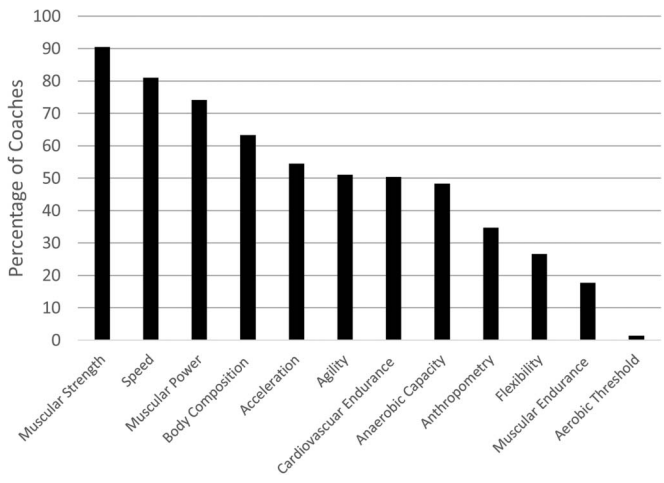

Figure 8. Different physical tests and the percentage of strength and conditioning coaches surveyed who reported using each physical test with their athletes.

Table 3

Strength and conditioning coach responses to the unique aspects of their strength and conditioning programs.

Rank	Theme	Exemplar responses	Percentage of coaches
1	Nothing/focused on basics	"No, just keep it simple and stick to the basics"	52
2	Sport-specific/individualized training	"We consider athletic performance in relation to athletes sport skill development - the curriculum is tailored to each players traits for example the learning focus and movement training needs change for early maturers compared to late maturers"	12
3	Holistic athlete development	"We have full time student athletes from U12 to U23's so we are able to holistically develop them as both athletes and people"	10
4	Miscellaneous	"Integration of interns into all facets of the program" and "I am the only employed strength coach for 300 athletes"	8
5	Technology/player testing and monitoring	"The use of technology for instantaneous feedback of exercise technique/performance" and "We regularly collect data on peak and absolute power outputs with all athletes"	7
6	Injury reduction/load management	"Integrating prehab and movement skills into specific and isolated sessions" and "Load management (gym + swimming + tec/tac work)"	6
7	Functional training	"Including motor learning and coordination" and "3D functional training"	6
8	Periodized	"It is adapted to the training and competition cycle of the athlete" and "The use of micro dosing through the week for improved athletic development"	6

3D, three dimensional; tec/tac, technical and tactical.
Some coaches detailed more than one response. Which was further sub-divided amongst the themes created.

training programs, which is of importance given its continued growth and application into all levels of sport (25). In total, 65% of SCCs reported using technology-based equipment, which additional comments from SCCs revealed jump assessment devices were most frequently used. This seems rational given all SCCs prescribed plyometrics, 84% prescribed plyometrics for lower-body power, and 74% physically tested muscular power, in which jump assessment devices may be used to ascertain whether training programs supported the specific physical adaptations desired. The survey received open-ended responses from some SCCs on the use of mobile device applications for monitoring and testing athletes, for which nowadays there are affordable and commercially available applications to assess different physical abilities (i.e., jumping performance) (19); however the use of such

Table 4

Strength and conditioning coach responses to changes or modifications they would make to their strength and conditioning programs given unlimited time and resources.

Rank	Theme	Exemplar responses	Percentage of coaches
1	Technology/player testing and monitoring	"I would like to integrate more technology if we had the funds" and "I would use more technology to monitor athlete well-being and training progress" and "More automated monitoring data collection and reporting"	40
2	Nothing/no change	"I don't think so. With our limited time and resources it forces us to keep things very simple and use bang for our buck training styles. Any more time or resources may muddy our waters a bit and may take away from the success we are seeing"	15
3	Programming specific exercises	"More speed and plyometric work" and "Upper-body ballistic training, high-speed running training, technical/contextual speed and change of direction training"	12
4	Individualization of training	"Individualized approach for every athlete" and "Individualize lifts each day based on practice demands as practice loads are typically sporadic"	8
5	Equipment/space	"I would like Keiser racks, football bars, trap bars, safety bars, prowler sleds, pit sharks, GPS systems" and "If provided with better open space I would make my athletes move, sprint, etc more often"	8
6	Scheduling/recovery	"I would train lower-body strength Tue and Thu PM. Whole-body power Thu AM. Incorporate plyos into AM activation" and "Train in smaller groups with some of the bigger teams like football and baseball"	7
7	Staff	"Have more S&C coaches to monitor/lead workouts" and "Yes, hire more staff to further split groups up."	6
8	Miscellaneous	"Integration of more academic research" and "pregame preparations, fueling station/training table"	5
9	Time	"Our biggest limitation is time with athletes" and "Have more time with the athletes"	5

GPS, global positioning system; S&C, strength and conditioning.
Some coaches detailed more than one response. Which was further sub-divided amongst the themes created.

Table 5

Strength and conditioning coaches' responses to what they believe future trends in strength and conditioning will be.*

Rank	Theme	Exemplar responses	Percentage of coaches
1	Technology	"I believe that technology is going to continue to take over how we train athletes" and "Wearable technology for readiness to train"	30
2	Variety of training	"Greater awareness of conditioning, strength, and agility outside the gym walls" and "The old fundamentals of just get strong through nonspecific movements needs to evolve. The link should be closer between skills and S&C"	21
3	Miscellaneous	"S&C will become more popular and important" and "Greater sports specialization among S&C coaches"	12
4	Testing and monitoring	"Daily monitoring and manipulation of program based on results" and "Digital athletic profiles for each individual athlete measured against each day, accounting for sleep and caloric intake providing readiness measurements that dictate practice/training participation levels"	9
5	Education	"I'm hoping that you have to have a degree in a science based field before you can be a full-time strength coach in the collegiate and professional sectors" and "More desire toward coaches gaining S&C accreditation and higher degrees"	8
6	Data analytics	"Data driven with wearable technology, AI, and deep learning. Real data evidence base may be another trend" and "Machine learning to guide decision making"	7
7	Individualization of programs	"Individual programs and evaluation of the player by position and body type and style of play" and "Total individualization of training, each athletes receive what they need, no more, no less"	7
8	Prehabilitation/recovery	"Injury prevention and corrective exercises" and "More focus on recovery rather than just on training"	6
9	Improved pay	"The salaries of S&C coaches increasing due to the realization of the value of S&C coaches"	4
10	Youth S&C	"In the youth sector in the UK—growth. It will become an integrated part of most high schools alongside PE teachers" and "S&C can be introduced to our education system like being employed in primary, secondary, tertiary education"	4

*AI, artificial Intelligence; S&C, Strength and conditioning; PE, physical education; UK, United Kingdom.
Some coaches detailed more than one response. Which was further sub-divided amongst the themes created.

applications was not specifically surveyed. Furthermore, responses to open-ended questions (Tables 4 and 5) revealed 40% of SCCs reported technology being something they would add to their programs with the predominant focus of testing and monitoring athletes, whereas 30% of SCCs believed it will also be an area that will become increasingly important in the future of strength and conditioning. Therefore, given the development and integration of technology, this may become more of a focus in future research surveying practices of SCCs.

In regards to training load and recovery between sessions, it was observed most SCCs planned strength and conditioning and sports training sessions on the same day, irrespective of the focus of training (speed, strength, and power). Whereas, 48 hours recovery was most prescribed between strength and conditioning sessions and competition, which suggests SCCs provided additional time for athletes to fully recover. The recovery duration provided to athletes is highly dependent on the type and intensity of the physical activity being performed, whereas it is imperative athletes receive adequate recovery from physical training before sports competition to ensure they can perform optimally (1,4). As observed multiple sessions may occur in the same day, whereas it is advised that if sessions are focusing on opposing physical qualities and performed within a short time frame this may hinder neuromuscular and aerobic adaptations, therefore a minimum of 6 hours recovery should be provided between sessions for concurrent training practices (33). However, the specific duration of recovery between sessions and physical characteristics of the competition being undertaken was not explicitly investigated in this study.

Concentric and eccentric type training exercises were most commonly reported in this study. In a survey on the strength and conditioning practices of university and high school cricket coaches, it was observed only 1 out of 15 reported using eccentric training for injury prevention (30), which is surprising considering eccentric training has been shown to reduce injuries in cricket players (15). It was suggested the lack of strength and conditioning education of coaches may be an underlying factor for such practice (30). Therefore, it may be suggested the SCCs in this study had a deeper understanding of strength and conditioning principles and used a more comprehensive approach to prescribe resistance training exercises (e.g., types of contraction) to develop the physical qualities of athletes and reduce the likelihood of injury (41). However, it must be noted in this study the question for types of resistance training used was more general in nature compared with Pote's study that was regarding injury prevention.

Olympic weightlifting and associated derivatives were prescribed by 87% of SCCs, similar to that reported in NBA (37) (95%), NHL (12) (91%), rugby union (21) (88%), NFL (11) (88%), rowing (17) (87%), and wrestling (14) (83%), whereas the most prescribed exercises in this study were the hang clean, power clean, and clean high pull. It is surprising the limited prescription of the snatch and snatch derivatives, given it has been shown hang cleans and hang snatches provide similar improvements in athletes' power, strength, and speed (2). Whereas, it is recommended that Olympic weightlifting movements must be performed safely and with good technique, where the use of derivatives such as the clean high pull can be just as effective in improving athletic development such as triple extension, when performed with maximal intent (40). Therefore, it may be speculated that SCCs predominantly use the clean and clean derivatives for simplicity and safety while not impeding athletic development.

Speed development training was prescribed by 99% of SCCs, similar to that reported in NFL (11), MLB (13), NBA (37), wrestling (14) (100%), NHL (12) (96%), and rugby union (21) (93%). The most prescribed exercises for speed development were plyometrics (90%), strength training (78%), resisted running (63%), and sport-specific movements (56%) indicating SCCs used a range of exercises along the force-velocity continuum, which is important to comprehensively develop the force-velocity characteristics of athletes (40,45). Furthermore, using a combination of plyometrics and sport-specific movements has been recommended to transfer physical adaptations (e.g., speed development) to sports performance (8,32).

All SCCs reported programming plyometric exercises that were predominantly prescribed all year round (66%), similar to previous surveys in NHL (12), NBA (37), wrestling (14), and rugby union (21). Whereas, plyometrics were mostly prescribed before weights (40%) and as complex training (35%), which is in line with research on power development (24). It has been recommended using complex training for power development, where the short-term intrasession gains in power derive from post activation potentiation, whereas programming complex training within a training cycle has also shown increases in lower-body power metrics, such as peak ground reaction force during a countermovement jump (24,26). It should be noted that increases in lower-body power have not shown to differ significantly from when plyometrics and resistance training were performed separately, but complex training may be a more time efficient option for SCCs to implement in their program (22,24,26). The most prescribed plyometric exercise in this study was multiple hops/lunges (84%). Similarly, a survey on high school SCCs working across multiple sports also found multiple hops/lunges (89%) to be the most prescribed (10). From previous surveys on specific sports, there was no single plyometric exercise most prescribed, such as upper-body plyometrics in NBA (37) (100%), box drills in NHL (12) (91%), jumps in place in MLB (13) (86%), jumps in place in wrestling (14) (82%), jumps in place in rowing (17) (75%), multiple hops, box drills, and jumps in place in rugby union (21) (all 74%), and multiple hops and bounding in NFL (11) (both 65%). This may indicate sport-specific or preferential plyometric exercises being prescribed in certain sports, which raises the importance of further evidencing the practices of SCCs in other sports.

Flexibility exercises were prescribed by 99% of SCCs, whereas dynamic (98%), active (94%), and static (85%) stretching was reported as being used "sometimes" to "commonly" (Table 2). Dynamic stretching was more commonly used compared with previous studies in NFL (11) (54%), NHL (12) (61%), MLB (13) (81%), rugby union (21) (86%), and NBA (37) (90%), whereas static stretching was the same as reported in NFL (11) (85%), above rugby union (21) (70%), and below NBA (37) (100%) and MLB (13) (100%). Furthermore, similar to previous research ballistic stretching was deemed least popular; however, results in this study (57%) indicated ballistic stretching to be more commonly used compared with the NHL (12) (17%), MLB (13) (19%), NBA (37) (25%), and NFL (11) (31%). Although, it was the least recommended it is still surprising that a large proportion of SCCs are using ballistic stretching given recommendations not to use this due to an increased risk of injury (28). Whereas, in regards to the time which athletes were encouraged to complete flexibility exercises, before and after workouts and practice, and independently/athlete led were most reported, similar to other studies (11–13,21,37). Warming up before activity has been advised in a systematic review and meta-analysis of 32 studies that showed an appropriate warm-up improved physical performance in 79% of studies assessed (16). Whereas, performing static or dynamic stretches in addition to a comprehensive warm-up showed no further effect on flexibility, high-intensity running, jumping, or change of direction performance, irrespective of athletes perceiving this to have additional performance benefits (3). However, giving athletes the responsibility to independently conduct stretches as reported in this study may allow them to feel more confident and psychologically prepared for the subsequent activity, therefore, should not be discouraged (3).

This study adapted a survey previously used to investigate the practices of SCCs in other sports, which allows for comparisons to be drawn amongst coaches. Respondents were from 48 sports, 17 countries, and different expertise levels, providing an inclusive overview of practices. Strength and conditioning coaches had academic and professional qualifications commensurate or exceeding that of SCCs in previous surveys. Results demonstrated similar responses to those received by SCCs in other studies (e.g., use of physical testing and Olympic weightlifting). Most practices prescribed by SCCs in this study adhered to contemporary research and practical guidelines in strength and conditioning. Original insights into the practices of SCCs the types of resistance training exercises used, integration of technology, monitoring of athlete well-being, internships, and opinions on future trends in strength and conditioning are provided.

Practical Applications

Based on the findings of this study, the following practical applications can be considered by SCCs: internships play an important role in providing SCCs a chance to apply theory to practice and obtain foundational knowledge before completing strength and conditioning certifications and obtaining employment. Working in more than one sport allows for diverse experience and provides opportunities for SCCs to develop their knowledge and practice. Strength and conditioning coaches should "focus on the basics" in terms of program development (strength, power, speed, agility, and flexibility) and monitoring player progress through physical testing. Periodization is important and including less strength and conditioning sessions in-season assists with recovery, while reducing strength and conditioning sessions before competition is important for optimal performance. Monitoring athlete well-being is becoming increasingly important and should be a consideration for SCCs. Finally, because of the current use and desired integration of technology, it is important SCCs keep up to date with such advances and ensure their use is appropriate for their purpose.

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