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Practices and perceptions of strength and conditioning training in female golf: A cross-sectional survey study of high-level amateur players

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ABSTRACT

This study aims to ascertain an in-depth understanding of current practices and perceptions of S&C training in high-level amateur female golfers. A cross-sectional, explorative survey study was constructed which asked questions relating to four key areas: i) general participant information, ii) current strength and conditioning (S&C) practices, iii) the perceived influence of S&C training on golf performance, and iv) knowledge and awareness of S&C. Results showed that the majority of female players had participated in some form of S&C training in the past, with the majority believing that clubhead speed and carry distance were the primary golfing metrics which could be positively impacted. More specifically, 91–97% of the players “Strongly agreed” or “Agreed” that the key physical characteristics for golf were strength and power for the lower and upper body, and flexibility. Interestingly, 58% of the players believed that S&C training should mimic the movement of the golf swing, which based off current evidence, is not how drive metrics and ultimately shots gained, can be maximised. This survey study provides useful information relating to the practices and perceptions of S&C training in high-level female amateur players and areas where education may be able to further advance player understanding of physical preparation.

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Golfers; beliefs; physical preparation

Introduction

Golf is typically identified as a skill-based sport, that is often said to be focused on technical and tactical aspects of the game, aiming to complete 18 holes in as few shots as possible (Bishop et al., 2022). In recent years there has been a growing recognition of the potential benefits that S&C can have on golf performance (Ehlert, 2020, 2021; L. Robinson et al., 2023). This has led to an increased understanding of and reliance on physical preparation, with both golf professionals and S&C practitioners acknowledging the importance of key metrics such as: club head speed (CHS), ball speed, and driving distance (Ehlert, 2020). Importantly, many of these factors can be positively impacted by improving the strength, power, and range of motion during the swing (L. Robinson et al., 2023). Due to the demands placed on high-level golfers in the modern game (e.g., longer courses, long practice sessions, travelling through different time zones, increased number of tournaments, etc.), there is now often a dual focus on performance enhancement (Bishop et al., 2022) and increasing the career longevity (Brearley et al., 2019), to deal with the challenging schedule many high-level players face.

When focusing on performance specifically, it is largely accepted that improving physical characteristics such as: upper body and lower body strength, upper body and lower body power, speed, and mobility are beneficial to golf.

Specifically, these characteristics have been shown to be significantly associated with a golfer's ability to generate force, which is crucial for achieving maximum CHS (Ehlert, 2021). For example, Oranchuk et al. (2020) found a large association ($r = 0.64$) between back squat one-repetition maximum (1RM) and CHS in collegiate golfers, whilst J. E. Wells et al (2018, 2019) found significant relationships between countermovement jump (CMJ) positive impulse and CHS (r range = 0.62–0.79). For the upper body, Keogh et al. (2009) demonstrated a moderate correlation ($r = 0.50$) between 1RM bench press and CHS, which is supported by Torres-Ronda et al. (2011), who reported even stronger associations between 1RM bench press with peak ball speed ($r = 0.61$) and average ball speed ($r = 0.62$). Despite these consistently moderate to large relationships with golfing metrics, they are associative study designs and do not provide us with an appreciation of cause and effect.

With regard to intervention studies, results have shown that some form of S&C practice can have a positive effect on drive distance, which is fundamental for successful play on the golf course (Bliss & Langdown, 2023). For example, Fletcher and Hartwell (2004) found a 4.3% increase in CHS after implementing an 8-week strength and plyometric program, which is in line with the findings of Oranchuk et al. (2020), who reported a 3.2% improvement in CHS, after an 8-week strength and power intervention. Finally, Doan et al. (2006), highlighted a 1.6% increase in CHS (equating to

a ~5 m increase in total distance) after an 11-week strength, power and flexibility program, when performed 3 times per week. Thus, it seems that the current research points towards an increase in CHS and distance if a golfer undertakes a training program which encompasses some strength, power and flexibility components. However, the majority of research has been conducted on male golfers and there is a clear lack of S&C-related research in female golf, which has been acknowledged recently (L. Robinson et al., 2023).

Despite this supporting evidence in favour of S&C-based training, not all players undertake physical training as the sport does not have a long-standing history of integrating physical preparation (Bishop et al., 2022). Consequently, Evans and Thomas (2012) undertook a study on the perceptions and practices of Australian golf coaches on physical fitness and highlighted that 84% of the respondents reported a desire to understand more around physical fitness for golf. More recently, J. E. Wells and Langdown (2020) employed a survey-based study reviewing the perceptions and practices of S&C in highly skilled golfers ($n = 430$). Firstly, results showed that over 40% of the golfers believed that S&C had the potential to increase injury risk and hinder their longevity in the game, which is vastly different to what the existing evidence based suggests (Lauersen et al., 2014). Contrary to this, Bliss and Langdown (2023) highlight that misconceptions surrounding S&C are still evident in golfing circles, yet 78.5% of the golfers are of the opinion that physical training can improve on-course performance. Secondly, 63.25% of the players “Strongly Agree”, “Agree” or “Somewhat Agree” that simulating the golf swing in the gym would provide performance enhancement effects when on the course or practice range. However, current evidence suggests that the most effective methods for improving CHS and ball speed are more traditional methods of resistance training (e.g., compound exercises such as back squat, deadlift, bench press, and row variations) as these are the most effective at enhancing force production capabilities (a key factor in the development of CHS during the swing) (Ehlert, 2020). Finally, for those players who did participate in S&C training, many utilised hypertrophy repetition ranges (J. E. Wells & Langdown, 2020). Naturally, if the side effects of this are increased cross-sectional area, then it is likely that force production capabilities will also improve. However, there is also the risk that high-volume repetitions during resistance training will lead to delayed onset muscle soreness, which, if done over an extended period, is undesirable for training and competition.

Collectively, this information highlights a number of misconceptions about S&C training for golf and best practice (Bishop et al., 2022; Coughlan et al., 2023). Furthermore, and to the authors’ knowledge, no comparable survey has been completed solely with female golfers. Therefore, the aim of this study was to ascertain an in-depth understanding of current practices and perceptions of S&C training in high-level amateur female golfers.

Methods

Experimental design

To address the aims of the research, a cross-sectional, explorative survey study was constructed to gain insights into the current practices and perceptions of S&C in high-level female amateur players. Short answers and multiple-choice questions were used, whilst also allowing participants to submit “other”, open responses if they wanted to. This approach allowed answers to be analysed and categorised into themes, by utilising content analysis. In order to target the relevant participants, the author team partnered with practitioners working on the **Blinded for Peer Review** and at **Blinded for Peer Review**, enabling the widest possible participant pool to be targeted in the UK and Europe.

Participants

Convenience sampling was employed for this survey, with a total number of 157 responses received. To be eligible for the survey, golfers were required to be categorised as a high-level female golfer (≤ 10 handicap) at the time of completion (Ehlert, 2020). Ethical approval was granted through the research and ethics committee at **Blinded for Peer Review**.

Survey

The survey was created on the platform Mometric. Although it was designed to generate new knowledge surrounding female golf, it was also influenced by previous surveys conducted in golf (Bliss & Langdown, 2023; J. E. Wells & Langdown, 2020). Participants were contacted via social media platforms (e.g., Twitter, LinkedIn and Instagram), direct emails from staff working on the Ladies European Tour and at England Golf, and word of mouth. The survey opened on 24 January 2023 and closed for responses on 15 September 2023. Responses were anonymised for data analysis, and consent was obtained prior to entering the survey. Finally, the survey consisted of 30 questions and four sections: i) general participant information, ii) S&C practices, iii) Likert scale questions on S&C for golf performance, and iv) knowledge and awareness of S&C.

Data analysis

By implementing manifest content analysis, this approach enhances the reliability and accuracy of interpretations of the researchers, providing a more thorough insight into the research (Krippendorff, 2018). Content analysis is based on the premise that text can serve as a valuable and comprehensive insight into a particular phenomenon (Kleinheksel et al., 2020), with the primary purpose to analyse the text data collected via “Other” responses. Due to the nature of manifest content analysis, a frequency analysis with percentage of responses was undertaken for “Other” responses (Table 1). Consequently, the following categories were developed, prior to the formation of themes:

Table 1. Participants “other” responses to areas of strength and conditioning (S&C) training for golf.

Rank	Theme	Example Responses	Respondents n (%)
1	Player Education on S&C Training	<ul style="list-style-type: none"> • “I don’t know enough that could specifically benefit myself as a woman in golf”. • “I worry I do the right exercises” • “Don’t know how to” • “I think it should align with movements that you go through in you golf swing but doesn’t have to fully replicate the golf swing. I think a lot of single leg rotation and coordination things are good to use resistance training” • “I know that S&C improves golfing ability, got to be careful not to become muscle bound” • “I worry when I get sore if I am doing things that will help my golf” • “Not fully because there are many conflicting arguments for and against doing certain movements for golf benefit along with the added challenges of hormones within a female that will influence and impact on quality of S&C depending on when training” 	68 (46.9)
2	Barriers to S&C Training	<ul style="list-style-type: none"> • “Financial restrictions” • “Lack of time means facilities need to be close by” • “Don’t know where to go” • “Strength and conditioning for golf is not advertised anywhere” • “No coach/trainer who exactly knows the benefits and can inform me in that regard for golf specifically” • “I am 62 and believe I am too old to change my ways after 50 years” 	35 (24.1)
3	Benefits of S&C Training	<ul style="list-style-type: none"> • “Reducing chances of injury”. • “Body strength” • “Prevent injury” • “General control and stability” • “Endurance” • “It will give me lot more flexibility and should help with my golf” 	18 (12.4)
4	Coach Selection	<ul style="list-style-type: none"> • “I liked what I saw on their social media” • “Provided by my University” • “I was given the opportunity of S&C through the institute” • “They are my coach for my golf team at my University” 	16 (11)
5	Physical Capacities Targeted During S&C Training	<ul style="list-style-type: none"> • “Usually do some running” • “Triathlon” • “Abdominal strengthening” • “Generally getting stronger/more powerful is the most important thing” 	8 (5.5)

total “other” responses n = 145.

- Player education on S&C training
- Barriers to S&C training
- Benefits of S&C training
- Coach selection
- Physical capacities targeted during S&C training

Following this, participant responses were used to develop themes during data analysis (Braun & Clarke, 2006). The total number of responses were inputted to Microsoft Excel, whereby the authors analysed, and then developed the subsequent themes. The initial stage was the familiarisation of data, whereby the authors reviewed responses, and themes were developed with the aim of providing a transparent overview of the methods employed. Consequently, the following themes were generated:

- *General Participant Information.* This section provided background information on the players, such as: country of residence, years playing golf and current playing level (e.g., LET, LPGA or both).
- *S&C Practices.* This section of the survey contained answers relating to current S&C training practices within touring female professional golfers (e.g., training history, training frequency, periodisation of training, etc.).
- *Likert Scale Questions on S&C and Golf Performance.* This section focused on the perceived influence S&C may have on a player’s golf shot metrics.

- *Knowledge and Awareness of S&C Practices.* This section focused on information relating to any barriers that may be evident for players engaging in S&C training, their beliefs of S&C training for golf, and whether it was believed that any further education surrounding the benefits of S&C for golf, would be useful to them.

To convey the scale of percentages associated with participant responses, the qualitative terms were assigned: <30% = minority; ~30% = approximately a third; ~50% = approximately half; 55–74% = majority; ≥75% = most; 100% = all respondents, as per previous research (Shaw et al., 2023). Finally, intercoder reliability was calculated at 89.64%, with Cohen’s κ calculated for the intercoder agreement ($\kappa = 0.936, p < 0.001$). This represented “almost perfect” agreement according to previously published descriptors for Cohen’s κ interpretation (McHugh, 2012).

Results

General participant information

Figure 1 provides an overview of the results pertaining to questions in this opening section of the survey, which focused on player demographics: (a) country of residence, (b) years playing golf, (c) current handicap, and (d) current level of playing. A total of 157 respondents completed the

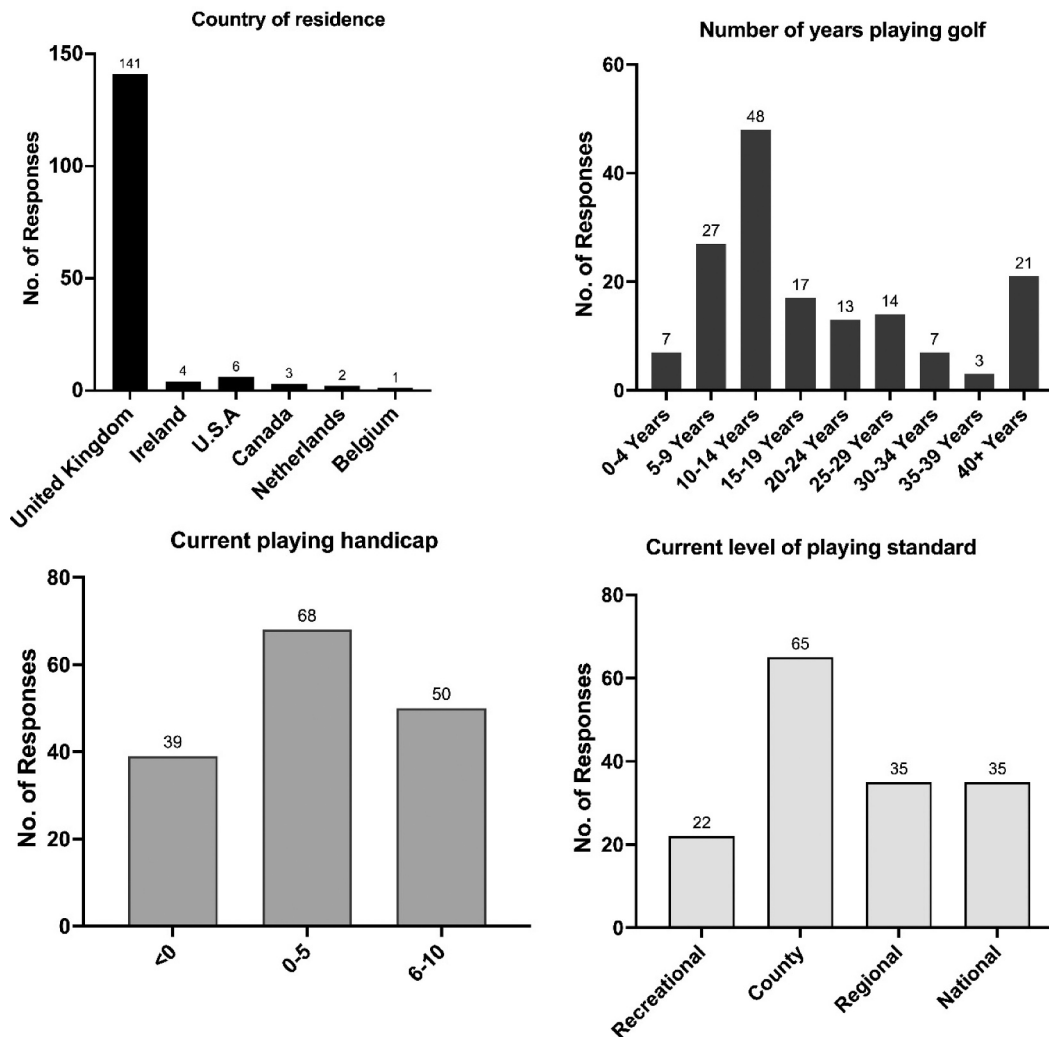


Figure 1. Data showing responses relating to general participant information in high-level amateur female golfers.

survey, with 141 in the United Kingdom (89.8%), six from the USA (3.8%), four from Ireland (2.5%), three from Canada (1.9%), two from the Netherlands (1.3%), and one from Belgium (0.7%). The most reported number of years golfing was 10–14 years ($n = 48$, 30.6%), with 0–5 handicap category most common among participants ($n = 68$, 43.3%). The county level was the most answered level of golf in the survey ($n = 65$, 41.4%), with regional ($n = 35$, 22.3%), and national next ($n = 35$, 22.3%), and finally recreational ($n = 22$, 14%).

Strength and conditioning practices

Figure 2 provides an overview of responses for S&C practices for this cohort of female players. Of the 157 respondents, 128 (81.5%) stated they had participated in some form of S&C or fitness training in the past, of which 68 (43.3%) had participated in four or more years of structured training. The most frequent response surrounding times per week training was 3 times per week ($n = 44$, 34.3%), followed by 2 times per week ($n = 39$, 30.4%), 1 time per week ($n = 24$, 18.8%), 4 times per week ($n = 13$, 10.2%), 5 times per week ($n = 7$, 5.5%), and finally 6 times per week ($n = 1$, 0.8%). When asked what time of year the

player undertook S&C training in, the majority of respondents ($n = 99$, 75.6%) answered “All Year Round”, whilst “Off-Season Only” ($n = 28$, 21.4%) and “In-Season Only” ($n = 4$, 3%) received fewer responses.

Figure 2 also contains further detailed questions surrounding the practices players currently take part in. Question 12 asked participants “What times of the year do you currently undertake your S&C training?” for those who responded with “off-season only”, 35 players (32.1%) outlined that “I would rather practice golf”. Other common answers were “Fatigue” ($n = 22$, 20.2%), “Time Constraints” ($n = 17$, 15.6%), “Lack of Facilities” ($n = 15$, 13.8%), “Fear of Injury” ($n = 12$, 11%), and ($n = 3$, 2.8%) “Other”. “Other” responses contained “Usually do some running and play some summer hockey if I can if it fits in with golf schedule”, “Running”, and “I’m doing GCSE’s so not a lot of time for S&C”. The majority of players ($n = 110$, 25.3%) highlighted “Strength” as the physical capacity they train when in the gym. “Core training” ($n = 81$, 18.7%), “Mobility” ($n = 79$, 18.2%) and “Power” ($n = 71$, 16.3%) were also commonly selected responses. Among the players who participated in the survey about the areas of golf performance that can be improved through S&C, the majority of responses emphasised “Club Head Speed” ($n = 139$, 25.7%) and “Carry Distance” ($n =$

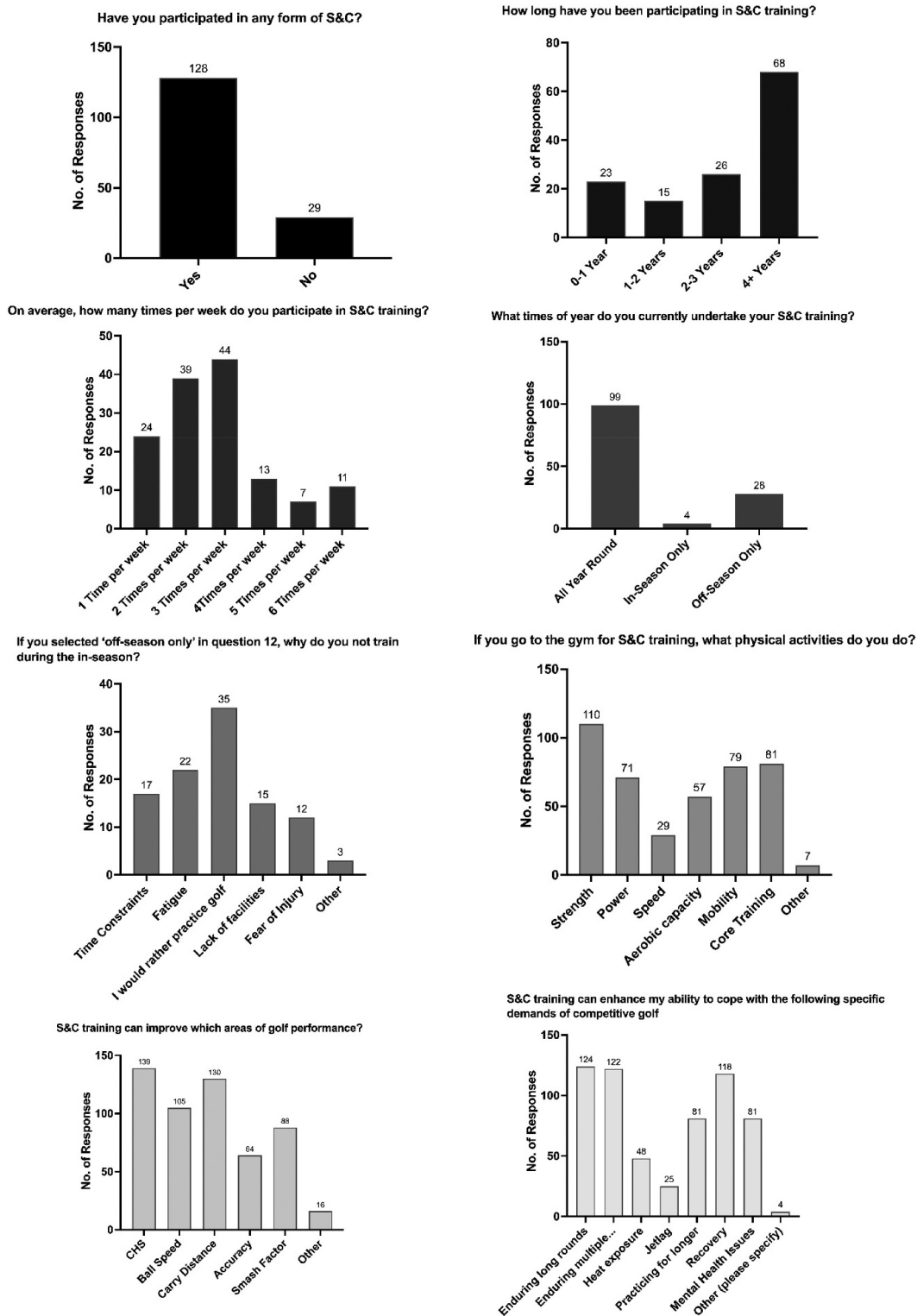


Figure 2. Data showing responses relating to current strength and conditioning practices in high-level amateur female golfers.

130, 24%). The next most frequently mentioned area was “Ball Speed” ($n = 105$, 19.4%), followed by “Smash Factor” ($n = 88$, 16.2%), and “Accuracy” ($n = 64$, 11.8%). Finally, the players were asked how S&C training can enhance their ability to cope with the demands of competitive golf, of which there were numerous frequent answers such as: “Enduring Long Rounds”

($n = 124$, 20.5%), “Enduring Multiple Rounds in One Day” ($n = 122$, 20.2%), “Recovery” ($n = 118$, 19.6%), with “Mental Health Issues” and “Practicing for Longer” receiving the same amount of answers ($n = 81$, 13.4%). “Heat Exposure” ($n = 48$, 8%), “Jetlag” ($n = 25$, 4.1%) and “Other” ($n = 4$, 0.7%) were the remaining answers from respondents. It should be noted that

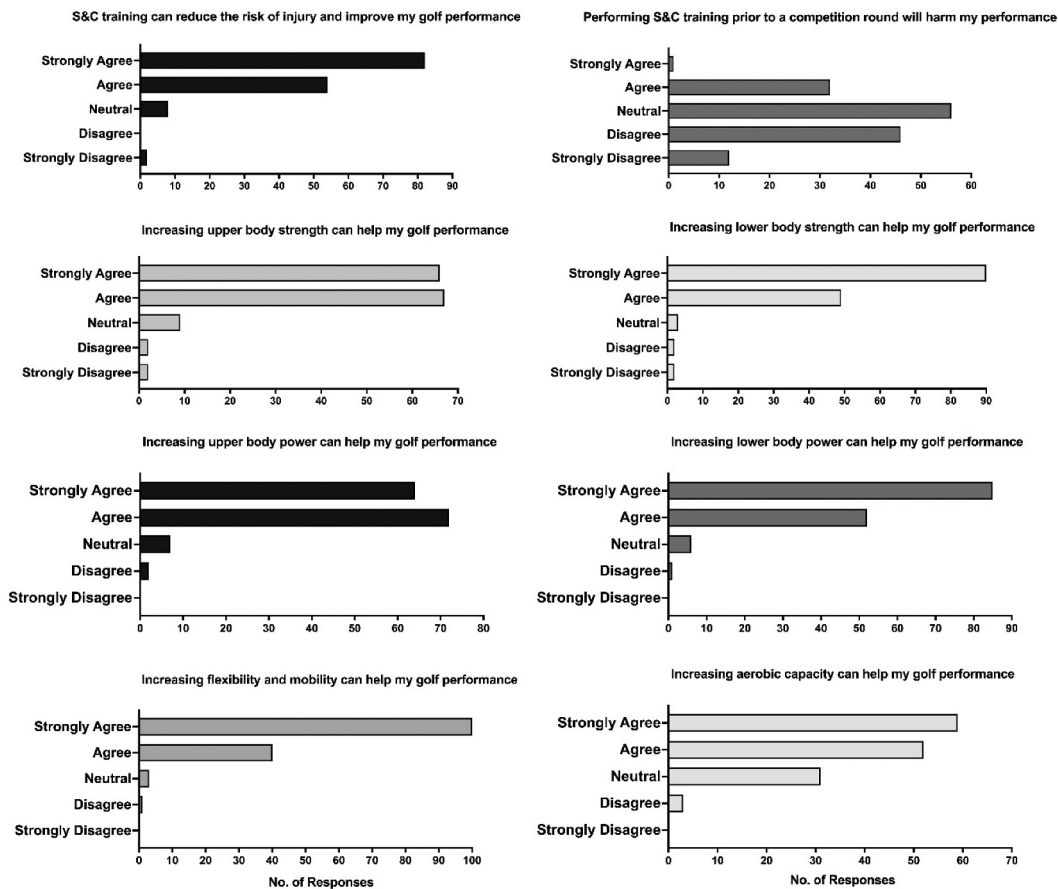


Figure 3. Data showing Likert scale responses relating to strength and conditioning characteristics and golf performance in high-level amateur female golfers.

pre-populated responses were presented to the participants for this section, and a response to select “It doesn’t” or “Disagree” was not available.

Likert scale questions on S&C and golf performance

Figure 3 indicates that the majority of respondents “Strongly Agree” ($n = 82$, 56.2%) or “Agree” ($n = 54$, 37%) that S&C can reduce the risk of injury and improve golf performance. When asked “Performing S&C training prior to a competition round will harm my performance”, most answers were reported as “Neutral” ($n = 56$, 38.1%), “Disagree” ($n = 46$, 31.3%), and “Agree” ($n = 32$, 21.8%). The final two questions were based around upper body and lower body strength aiding golf performance, with the majority of answers for upper body strength falling into “Strongly Agree” ($n = 66$, 45.2%) and “Agree” ($n = 67$, 45.9%), and for the lower body, more players favoured the “Strongly Agree” category ($n = 90$, 61.7%) and “Agree” ($n = 49$, 33.6%).

Furthermore, Figure 3 aims to understand perceptions around further physical capacities and golf performance, such as increasing upper body power helping golf performance, of which “Agree” was most answered ($n = 72$, 49.7%), followed by “Strongly Agree” ($n = 64$, 44.1%). “Increasing lower body power can help my golf performance” received a similar answer set, with “Strongly Agree” ($n = 85$, 59%) and “Agree” ($n = 52$, 36.1%) most commonly answered. Out of 144 total answers, the

majority ($n = 100$, 69.4%) selected “Strongly Agree” that increasing flexibility and mobility can help golf performance, with “Agree” next common answer ($n = 40$, 27.8%). Finally, with respect to increasing aerobic capacity and aiding golf performance, “Strongly Agree” ($n = 59$, 40.7%) and “Agree” ($n = 52$, 35.9%) were answered similar, with “Neutral” ($n = 31$, 21.4%) and “Disagree” ($n = 3$, 2.1%) the remaining answers.

Knowledge and awareness of S&C practices

Finally, Figure 4 focuses on knowledge and awareness of S&C practices for golf performance. “Time Constraints” ($n = 39$, 28.5%), “Fatigue” ($n = 16$, 11.7%) and “I would rather practice golf” ($n = 16$, 11.7%) were the three most common answers when asked what factors contribute to not participating in S&C training. The overarching theme surrounding knowledge about the potential benefits of S&C training for golf performance was positive (“Yes”, $n = 108$, 77.1%), with “No” ($n = 32$, 22.9%) filling the remaining answers. Out of 131 total responses to “Do you believe that resistance training in a gym environment should replicate the golf swing?”, answers were divided between “Yes” ($n = 76$, 58%), and “No” ($n = 55$, 42%). The final question was “If you work with an S&C coach, can you provide the reason you work this person?”, with “They were provided as part of regional/national coaching programme” most commonly answered ($n = 46$, 32.2%), followed by “They are highly qualified in their

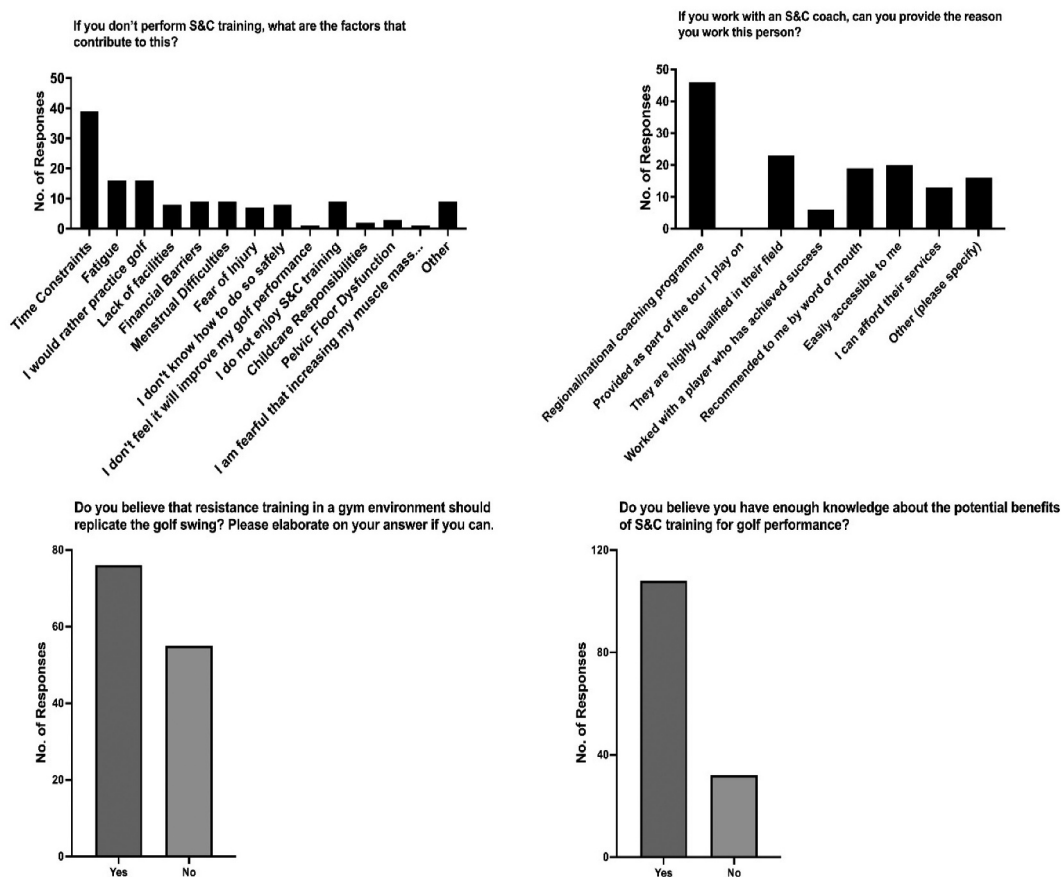


Figure 4. Data showing responses relating to knowledge and awareness of strength and conditioning training in high-level amateur female golfers.

field" ($n = 23$, 16.1%), and "They are easily accessible to me" ($n = 20$, 14%).

Discussion

The aim of this study was to provide an in-depth, novel understanding of current practices and perceptions of S&C training in high-level amateur female golfers and to the authors' knowledge, this is the first study to investigate this research question solely in high-level amateur female players.

Strength and conditioning practices

The findings of this study indicate that most players (81.5%) have engaged in some form of S&C, which from an S&C standpoint, is positive for female golf. In addition, it appears that just over half the players (51.5%) have participated in ≥ 4 years of structured physical training. Further to this, 76% of the high-level amateurs indicated that they trained all year round, alongside 93% ("Strongly Agree" or "Agree") acknowledging that S&C can reduce the risk of injury and improve golf shot performance. Finally, 77% of the players suggested they had sufficient knowledge about the potential benefits of S&C training for golf, which indicates that there is a desire for many high-level female players to continually improve their individual physical capacities and over-arching health. In contrast, 18.5% of the participants had never participated in S&C training,

with 49.2% reporting that they train either once or twice a week. Although S&C training has clear benefits for enhancing golf performance (e.g., increased CHS, ball speed and carry distance) (Ehlert, 2020), ~20% of the respondents are failing to take advantage of this opportunity. L. Robinson et al. (2023) acknowledged the importance of efficient mobility in the hips and thoracic spine to create X-Factor stretch. However, this is with respect to an individual's mobility levels, without the suggestion of an ideal "maximum" or "optimal" degree of separation. "Other" responses on which physical capacities participants train for included: "Triathlon", "Abdominal strengthening" and the "Sauna", noting that the latter is not a physical capacity and may demonstrate a potential lack of understanding in the question. Participants were also asked how S&C training can enhance the ability to cope with the demands of competitive golf, with some example responses being: "Becoming stronger", "Coordination", and "Improving sleep". Collectively, it seems evident from some of these responses that female amateur golfers may benefit from additional education surrounding the link between golf and S&C training, given some answers appeared to be largely unrelated to the purpose of the question being asked.

Data shown in Figure 2 demonstrates that 35% of the golfers "would rather practice golf" during the in-season rather than engage in S&C training. It should be acknowledged that practice time is essential for competitive golfers, especially considering they are often faced with

a condensed competition schedule, potential financial pressures (depending on skill level and which tournaments the players commit to), and consistent demand for high-performance on the golf course (Bliss & Langdown, 2023). However, looking at a wider, more holistic yearly training structure, it is vital to ensure that golfers are physically robust to withstand high swing velocities and large repetitive loading from the swing, which can lead to common injuries, such as the wrist, neck, and lower back (McHardy et al., 2006; P. Robinson et al., 2019; M. F. Smith & Hillman, 2012). Linked to this, some form of consistent physical training is undoubtedly essential to help ensure golfers can continue to play from a longevity standpoint, in addition to providing important long-term health benefits (Bishop et al., 2022; Ehlert & Wilson, 2019; Murray et al., 2016, 2017).

The needs analysis for golf informs us that force production and rate of force development are key physical characteristics that can positively impact CHS and distance (Bishop et al., 2022). These qualities can be achieved through increasing strength and power in both upper and lower extremities, whilst concurrently optimising mobility in the hips and thoracic region, to increase the ability to separate these two areas of the body, during the swing (Bishop et al., 2022). Despite the limited quantity of literature in female golf and physical training, the available evidence indicates that being strong and powerful in both the upper and lower body is advantageous (L. Robinson et al., 2023). Interestingly, when considering the collective results for strength, power, speed, and mobility in this survey, 67% of the participants trained on these physical qualities, which aligns with 69% of respondents recognising that physical training can aid performance metrics such as CHS, ball speed and carry distance. Whilst S&C training can improve key physical capacities for golf performance, it was also recognised by respondents that this form of training can aid with “Enduring Long Rounds” (20.6%), “Enduring Multiple Rounds in One Day” (20.2%), and “Recovery” (19.6%). Sometimes, the demands of high-level female amateur golf will entail two rounds per day, which will have substantially greater effects on physiological fatigue than a single round. Therefore, participants acknowledging the impact that S&C training can have in these three areas can be seen as a positive finding from our survey, beyond just believing that it will only help with immediate physical capacity improvements. Nevertheless, it is concerning that only ~20% of the participants supported this notion, which highlights the need for further education on the broader benefits of S&C training for female golfers. “Other” responses for the question: “S&C training can improve which areas of golf performance” included: “Dispersion”, “Reducing chance of injury”, “Body strength” and “Handicap”. Taken together, these responses provide some evidence of the broad perspective that players have relating to some of the wider benefits of S&C training.

Likert scale questions on S&C and golf performance

There is a general consensus that S&C training is beneficial to female golfers, as evident in Figure 3. The overarching theme is highlighted by 93% of the participants who “Strongly agreed” or “Agreed” that S&C can reduce the risk of injury and provide an increase in golf performance. This can be seen further through “Strongly Agree” or “Agree” responses on physical characteristics that can aid golf performance such as: upper body strength (91%), lower body strength (95%), upper body power (94%), lower body power (95%) and flexibility (97%). Research in golf has demonstrated that compound movement exercises utilised in the upper body have led to positive relationships with CHS ($r = 0.48\text{--}0.61$) (Sheehan et al., 2022; G. D. Wells et al., 2009). McHardy and Pollard (2005) highlight the importance of the upper body to provide sequential rotation of the torso and upper limbs to transfer energy from the ground up, through the trunk, and then down the shaft and into the club head. In particular, the pectoralis major, latissimus dorsi, external obliques, erector spinae, and flexor carpi ulnaris are the primary contributors within the upper body. Keogh et al. (2009) presented a moderate correlation between a one-repetition maximum (1RM) bench press and CHS ($r = 0.50$), whilst Torres-Ronda et al., (2014) found large correlations between 1RM bench press with peak ball speed ($r = 0.61$) and average ball speed ($r = 0.62$). With regard to lower body strength, Oranchuk et al. (2020) reported a large correlation between 1RM back squat and CHS ($r = 0.64$) in 12 NCAA collegiate golfers, alongside Hellström (2008) who found a significant correlation between vertical jump peak power and CHS ($r = 0.61$) when looking at lower body power. Finally, Brown et al. (2011) reported a positive relationship between CHS and thoracic mobility as tested during a seated rotational test in both clockwise ($r = 0.52$) and counter-clockwise ($r = 0.71$) directions. Collectively, it is encouraging to see that there is an appreciation of the important physical characteristics that can positively impact golf performance from high-level female amateur golfers.

When asked when to perform this type of training, 22% “Strongly Agreed” or “Agreed” that performing S&C prior to a round will harm performance, with 38% of answers deemed “Neutral”. This perception could be due to participants being wary of inducing fatigue or believing that delayed onset of muscle soreness (DOMS) will have a detrimental effect on their performance on the course. This notion could be accepted, particularly if the golfer has a low training age, nevertheless it is important to acknowledge that S&C training prior to a round of golf can be implemented in a micro-dosed manner (involving a reduced number of sets and repetitions), acting as a priming session, to yield acute benefits prior to play or simply serving as an extension of a good-quality warm-up (Coughlan et al., 2023). Regardless though, completing a full S&C training session (i.e., high volumes of a gym-based training programme), immediately prior to a golf competition, is not suggested.

Knowledge and awareness of S&C practices

The most commonly reported responses regarding barriers to S&C were "Time Constraints" (28%), "Fatigue" (12%) and "I would rather practice golf" (12%). Interestingly, there was a general theme from the responses that players thought they had enough knowledge about the potential benefits of S&C for golf performance (77%), with the remaining 23% answering "No". In addition, Figure 4 shows that 58% of the respondents believe that resistance training in the gym should replicate the golf swing, with the remaining 42% in disagreement. Players were provided with the opportunity to elaborate on their answer to this question, which showcased some interesting opinions. Responses included: "I think it should align with movements that you go through in your golf swing but doesn't have to fully replicate the golf swing. I think a lot of single leg rotation and coordination things are good to use for resistance training", "Because it isolates the swing muscles", and "Muscle memory". These examples provide an interesting discussion point. Firstly, a comparable 63% of (male and female) players also had the same opinion in the survey study conducted by J. E. Wells and Langdown (2020). Second, Hegedus et al., (2016) researched the effects of a "Golf-Specific Resistance Training" (GSRT) programme, which entailed numerous unilateral, and isolated trunk exercises (some replicating the golf swing), vs. a traditional resistance training programme, which entailed exercises such as deadlifts, presses, and bent over rows, on CHS and distance. Effect size data show that the traditional resistance training group exhibited greater improvements in CHS ($g = 0.85$) and distance ($g = 1.30$) compared to the GSRT group ($g = 0.73$ and 0.46 , respectively). In addition, the GSRT programme cannot be considered golf-specific when multiple exercises are programmed unilaterally, as the golf swing does not take place on one limb for able-bodied players. Whilst force production is still required for any movement, golf is predominantly a bilateral, high-velocity rotational sport that requires large amounts of force transfer from the ground up. With this in mind, it seems fair to assume that golfers should focus much of their S&C-based training on trying to enhance vertical ground reaction forces and at high-velocity. Thus, it should not be surprising that the traditional programme was more effective given human movement is underpinned by force production. With 58% of respondents in agreement that resistance training should replicate the golf swing, it could be argued that there is a lack of understanding on how physical training can enhance drive metrics. "Other" responses to the question: "If you don't perform S&C training, what are the factors contributing to this?", included: "Do not know how to", "I worry I don't do the right exercises", "Lack of time means that facilities need to be close by", and "Financial restrictions". Based on some of these responses, and as previously mentioned, it seems apparent that female amateur golfers would benefit from education related to S&C training. For example, responses relating to not knowing how to perform certain exercises or being concerned about which exercises are correct undoubtedly come under the remit of an S&C

practitioner's responsibility. Other example answers relating to facilities and financial implications are likely harder challenges to overcome. However, a possible contingency plan for female players impacted in this way, might be to visit a qualified practitioner on an ad-hoc basis (e.g., once per month) and aim to accumulate some equipment at home over time (e.g., bands, dumbbells, etc.), so that some structured S&C training can be conducted without excessive financial commitment.

As displayed in Figure 4, the most common answer surrounding the reason to work with an S&C practitioner is "They were provided as part of regional/national coaching programme" (32%), followed by "They are highly qualified in their field" (16%). High-level female golfers demonstrate trust in practitioners that have been employed through national or regional coaching programmes, indicating they feel it is important that S&C practitioners have experience coaching within the sport, coinciding with well-recognised qualifications (e.g., honours degrees and professional accreditations). This notion can arguably be applied to any sporting context but for golf, practitioners who understand the biomechanics of the sport are more likely to be able to integrate better with the player and technical coach, as part of the multi-disciplinary team (J. E. Wells & Langdown, 2020). "Other" responses to the question "If you work with an S&C coach, can you provide the reason you work with this person?" included: "University PT coach", "They are my coach at my University" and "I was given the opportunity of S&C through the institute", highlighting the potential role organisational structures (e.g., universities, institutes, etc.) have, in providing S&C support at the amateur level.

There are some limitations in the current study to be acknowledged. Firstly, 86% of our responses were answered by county, regional and national squad players, with the remaining 14% of the respondents not involved in competitive squads. Whilst it seems positive to have such a high standard of amateur player for this research, it is possible that the answers are a representation of their experience of S&C training. Specifically, players involved at this level are likely to have some level of S&C support through a national golf programme (e.g., England, Scotland or Wales Golf), in comparison to golfers not involved in competitive squads. Second, our responses were primarily obtained from the United Kingdom (90% of the total responses). Future research should aim to target a broader international female golf cohort (e.g., players from the USA, Sweden, South Korea, etc. where they are having notable success in elite amateur tournaments) and also undertake similar investigations at the professional level. Finally, it should be noted that the phrase "golf performance" was used in some of the questions in our survey. Although anecdotal, future research should consider that players may have a different interpretation of what this means. Whilst this was inferred in our questioning by referring to example golf metrics (e.g., CHS, ball speed, etc.), researchers or practitioners looking to design survey studies in future, should factor in ambiguity around terms or phrases that may encompass a broad understanding of performance within a given sport.

Conclusion

The results of this study indicate that most high-level female golfers (~93%) recognise the positive impact that S&C can have on golf performance, along with its role in minimising injury risks. However, there are still existing areas where some golfers lack an adequate understanding regarding the advantages of S&C and evidence-informed application. There is a clear tendency to prioritise golf practice over periodised physical training and whilst it is accepted that this is essential for golfers, having some dedicated time for structured physical training also seems paramount for performance enhancement, injury risk mitigation and potential longevity in the game. Finally, there appears to be a lack of understanding regarding the golf swing being replicated in the gym environment, yet the research points towards an emphasis on strength and ballistic force production becoming a priority for golfers. Given the results of this survey, it is recommended that continuing education on S&C training is also provided for female golfers in order to emphasise the multi-factorial benefits it can have on the game.

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