Golf Strength and Conditioning Program Analysis:

Are Coaches Using Golf-Specific Practices?

By

Philip Herder

A Thesis

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Zachary Rourk, Ph.D.	Date
Gregory Ruegsegger, Ph.D.	Date
Travis Tubré, Ph.D.	Date
Director, Graduate Studies	Date

University of Wisconsin-River Falls

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Abstract

The beliefs and perceptions of golf strength and conditioning coaches dictate how golfers are trained. As dynamic correspondence and transfer of training principles highlight, distinctions between utilized training interventions could provide explanations regarding appropriate practices for golfers. The present study followed a grounded theory qualitative structure. The purpose was to investigate golf strength and conditioning coaches' training beliefs, training practices, and to define a golf-specific exercise. Eighteen golf strength and conditioning coaches participated in virtual semi-structured interviews, and each provided a training program example reflecting their beliefs used in practice. Qualitative and quantitative data in the form of a survey, interview, and the training program example were collected. A grounded theory emerged that indicated a lack of consensus in the golf strength and conditioning field for what defines a golf-specific exercise and the use of such interventions in training programs for golfers. The present grounded theory speculated shortcomings exist because "golf-specific" had yet to be defined in the field and literature, in conjunction with held misconceptions about training principles and specificity. Furthermore, data suggested golf strength and conditioning coaches utilized Western civilization strength and conditioning characteristics of incorporating powerlifting exercises and utilizing indirect performance measures to assess training progress for golfers. This study was the first of its kind to quantify golf specificity and define golf-specific. As the grounded theory supplied an initial analysis of the specificity of training golfers, future studies should continue to develop the evolving concept of golf-specific training.

Keywords: golf-specific, strength and conditioning, golf, golf-specific training, golf training, transfer of training, dynamic correspondence, golf performance, grounded theory

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Chapter 1- Introduction

According to the National Golf Foundation, over 40 million people in the U.S. over the age of five played golf either on-course or indoors in 2022 [42]. The number of golf rounds played during 2022 was up 13% compared to the annual averages from 2015 to 2019 [42]. The increase in golf popularity has led golfers to experiment with different strategies to improve their game and performance on the course. This competitive landscape has spearheaded the necessity for golfers to train off the course to optimize performance. Professional players such as Tiger Woods, Dustin Johnson, and Bryson DeChambeau have been public about how their training practices have changed over their careers. Players, coaches, and researchers have attempted to replicate tour professionals' practices in hopes of maximizing each golfer's performance, furthering the demand for the utilization of strength and conditioning in the industry. While aspects of strength and conditioning methods may be similar for tour professionals, differences in training practices influence adaptations. Golf is unique compared to other sports where the age range widely varies from kids younger than 5 years old learning golf to adults older than 70 playing during retirement years. The desired goals of any age golfer can be drastically different influencing how a golf strength and conditioning coach would train each client. Controversy remains regarding what practices elicit desired adaptations for golfers.

Research in the golf industry has evaluated the efficacy of flexibility, strength, and golf-specific intervention impact on various performance outcomes such as clubhead speed, driving distance, and swing kinematic data [2, 5, 6, 17, 19-21, 25, 32-36, 39, 45, 46, 48, 49, 52, 53, 63]. Training interventions have widely shown to improve these indirect performance variables correlated with players' golf score [2, 6, 17, 19-21, 25, 32, 34-36, 48, 49, 53]. An important distinction in evaluating performance improvements are the differences between direct and indirect sport performance measures. While many of the kinematic variables of the golf swing have been widely researched and correlative relationships exist with scoring average and handicap, indirect performance measures are not the most valid for golf performance. Direct golf performance measures of scoring average and handicap precisely evaluate the skill of a golfer and generally determine who are the top players.

Concepts of specificity and transfer of training such as movement patterns, physical characteristics, and change in performance variables have been frequent topics of discussion [2, 25, 35, 45, 63]. To understand the role of strength and conditioning for golfers, John Hellstrom wrote a chapter in *Routledge International Handbook of Golf Science* titled "Strength and Conditioning for Golf" where he describes various goals for golfers [25]. Hellstrom offers suggestions based on previous research for appropriate and effective training practices to improve golf performance [25]. He summarizes the chapter as "Strength and conditioning can be helpful for golfers to be able to play, to hit the ball further with higher precision, and to score lower" [25]. Even though improving indirect measures of golf performance such as precision, clubhead speed, swing efficiency, and injury resilience can be essential, finding the proper combination is necessary to directly analyze whether or not direct golf performance is optimized. Hellstrom shares his recommendations on exercises specific for golf:

> Although there is a need for more research regarding the effect of S&C training on golf swing and ball flight precision, it is likely that some flexibility and neuro-muscular training should be specific to the golf swing to have a better effect on performance. That means stand up, using multi-joint exercises that coordinate the whole body in a down-to-up kinematic sequence, and including horizontal plane movements. The training also

needs to be varied over time, to achieve both injury prevention and performance goals [25, p. 332].

Table 1

Literature Defining Sport-Specific Golf Training

Author/Year	Plyometric	Rotational Movement	Medicine Ball	Sequential Chain	ROM (flexibility)	Body Stability (Balance)	Muscles of a Golf Swing	Performing Swing	Resistance (strength)	General Exercises	RFD	Power	Injury Prevention	Cable/Band	Multi-Joint Exercise	Endurance
Fletcher 2004	x	x	x	x	x	x	x	x								
Fradkin 2004		x					x	x								
Doan 2006		x	x	x	x		x	x	x	x	x	x			x	
Lehman 2006		x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Lephart 2007		x			x	x	x	x	x	x					x	
Newton 2007			x				x	x	x	x	x	x			x	
Brandon 2009					x	x	x		x	x			x	x		x
Kim 2010		x	x		x	x	x	x	x	x		x	x	x	x	
Meira 2010		x			x	x	x	x	x	x		x	x	x	x	x
Bull 2012	x	x	x		x		x		x		x	x	x		x	
Lamberth 2013			x		x		x		x	x			x	x	x	
Lewis 2016	x	x	x		x		x	x				x			x	
Olivier 2016	x	x			x	x	x		x	x		x		x	x	x
Hellstrom 2017		x	x	x	x		x		x		x		x		x	
Sorbie 2019		x			x	x	x		x			x	x			
Redondo 2020	x	x			x	x	x	x				x		x	x	

Defining a golf-specific exercise is necessary to implement exercises aiding the requirements needed to perform the golf swing. Aspects of exercises specific for golfers have been previously highlighted [5, 6, 17, 20, 21, 25, 32-36, 39, 45, 46, 49, 53]. Important aspects of golf-specific exercises are combinations of characteristics including rotation, range-of-motion (ROM) of a golf swing, same muscle utilization, swing performance, resistance for strength purposes, power, and/or multi-joint movement. Table 1 outlines an analysis of studies documenting specific characteristics of what training for golf should be. Therefore, for the purpose of this study, a golf-specific exercise will be defined as a transverse planar movement where force is initiated at the ground level and transferred through the hands.

Though various strength and conditioning practices have demonstrated effectiveness in improving indirect measures of golf performance, there is a dearth of information related to utilized training interventions in the field [52, 63]. While indirect measures such as clubhead speed, driving distance, swing kinematic data, etc., are correlated with direct golf performance, few studies have analyzed the influence of training interventions on direct measures of golf performance. Wells and Langdown (2020) went as far as to propose it is likely that PGA assistant professionals hold misconceptions related to strength and conditioning's role in golf performance, most notably highlighting that at least 50% of participants engage year-round in endurance training, Olympic weightlifting, and high-intensity interval training (HIIT) [63]. However, with many different shots and an infinite number of variables affecting golfers' performance, which training practices effectively and optimally transfer to the course? Can exercises be categorized into "types" of training? Do professionals rely on indirect measures to determine the efficacy of training programs?

The purpose of this study was to document and evaluate implemented training programs by strength and conditioning coaches in the golf industry to discover the validity of training practices for golfers. Specifically, are golf strength and conditioning coaches applying golf-specific training? We hypothesize that golf strength and conditioning coaches believe their training practices to be golf-specific, and that these practices are not reflective of what research and dynamic correspondence describe as golf-specific training.

Chapter 2- Literature Review

Defining Needs Analysis and Dynamic Correspondence

When developing effective strength and conditioning programs for golfers, different variables need consideration to identify individual strengths and weaknesses [25, 45]. The efficacy of a "one-size-fits-all" approach to training athletes is a difficult determination because of the amount of variability between athletes, sports, and the stressors imposed on the body. However, standardization of outcome measures may be useful to regulate specific adaptations for the sport-specific athlete [1, 36].

As stated in the *NSCA: Essentials of Strength Training and Conditioning,* a needs analysis is defined as a "two-stage process that includes an evaluation of the requirements and characteristics of the sport and an assessment of the athlete" for the strength and conditioning professional to conduct when designing a training program [50, p. 441]. A needs analysis is the foundation in understanding the demands of sport performance and provides the basis for applying transfer of training principles. Furthermore, dynamic correspondence outlines transfer of training and training specificity as:

> The means and methods of strength training for specific sports should be chosen to enhance the required motor qualities in terms of the amplitude and direction of the movement, the accentuated region of force production, the dynamics of the effort, the rate and time of maximum force production, and the regime of muscular work [59, p. 241].

Interventions Impacting Golf Performance

Research in golf training has targeted biomechanics of the golf swing, efficacy of training practices, and professionals' valuation of training interventions [1-3, 5, 6, 8, 9, 11, 17-22, 25-28, 30, 32-37, 39-41, 43-46, 48, 49, 52, 53, 61]. When creating a training program, the understanding and consideration of these components are crucial to effectively train golfers.

Biomechanics of the Golf Swing

"The objective of any golf swing is to hit the ball in the proper direction and for proper distance with the most efficient motion" [1]. Swing biomechanics influence the achievement of those goals [1, 3, 5, 8, 9, 11, 18, 22, 26-28, 30, 37, 40, 43, 44, 61]. In previous studies, different variables have investigated the standard characteristics of a golf swing [1, 3, 8, 11, 22, 38, 43, 44]. Variables of importance to the strength and conditioning field include x-factor, x-factor stretch, ground reaction forces (GRF), and crunch factor (CF).

The x-factor and x-factor stretch are derived from the relationship between the hips and the shoulders in the transverse plane. The x-factor can be described as "the relative rotation of the shoulders with respect to the hips during the golf swing" [8]. Specifically, research has demonstrated an increase in x-factor at the top of the backswing improves rotational velocities throughout the swing, leading to higher clubhead speeds and the potential for increased ball speeds and further distances. The x-factor stretch refers to "the increase in x-factor during the early part of the downswing" where the hips initiate the downswing while the shoulders hold the club at the back of the downswing [8]. While the x-factor is an important variable in rotational velocities and clubhead speed, further research has illustrated the x-factor stretch may be more important for players to consider [8].

Peak GRF in both the lead and trail foot have displayed a positive relationship with clubhead speed [23]. Additionally, differences between skill levels in the development of GRF and transfer of force through the kinetic chain have been well documented. Higher-skilled players create greater GRF during the backswing and transfer the force to the lead leg better compared to lower-skilled players where GRF is smaller in magnitude on the backswing with tendencies of weight remaining on the trail leg through impact [29]. Production of GRF is important because of the kinetic chain or link concept. The kinetic chain concept can be described as "large base body segments passing momentum to smaller body segments" [61]. Forces at the ground level transfer up the system, or chain, to increase rotational velocity in the golf swing [3, 27, 44]. The product of this kinetic chain is clubhead speed, ball speed, and distance, all of which are considered important indirect golf performance variables [44].

Over the past few decades, researchers have investigated the CF [11, 18, 22, 28, 41, 54]. Sugaya et al. (1997) first calculated the CF as the product of lateral flexion spine angle and axial angular velocity of the trunk at impact during the golf swing [54]. A greater CF product is theorized to be more harmful than a smaller CF value [11]. CF is proposed to "objectively measure and compare the mechanics of the lumbar spine in healthy and pathologic golf swings" [11, 41]. "The CF has been described as a measure to evaluate the risk of low back injuries in golfers and is based on the notion that lateral flexion and axial trunk rotation jointly contribute to spinal degeneration" [11]. Lumbar spine injuries or pain are the most frequent injuries discussed in golf literature and mentioned by golfers [5, 22, 39]. While Sugaya et al. (1997) initial equation to quantify the CF and its relationship with lower back pain is theory based, studies have evaluated injury prevention and risks associated with the CF [11, 18, 22, 41]. Findings indicate training strategies to combat lower back pain can focus on specific muscles including the transversus abdominis and multifidi muscles, as well as prioritizing hip strength and mobility with pelvis and trunk rotation [18, 22]. Additionally, analysis of the lumbar positioning and pelvic sequencing can diagnose inefficiencies and potential injury risks [18]. From this analysis, a swing or sequence adjustment could be considered if the professional believes the injury risk outweighs the present performance. Considering back injuries and spinal health during a swing and fitness evaluation could be useful and appropriate when creating golf training programs.

An added piece of golf biomechanics literature has explored high-level golf coaches' perceptions of technical parameters in the golf swing compared to the biomechanical literature [52]. Smith et al. (2015) observed and interviewed 16 high-level golf coaches to analyze their perceptions of important technical parameters of an elite golf swing [52]. Researchers found coaches spoke most often about five key technical parameters; club motion, posture, body rotation, sequential movement of body segments, and arm and wrist action [52]. Furthermore, the study found coaches tended to focus on posture and body rotation as the primary technical parameters. "Methodological limitations in the golf biomechanics literature make it difficult to examine the complex movement with regards to the five key technical parameters" [52]. While individual coaches had different strategies for analyzing golf swings, and limitations exist in the golf biomechanics literature to understand the specific mechanisms of performance, applying aspects of the golf swing movement coupled with contextual information about the individual and environment can maximize performance when training golfers.

Efficacy of Golf Training Interventions

"General" and "golf-specific" training interventions have both demonstrated improvements in various golf swing kinematic variables, including clubhead speed, x-factor stretch, and additional limb velocities [2, 4-6, 10, 13, 16, 17, 19-21, 24, 25, 32-36, 38, 39, 45-47, 49, 51, 53, 55-57, 64]. In a recent systematic review by Ehlert (2020), 25 studies were analyzed to determine the impact of strength and conditioning interventions on golf performance variables. The primary inclusion criterion for the studies was the evaluation of a strength and conditioning intervention effect on golf performance variables compared to a control group [19].

While the review categorized the types of training used in the 25 studies (strength, power, plyometrics, functional, flexibility, and golf-specific), the analysis did not discern the differences between the training methods. Varying skill levels, training program durations, and training programs widely improved clubhead speed, ball speed, and driver carry distance [19]. While the review highlighted these indirect golf performance measures, Ehlert additionally analyzed three studies that outlined strength and conditioning interventions' influence on handicap and scoring average [19]. The three studies presented mixed results with only one displaying a statistically significant improvement in handicap and scoring average. All three studies were with junior golfers (anywhere from 12-19 years old) and did not supply information on participants' training age [4, 19, 51, 58]. These factors influence the trainability of golfers and the adaptations that could be made over the course of a training intervention.

Studies have looked at the effectiveness of "general" training and "golf-specific" training interventions [2, 4, 6, 10, 13, 16, 17, 20, 21, 24, 32, 33, 35, 38, 46, 47, 49, 51, 53, 55-57, 58, 64, 65]. Sixteen of twenty studies analyzed "general" or standard exercise programs and resulted in statistically significant improvements in at least one of the indirect golf performance variables of clubhead speed, ball speed, x-factor, and flexibility [4, 6, 13, 16, 17, 20, 32, 33, 38, 46, 47, 49, 51, 53, 55-58, 64, 65]. When analyzing the makeup of these "general" training programs, exercise classification can be difficult as programs did incorporate exercises deemed as "golf-specific." In these studies, analysis of indirect golf performance measures such as flexibility, muscular strength, clubhead speed, and swing kinematics determined whether golf performance improved.

In contrast to the "general" training program studies, few studies have evaluated "golf-specific" interventions [10, 21, 35]. Three studies highlighting "golf-specific" training resulted in statistically significant improvements in the same indirect golf performance measures analyzed in the "general" training intervention studies. In an 8-week golf-specific training intervention, Lephart et al. (2007) found statistically significant improvements after the completion of the training intervention including a 7% increase in upper torso axial rotation and a 14% increase in x-factor velocity [35]. Upper torso axial rotation and x-factor velocity are reflected in clubhead speed and smaller standard deviation ball velocity [60]. A 2016 study by Hegedus et al. analyzed and compared a "general" and "golf-specific" training program [24]. One group trained using a "general" intervention, and a different group trained using a "golf-specific" intervention for the 10-week duration of the study. Both 10-week training programs resulted in statistically significant improvements in clubhead speed, although no statistical differences were found between the training groups' results. In a different approach, Álvarez et al. (2012) conducted a 23-week, in-season study with three separate 6-week phases. The first 6-week phase started with "strength" focalized training, progressed to "explosive-strength" for the second 6-week phase, and ended with a 6-week "golf-specific" phase. After the completion of the 18 weeks of training, a 5-week retention period analyzed results post-training [2]. The authors found statistically significant results for the improvement of ball speed and club mean acceleration when comparing pre-to-posttest and in comparing the training group to the control group. Further, Álvarez et al. analyzed the time and group interaction for ball speed and club mean acceleration after each 6-week training phase. Results showed statistically significant improvements for both ball speed and club mean acceleration after each 6-week intervention along with the results after the 5-week retention period when compared to the baseline results at the start of the program. However, considering the training phases utilized, distinguishing the potential performance improvement from each phase was difficult to discern. Delayed training effects, lack of progressive overload and "de-load" weeks, insufficient information on participants' training age, and interventions taking place during the competitive season were all possible confounding variables. Furthermore, the structure of training interventions seemed to align with the assumption a "strength base" is needed before "speed" and "sport-specific" interventions are appropriate after the initial phases. Additionally, it is important to note the "golf-specific" practices used during the 3rd training phase may or may not encompass golf-specificity utilization. While various training interventions may improve indirect golf performance variables, considering specific components of a training program can be necessary to optimize golf performance.

Golf Professionals' Valuation of Strength and Conditioning

Part of the training program creation process is to consider research on training intervention effectiveness for desired adaptation outcomes coupled with each coach's empirical evidence. Professionals in the golf industry decide to use certain training practices for different reasons. Research has yet to document golf strength and conditioning coaches' training programs. Few studies have analyzed professionals' perceptions of what is important in the golf swing and how strength and conditioning can influence golf performance [25, 63].

Wells and Langdown (2020) conducted a study that analyzed 430 PGA assistant professionals' strength and conditioning perceptions regarding practices for golfers [63]. Opinions varied about training for golfers with most participants who "somewhat agreed" to "somewhat disagreed" on the use of sport science and physical assessments at the golf club where they worked. The decision to include resistance training, whether training should replicate the golf swing, the skill level at which to begin training, and if gym training is more important for highly skilled players compared to amateur players resulted in mixed responses. Additionally, results of the survey indicated professionals applied different strength and conditioning modalities throughout an entire annual program [63]. The authors went as far as to say misconceptions about strength and conditioning for golf existed, specifically citing about 50% of the participants who utilized static stretching to warm up and participants who disagreed to agreed in believing resistance training may lead to an increased risk of injury with reduced flexibility [63]. The lack of consensus by professionals in the field resulted in a variety of opinions on how to optimize training to improve performance on the course. However, an overwhelming majority of the participants agreed on the importance sports science can have on golf performance. Yet, the validity of what coaches believe and use for training golfers is unknown with PGA assistant professionals having such varied beliefs towards training for golf performance.

Golf biomechanics provides an adequate foundation to further understand the relationship between the human body and the golf swing. Various training interventions have been shown to influence both direct and indirect measures of golf performance [2, 4-6, 10, 13, 16, 17, 19-21, 24, 25, 32-36, 38, 39, 45-47, 49, 51, 53, 55-58, 64, 65]. Misconceptions and a lack of concurrence exist between golf coaches regarding the role of strength and conditioning with golfers [63]. Currently, combining the research in biomechanics, training intervention results on direct and indirect performance measures, and opinions held by professionals in the field, limitations exist in the golf strength and conditioning field to optimize golf performance. Additionally, there is a gap between training knowledge and application by coaches in the golf strength and conditioning industry.

Chapter 3- Methods

Participant Selection

Eighteen strength and conditioning coaches participated in the present study. Inclusion criteria were that they actively train golf athletes in a strength and conditioning capacity, they had at least five years of experience in the field, they held a minimum of a Level 1 Titleist Performance Institute (TPI) certification, and they currently worked in the golf strength and conditioning field. TPI's "Find an Expert" database and Golf Digest's "Top 50 Fitness Trainers" from each year since 2017 were used to identify potential qualified participants. Six hundred seventeen participants were contacted via email or through social media accounts using a standardized script listed in Appendix A. Fifty-three professionals responded equating to a response rate of 8.59%. Initially, 20 coaches agreed to participate. However, two coaches dropped out during the interview process due to schedule conflicts.

Protocol Overview

Once confirmed, each participant scheduled an interview time and produced a training program for analysis. Thirteen of the eighteen participants provided a training program example prior to the interview which helped guide the interview and allowed the practitioner the opportunity to ask specific questions pertaining to their training program. The other five participants produced their training program examples after the interview. Additionally, each participant was contacted via email to answer any follow-up questions about the program. Due to the variability in practice, participants chose the example each wanted documented as a reflection of themself as a golf strength and conditioning professional. All coaches who took part gave informed consent, and ethical clearance was obtained from the University of Wisconsin-River Falls Institutional Review Board for all procedures.

Research Design

The study was based on a grounded theory framework utilizing methodologies from theorists Corbin and Strauss (2008), authors of *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory (4th Edition)*, as well as Charmaz (2014), author of *Constructing Grounded Theory: Second Edition*. *Constructing Grounded Theory* [7, 12].

> Qualitative research begins with assumptions and the use of interpretive/theoretical frameworks that inform the study of research problems addressing the meaning individuals or groups ascribe to a social or human problem. To study this problem, qualitative researchers use an emerging qualitative approach to inquiry, the collection of data in a natural setting sensitive to the people and places under study, and data analysis that is both inductive and deductive and establishes patterns or themes. The final written report or presentation includes the voices of the participants, the reflexivity of the researcher, a complex description and interpretation of the problem, and its contribution to the literature or a call for change [14, p. 44].

The study design included virtual semi-structured interviews, golf training program examples provided by the participants, and a 10-question survey designed to quantify participants' beliefs on training golfers, golf-specific exercises, and training goals associated with golfers. One-on-one semi-structured interviews directed the practitioner to ask specific questions on golf specificity and allowed the discussion to guide additional questions. Each participant determined what information they wanted to contribute about golf training practices and experiences. Additionally, this style of interviewing allowed the practitioner to gain experience with each interview and highlight discovered concepts for future interviews [12]. All interviews were completed over a 3-month period. The same interviewer conducted each session with all participants. Zoom was used as the virtual tool for conducting interviews due to its accessibility, ease of use, and ability to record visual and audio data. Visual and audio data not only provided coaches opportunities to describe their philosophies and training programs but allowed for additional explanation and context to be analyzed following the interview. In congruence with grounded theory methods, non-verbal cues such as facial expressions, tone changes, and pauses provided human interaction factors for the interviewer to interpret and apply to the gathered data [12]. Two interviews faced brief interruptions due to connection issues. When issues were experienced, the interview would temporarily pause and would restart when all connection problems were resolved. Each interview was recorded and saved for future review.

Grounded Theory Approach

Grounded theory design revealed golf strength and conditioning professionals' beliefs on sport-specific practice in golf and contributed explanations for why and how coaches utilize training programs [15, pp. 82-90]. Documenting coaches' beliefs and practices was necessary to understand the utilization of training in practical application compared to what golf training literature had proposed as appropriate practices. As stated by Corbin and Strauss (2008):

> Theory, on the other hand, explains why events, happened and how persons give meaning to those events then based on that meaning and the resources they have to work with and what they think, do, and say—something alone or with others—to respond, live with, change, or shape their worlds to deal with that event [12, p. 190].

A theory grounded in the data allowed development and critical thinking about specific golf strength and conditioning interventions:

> The most important aspect of theory is showing the relationship between concepts by (a) defining the main issue, event, or problem area under investigation as perceived by

> participants; (b) explaining the potential context for action-interaction; (c) relating the action and interaction to the meaning given to problem, issue, or event and explaining how this action and interaction is subject to change with changes in context; and (d) relating the results or outcomes to action and interaction. Constructing theory necessitates that an idea be explored fully and considered from many different angles or perspectives [12, p. 62].

It is important to remember that qualitative research, specifically grounded theory, is a moving and evolving process where theories and concepts do not hold the test of time. There is constant change due to discoveries based on data, interpretations, and critical thinking. “An assumption made in qualitative research is that truth is equivalent to what we know—but eventually it may be judged partly or even wholly wrong” [12, p. 20]. While theories provide a foundation for future analysis on related topics, the evolution of the subject matter is inevitable.

> In short, grounded theory relies on reasoning – making inferences – about empirical experience. Thus, a major strength of the grounded theory method is that these budding conceptualizations can lead researchers in the most useful, emergent, and often unanticipated theoretical direction to understand their data [7, p. 201].

To advance the golf strength and conditioning industry, critically analyzing training processes is necessary to further investigate the specific means coaches use to improve golf performance compared to research, empirical evidence, and the constant evolution of golf performance. While the direction the golf strength and conditioning field will evolve is unknown, documentation on golf training interventions in the field is an important distinction to utilize appropriate practices with golfers.

> Grounded theorists evaluate the fit between their initial research interests and their emerging data. We do not force preconceived ideas and theories on our data. Rather we follow leads that we define in the data or design another way of collecting data to pursue our initial interests [7, p. 32].

A proposed grounded theory could lead professionals to design golf training programs that fit the specific needs of the sport, the sporting movements, and the individual.

Critics of qualitative research and grounded theory frameworks scrutinize the validity of assumptions and interpretations. In such studies, critics question the effectiveness of applying broader concepts to the studied population due to situational and environmental variability [7, p. 243]. As can be the case where misinterpretations are made regarding grounded theory data, the aim of the research is not to quantify data and produce concrete concepts. As proposed by Charmaz (2014):

> Critics of grounded theory commonly miss five crucial points about the method: 1) theorizing is an ongoing activity; 2) grounded theory methods provide constructive ways to proceed with this activity; 3) the method involves abduction as well as induction; 4) the research problem and the researcher's unfolding interests can shape the content of theorizing, rather than the method presupposing the content; and 5) the products of theorizing reflect how researchers acted on these points [7, p. 244].

One of the main goals of grounded theory is to propel the field of study forward with new and creative ideas to effectively achieve the desired performance. The theory is rooted in data and allows continued evolution in the field of study for professionals and researchers to use proposed concepts and build on the central ideas. Although change and progress are inevitable, it is difficult to adjust aspects of philosophies where familiar practices and beliefs become second nature. Charmaz (2014) states:

> Through their affiliations people learn – and absorb – routine meanings and practices. As life becomes routine, the interpretive process compresses and people engage less in an overt inner conversation to mull over their situations. They are unlikely to change either their practices or meanings unless their situations have become problematic and their habitual responses no longer work or new, unanticipated situations or opportunities arise [7, p. 271].

Despite professionals' ingrained experiences and thoughts, exploration of new and different concepts can constantly challenge self-beliefs and practices with the goal of higher performance and understanding.

While grounded theory is based on qualitative data, both quantitative and qualitative data are present in this study to provide different perspectives on how to evaluate training practices and programs. Quantitative measures numerically defined the content of the coaches' programs. Qualitative answers during the interviews allowed context to explain why and how coaches develop their training programs for golfers. As said by Charmaz (2014), "Quantitative researchers test preconceived hypotheses; grounded theorists can offer the grist for emergent hypotheses that quantitative researchers might pursue" [7, p. 198]. To advance the golf strength and conditioning field, professionals must be objective when analyzing beliefs and perspectives, even though differences may challenge the status quo and their beliefs.

Data Analysis Procedure

At the conclusion of each interview, audio and visual recordings were automatically saved using the participant's last name. In one case, two separate recordings were saved due to connection issues.

Additionally, quantitative and qualitative data were gathered in the form of the 10-question survey and each participant's training program example. The survey incorporated Likert-Scale questions, open-ended definition responses, and specific numerical questions to quantify the beliefs and practices of each coach, see Appendix B. To quantify qualitative questions #1 and #2, Likert-Scale answers were assigned numerical values of "1" for Strongly Disagree and increased to "5" for Strongly Agree. Responses to the open-ended questions counted for the number of participants highlighting certain characteristics. The mean was calculated for the specific numerical questions. The survey was completed at the beginning of each interview to gather initial perspectives before the discussion. Participants were instructed to be clear and concise when selecting or providing an answer. Each participant was made aware that the interview discussion was their opportunity to provide contextual information about their beliefs and practices. The practitioner collected training program examples prior to the interview. Five participants did not produce an example prior to the interview for undisclosed reasons but supplied an example after the interview. Training program examples and responses from the survey produced data on golf-specific practices, training means utilized in programs, and beliefs on the role of strength and conditioning for golfers.

Questions posed during the interviews aimed to gather information detailing coaches' philosophies on golf specificity, approaches when creating training programs, and perceptions of golf-specific exercises. Each interview had a similar question structure with additional follow-up questions, if needed, posed by the practitioner for further information or clarification. The semi-structured interview outline is listed in Appendix B.

Data Analysis

Inductive procedures identified golf strength and conditioning coaches' utilization and perceptions of golf-specific exercises. In congruence with grounded theory analysis methods, open, axial, and selective coding created emergent themes around coaches' beliefs and philosophies when training golfers [7, 12]. Additionally, theoretical coding frameworks explained and supplied the foundation for the grounded theory presented.

Video and audio recordings were analyzed after the completion of each interview to continually develop the theory rooted in the data collected. The interview structure evolved over the course of data collection for future interviews to focus on specific topics that pertained to the previously found results [12]. Coding discovered meaningful data within each interview. Notes taken during interviews incorporated brief initial thoughts and primary details. The interviewer was able to listen and guide the interview based on the discussions. Interview questions remained consistent throughout the data collection process with the addition of other topics as interviews continued to better direct the data collection in accordance with grounded theory methods [12].

Meaningful data from the interviews was compared using axial and selective coding. Higher-order categories and sub-categories were determined based on emergent themes during the interviews. The development of higher-order categories and sub-categories represented the philosophies, practices, and perceptions of golf-specific exercises in golf training programs. Interviews were analyzed and coded on three separate occasions. The initial analysis was conducted after the interview was completed and before the next interview with the goal of documenting answers and initial perspectives. The second analysis was completed after all interviews had taken place and sought to determine the underlining meanings coaches had with golf-specificity. The final analysis occurred two months after all the interviews were completed by extracting key quotations and contextualizing discussions and participants' statements. The complete interview analysis outline is displayed in Figure 1.

Figure 1

Interview Analysis Process

<u>Stage 1</u>
- Performed initial analysis of training program provided
- Formed specific questions and/or clarification comments about training program example

<u>Stage 2</u>
- Conducted semi-structured interviews
- Individualized specific questions to each participant about their training examples

<u>Stage 3</u>
- Analyzed initial interview after interview completion and before the next participant
- Recorded survey responses
- Coded initial interview answers via axial and theoretical coding
- Looked for emerging themes to guide future interviews

<u>Stage 4</u>
- Analyzed second round of interviews after completion of all interviews
- Analyzed training program example quantifying magnitude of golf specificity
- Studied axial and theoretical coding to narrow in on primary emergent themes

<u>Stage 5</u>
- Analyzed final round of interviews two months after completion
- Extracted key quotations
- Narrowed axial and theoretical coding

<u>Stage 6</u>
- Reviewed all data and calculations
- Conducted axial and theoretical coding on training program examples

The first analysis encompassed stages 1-3 listed in Figure 1. This included an initial overview of the provided training program example, conducted interviews, documented survey answers, and coded interviews for preliminary themes. Responses to the structured interview questions quantified and analyzed coaches' backgrounds, beliefs, and practices. Quantified answers were incorporated only if the participant explicitly said or alluded to certain characteristics. This data provided context about the studied population. Additionally, survey responses supplied qualitative data.

During the second analysis, stage 4 evaluated the training program examples to determine the golf specificity of coaches' training programs and coded to focus on primary themes. As previously mentioned, a golf-specific exercise was defined as a transverse planar movement where force is initiated at the ground level and transferred through the hands. The definition of a golf-specific exercise determined whether an exercise used in a training program was golf-specific or not. If the exercise matched the definition criteria, the exercise was considered golf-specific. If the exercise was not performed in the transverse plane and force was not generated at the ground level and transferred through the hands, then it was not considered to be golf-specific. The calculated ratio of golf-specific exercises to the total exercises in the program determined the golf-specificity magnitude of each training program. Warm-up movements and stretches were not included as part of the total exercises because the movements were not the primary means of the training program. Every calculated proportion was compared to each participant's response to the final question asked during the interview, "What percentage of exercises used in your training program are golf-specific?" This linkage provided data to analyze the relationship between how participants perceive golf-specificity and the practical golf-specific utilization in their programs, and how the discussion may have affected their response pre- and post-interview.

The final interview analysis during stages 5 and 6 sought to derive core quotations reflective of participants' responses to interview questions and to conduct a final review of all data collected. Context to answers was considered during the analysis based on the participants' earlier responses to associated questions, non-verbal cues, and the portrayed representation of themselves as professional golf strength and conditioning coaches. The data helped illustrate frameworks for each training program example.

Additional data was gathered on common practices coaches used in their training programs. Practices were quantified by the number of coaches who used similar exercises or types of movements to document commonalities utilized in golf training programs regardless of golf specificity. The goal was to gather data on what coaches were doing and then compare the results to what the literature had proposed to implement for golf training programs.

Chapter 4- Results

Data collection produced 18 golf strength and conditioning programs, 18 hours of interview data, and 18 completed surveys that quantified participants' beliefs on training golfers, golf-specific exercises, and training objectives associated with golfers. Seventeen male coaches and one female coach participated. Coaches from the following states, including [MN, WI, CA, WA, TX, UT, AL, FL, NC, VA, MD, MA, and CT] took part. Additionally, one coach from England participated. The variety from different regions in golf off-season and in-season training provided a comprehensive background on training philosophies. The participants ranged in age from late-twenties to mid-seventies with varying experiences in the golf industry helping golfers of all ages and skill levels. The average participant age was approximately 40 years old.

Results of this study are provided in several different methods. All data provided the foundation and context for the discovered grounded theory. Data are presented for the survey responses, numerical categorization for responses is provided for the structured interview questions, and training program examples quantify golf specificity and specific exercises used by coaches. Additionally, this grounded theory design produced interview excerpts reflecting the participants' beliefs and training practices associated with golf specificity. Excerpts from the interview questions and any unstructured discussions that spoke to professionals' opinions about golf-specific exercises are presented and discussed. Specific themes and analytic frameworks were discovered via coding. Axial coding supplied data on the specific "axis" or main topics of golf-specific exercises in the context of what coaches believed and used for training practices. Theoretical coding formed the framework for the grounded theory proposed. The data provided specific themes to each question and allowed contextual information to the broader concept in question on golf-specific exercises. Similarities and discrepancies between the data and literature are presented in the Discussion section.

Survey Responses

The survey responses produced data quantified with mean scores and number of coaches who stated various characteristics.

Table 2

Golf-Specific Exercise Perceived Utilization

Golf-Specific Exercise Incorporation M-Value[a]	4.17
Golf-Specific Exercise Importance M-Value[b]	3.94
Golf-Specific Exercise Perceived Utilization Porportion M-Value[c]	66.67%
Number of Months Golf-Specific Exercises are the Priority M-Value[d]	8.55

Note. M-Value = Mean Value; [a]1-5, Strongly Disagree = 1, Strongly Agree = 5; [b]1-5, Strongly Disagree = 1, Strongly Agree = 5; [c]0-100% Golf-Specific Exercises in Training Program; [d]0-12 Months of an Annual Training Program

Question #1: "Golf-specific exercises should be incorporated in a golf training program. Please circle one answer," resulted in a mean value of 4.17 which meant participants tended to agree or strongly agree with incorporating golf-specific exercises in a golfer's training program. Question #2: "Golf-specific exercises are important in a golf training program. Please circle one answer," resulted in a mean value of 3.94 which meant participants tended to agree with the importance of including golf-specific exercises in a golfer's training program. Results in Table 2 suggest golf-specific exercises had a positive connotation in a program for golfers. Participants indicated an agreement with the incorporation and importance of golf-specific exercises. Question #6: "Circle the percentage that best reflects the proportion of golf-specific exercises used in your training programs," resulted in a mean percentage of 66.67%. This represented the proportion of golf-specific exercises participants estimated to include in their training programs. In comparison, golf-specific exercise analysis of the provided training program examples from each participant resulted in a mean percentage of 11.28%. Participants believed two of every three exercises they used were golf-specific, but the measured result was approximately 1 of every 10 exercises being golf-specific. Question #7: “Circle the number of months that best represents how long golf-specific exercises are the primary means in your training programs during an annual training program,” resulted in a mean value of 8.55 months.

Table 3

Defining a Golf-Specific Exercise

Characteristics	No. of Participants
An exercise that helps the golfer perform swing more optimally	8
Functional directly (movement pattern) or indirectly (correlational characteristics) to the golf swing	6
Looks like or mimics the golf swing	4
Includes a rotary component	3
Using same muscles, motor patterns, speed, RFD, etc.	2
Only for a golfer	2
Functional movment	2
Golf posture	2
Any exercise	2
Prevents injury	1
Incorporates lateral bend	1

Question #3: “How do you define a golf-specific exercise? Please provide your definition below,” derived the notion that participants believed a golf-specific exercise was any exercise that positively affected the golf swing. Participants provided their definitions and any characteristics they desired to highlight. This resulted in multiple recorded answers for defining a golf-specific exercise as listed in Table 3.

Table 4

Golf-Specific Agreement & Magnitude of Agreement

Exercises	M-Value for Golf-Specific Agreement[a]	M-Value for Degree of Golf-Specific Agreement[b]
Rotational Medicine Ball Toss	0.889	8.667
Cable Wood Chop	0.889	8.222
Deadlift	0.833	7.944
Vertical Jump	0.833	7.944
Back Squat	0.833	7.667
Medicine Ball Slam	0.833	7.278
Olympic Lifts	0.778	7.111
Seated Medicine Ball Throw	0.722	6.611
Overhead Medicine Ball Throw	0.667	6.5
Bench Press	0.611	5.778

Note. M-Value = Mean Value; [a]Disagree = 0, Agree = 1; [b]1-10, Extremely non-golf-specific = 1, Extremely golf-specific = 10

Question #4: "Do you consider the following exercises golf-specific? Agree (A)-1 or disagree (B)-0," resulted in participants' agreement that a rotational medicine ball toss and a cable wood chop were the most golf-specific, and a bench press was the least golf-specific of the exercises listed. Question #5: "On a scale of 1-10, 10 being extremely golf-specific, 1 being extremely non-golf-specific, how would you rate the following exercises?" resulted in an agreement with question #4's results with rotational medicine ball toss as the most golf-specific and bench press as the least golf-specific of the exercises listed. Table 4 data signified the disconnection between participants in quantifying golf specificity. In terms of classifying whether an exercise was golf-specific or not, the exercise either fits the criteria, or it does not; the exercise should be either a "10" or "1." There is no middle ground for categorizing specificity, but what participants created was their belief on the degree to which an exercise can help or transfer to golf performance. One participant graded every exercise listed as a "1" except the rotational medicine ball toss which they graded as a "5." Two participants graded all exercises listed as a "10." Nevertheless, when quantifying the golf specificity of an exercise, participants believed a characteristic of golf-specific exercises included a compound multi-joint movement.

Table 5

Quantatitive Training Evaluations

Assessments	No. of Participants
Vertical Jump	15
TPI Screen	13
Swing Metrics (clubhead speed, carry distance, kinematic sequence, etc.)	11
Balance	10
Power Output	9
Strength Parameters	8
Rotational Movements	5
Handicap	1
Blood/Hormone Test	1
Nutrition	1
None	1

For Question #8: "What data do you collect to evaluate the progress of your golfers? Please be thorough and specific. (Examples: 1 RM tests, balance test, vertical jump height, driving distance, etc.)," participants reported the utilization of primarily indirect golf performance measures to assess their golfers with only one coach who directly tracked score or handicap. Vertical jump was the most common evaluation measure. All results are listed in Table 5.

Question #9: "Which of the following training goals do you prioritize throughout a golf training program? Please rank the following based on priority level. (Use

Table 6

Annual Training Program Goal Priority

Training Goals	M-Value[a]
Rotational Power	3
Hip Mobility	3
Torso Mobility	2.94
Core Stability	2.89
Rotational Strength	2.83
Max Power	2.77
Max Speed	2.72
Balance	2.72
Ankle Mobility	2.56
Max Lower-Body Strength	2.22
Anaerobic Glycolytic Conditioning	2.11
Max Upper-Body Strength	2.06
Hypertrophy	1.83
Repeated Sprint Ability	1.83
Aerobic Conditioning	1.78

Note. M-Value = Mean Value; [a]0-3, N/A = 0, Low = 1, Medium = 2, High = 3

Low-1, Medium-2, High-3, or N/A if not-applicable-0)," resulted in varying prioritization of numerous training goals as listed in Table 6. The highest graded goals of "rotational power" and "hip mobility" match the needs to perform the golf swing. However, while there are some similarities in the training goals listed, for 15 separate training goals to have close to a "medium" level of priority or greater suggests there may be prioritized training outcomes that are not needed for golf performance. When a coach focuses on multiple goals instead of a few essential goals for golf performance, time is taken away from developing and maximizing the efficiency of top-priority goals.

Question #10: "Are there any physical limitations that you focus on that seem specific to golfers? For instance, ankle dorsiflexion, thoracic mobility, etc.," supplied in-depth information about what participants believed were limitations they had seen with their golfers. Participants were able to communicate any number of limitations their clients experienced with each participant mentioning at least two primary limitations. Thoracic mobility and hip mobility were the most common limitation responses as listed in Table 7.

Table 7

Common Golfer Physical Limitations

Limitations	No. of Participants
Thoracic Mobility	15
Hip Mobility	13
Shoulder Mobility	8
Ankle Mobility	7
Disassociation of Upper and Lower Body	3
Core Function	3
Glute Strength	2
Weak Posterior Chain	2
None	2
Lead Knee Pain	2
Wrist Mobility	1
Balance	1
Posture	1

Structured Interview Questions

Responses to structured interview questions gave qualitative data that was coded, and it categorized the number of coaches who mentioned specific details for each question. Details regarding golf-specific exercises are discussed in this section with the entire results provided in Appendix B.

When asked to supply a further definition of a golf-specific exercise, each participant stated, in different verbiage, that golf-specific exercises were exercises that positively impact the golf swing. However, only three participants went on to stress the importance of matching similar characteristics of the golf swing such as movement, speed, load, and rate-of-force development patterns in exercises.

When asked, “What perceptions do you have about golf-specific exercises in a training program with golfers?” participants lacked consensus in associating golf-specific exercises as positive. Seven participants had negative associations with golf-specific exercises. Four of those participants believed professionals focused too much on the exercise looking like the golf swing, and professionals should focus on transfer rather than specificity. On the contrary, 10 participants had positive associations with golf-specific exercises. Six of those professionals believed golf-specific exercises help skill development in the golf swing. One participant had both positive and negative beliefs regarding golf-specific exercises depending on the individual client.

Participants’ responses varied as to the perceived needs analysis for golf. Fifteen of the eighteen participants did not initially know what the interviewer referred to when they were asked on their perspective on what a needs analysis for golf would be. Only after a brief explanation by the interviewer were they able to provide their details and characteristics. The most common response communicated by six of the participants was that TPI had “laid the foundation” for what professionals used in determining each golfer’s needs.

The most frequent response regarding the goals of golf-specific exercises was to improve indirect performance measures including clubhead speed and ball speed.

In distinguishing between general and golf-specific exercises, 16 participants believed the general exercises they utilized were also golf-specific, indicating there were no differences between general and golf-specific exercises. Participants commonly explained the exercises that had positive influences on indirect golf performance measures could be considered general and golf-specific.

Eight participants responded, when distinguishing between general and golf-specific exercises, that the primary “con” of golf-specific exercises was the focus on too much rotation and/or mimicking the golf swing.

The concluding question for participants was to quantify the proportion of their training programs they considered golf-specific. This was a similar inquiry to Question #6 in the survey where the participants were asked to circle the percentage that best represented the proportion of golf-specific exercises utilized in their training programs. Six participants had differing responses between the question posed in the survey at the beginning of the interview and the final question at the end of the interview. Three of those six participants had a percent difference of 25%, one participant had the greatest percent difference of 55%, and the overall mean percentage difference for those six participants was 37.5%. This meant that 6 of the 18 coaches (1 out of 3) changed their beliefs regarding golf-specific exercises pre-to-post-interview, and therefore, adjusted their quantification of golf specificity utilized in their training programs by more than 35%.

Golf Specificity of Training Program Examples

The final question of the interview read, "What percentage of exercises used in your training program are golf-specific?," the mean percentage perceived incorporation of golf-specific exercises was 70.28%. This meant participants believed about 7 of every 10 exercises utilized were golf-specific. 70.28% was slightly higher compared to the responses in Question #6 of the survey, "Circle the percentage that best reflects the proportion of golf-specific exercises used in your training programs," where 66.67 % was the believed incorporation of golf-specific exercises. In comparison, the mean percentage for golf-specific exercises used in the training program examples was 11.28%. Additionally, each participant overestimated quantifying the proportion of golf-specific exercises used, where they believed their training program was of greater golf specificity than was measured.

The complete tally of similar exercises or common movements coaches utilized based on the training program examples provided are listed in Table 8. All coaches used a squat exercise or a variation of the movement and "core" work of some sort. The three powerlifts were popularly used exercises. Also, rotational, jump, and row movement patterns were common exercises used in the

Table 8

Exercise Utilization in Training Program Examples

Exercise Characterization	No. of Participants
Core (planks, deadbugs, bear crawls, sit up, etc.)	18
Squat	18
Rotations	17
Deadlift	16
Arm Rows	14
Jumps/Plyometrics	14
Bench Press	13
Lunge (frontal + sagittal plane)	12
Push-Up	12
Overhead Press	11
Medicine Ball Slam	11
Cardio (walk, bike, stairmaster)	9
Bridge	8
Bicep Curl	6
Kettlebell Swing	6
Step-Up (frontal + sagittal plane)	6
Cleans	4
Speed Sticks	4
TPI-Specific	3
Landmine Rotation-to-Press	3
Leg Press	2

training program examples. One other exercise to highlight was that three participants used exercises specific to TPI. This finding was surprising given that each participant was at least TPI Level 1 certified.

Defining a Golf-Specific Exercise

Throughout the interview process, golf specificity was the main task presented to the participants. Phrases and depictions of participants' beliefs regarding golf-specific exercises were recorded and analyzed. As part of this grounded theory framework, statements were contextualized by considering tone, word choice, non-verbal cues, etc.

Coaches discussed their perceptions on what a needs analysis for golf would encompass. Conducting a needs analysis for golf is necessary to understand the required tasks during the sport. A needs analysis supplies information on metabolic demands, kinematics, kinetics, muscle actions, and force-velocity relationships in sports [50, p. 441]. Three coaches provided thorough detail and information outlining their perspectives on what a needs analysis for golf would encompass. One participant outlined the needs of a golfer and golf specificity:

> "I think it's hard to answer that initial question without an agreed-on definition for golf specificity. I think there's a lot that needs to be taken into account for specificity. Most people consider movement patterns in terms of what an exercise visually looks like, but they completely forget about the velocity of the movement, the weight of the implement being used, the balance point, and the different type of implement being used where the direction of force is different such as a dumbbell compared to a cable compared to a resistance band. For an exercise to be considered golf-specific, it needs to match a lot of criteria in my opinion. That would be movement pattern, velocity, load, contraction type, force/time characteristics, and type of implement."

In comparison, fifteen coaches expressed uncertainty regarding what to answer for the needs of a golfer. As one of the fifteen coaches said:

> "That's a broad look of where I'm at right now. I think the majority of golfers need to do a fitness program for a reasonable amount of time. A strength base is necessary. A strength base can improve your power, efficiency, and technical aspects of your swing."

Coaches went as far to say there was not a distinction that made an exercise golf-specific. Another coach who expressed uncertainty described classifying exercises as:

> "Any exercise is golf specific. Since you're basically using every part of your body, every part of your body needs to be fit."

Table 3

Defining a Golf-Specific Exercise

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Looks like or mimics the golf swing	4
Includes a rotary component	3
Using same muscles, motor patterns, speed, RFD, etc.	2
Only for a golfer	2
Functional movment	2
Golf posture	2
Any exercise	2
Prevents injury	1
Incorporates lateral bend	1

Characteristics defining a golf-specific exercise were discussed by participants and recorded throughout the survey and interview questions. As mentioned previously, Question #2 from the survey listed in Table 3, "Helps perform the swing more optimally," "Can transfer to the golf swing," and "It doesn't need to look like the golf swing," were popular responses regarding the definition of a golf-specific exercise. The complexity and nuanced nature of categorizing exercises challenged coaches to critically analyze their beliefs and practices. While characteristics of golf-specific exercises were similar, distinctions existed between coaches' beliefs with a wide range of responses regarding golf-specific exercises and the utilization of such techniques. As one coach alluded to when defining golf specificity:

> "I'm a generalist. Everything we do in the weight room is general physical preparation. The only real specific is swinging speed sticks. I think a specific exercise to a sport skill exercise has the same speed, recruits the same muscles, and uses the same motor patterns. My program doesn't really fit that criteria as golf-specific, but there's still a lot of ability to transfer."

Without a previous definition, determination of what golf-specific was and coaches' utilization of golf-specific training were important distinctions. As said above by one golf strength and conditioning coach, there were countless factors involved in deciding if an exercise was golf-specific including "movement pattern, velocity, load, contraction type, force/time characteristics, and type of implement."

When asked about distinctions separating golf-specific and general exercises, coaches had a variety of responses. One coach defined general exercises as:

> "General is a push, pull, squat, hinge, or single leg balance. Differentiations between specific and general is the motor coordination and reaction time in those positions. General is can we do those basic movements."

As another coach stated:

> "I wouldn't necessarily make that distinction between general and golf-specific. I think golf-fitness is fitness. If you implement movements in the wrong way, and if you stress the body in the wrong way, you can have negative effects on your golf swing but also just movements in general. I think a broadening of the overall perception of golf fitness would take it away from golf-specific to build more functional individuals who can create

> specific performance relative to gym work, but also adjust to the technical aspects of what they're doing."

Coaches continually referred to general exercises as "basic movements" that any person should be able to do. This verbiage alluded to golf-specific exercises and the golf swing as unnatural movements compared to a push, pull, squat, hinge, etc. Basic movements or "general" seemed to encompass sagittal plane movements compared to the golf swing performed primarily in the transverse plane. The distinction that basic movements do not include rotary movements could be flawed where activities such as walking and running, relatively "basic" movements, incorporate movements in the transverse plane. Factors such as the plane of movement influence the body demands for varying exercises. From a participant's perspective:

> "Golf-specific exercises improve the skills of the golf swing. You can either improve your fitness or improve your skill. Improving your fitness may or may not improve your golf game, but improving your skill can help you swing at a higher level."

Outlining the goal of each exercise is necessary to highlight the transferability of the exercise to the desired outcome. As one participant stated:

> "I see fewer limits on exercises. I don't look at something and say, 'Hey, that's a great golf-specific exercise!' I say, 'That's a great exercise!' If I can tweak different exercises to address certain limitations, that's what I'm looking for."

Confused connotations of golf-specific and golf specificity existed where a perception from multiple participants was that golf-specific exercises were exercises that look like the golf swing. As one participant said:

> "I think improving specific moving patterns, sequencing in the gym, where you take out the technicality and the mental side of actually hitting a ball and just allow the body to go

> through that pattern at an increased rate with varied loads, tensions, and intensities. I think that gives a player an opportunity to explore movement, to understand their position in space with proprioception, and awareness with the ground. I think working through patterns that allow that sequencing to occur can vastly improve potential in terms of a golf swing. In terms of everything else, I think everything can be beneficial if applied well and in the right setting and goal for the individual."

Although this participant had a different definition for a golf-specific exercise, he highlighted key characteristics that incorporate golf specificity with movement patterns, sequencing, and varying the loads in positions of the golf swing. In contrast, a different participant expressed:

> "The only sport you can lift specific in is Olympic weightlifting and powerlifting."

This was a vastly different outlook regarding specificity to incorporate "lifting" or strength and conditioning practices with golfers compared to the quote from the previous participant.

One area of debate was the transferability of exercises to the golf swing. If an exercise can transfer to the golf swing, does that make the exercise golf-specific? As one participant said:

> "I never say sport-specific. I say directly related. So, is a deadlift directly related to golf? 100%, and that's testing done by guys a lot smarter than I am. Is a squat? Yes. Bench Press? Yes, but if you look at some other research in the field, a standing chest press with a cable recruits more stability than bench press. From my stance, it's more of what is directly relatable."

The degree to which an exercise is "directly related" or transferrable to the sporting movement falls on a continuum, but the categorization of an exercise should either be sport-specific or not. However, as the same participant said about his philosophies for training golfers:

> "From my viewpoint to keep it simple, how can I train a lean defensive back in the NFL and make you a hell of a golfer."

The theme of building robust athletes through strength and conditioning practices to make them better golfers was a common thought. As a separate participant articulated:

> "If you walk past a gym and see athletes working out, you should have no clue what sport they're in."

This thought inferred athletes train similarly where the needs and demands for each sport were essentially the same. Likewise, a different coach stated:

> "A golf-specific exercise could look footballish, baseballish, or basketballish. It's all about what the individual needs are. If you need more strength, power, or speed there's only one way to train for it. Just make them more athletic."

In contrast, consider a comment from Question #4 from the survey, "Do you consider the following exercises golf specific? Agree (A)-1 or disagree (B)-0?" made by one of three participants who provided an in-depth review of a needs analysis for golf and matched many of the defined components regarding a golf-specific exercise:

> Interviewer: "Do you consider the following exercises to be golf specific? Agree (A) or disagree (B)?"
>
> Participant's Response: "Do they help something in the golf swing? Yes! But are they golf-specific? Absolutely not! I could get my grandma to do those."

Individualized Training Programs

Each participant mentioned they value an individualized approach where the needs of each golfer are the foundation of training. As one coach said:

> "Depending on why they're there with me, it's did we fix what was the problem. Are they improving the performance goals they had?"

The important distinction as to how the golfer improves is subjective to each person. As one coach stated:

> "The main goal of our training programs is to move more efficiently and effectively."

The means to accomplish these tasks can be different for each coach. Every golfer has strengths and weaknesses needing improvement for their unique swing. To identify individual swing strengths and weaknesses, four coaches analyzed individual swing kinematic data themselves. 10 coaches utilized swing kinematic data and relied on secondary sources for such information. Four coaches did not utilize swing kinematic data. One participant, who did not use swing kinematic data but used a wide variety of body analysis assessments, alluded to the potential importance of swing kinematic data:

> "If players do use it, they mainly use it with their swing coach. I'd love to see it utilized more. If a player's clubhead speed increases, I don't know why it's increased. I don't know if it's a change in pelvis-torso separation. I don't know if it's a change in ground reaction force. It's going to come down to technical work. It's difficult to isolate the variables to tell what's the cause."

Understanding the strengths and weaknesses of a golfer's swing can lay the foundation for the focus of the program to improve golf performance effectively and efficiently. Within an individualized training approach, the primary focus in helping a golfer improve may or may not be valid if the coach does not understand a golfer's swing. One participant who did use swing kinematic data explained their perspective as to how they utilized the data:

> "Something that we focus on and separates us from other coaches is the non-standardized approach. Each individual has their own program with their own specific needs. This allows for more goal-driven programs for our clients. We want to attack the individual phases of the swing. Our players already get enough work with the entirety of the golf swing. We'll let their technical work produce the golf-specific effect. However, we do pay attention more to be plane specific with rotational work."

Plane specificity of a movement can be an important distinction with unique individual golf swing planes. A general example outlining this thought is the similarity and difference between the downswing plane in baseball and golf swings. While both movements are performed in the transverse plane, and force is initiated from the ground up, the ball is hit at different heights for each sport causing the swing planes to differ [61]. In other words, the vertical and horizontal swing plane relationship during the downswings could indicate how a transverse plane exercise is or should be performed based on what the goals are. While the plane specificity of movement may appear to be a minute difference, the application of a steep versus shallow plane in the golf swing can drastically alter golf performance. Specific adaptations are made from the imposed demands, also known as the "SAID Principle."

Perceptions of Strength and Conditioning

Additionally, interviews determined the views golf strength and conditioning coaches had regarding their roles in helping golfers through training means. Not surprisingly, each coach perceived strength and conditioning as a necessary and important aspect of a golfer's performance. However, differences were found regarding the training means to achieve optimal golf performance. As one coach articulated on training:

> "Everything I do I don't look at as golf-specific, but I do look at it as golf-specific. Everyone needs essentially the same thing. Golfers just need to then work on their swing to have it transfer."

This coach implied that golfers need the same characteristics and training program to perform well at golf. In contrast, as one coach said:

> "You're hoping the golfer's body is in better physical condition to withstand the stresses that the sport imposes on it. So, for practice and play they have high swing volume, and we know for golf with having a high repetitive action, overuse injuries are common. Strength and conditioning has a role in increasing power output. Finally, depending on the technical change that they are struggling with physically, you may be able to provide interventions to help with those patterns."

This was a different viewpoint on the influence strength and conditioning can have on a golfer's game. For this coach, there was injury prevention, speed output, and technical change with a training program specific to each golfer. A college golf strength coach expressed a combination approach to both thoughts:

> "If my athletes are available, even if we don't see any performance gains, that's my job is to keep them on the course. We're building robust athletes. Working through the important movement patterns such as squat, hinge, lunge, push, pull, core, and single leg movements to give them a lot of what they don't see on the course."

Chapter 5- Discussion

The purpose of this study was to document and evaluate training programs implemented by golf strength and conditioning coaches. Furthermore, collected data provided context on coaches' beliefs regarding golf-specific exercises and the specificity of training. Discovered themes, beliefs, and practices were compared to prior golf-specific training research. A grounded theory developed, displaying coaches' misconceptions on what constituted a golf-specific exercise and coaches' lacking consensus for the utilization of such interventions. Based on the data, these errors were present due to the nonexistence of a previous "golf-specific" definition and held misconceptions about training theories and principles. Both concepts appear to have validity in contributing to the perception variance of golf-specific exercises among golf strength and conditioning professionals, although additional research is needed to evolve golf specificity.

The preeminent topic of discussion was a golf-specific exercise. Findings showed disunity between golf strength and conditioning coaches in classifying golf-specific exercises. When participants supplied their definition for a golf-specific exercise, the most popular belief was any exercise that "helps the golfer perform the golf swing more optimally." In theory, this concept seems practical to improve golf performance. However, the complexity of transfer of training and dynamic correspondence principles provides distinctions between training practices improving sport performance "more optimally" versus "most optimally." As seen throughout golf literature, a variety of training interventions can improve indirect golf performance measures in various populations [2, 4-6, 10, 13, 16, 17, 19-21, 24, 25, 32-36, 38, 39, 45-47, 49, 51, 53, 55-57, 64]. However, for an exercise and training intervention to follow the principles of transfer of training and dynamic correspondence, matching the demands of the sport to training will result in the best transfer to that sport's performance. In contrast, results from Question #5 of the survey, “On a scale of 1-10, 10 being extremely golf specific, 1 being extremely non-golf specific, how would you rate the following exercises?” indicated the exercises listed were believed to be at least moderately-to-very golf-specific with mean scores above five for each listed exercise. This was a misrepresentation by participants in classifying golf-specific exercises and training specificity. There is not a middle ground to classify and quantify exercise specificity to the sport. The exercise either is golf-specific or it is not. However, an argument could be made about the degree to which an exercise transfers to golf performance. These are different misunderstood topics that highlight the importance of exercise and training classification. Giving an exercise a score of five in terms of golf specificity refers to the strength and conditioning coaches’ beliefs concerning the transfer or applicability of the exercise to golf. Although strength and conditioning interventions such as “general” and “sport-specific” training are popularly used by coaches and scrutinized in the industry, the specific components of training styles and exercises are crucial distinctions when training for sport performance because of the SAID Principle. Seemingly insignificant small details of how a movement is performed are important considerations to match training to the desired adaptations.

Surprisingly, two participants reported all 10 exercises in Question #5 of the survey to be a 10, or completely golf-specific, signifying the belief that these two participants did not distinguish between “general” and “golf-specific.” This called attention to misguided knowledge about transfer of training and dynamic correspondence. For example, the bench press exercise, one of the listed exercises in the survey for participants to quantify the magnitude of golf specificity for each exercise, requires force generated predominantly from the upper body with movement primarily in the sagittal plane. In comparison, an efficient golf swing requires force generated predominantly from the lower body with movement primarily in the transverse plane.

The argument of a bench press exercise being golf-specific asserts that it is effective and efficient for improving golf performance is not only inaccurate, but also does not make intuitive sense.

Correspondingly, fewer than 20% of the participants (three participants) were able to provide an in-depth evaluation of what encompassed a needs analysis for golfers. Highlighted by the NSCA, a needs analysis is “Step 1” for the strength and conditioning professional before starting an athlete on a training program [50, p. 441]. While each participant was TPI certified, and several coaches called attention to utilizing TPI methods to assess and train golfers, TPI should be only one resource that is part of the research process. However, the responsibility of the golf strength and conditioning professional is to conduct their own research and seek knowledge to understand the sport of golf, the golf swing movement, and the evaluation of individuals to form their own interpretations concerning appropriate training practices for golfers.

In addition, data displayed the lack of consensus between golf strength and conditioning professionals when answering, “What perceptions do you have about golf-specific exercises in a training program with golfers?” with seven participants who had negative perceptions and 10 participants who had positive perceptions. One participant believed golf-specific exercises were both positive and negative depending on the individual and the desired outcomes. Considering the emergent themes “should focus more on transfer rather than specificity” and “people think exercises need to look like the golf swing” from the seven participants who negatively viewed golf-specific exercises, these themes do not seem to be logical or carry much merit. Considering transfer of training and dynamic correspondence, training directly for sport performance, the most applicable activity an athlete can do to improve performance is their sporting movement and other exercises that would match the characteristics of the sporting movement. While golf-specific exercises do not need to necessarily mimic the golf swing, it seems erroneous assumptions exist about an exercise that looks like the sporting movement not having positive implications on sport performance. Western civilization strength and conditioning ideals afford context to the negative perceptions of "sport-specific" interventions as further displayed in data regarding powerlifts. Powerlifting data from the provided training program examples resulted in all participants who utilized a squat variation, 16 participants who utilized a deadlift variation, and 13 participants who utilized a bench press variation. Additionally, agreement or disagreement on whether an exercise was golf-specific in survey Question #4, "Do you consider the following exercises golf specific? Agree (A)-1 or disagree (B)-0?," five out of every six participants classified both a squat and deadlift as a golf-specific exercise. As commonly seen in Western civilization strength and conditioning, the philosophy to incorporate powerlifts as primary exercises in training programs exists in golf strength and conditioning programs.

An additional emergent theme displayed throughout the data was the reliance on indirect measures of golf performance for assessment purposes and validation of whether an intervention leads to golf performance improvement. Indirect golf performance measures are common in golf performance literature [2, 4-6, 10, 13, 16, 17, 19-21, 24, 25, 32-36, 38, 39, 45-47, 49, 51, 53, 55-57, 64]. Question #8 from the survey, "What data do you collect to evaluate the progress of your golfers? Please be thorough and specific. (Examples: 1 RM tests, balance test, vertical jump height, driving distance, etc.)," quantified how participants evaluated and assessed whether golfers were progressing while using their training program. Utilization of indirect golf performance measures commonly seen in golf performance literature was also used by participants with only one participant who mentioned using handicap or scoring average (a direct golf performance measure) as an evaluative measure. While other data measures such as vertical jump, TPI assessments, swing metrics, balance, power output, and strength tests were popular responses and had been shown to be correlated to elements of golf performance, the measures did not directly quantify golf performance on the course. Quantifying the influence of training on direct sport performance is difficult and nearly impossible to discern for dynamic sports. Three studies that analyzed training intervention influence on golf handicap had mixed results with one study that found statistically significant results in decreasing the handicaps of the participants. These studies primarily relied on "general" training exercises with few exercises fulfilling the "golf-specific" definition [4, 51, 58]. Two of the three studies provided an outline of the training intervention program plan with both studies primarily using plyometric, jump, balance, and other strength exercises [4, 51]. Future studies should evaluate the influence of various training interventions on direct golf performance.

While indirect golf performance measures are relatively easy to quantify changes and improvements as a result of training, in comparison to golf performance on the course, the validity of such measures must be considered. Several indirect golf performance measures such as anthropometric, flexibility, strength, endurance, clubhead speed, carry distance, and swing kinematic data have shown a correlative relationship with direct golf performance. This has led to common inferred causal relationships between these indirect measures with direct golf performance [31, 62]. Even TPI validates indirect performance measures of "power" with the vertical jump, medicine ball seated chest pass, and medicine ball sit-up and throw tests to predict a golfer's clubhead speed. While the data displays golf strength and conditioning coaches' utilization of indirect performance measures, consideration of golf performance assessments based on direct golf performance are more valid measurements compared to improving indirect exercise tests. Additionally, in comparing previous literature to the present study, a gap exists in the utilization of indirect golf performance measures to gauge improvements from the imposed intervention. As seen in prior golf literature, improvements with indirect golf performance measures can be impacted no matter what type of training intervention was used [2, 4, 6, 10, 13, 16, 17, 20, 21, 24, 32, 33, 35, 38, 46, 47, 49, 51, 53, 55-58, 64, 65]. However, indirect golf performance measures may or may not be a valid representation of overall golf performance. Concurrently, existing golf-specific exercise studies may or may not represent what golf-specificity training and golf-specific exercises are, therefore the validity can be questioned of such results [2, 10, 21, 24, 35]. Future studies are needed to explore golf-specific exercise and its impact on golf performance.

Limitations

"Qualitative research is a form of research in which the researcher or a designated coresearcher collects and interprets data, making the researcher as much a part of the research process as the participants and the data they provide" [12, p. 4]. As such, the qualitative grounded theory structure of the present study was a limitation. Although interpretations and theories made by the researcher involved a level of subjective reasoning and interpretation of the data, this was the design and goal of the practice to propel the golf strength and conditioning field forward to new and innovative ideas of discovery. While controversy remains over the application of training interventions for golfers, present data outlined the variance of characterizing and applying training. The structure of this study supplied data to evolve golf training discussions as the golf strength and conditioning field searches for effective training practices.

Additionally, a limitation of the present study was the focus on multiple topics within the golf strength and conditioning field. Part of the grounded theory process was to allow the theory to be “grounded” in the data and evolve during data collection. Without knowing prior to the interviews what theories would emerge, the time dedicated to discussing golf-specific exercises was sufficient but could have been a greater topic of exploration. A variety of questions pertaining to concepts within golf strength and conditioning took time away from gathering additional data about what appeared as the theory regarding golf-specific exercises. Additional limitations were the training program examples provided by the participants. Each participant sent one example for analysis. While this was a training program written and prescribed by participants, each was a singular example where the situation and context of different clients influenced the content of the training programs. However, each participant was able to select whatever program they wished to use as a reflection of themselves and was afforded opportunities throughout the interview to discuss any information and context to their training philosophies and programs. It is recommended that future research further analyze the application of practices being utilized in the golf strength and conditioning field.

Conclusion

This study outlined a grounded theory that golf strength and conditioning professionals held misconceptions regarding the definition of a golf-specific exercise. A lack of training characterization and categorization in the field coupled with the application of misguided knowledge concerning training intervention transferability to golf performance were probable factors for the theory formation. The present study was the first to define a golf-specific exercise to allow professionals in the field to characterize exercises and analyze the impact of various interventions on golf performance. Distinctions in defining and characterizing types of training and exercises are not to criticize the application of utilized practices; rather, it is to distinguish and to critically think about the validity of training practices with specific sport athletes. While exercises such as bench press, squat, and deadlift allow the athlete to get better at bench pressing, squatting, deadlifting, and other similar movements, this does not mean the athlete will improve performance or improve performance optimally in their specific sport. Strength and conditioning professionals should consider, “Are we training athletes to improve in the gym, or are we training athletes to improve at their sport?” If improving direct sport performance is the goal, training should match the needs of the sport and the demands of sporting movements. The utilization of the strength and conditioning concepts of transfer of training and dynamic correspondence can continually evolve the golf strength and conditioning field to optimize golf performance. Further research should explore golf-specific exercises and the use of such practices in training programs designed to improve golf performance.

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Appendix A

Standardized Participant Invitation Script

Dear (Participant),

My name is Philip Herder. I am a graduate student at the University of Wisconsin-River Falls and the Director of Research at Interlachen Country Club in Edina, MN. I am conducting research on golf strength & conditioning programs, and I am inviting you to participate. Participants must be responsible for training golf athletes, have at least 5 years of experience in the field, are TPI certified, and currently work in the field to partake in the study.

Participation in this research includes completing a virtual interview about the training programs you use with your golfer, which will take approximately 60 minutes. We ask you provide a copy of a training program or an annual training program example which is the focus of the research. Further analysis will be done on your training program example to describe training methods being used in the golf training industry in comparison to what past literature has concluded about golf training.

If you have any questions or would like to participate in the research, I can be reached via phone number, email, or social media.

Appendix B

Interview Structure

Figure B1. Survey Structure

1. Golf-specific exercises should be incorporated in a golf training program. Please circle one answer.

   Strongly Agree-5 Agree-4 Neutral-3 Disagree-2 Strongly Disagree-1

2. Golf-specific exercises are important in a golf training program. Please circle one answer.

   Strongly Agree-5 Agree-4 Neutral-3 Disagree-2 Strongly Disagree-1

3. How do you define a golf-specific exercise? Please provide your definition below.

4. Do you consider the following exercises golf specific? Agree (A)-1 or disagree (B)-0?

   a) Deadlift ______
   b) Overhead Medicine Ball Throw ______
   c) Vertical Jump ______
   d) Olympic Lifts ______
   e) Rotational Medicine Ball Toss ______
   f) Bench Press ______
   g) Back Squat ______
   h) Cable Wood Chop ______
   i) Medicine Ball Slam ______
   j) Seated Medicine Ball Throw ______

5. On a scale of 1-10, 10 being extremely golf specific, 1 being extremely non-golf specific, how would you rate the following exercises?

   a) Deadlift ______
   b) Overhead Medicine Ball Throw ______
   c) Vertical Jump ______

d) Olympic Lifts _____

e) Rotational Medicine Ball Toss _____

f) Bench Press _____

g) Back Squat _____

h) Cable Wood Chop _____

i) Medicine Ball Slam _____

j) Seated Medicine Ball Throw _____

6. Circle the percentage that best reflects the proportion of golf-specific exercises used in your training programs.

   0   25%   50%   75%   100%

7. Circle the number of months that best represents how long golf-specific exercises are the primary means in your training programs during an annual training program.

   0   1   3   6   9   12

8. What data do you collect to evaluate the progress of your golfers? Please be thorough and specific. (Examples: 1 RM tests, balance test, vertical jump height, driving distance, etc.)

9. Which of the following training goals do you prioritize throughout a golf training program? Please rank the following based on priority level. (Use Low-1, Medium-2, High-3, or N/A if not-applicable-0)

a) Max Lower-Body Strength _____

b) Max Upper-Body Strength _____

c) Max Power _____

d) Max Speed _____

e) Hypertrophy _____

f) Aerobic Conditioning _____

g) Anaerobic Glycolytic Conditioning _____

h) Repeated Sprint Ability _____

i) Rotational Strength _____

j) Rotational Power _____

k) Core Stability _____

l) Balance _____

m) Ankle Mobility _____

n) Hip Mobility _____

o) Torso Mobility _____

10. Are there any physical limitations that you focus on that seem specific to golfers? For instance, ankle dorsiflexion, thoracic mobility, etc.

Figure B2. Interview Questions & Answers

1. First, if you could provide background information on your career and your journey during your professional career.

Table 9

Participant Background Information

Characteristics	No. of Participants
Exercise & Sport Science Degree	13
Played collegiate golf	9
Physical Therapist	4
Originally from outside the U.S.	3

2. Describe your current position and the responsibilities you have with golfers.

Table 10

Participant Current Position

Occupation	No. of Participants
Owner (business, facility, etc.)	12
Head S&C Coach	4
Golf Trainer	2

Table 11

Participant Role with Golfers

Responsibilities	No. of Participants
Program & Coach	17
Developing App and/or YouTube Workouts	4
Clinically Treat Clients	2
Only Programming	1

a. What skill levels do you primarily work with?

Table 12

Participant Clientele Demographic

Skill Level	No. of Participants
Amateur	10
Professional	7
Collegiate	7
Seniors	7
Junior	7

3. How do you analyze the efficacy of your training programs?

Table 13

Measuring Validity of Training Program

Efficacy Analysis	No. of Participants
Improvement in movement patterns	10
Verbal feedback from clients	9
Swing metrics	9
Doing no harm	5
Did the client reach their goal?	3
Body composition	3
Analytic software with objective data	2

a. Is individual swing kinematic data utilized in creating and adjusting training programs? How so?

Table 14

Data to Create Training Programs

Utilization of Individual Swing Kinematic Data	No. of Participants
Yes	14
Yes, but use swing coach for knowledge	10
Yes, but only for initial client analysis	4
No	4
No, but hope to use in future	3

b. What strategies do you use to continually evolve and adjust your training programs to improve performance?

Table 15

Data to Evolve Training Programs

Strategies	No. of Participants
Learning from other professionals in the field	9
Learning through certifications	7
Experimentation	6
Research (seeking out and doing own analysis)	4
Feedback from Clients	3

4. What are some training philosophies you have?

Table 16

Strength and Conditioning Principles

Golf Training Philosophies	No. of Participants
Dependent on individual	17
Focus on functional movements to move in all planes	7
Necessity for "base strength" first to provide foundation	7
Do no harm	6
Mobility is key	5
No barbells	2
Feet are important to "build from the ground up"	2
1:2 ratio for push : pull exercises	1
3:1 ratio for lower : upper body exercises	1

a. What is your perception of the role of strength & conditioning with golfers?

Table 17

Role of Strength and Conditioning with Golfers

Perceptions	No. of Participants
Necessity to improve at golf	11
As important as golf practice	5
Useful to lengthen and improve career in golf	4
Should be utilized to improve mobility and to move better	3
Not as important as golf practice	3
Is both positive and negative	2

5. With analyzing the training program example you provided, what is your approach with designing an annual training program, mesocycles, and/or microcycles?

Table 18

Approach to Designing a Training Program

Characteristics	**No. of Participants**
Dependent on competition schedules + individuals	12
Periodization of cycles	10
Undulating cylces	6
Start higher rep counts and progress to lower rep counts	4
Continuous reevaluation of TPI screen	4

a. What training goals are focused on during a training program?

Table 19

Goal Prioritization in Training Program

Primary Training Goals	No. of Participants
Injury prevention	10
Improve the clients' goals	5
Move better	4
Bigger muscles	3
Increase rate-of-force development	2
Improve core function	2
Improve fundamentals for golf swing	2
Feel better before, during, and after a golf round	1

b. What types of training are primarily used?

Table 20

Types of Training

Utilized Training	No. of Participants
Mobility	12
Core	9
Plyometrics	8
Unilateral exercises	8
Power	7
Speed	5
HIIT	3
Balance	2
Cardio	2
Flexibility	1

i. What exercises/movements are the focus?

Table 21

Types of Exercises

Utilized Exercises	No. of Participants
Hinge	17
Squat	14
Lunge	10
Push/Pull	6
Rotation	5
Anti-Rotation	3
Bridges	1

6. What is your definition of a golf-specific exercise?

Table 22

Defining a Golf-Specific Exercise

Characteristics	No. of Participants
Helps perform the golf swing more optimally	5
Anything in the kinematic sequence	4
Anything that can keep golfers playing	4
Doesn't need to look like the golf swing	4
Mimics swing	3
Difficult to define/does not exist	3
Matches movement, speed, load, rate-of-force development, etc.	3
Fitness + functional movements	3
Unable to apply to another sport	1

a. What perceptions do you have about golf-specific exercises in a training program with golfers?

Table 23

Perceptions about Golf-Specific Exercises

Connotation	Characteristics	No. of Participants
Positive		11
	Help golf skills become more efficient	6
	Whatever will help a golfer adapt to the stresses of a round	2
	Helps build the tool-box	2
	Creates buy-in for golfers why fitness is helping their swing	1
	Can be great when used at the right time	1
Negative		8
	Need for focus on transfer rather than specificity	4
	People think exercises need to look like the golf swing	4
	Problem with overload not being same speed but same movement pattern	2

b. What is your perception on what a needs analysis for golf would encompass?

Table 24

Perceptions on Golfer Needs Analysis

Characteristics	No. of Participants
TPI has laid foundation	6
Up to coach to use information to help client for what they need	5
Move in sagittal, frontal, + transverse planes	4
Matches movement, speed, load, rate-of-force development, etc.	4
Squat/Lunge	2
Basic fundamental movements	2
Most people just need a fitness plan	1
Infinite number of ways to swing a golf club	1

c. What do you believe the goals of golf-specific exercises are?

Table 25

Goal of Golf-Specific Exercises

Characteristics	No. of Participants
Improve indirect golf performance measures	10
Move more efficiently	5
Improve a golfers' swing	5
Prevent injury	4
Strengthen aspects of the golf swing	2
Increase rate-of-force development for golf swing	1
Narrow gap between movements for training and hitting golf shots	1

d. What is the role of general exercises compared to the role of golf-specific exercises?

Table 26

Role of General Exercises Compared to Golf-Specific Exercises

Characteristics	No. of Participants
Move body in functional patterns	5
Goal is overall health + well-being	4
Create an ideal body image for people	3
Should always be the primary goal	3
Help transfer strength to speed	2
Helps more than people think	2
Add novelty	1

e. What are some pros and cons you see with golf-specific exercises compared to general exercises?

Table 27

Perceptions on Golf-Specific Exercise Utilization Compared to General Exercises

Connotation	Characteristics	No. of Participants
Pros		
	Can add to golf performance for the right person	2
	Helps golfers with technical pieces in the golf swing	2
	Strengthens certain tissues in certain swing positions	2
	Helps ability to rotate for golf swing	1
	Promotes golf posture	1
	Improves clubhead speed	1
	Improves certain movement patterns	1
	Can improve anything a golfer does	1
Cons		
	Too much focus on rotation/mimicking the golf swing	8
	Questionable transferability to the golf performance on the course	3
	Too much of the same pattern can lead to injury	2
	Bad information about practices in the industry regarding safety and optimization	2
	Too complex for most individuals	1
	Best way to score better is to actually play	1

f. How should golf-specific exercises be utilized?

Table 28

Utilization of Golf-Specific Exercises

Characteristics	No. of Participants
Help players improve on an individual basis	4
No right or wrong way	3
Job of professional to decide what's appropriate	3
Should be used during preseason phase for specificity	2
Use at the beginning of a session to develop plane specific power	1

g. Have your beliefs evolved through your career about training for golf-specific exercises? How so?

Table 29

Belief Evolution on Golf-Specific Exercises

Time	Characteristics	No. of Participants
Past		
	Had to look like the golf swing	4
	Focused more on sport training	3
	Basic programming	2
	Don't lift heavy	2
	More flexibility + mobility training	1
	1-rep max training	1
	Stability movements on "unstable" surfaces	1
	Stregnth + Conditioning will hurt your golf game	1
Present		
	Many different exercises can help the golf swing	4
	All exercises can transfer to the golf swing	4
	Need to find weaknesses in the chain	3
	Focus on fundamental movements	2
	More specific with programming	2
	Lift heavy + explosive	2
	Combination of strength + mobility	1
	Injury prevention	1
	More plane-specific for exercises	1
	Move to play golf + not vice versa	1
	Speed Sticks	1

h. What percentage of exercises used in your training program are golf-specific?

Table 30

Golf-Specific Exercise Utilization Proportion in Training Program

Did Participant's Answer Change?[a]	No. of Participants
Yes, from 75% to 100%	3
Yes, from 25% to 80%	1
Yes, from 75% to 30%	1
Yes, from 75% to 25%	1
No	12

Note. [a]Answer changed from Question #6 from the survey quantifying golf-specific exercise utilization proportion

Golf Strength and Conditioning Program Analysis:

Are Coaches Using Golf-Specific Practices?

By

Philip Herder

A Thesis

Submitted in Partial Fulfillment of

the Requirements for the Degree of

Master of Science in Strength and Conditioning

Zachary Rourk, Ph.D. Date

Gregory Ruegsegger, Ph.D. Date

Travis Tubré, Ph.D. Date

Director, Graduate Studies Date

University of Wisconsin-River Falls

2024

Abstract

The beliefs and perceptions of golf strength and conditioning coaches dictate how golfers are trained. As dynamic correspondence and transfer of training principles highlight, distinctions between utilized training interventions could provide explanations regarding appropriate practices for golfers. The present study followed a grounded theory qualitative structure. The purpose was to investigate golf strength and conditioning coaches' training beliefs, training practices, and to define a golf-specific exercise. Eighteen golf strength and conditioning coaches participated in virtual semi-structured interviews, and each provided a training program example reflecting their beliefs used in practice. Qualitative and quantitative data in the form of a survey, interview, and the training program example were collected. A grounded theory emerged that indicated a lack of consensus in the golf strength and conditioning field for what defines a golf-specific exercise and the use of such interventions in training programs for golfers. The present grounded theory speculated shortcomings exist because "golf-specific" had yet to be defined in the field and literature, in conjunction with held misconceptions about training principles and specificity. Furthermore, data suggested golf strength and conditioning coaches utilized Western civilization strength and conditioning characteristics of incorporating powerlifting exercises and utilizing indirect performance measures to assess training progress for golfers. This study was the first of its kind to quantify golf specificity and define golf-specific. As the grounded theory supplied an initial analysis of the specificity of training golfers, future studies should continue to develop the evolving concept of golf-specific training.

Keywords: golf-specific, strength and conditioning, golf, golf-specific training, golf training, transfer of training, dynamic correspondence, golf performance, grounded theory

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Chapter 1- Introduction

According to the National Golf Foundation, over 40 million people in the U.S. over the age of five played golf either on-course or indoors in 2022 [42]. The number of golf rounds played during 2022 was up 13% compared to the annual averages from 2015 to 2019 [42]. The increase in golf popularity has led golfers to experiment with different strategies to improve their game and performance on the course. This competitive landscape has spearheaded the necessity for golfers to train off the course to optimize performance. Professional players such as Tiger Woods, Dustin Johnson, and Bryson DeChambeau have been public about how their training practices have changed over their careers. Players, coaches, and researchers have attempted to replicate tour professionals' practices in hopes of maximizing each golfer's performance, furthering the demand for the utilization of strength and conditioning in the industry. While aspects of strength and conditioning methods may be similar for tour professionals, differences in training practices influence adaptations. Golf is unique compared to other sports where the age range widely varies from kids younger than 5 years old learning golf to adults older than 70 playing during retirement years. The desired goals of any age golfer can be drastically different influencing how a golf strength and conditioning coach would train each client. Controversy remains regarding what practices elicit desired adaptations for golfers.

Research in the golf industry has evaluated the efficacy of flexibility, strength, and golf-specific intervention impact on various performance outcomes such as clubhead speed, driving distance, and swing kinematic data [2, 5, 6, 17, 19-21, 25, 32-36, 39, 45, 46, 48, 49, 52, 53, 63]. Training interventions have widely shown to improve these indirect performance variables correlated with players' golf score [2, 6, 17, 19-21, 25, 32, 34-36, 48, 49, 53]. An important distinction in evaluating performance improvements are the differences between direct and indirect sport performance measures. While many of the kinematic variables of the golf swing have been widely researched and correlative relationships exist with scoring average and handicap, indirect performance measures are not the most valid for golf performance. Direct golf performance measures of scoring average and handicap precisely evaluate the skill of a golfer and generally determine who are the top players.

Concepts of specificity and transfer of training such as movement patterns, physical characteristics, and change in performance variables have been frequent topics of discussion [2, 25, 35, 45, 63]. To understand the role of strength and conditioning for golfers, John Hellstrom wrote a chapter in *Routledge International Handbook of Golf Science* titled "Strength and Conditioning for Golf" where he describes various goals for golfers [25]. Hellstrom offers suggestions based on previous research for appropriate and effective training practices to improve golf performance [25]. He summarizes the chapter as "Strength and conditioning can be helpful for golfers to be able to play, to hit the ball further with higher precision, and to score lower" [25]. Even though improving indirect measures of golf performance such as precision, clubhead speed, swing efficiency, and injury resilience can be essential, finding the proper combination is necessary to directly analyze whether or not direct golf performance is optimized. Hellstrom shares his recommendations on exercises specific for golf:

> Although there is a need for more research regarding the effect of S&C training on golf swing and ball flight precision, it is likely that some flexibility and neuro-muscular training should be specific to the golf swing to have a better effect on performance. That means stand up, using multi-joint exercises that coordinate the whole body in a down-to-up kinematic sequence, and including horizontal plane movements. The training also

needs to be varied over time, to achieve both injury prevention and performance goals [25, p. 332].

Table 1

Literature Defining Sport-Specific Golf Training

Author/Year	Plyometric	Rotational Movement	Medicine Ball	Sequential Chain	ROM (flexibility)	Body Stability (Balance)	Muscles of a Golf Swing	Performing Swing	Resistance (strength)	General Exercises	RFD	Power	Injury Prevention	Cable/Band	Multi-Joint Exercise	Endurance
Fletcher 2004	x	x	x	x	x	x	x	x								
Fradkin 2004		x					x	x								
Doan 2006		x	x	x	x		x	x	x	x	x	x			x	
Lehman 2006		x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Lephart 2007		x			x	x	x	x	x	x					x	
Newton 2007			x				x	x	x	x	x	x			x	
Brandon 2009					x	x	x		x	x			x	x		x
Kim 2010		x	x		x	x	x	x	x	x		x	x	x	x	
Meira 2010		x			x	x	x	x	x	x		x	x	x	x	x
Bull 2012	x	x	x		x		x		x		x	x	x		x	
Lamberth 2013			x		x		x		x	x			x	x	x	
Lewis 2016	x	x	x		x		x	x				x			x	
Olivier 2016	x	x			x	x	x		x	x		x		x	x	x
Hellstrom 2017		x	x	x	x		x		x		x		x		x	
Sorbie 2019		x			x	x	x		x			x	x			
Redondo 2020	x	x			x	x	x	x				x		x	x	

Defining a golf-specific exercise is necessary to implement exercises aiding the requirements needed to perform the golf swing. Aspects of exercises specific for golfers have been previously highlighted [5, 6, 17, 20, 21, 25, 32-36, 39, 45, 46, 49, 53]. Important aspects of golf-specific exercises are combinations of characteristics including rotation, range-of-motion (ROM) of a golf swing, same muscle utilization, swing performance, resistance for strength purposes, power, and/or multi-joint movement. Table 1 outlines an analysis of studies documenting specific characteristics of what training for golf should be. Therefore, for the purpose of this study, a golf-specific exercise will be defined as a transverse planar movement where force is initiated at the ground level and transferred through the hands.

Though various strength and conditioning practices have demonstrated effectiveness in improving indirect measures of golf performance, there is a dearth of information related to utilized training interventions in the field [52, 63]. While indirect measures such as clubhead speed, driving distance, swing kinematic data, etc., are correlated with direct golf performance, few studies have analyzed the influence of training interventions on direct measures of golf performance. Wells and Langdown (2020) went as far as to propose it is likely that PGA assistant professionals hold misconceptions related to strength and conditioning's role in golf performance, most notably highlighting that at least 50% of participants engage year-round in endurance training, Olympic weightlifting, and high-intensity interval training (HIIT) [63]. However, with many different shots and an infinite number of variables affecting golfers' performance, which training practices effectively and optimally transfer to the course? Can exercises be categorized into "types" of training? Do professionals rely on indirect measures to determine the efficacy of training programs?

The purpose of this study was to document and evaluate implemented training programs by strength and conditioning coaches in the golf industry to discover the validity of training practices for golfers. Specifically, are golf strength and conditioning coaches applying golf-specific training? We hypothesize that golf strength and conditioning coaches believe their training practices to be golf-specific, and that these practices are not reflective of what research and dynamic correspondence describe as golf-specific training.

Chapter 2- Literature Review

Defining Needs Analysis and Dynamic Correspondence

When developing effective strength and conditioning programs for golfers, different variables need consideration to identify individual strengths and weaknesses [25, 45]. The efficacy of a "one-size-fits-all" approach to training athletes is a difficult determination because of the amount of variability between athletes, sports, and the stressors imposed on the body. However, standardization of outcome measures may be useful to regulate specific adaptations for the sport-specific athlete [1, 36].

As stated in the *NSCA: Essentials of Strength Training and Conditioning,* a needs analysis is defined as a "two-stage process that includes an evaluation of the requirements and characteristics of the sport and an assessment of the athlete" for the strength and conditioning professional to conduct when designing a training program [50, p. 441]. A needs analysis is the foundation in understanding the demands of sport performance and provides the basis for applying transfer of training principles. Furthermore, dynamic correspondence outlines transfer of training and training specificity as:

> The means and methods of strength training for specific sports should be chosen to enhance the required motor qualities in terms of the amplitude and direction of the movement, the accentuated region of force production, the dynamics of the effort, the rate and time of maximum force production, and the regime of muscular work [59, p. 241].

Interventions Impacting Golf Performance

Research in golf training has targeted biomechanics of the golf swing, efficacy of training practices, and professionals' valuation of training interventions [1-3, 5, 6, 8, 9, 11, 17-22, 25-28, 30, 32-37, 39-41, 43-46, 48, 49, 52, 53, 61]. When creating a training program, the understanding and consideration of these components are crucial to effectively train golfers.

Biomechanics of the Golf Swing

"The objective of any golf swing is to hit the ball in the proper direction and for proper distance with the most efficient motion" [1]. Swing biomechanics influence the achievement of those goals [1, 3, 5, 8, 9, 11, 18, 22, 26-28, 30, 37, 40, 43, 44, 61]. In previous studies, different variables have investigated the standard characteristics of a golf swing [1, 3, 8, 11, 22, 38, 43, 44]. Variables of importance to the strength and conditioning field include x-factor, x-factor stretch, ground reaction forces (GRF), and crunch factor (CF).

The x-factor and x-factor stretch are derived from the relationship between the hips and the shoulders in the transverse plane. The x-factor can be described as "the relative rotation of the shoulders with respect to the hips during the golf swing" [8]. Specifically, research has demonstrated an increase in x-factor at the top of the backswing improves rotational velocities throughout the swing, leading to higher clubhead speeds and the potential for increased ball speeds and further distances. The x-factor stretch refers to "the increase in x-factor during the early part of the downswing" where the hips initiate the downswing while the shoulders hold the club at the back of the downswing [8]. While the x-factor is an important variable in rotational velocities and clubhead speed, further research has illustrated the x-factor stretch may be more important for players to consider [8].

Peak GRF in both the lead and trail foot have displayed a positive relationship with clubhead speed [23]. Additionally, differences between skill levels in the development of GRF and transfer of force through the kinetic chain have been well documented. Higher-skilled players create greater GRF during the backswing and transfer the force to the lead leg better compared to lower-skilled players where GRF is smaller in magnitude on the backswing with tendencies of weight remaining on the trail leg through impact [29]. Production of GRF is important because of the kinetic chain or link concept. The kinetic chain concept can be described as "large base body segments passing momentum to smaller body segments" [61]. Forces at the ground level transfer up the system, or chain, to increase rotational velocity in the golf swing [3, 27, 44]. The product of this kinetic chain is clubhead speed, ball speed, and distance, all of which are considered important indirect golf performance variables [44].

Over the past few decades, researchers have investigated the CF [11, 18, 22, 28, 41, 54]. Sugaya et al. (1997) first calculated the CF as the product of lateral flexion spine angle and axial angular velocity of the trunk at impact during the golf swing [54]. A greater CF product is theorized to be more harmful than a smaller CF value [11]. CF is proposed to "objectively measure and compare the mechanics of the lumbar spine in healthy and pathologic golf swings" [11, 41]. "The CF has been described as a measure to evaluate the risk of low back injuries in golfers and is based on the notion that lateral flexion and axial trunk rotation jointly contribute to spinal degeneration" [11]. Lumbar spine injuries or pain are the most frequent injuries discussed in golf literature and mentioned by golfers [5, 22, 39]. While Sugaya et al. (1997) initial equation to quantify the CF and its relationship with lower back pain is theory based, studies have evaluated injury prevention and risks associated with the CF [11, 18, 22, 41]. Findings indicate training strategies to combat lower back pain can focus on specific muscles including the transversus abdominis and multifidi muscles, as well as prioritizing hip strength and mobility with pelvis and trunk rotation [18, 22]. Additionally, analysis of the lumbar positioning and pelvic sequencing can diagnose inefficiencies and potential injury risks [18]. From this analysis, a swing or sequence adjustment could be considered if the professional believes the injury risk outweighs the present performance. Considering back injuries and spinal health during a swing and fitness evaluation could be useful and appropriate when creating golf training programs.

An added piece of golf biomechanics literature has explored high-level golf coaches' perceptions of technical parameters in the golf swing compared to the biomechanical literature [52]. Smith et al. (2015) observed and interviewed 16 high-level golf coaches to analyze their perceptions of important technical parameters of an elite golf swing [52]. Researchers found coaches spoke most often about five key technical parameters; club motion, posture, body rotation, sequential movement of body segments, and arm and wrist action [52]. Furthermore, the study found coaches tended to focus on posture and body rotation as the primary technical parameters. "Methodological limitations in the golf biomechanics literature make it difficult to examine the complex movement with regards to the five key technical parameters" [52]. While individual coaches had different strategies for analyzing golf swings, and limitations exist in the golf biomechanics literature to understand the specific mechanisms of performance, applying aspects of the golf swing movement coupled with contextual information about the individual and environment can maximize performance when training golfers.

Efficacy of Golf Training Interventions

"General" and "golf-specific" training interventions have both demonstrated improvements in various golf swing kinematic variables, including clubhead speed, x-factor stretch, and additional limb velocities [2, 4-6, 10, 13, 16, 17, 19-21, 24, 25, 32-36, 38, 39, 45-47, 49, 51, 53, 55-57, 64]. In a recent systematic review by Ehlert (2020), 25 studies were analyzed to determine the impact of strength and conditioning interventions on golf performance variables. The primary inclusion criterion for the studies was the evaluation of a strength and conditioning intervention effect on golf performance variables compared to a control group [19].

While the review categorized the types of training used in the 25 studies (strength, power, plyometrics, functional, flexibility, and golf-specific), the analysis did not discern the differences between the training methods. Varying skill levels, training program durations, and training programs widely improved clubhead speed, ball speed, and driver carry distance [19]. While the review highlighted these indirect golf performance measures, Ehlert additionally analyzed three studies that outlined strength and conditioning interventions' influence on handicap and scoring average [19]. The three studies presented mixed results with only one displaying a statistically significant improvement in handicap and scoring average. All three studies were with junior golfers (anywhere from 12-19 years old) and did not supply information on participants' training age [4, 19, 51, 58]. These factors influence the trainability of golfers and the adaptations that could be made over the course of a training intervention.

Studies have looked at the effectiveness of "general" training and "golf-specific" training interventions [2, 4, 6, 10, 13, 16, 17, 20, 21, 24, 32, 33, 35, 38, 46, 47, 49, 51, 53, 55-57, 58, 64, 65]. Sixteen of twenty studies analyzed "general" or standard exercise programs and resulted in statistically significant improvements in at least one of the indirect golf performance variables of clubhead speed, ball speed, x-factor, and flexibility [4, 6, 13, 16, 17, 20, 32, 33, 38, 46, 47, 49, 51, 53, 55-58, 64, 65]. When analyzing the makeup of these "general" training programs, exercise classification can be difficult as programs did incorporate exercises deemed as "golf-specific." In these studies, analysis of indirect golf performance measures such as flexibility, muscular strength, clubhead speed, and swing kinematics determined whether golf performance improved.

In contrast to the "general" training program studies, few studies have evaluated "golf-specific" interventions [10, 21, 35]. Three studies highlighting "golf-specific" training resulted in statistically significant improvements in the same indirect golf performance measures analyzed in the "general" training intervention studies. In an 8-week golf-specific training intervention, Lephart et al. (2007) found statistically significant improvements after the completion of the training intervention including a 7% increase in upper torso axial rotation and a 14% increase in x-factor velocity [35]. Upper torso axial rotation and x-factor velocity are reflected in clubhead speed and smaller standard deviation ball velocity [60]. A 2016 study by Hegedus et al. analyzed and compared a "general" and "golf-specific" training program [24]. One group trained using a "general" intervention, and a different group trained using a "golf-specific" intervention for the 10-week duration of the study. Both 10-week training programs resulted in statistically significant improvements in clubhead speed, although no statistical differences were found between the training groups' results. In a different approach, Álvarez et al. (2012) conducted a 23-week, in-season study with three separate 6-week phases. The first 6-week phase started with "strength" focalized training, progressed to "explosive-strength" for the second 6-week phase, and ended with a 6-week "golf-specific" phase. After the completion of the 18 weeks of training, a 5-week retention period analyzed results post-training [2]. The authors found statistically significant results for the improvement of ball speed and club mean acceleration when comparing pre-to-posttest and in comparing the training group to the control group. Further, Álvarez et al. analyzed the time and group interaction for ball speed and club mean acceleration after each 6-week training phase. Results showed statistically significant improvements for both ball speed and club mean acceleration after each 6-week intervention along with the results after the 5-week retention period when compared to the baseline results at the start of the program. However, considering the training phases utilized, distinguishing the potential performance improvement from each phase was difficult to discern. Delayed training effects, lack of progressive overload and "de-load" weeks, insufficient information on participants' training age, and interventions taking place during the competitive season were all possible confounding variables. Furthermore, the structure of training interventions seemed to align with the assumption a "strength base" is needed before "speed" and "sport-specific" interventions are appropriate after the initial phases. Additionally, it is important to note the "golf-specific" practices used during the 3^{rd} training phase may or may not encompass golf-specificity utilization. While various training interventions may improve indirect golf performance variables, considering specific components of a training program can be necessary to optimize golf performance.

Golf Professionals' Valuation of Strength and Conditioning

Part of the training program creation process is to consider research on training intervention effectiveness for desired adaptation outcomes coupled with each coach's empirical evidence. Professionals in the golf industry decide to use certain training practices for different reasons. Research has yet to document golf strength and conditioning coaches' training programs. Few studies have analyzed professionals' perceptions of what is important in the golf swing and how strength and conditioning can influence golf performance [25, 63].

Wells and Langdown (2020) conducted a study that analyzed 430 PGA assistant professionals' strength and conditioning perceptions regarding practices for golfers [63]. Opinions varied about training for golfers with most participants who "somewhat agreed" to "somewhat disagreed" on the use of sport science and physical assessments at the golf club where they worked. The decision to include resistance training, whether training should replicate the golf swing, the skill level at which to begin training, and if gym training is more important for highly skilled players compared to amateur players resulted in mixed responses. Additionally, results of the survey indicated professionals applied different strength and conditioning modalities throughout an entire annual program [63]. The authors went as far as to say misconceptions about strength and conditioning for golf existed, specifically citing about 50% of the participants who utilized static stretching to warm up and participants who disagreed to agreed in believing resistance training may lead to an increased risk of injury with reduced flexibility [63]. The lack of consensus by professionals in the field resulted in a variety of opinions on how to optimize training to improve performance on the course. However, an overwhelming majority of the participants agreed on the importance sports science can have on golf performance. Yet, the validity of what coaches believe and use for training golfers is unknown with PGA assistant professionals having such varied beliefs towards training for golf performance.

Golf biomechanics provides an adequate foundation to further understand the relationship between the human body and the golf swing. Various training interventions have been shown to influence both direct and indirect measures of golf performance [2, 4-6, 10, 13, 16, 17, 19-21, 24, 25, 32-36, 38, 39, 45-47, 49, 51, 53, 55-58, 64, 65]. Misconceptions and a lack of concurrence exist between golf coaches regarding the role of strength and conditioning with golfers [63]. Currently, combining the research in biomechanics, training intervention results on direct and indirect performance measures, and opinions held by professionals in the field, limitations exist in the golf strength and conditioning field to optimize golf performance. Additionally, there is a gap between training knowledge and application by coaches in the golf strength and conditioning industry.

Chapter 3- Methods

Participant Selection

Eighteen strength and conditioning coaches participated in the present study. Inclusion criteria were that they actively train golf athletes in a strength and conditioning capacity, they had at least five years of experience in the field, they held a minimum of a Level 1 Titleist Performance Institute (TPI) certification, and they currently worked in the golf strength and conditioning field. TPI's "Find an Expert" database and Golf Digest's "Top 50 Fitness Trainers" from each year since 2017 were used to identify potential qualified participants. Six hundred seventeen participants were contacted via email or through social media accounts using a standardized script listed in Appendix A. Fifty-three professionals responded equating to a response rate of 8.59%. Initially, 20 coaches agreed to participate. However, two coaches dropped out during the interview process due to schedule conflicts.

Protocol Overview

Once confirmed, each participant scheduled an interview time and produced a training program for analysis. Thirteen of the eighteen participants provided a training program example prior to the interview which helped guide the interview and allowed the practitioner the opportunity to ask specific questions pertaining to their training program. The other five participants produced their training program examples after the interview. Additionally, each participant was contacted via email to answer any follow-up questions about the program. Due to the variability in practice, participants chose the example each wanted documented as a reflection of themself as a golf strength and conditioning professional. All coaches who took part gave informed consent, and ethical clearance was obtained from the University of Wisconsin-River Falls Institutional Review Board for all procedures.

Research Design

The study was based on a grounded theory framework utilizing methodologies from theorists Corbin and Strauss (2008), authors of *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory (4th Edition)*, as well as Charmaz (2014), author of *Constructing Grounded Theory: Second Edition*. *Constructing Grounded Theory* [7, 12].

> Qualitative research begins with assumptions and the use of interpretive/theoretical frameworks that inform the study of research problems addressing the meaning individuals or groups ascribe to a social or human problem. To study this problem, qualitative researchers use an emerging qualitative approach to inquiry, the collection of data in a natural setting sensitive to the people and places under study, and data analysis that is both inductive and deductive and establishes patterns or themes. The final written report or presentation includes the voices of the participants, the reflexivity of the researcher, a complex description and interpretation of the problem, and its contribution to the literature or a call for change [14, p. 44].

The study design included virtual semi-structured interviews, golf training program examples provided by the participants, and a 10-question survey designed to quantify participants' beliefs on training golfers, golf-specific exercises, and training goals associated with golfers. One-on-one semi-structured interviews directed the practitioner to ask specific questions on golf specificity and allowed the discussion to guide additional questions. Each participant determined what information they wanted to contribute about golf training practices and experiences. Additionally, this style of interviewing allowed the practitioner to gain experience with each interview and highlight discovered concepts for future interviews [12]. All interviews were completed over a 3-month period. The same interviewer conducted each session with all participants. Zoom was used as the virtual tool for conducting interviews due to its accessibility, ease of use, and ability to record visual and audio data. Visual and audio data not only provided coaches opportunities to describe their philosophies and training programs but allowed for additional explanation and context to be analyzed following the interview. In congruence with grounded theory methods, non-verbal cues such as facial expressions, tone changes, and pauses provided human interaction factors for the interviewer to interpret and apply to the gathered data [12]. Two interviews faced brief interruptions due to connection issues. When issues were experienced, the interview would temporarily pause and would restart when all connection problems were resolved. Each interview was recorded and saved for future review.

Grounded Theory Approach

Grounded theory design revealed golf strength and conditioning professionals' beliefs on sport-specific practice in golf and contributed explanations for why and how coaches utilize training programs [15, pp. 82-90]. Documenting coaches' beliefs and practices was necessary to understand the utilization of training in practical application compared to what golf training literature had proposed as appropriate practices. As stated by Corbin and Strauss (2008):

> Theory, on the other hand, explains why events, happened and how persons give meaning to those events then based on that meaning and the resources they have to work with and what they think, do, and say—something alone or with others—to respond, live with, change, or shape their worlds to deal with that event [12, p. 190].

A theory grounded in the data allowed development and critical thinking about specific golf strength and conditioning interventions:

> The most important aspect of theory is showing the relationship between concepts by (a) defining the main issue, event, or problem area under investigation as perceived by

> participants; (b) explaining the potential context for action-interaction; (c) relating the action and interaction to the meaning given to problem, issue, or event and explaining how this action and interaction is subject to change with changes in context; and (d) relating the results or outcomes to action and interaction. Constructing theory necessitates that an idea be explored fully and considered from many different angles or perspectives [12, p. 62].

It is important to remember that qualitative research, specifically grounded theory, is a moving and evolving process where theories and concepts do not hold the test of time. There is constant change due to discoveries based on data, interpretations, and critical thinking. “An assumption made in qualitative research is that truth is equivalent to what we know—but eventually it may be judged partly or even wholly wrong” [12, p. 20]. While theories provide a foundation for future analysis on related topics, the evolution of the subject matter is inevitable.

> In short, grounded theory relies on reasoning – making inferences – about empirical experience. Thus, a major strength of the grounded theory method is that these budding conceptualizations can lead researchers in the most useful, emergent, and often unanticipated theoretical direction to understand their data [7, p. 201].

To advance the golf strength and conditioning industry, critically analyzing training processes is necessary to further investigate the specific means coaches use to improve golf performance compared to research, empirical evidence, and the constant evolution of golf performance. While the direction the golf strength and conditioning field will evolve is unknown, documentation on golf training interventions in the field is an important distinction to utilize appropriate practices with golfers.

> Grounded theorists evaluate the fit between their initial research interests and their emerging data. We do not force preconceived ideas and theories on our data. Rather we follow leads that we define in the data or design another way of collecting data to pursue our initial interests [7, p. 32].

A proposed grounded theory could lead professionals to design golf training programs that fit the specific needs of the sport, the sporting movements, and the individual.

Critics of qualitative research and grounded theory frameworks scrutinize the validity of assumptions and interpretations. In such studies, critics question the effectiveness of applying broader concepts to the studied population due to situational and environmental variability [7, p. 243]. As can be the case where misinterpretations are made regarding grounded theory data, the aim of the research is not to quantify data and produce concrete concepts. As proposed by Charmaz (2014):

> Critics of grounded theory commonly miss five crucial points about the method: 1) theorizing is an ongoing activity; 2) grounded theory methods provide constructive ways to proceed with this activity; 3) the method involves abduction as well as induction; 4) the research problem and the researcher's unfolding interests can shape the content of theorizing, rather than the method presupposing the content; and 5) the products of theorizing reflect how researchers acted on these points [7, p. 244].

One of the main goals of grounded theory is to propel the field of study forward with new and creative ideas to effectively achieve the desired performance. The theory is rooted in data and allows continued evolution in the field of study for professionals and researchers to use proposed concepts and build on the central ideas. Although change and progress are inevitable, it is difficult to adjust aspects of philosophies where familiar practices and beliefs become second nature. Charmaz (2014) states:

> Through their affiliations people learn – and absorb – routine meanings and practices. As life becomes routine, the interpretive process compresses and people engage less in an overt inner conversation to mull over their situations. They are unlikely to change either their practices or meanings unless their situations have become problematic and their habitual responses no longer work or new, unanticipated situations or opportunities arise [7, p. 271].

Despite professionals' ingrained experiences and thoughts, exploration of new and different concepts can constantly challenge self-beliefs and practices with the goal of higher performance and understanding.

While grounded theory is based on qualitative data, both quantitative and qualitative data are present in this study to provide different perspectives on how to evaluate training practices and programs. Quantitative measures numerically defined the content of the coaches' programs. Qualitative answers during the interviews allowed context to explain why and how coaches develop their training programs for golfers. As said by Charmaz (2014), "Quantitative researchers test preconceived hypotheses; grounded theorists can offer the grist for emergent hypotheses that quantitative researchers might pursue" [7, p. 198]. To advance the golf strength and conditioning field, professionals must be objective when analyzing beliefs and perspectives, even though differences may challenge the status quo and their beliefs.

Data Analysis Procedure

At the conclusion of each interview, audio and visual recordings were automatically saved using the participant's last name. In one case, two separate recordings were saved due to connection issues.

Additionally, quantitative and qualitative data were gathered in the form of the 10-question survey and each participant's training program example. The survey incorporated Likert-Scale questions, open-ended definition responses, and specific numerical questions to quantify the beliefs and practices of each coach, see Appendix B. To quantify qualitative questions #1 and #2, Likert-Scale answers were assigned numerical values of "1" for Strongly Disagree and increased to "5" for Strongly Agree. Responses to the open-ended questions counted for the number of participants highlighting certain characteristics. The mean was calculated for the specific numerical questions. The survey was completed at the beginning of each interview to gather initial perspectives before the discussion. Participants were instructed to be clear and concise when selecting or providing an answer. Each participant was made aware that the interview discussion was their opportunity to provide contextual information about their beliefs and practices. The practitioner collected training program examples prior to the interview. Five participants did not produce an example prior to the interview for undisclosed reasons but supplied an example after the interview. Training program examples and responses from the survey produced data on golf-specific practices, training means utilized in programs, and beliefs on the role of strength and conditioning for golfers.

Questions posed during the interviews aimed to gather information detailing coaches' philosophies on golf specificity, approaches when creating training programs, and perceptions of golf-specific exercises. Each interview had a similar question structure with additional follow-up questions, if needed, posed by the practitioner for further information or clarification. The semi-structured interview outline is listed in Appendix B.

Data Analysis

Inductive procedures identified golf strength and conditioning coaches' utilization and perceptions of golf-specific exercises. In congruence with grounded theory analysis methods, open, axial, and selective coding created emergent themes around coaches' beliefs and philosophies when training golfers [7, 12]. Additionally, theoretical coding frameworks explained and supplied the foundation for the grounded theory presented.

Video and audio recordings were analyzed after the completion of each interview to continually develop the theory rooted in the data collected. The interview structure evolved over the course of data collection for future interviews to focus on specific topics that pertained to the previously found results [12]. Coding discovered meaningful data within each interview. Notes taken during interviews incorporated brief initial thoughts and primary details. The interviewer was able to listen and guide the interview based on the discussions. Interview questions remained consistent throughout the data collection process with the addition of other topics as interviews continued to better direct the data collection in accordance with grounded theory methods [12].

Meaningful data from the interviews was compared using axial and selective coding. Higher-order categories and sub-categories were determined based on emergent themes during the interviews. The development of higher-order categories and sub-categories represented the philosophies, practices, and perceptions of golf-specific exercises in golf training programs. Interviews were analyzed and coded on three separate occasions. The initial analysis was conducted after the interview was completed and before the next interview with the goal of documenting answers and initial perspectives. The second analysis was completed after all interviews had taken place and sought to determine the underlining meanings coaches had with golf-specificity. The final analysis occurred two months after all the interviews were completed by extracting key quotations and contextualizing discussions and participants' statements. The complete interview analysis outline is displayed in Figure 1.

Figure 1

Interview Analysis Process

<u>Stage 1</u>
- Performed initial analysis of training program provided
- Formed specific questions and/or clarification comments about training program example

<u>Stage 2</u>
- Conducted semi-structured interviews
- Individualized specific questions to each participant about their training examples

<u>Stage 3</u>
- Analyzed initial interview after interview completion and before the next participant
- Recorded survey responses
- Coded initial interview answers via axial and theoretical coding
- Looked for emerging themes to guide future interviews

<u>Stage 4</u>
- Analyzed second round of interviews after completion of all interviews
- Analyzed training program example quantifying magnitude of golf specificity
- Studied axial and theoretical coding to narrow in on primary emergent themes

<u>Stage 5</u>
- Analyzed final round of interviews two months after completion
- Extracted key quotations
- Narrowed axial and theoretical coding

<u>Stage 6</u>
- Reviewed all data and calculations
- Conducted axial and theoretical coding on training program examples

The first analysis encompassed stages 1-3 listed in Figure 1. This included an initial overview of the provided training program example, conducted interviews, documented survey answers, and coded interviews for preliminary themes. Responses to the structured interview questions quantified and analyzed coaches' backgrounds, beliefs, and practices. Quantified answers were incorporated only if the participant explicitly said or alluded to certain characteristics. This data provided context about the studied population. Additionally, survey responses supplied qualitative data.

During the second analysis, stage 4 evaluated the training program examples to determine the golf specificity of coaches' training programs and coded to focus on primary themes. As previously mentioned, a golf-specific exercise was defined as a transverse planar movement where force is initiated at the ground level and transferred through the hands. The definition of a golf-specific exercise determined whether an exercise used in a training program was golf-specific or not. If the exercise matched the definition criteria, the exercise was considered golf-specific. If the exercise was not performed in the transverse plane and force was not generated at the ground level and transferred through the hands, then it was not considered to be golf-specific. The calculated ratio of golf-specific exercises to the total exercises in the program determined the golf-specificity magnitude of each training program. Warm-up movements and stretches were not included as part of the total exercises because the movements were not the primary means of the training program. Every calculated proportion was compared to each participant's response to the final question asked during the interview, "What percentage of exercises used in your training program are golf-specific?" This linkage provided data to analyze the relationship between how participants perceive golf-specificity and the practical golf-specific utilization in their programs, and how the discussion may have affected their response pre- and post-interview.

The final interview analysis during stages 5 and 6 sought to derive core quotations reflective of participants' responses to interview questions and to conduct a final review of all data collected. Context to answers was considered during the analysis based on the participants' earlier responses to associated questions, non-verbal cues, and the portrayed representation of themselves as professional golf strength and conditioning coaches. The data helped illustrate frameworks for each training program example.

Additional data was gathered on common practices coaches used in their training programs. Practices were quantified by the number of coaches who used similar exercises or types of movements to document commonalities utilized in golf training programs regardless of golf specificity. The goal was to gather data on what coaches were doing and then compare the results to what the literature had proposed to implement for golf training programs.

Chapter 4- Results

Data collection produced 18 golf strength and conditioning programs, 18 hours of interview data, and 18 completed surveys that quantified participants' beliefs on training golfers, golf-specific exercises, and training objectives associated with golfers. Seventeen male coaches and one female coach participated. Coaches from the following states, including [MN, WI, CA, WA, TX, UT, AL, FL, NC, VA, MD, MA, and CT] took part. Additionally, one coach from England participated. The variety from different regions in golf off-season and in-season training provided a comprehensive background on training philosophies. The participants ranged in age from late-twenties to mid-seventies with varying experiences in the golf industry helping golfers of all ages and skill levels. The average participant age was approximately 40 years old.

Results of this study are provided in several different methods. All data provided the foundation and context for the discovered grounded theory. Data are presented for the survey responses, numerical categorization for responses is provided for the structured interview questions, and training program examples quantify golf specificity and specific exercises used by coaches. Additionally, this grounded theory design produced interview excerpts reflecting the participants' beliefs and training practices associated with golf specificity. Excerpts from the interview questions and any unstructured discussions that spoke to professionals' opinions about golf-specific exercises are presented and discussed. Specific themes and analytic frameworks were discovered via coding. Axial coding supplied data on the specific "axis" or main topics of golf-specific exercises in the context of what coaches believed and used for training practices. Theoretical coding formed the framework for the grounded theory proposed. The data provided specific themes to each question and allowed contextual information to the broader concept in question on golf-specific exercises. Similarities and discrepancies between the data and literature are presented in the Discussion section.

Survey Responses

The survey responses produced data quantified with mean scores and number of coaches who stated various characteristics.

Table 2

Golf-Specific Exercise Perceived Utilization

Golf-Specific Exercise Incorporation M-Value[a]	4.17
Golf-Specific Exercise Importance M-Value[b]	3.94
Golf-Specific Exercise Perceived Utilization Porportion M-Value[c]	66.67%
Number of Months Golf-Specific Exercises are the Priority M-Value[d]	8.55

Note. M-Value = Mean Value; [a]1-5, Strongly Disagree = 1, Strongly Agree = 5; [b]1-5, Strongly Disagree = 1, Strongly Agree = 5; [c]0-100% Golf-Specific Exercises in Training Program; [d]0-12 Months of an Annual Training Program

Question #1: “Golf-specific exercises should be incorporated in a golf training program. Please circle one answer,” resulted in a mean value of 4.17 which meant participants tended to agree or strongly agree with incorporating golf-specific exercises in a golfer’s training program. Question #2: “Golf-specific exercises are important in a golf training program. Please circle one answer,” resulted in a mean value of 3.94 which meant participants tended to agree with the importance of including golf-specific exercises in a golfer’s training program. Results in Table 2 suggest golf-specific exercises had a positive connotation in a program for golfers. Participants indicated an agreement with the incorporation and importance of golf-specific exercises. Question #6: “Circle the percentage that best reflects the proportion of golf-specific exercises used in your training programs,” resulted in a mean percentage of 66.67%. This represented the proportion of golf-specific exercises participants estimated to include in their training programs. In comparison, golf-specific exercise analysis of the provided training program examples from each participant resulted in a mean percentage of 11.28%. Participants believed two of every three exercises they used were golf-specific, but the measured result was approximately 1 of every 10 exercises being golf-specific. Question #7: "Circle the number of months that best represents how long golf-specific exercises are the primary means in your training programs during an annual training program," resulted in a mean value of 8.55 months.

Table 3

Defining a Golf-Specific Exercise

Characteristics	No. of Participants
An exercise that helps the golfer perform swing more optimally	8
Functional directly (movement pattern) or indirectly (correlational characteristics) to the golf swing	6
Looks like or mimics the golf swing	4
Includes a rotary component	3
Using same muscles, motor patterns, speed, RFD, etc.	2
Only for a golfer	2
Functional movment	2
Golf posture	2
Any exercise	2
Prevents injury	1
Incorporates lateral bend	1

Question #3: "How do you define a golf-specific exercise? Please provide your definition below," derived the notion that participants believed a golf-specific exercise was any exercise that positively affected the golf swing. Participants provided their definitions and any characteristics they desired to highlight. This resulted in multiple recorded answers for defining a golf-specific exercise as listed in Table 3.

Table 4

Golf-Specific Agreement & Magnitude of Agreement

Exercises	M-Value for Golf-Specific Agreement[a]	M-Value for Degree of Golf-Specific Agreement[b]
Rotational Medicine Ball Toss	0.889	8.667
Cable Wood Chop	0.889	8.222
Deadlift	0.833	7.944
Vertical Jump	0.833	7.944
Back Squat	0.833	7.667
Medicine Ball Slam	0.833	7.278
Olympic Lifts	0.778	7.111
Seated Medicine Ball Throw	0.722	6.611
Overhead Medicine Ball Throw	0.667	6.5
Bench Press	0.611	5.778

Note. M-Value = Mean Value; [a]Disagree = 0, Agree = 1; [b]1-10, Extremely non-golf-specific = 1, Extremely golf-specific = 10

Question #4: "Do you consider the following exercises golf-specific? Agree (A)-1 or disagree (B)-0," resulted in participants' agreement that a rotational medicine ball toss and a cable wood chop were the most golf-specific, and a bench press was the least golf-specific of the exercises listed. Question #5: "On a scale of 1-10, 10 being extremely golf-specific, 1 being extremely non-golf-specific, how would you rate the following exercises?" resulted in an agreement with question #4's results with rotational medicine ball toss as the most golf-specific and bench press as the least golf-specific of the exercises listed. Table 4 data signified the disconnection between participants in quantifying golf specificity. In terms of classifying whether an exercise was golf-specific or not, the exercise either fits the criteria, or it does not; the exercise should be either a "10" or "1." There is no middle ground for categorizing specificity, but what participants created was their belief on the degree to which an exercise can help or transfer to golf performance. One participant graded every exercise listed as a "1" except the rotational medicine ball toss which they graded as a "5." Two participants graded all exercises listed as a "10." Nevertheless, when quantifying the golf specificity of an exercise, participants believed a characteristic of golf-specific exercises included a compound multi-joint movement.

Table 5

Quantatitive Training Evaluations

Assessments	No. of Participants
Vertical Jump	15
TPI Screen	13
Swing Metrics (clubhead speed, carry distance, kinematic sequence, etc.)	11
Balance	10
Power Output	9
Strength Parameters	8
Rotational Movements	5
Handicap	1
Blood/Hormone Test	1
Nutrition	1
None	1

For Question #8: "What data do you collect to evaluate the progress of your golfers? Please be thorough and specific. (Examples: 1 RM tests, balance test, vertical jump height, driving distance, etc.)," participants reported the utilization of primarily indirect golf performance measures to assess their golfers with only one coach who directly tracked score or handicap. Vertical jump was the most common evaluation measure. All results are listed in Table 5.

Question #9: "Which of the following training goals do you prioritize throughout a golf training program? Please rank the following based on priority level. (Use

Table 6

Annual Training Program Goal Priority

Training Goals	M-Value[a]
Rotational Power	3
Hip Mobility	3
Torso Mobility	2.94
Core Stability	2.89
Rotational Strength	2.83
Max Power	2.77
Max Speed	2.72
Balance	2.72
Ankle Mobility	2.56
Max Lower-Body Strength	2.22
Anaerobic Glycolytic Conditioning	2.11
Max Upper-Body Strength	2.06
Hypertrophy	1.83
Repeated Sprint Ability	1.83
Aerobic Conditioning	1.78

Note. M-Value = Mean Value; [a]0-3, N/A = 0, Low = 1, Medium = 2, High = 3

Low-1, Medium-2, High-3, or N/A if not-applicable-0),” resulted in varying prioritization of numerous training goals as listed in Table 6. The highest graded goals of “rotational power” and “hip mobility” match the needs to perform the golf swing. However, while there are some similarities in the training goals listed, for 15 separate training goals to have close to a “medium” level of priority or greater suggests there may be prioritized training outcomes that are not needed for golf performance. When a coach focuses on multiple goals instead of a few essential goals for golf performance, time is taken away from developing and maximizing the efficiency of top-priority goals.

Question #10: “Are there any physical limitations that you focus on that seem specific to golfers? For instance, ankle dorsiflexion, thoracic mobility, etc.,” supplied in-depth information about what participants believed were limitations they had seen with their golfers. Participants were able to communicate any number of limitations their clients experienced with each participant mentioning at least two primary limitations. Thoracic mobility and hip mobility were the most common limitation responses as listed in Table 7.

Table 7

Common Golfer Physical Limitations

Limitations	No. of Participants
Thoracic Mobility	15
Hip Mobility	13
Shoulder Mobility	8
Ankle Mobility	7
Disassociation of Upper and Lower Body	3
Core Function	3
Glute Strength	2
Weak Posterior Chain	2
None	2
Lead Knee Pain	2
Wrist Mobility	1
Balance	1
Posture	1

Structured Interview Questions

Responses to structured interview questions gave qualitative data that was coded, and it categorized the number of coaches who mentioned specific details for each question. Details regarding golf-specific exercises are discussed in this section with the entire results provided in Appendix B.

When asked to supply a further definition of a golf-specific exercise, each participant stated, in different verbiage, that golf-specific exercises were exercises that positively impact the golf swing. However, only three participants went on to stress the importance of matching similar characteristics of the golf swing such as movement, speed, load, and rate-of-force development patterns in exercises.

When asked, “What perceptions do you have about golf-specific exercises in a training program with golfers?” participants lacked consensus in associating golf-specific exercises as positive. Seven participants had negative associations with golf-specific exercises. Four of those participants believed professionals focused too much on the exercise looking like the golf swing, and professionals should focus on transfer rather than specificity. On the contrary, 10 participants had positive associations with golf-specific exercises. Six of those professionals believed golf-specific exercises help skill development in the golf swing. One participant had both positive and negative beliefs regarding golf-specific exercises depending on the individual client.

Participants’ responses varied as to the perceived needs analysis for golf. Fifteen of the eighteen participants did not initially know what the interviewer referred to when they were asked on their perspective on what a needs analysis for golf would be. Only after a brief explanation by the interviewer were they able to provide their details and characteristics. The most common response communicated by six of the participants was that TPI had “laid the foundation” for what professionals used in determining each golfer’s needs.

The most frequent response regarding the goals of golf-specific exercises was to improve indirect performance measures including clubhead speed and ball speed.

In distinguishing between general and golf-specific exercises, 16 participants believed the general exercises they utilized were also golf-specific, indicating there were no differences between general and golf-specific exercises. Participants commonly explained the exercises that had positive influences on indirect golf performance measures could be considered general and golf-specific.

Eight participants responded, when distinguishing between general and golf-specific exercises, that the primary “con” of golf-specific exercises was the focus on too much rotation and/or mimicking the golf swing.

The concluding question for participants was to quantify the proportion of their training programs they considered golf-specific. This was a similar inquiry to Question #6 in the survey where the participants were asked to circle the percentage that best represented the proportion of golf-specific exercises utilized in their training programs. Six participants had differing responses between the question posed in the survey at the beginning of the interview and the final question at the end of the interview. Three of those six participants had a percent difference of 25%, one participant had the greatest percent difference of 55%, and the overall mean percentage difference for those six participants was 37.5%. This meant that 6 of the 18 coaches (1 out of 3) changed their beliefs regarding golf-specific exercises pre-to-post-interview, and therefore, adjusted their quantification of golf specificity utilized in their training programs by more than 35%.

Golf Specificity of Training Program Examples

The final question of the interview read, “What percentage of exercises used in your training program are golf-specific?,” the mean percentage perceived incorporation of golf-specific exercises was 70.28%. This meant participants believed about 7 of every 10 exercises utilized were golf-specific. 70.28% was slightly higher compared to the responses in Question #6 of the survey, “Circle the percentage that best reflects the proportion of golf-specific exercises used in your training programs,” where 66.67 % was the believed incorporation of golf-specific exercises. In comparison, the mean percentage for golf-specific exercises used in the training program examples was 11.28%. Additionally, each participant overestimated quantifying the proportion of golf-specific exercises used, where they believed their training program was of greater golf specificity than was measured.

The complete tally of similar exercises or common movements coaches utilized based on the training program examples provided are listed in Table 8. All coaches used a squat exercise or a variation of the movement and “core” work of some sort. The three powerlifts were popularly used exercises. Also, rotational, jump, and row movement patterns were common exercises used in the

Table 8

Exercise Utilization in Training Program Examples

Exercise Characterization	No. of Participants
Core (planks, deadbugs, bear crawls, sit up, etc.)	18
Squat	18
Rotations	17
Deadlift	16
Arm Rows	14
Jumps/Plyometrics	14
Bench Press	13
Lunge (frontal + sagittal plane)	12
Push-Up	12
Overhead Press	11
Medicine Ball Slam	11
Cardio (walk, bike, stairmaster)	9
Bridge	8
Bicep Curl	6
Kettlebell Swing	6
Step-Up (frontal + sagittal plane)	6
Cleans	4
Speed Sticks	4
TPI-Specific	3
Landmine Rotation-to-Press	3
Leg Press	2

training program examples. One other exercise to highlight was that three participants used exercises specific to TPI. This finding was surprising given that each participant was at least TPI Level 1 certified.

Defining a Golf-Specific Exercise

Throughout the interview process, golf specificity was the main task presented to the participants. Phrases and depictions of participants' beliefs regarding golf-specific exercises were recorded and analyzed. As part of this grounded theory framework, statements were contextualized by considering tone, word choice, non-verbal cues, etc.

Coaches discussed their perceptions on what a needs analysis for golf would encompass. Conducting a needs analysis for golf is necessary to understand the required tasks during the sport. A needs analysis supplies information on metabolic demands, kinematics, kinetics, muscle actions, and force-velocity relationships in sports [50, p. 441]. Three coaches provided thorough detail and information outlining their perspectives on what a needs analysis for golf would encompass. One participant outlined the needs of a golfer and golf specificity:

> "I think it's hard to answer that initial question without an agreed-on definition for golf specificity. I think there's a lot that needs to be taken into account for specificity. Most people consider movement patterns in terms of what an exercise visually looks like, but they completely forget about the velocity of the movement, the weight of the implement being used, the balance point, and the different type of implement being used where the direction of force is different such as a dumbbell compared to a cable compared to a resistance band. For an exercise to be considered golf-specific, it needs to match a lot of criteria in my opinion. That would be movement pattern, velocity, load, contraction type, force/time characteristics, and type of implement."

In comparison, fifteen coaches expressed uncertainty regarding what to answer for the needs of a golfer. As one of the fifteen coaches said:

> "That's a broad look of where I'm at right now. I think the majority of golfers need to do a fitness program for a reasonable amount of time. A strength base is necessary. A strength base can improve your power, efficiency, and technical aspects of your swing."

Coaches went as far to say there was not a distinction that made an exercise golf-specific. Another coach who expressed uncertainty described classifying exercises as:

> "Any exercise is golf specific. Since you're basically using every part of your body, every part of your body needs to be fit."

Table 3

Defining a Golf-Specific Exercise

Characteristics	No. of Participants
An exercise that helps the golfer perform swing more optimally	8
Functional directly (movement pattern) or indirectly (correlational characteristics) to the golf swing	6
Looks like or mimics the golf swing	4
Includes a rotary component	3
Using same muscles, motor patterns, speed, RFD, etc.	2
Only for a golfer	2
Functional movment	2
Golf posture	2
Any exercise	2
Prevents injury	1
Incorporates lateral bend	1

Characteristics defining a golf-specific exercise were discussed by participants and recorded throughout the survey and interview questions. As mentioned previously, Question #2 from the survey listed in Table 3, "Helps perform the swing more optimally," "Can transfer to the golf swing," and "It doesn't need to look like the golf swing," were popular responses regarding the definition of a golf-specific exercise. The complexity and nuanced nature of categorizing exercises challenged coaches to critically analyze their beliefs and practices. While characteristics of golf-specific exercises were similar, distinctions existed between coaches' beliefs with a wide range of responses regarding golf-specific exercises and the utilization of such techniques. As one coach alluded to when defining golf specificity:

> "I'm a generalist. Everything we do in the weight room is general physical preparation. The only real specific is swinging speed sticks. I think a specific exercise to a sport skill exercise has the same speed, recruits the same muscles, and uses the same motor patterns. My program doesn't really fit that criteria as golf-specific, but there's still a lot of ability to transfer."

Without a previous definition, determination of what golf-specific was and coaches' utilization of golf-specific training were important distinctions. As said above by one golf strength and conditioning coach, there were countless factors involved in deciding if an exercise was golf-specific including "movement pattern, velocity, load, contraction type, force/time characteristics, and type of implement."

When asked about distinctions separating golf-specific and general exercises, coaches had a variety of responses. One coach defined general exercises as:

> "General is a push, pull, squat, hinge, or single leg balance. Differentiations between specific and general is the motor coordination and reaction time in those positions. General is can we do those basic movements."

As another coach stated:

> "I wouldn't necessarily make that distinction between general and golf-specific. I think golf-fitness is fitness. If you implement movements in the wrong way, and if you stress the body in the wrong way, you can have negative effects on your golf swing but also just movements in general. I think a broadening of the overall perception of golf fitness would take it away from golf-specific to build more functional individuals who can create

> specific performance relative to gym work, but also adjust to the technical aspects of what they're doing."

Coaches continually referred to general exercises as "basic movements" that any person should be able to do. This verbiage alluded to golf-specific exercises and the golf swing as unnatural movements compared to a push, pull, squat, hinge, etc. Basic movements or "general" seemed to encompass sagittal plane movements compared to the golf swing performed primarily in the transverse plane. The distinction that basic movements do not include rotary movements could be flawed where activities such as walking and running, relatively "basic" movements, incorporate movements in the transverse plane. Factors such as the plane of movement influence the body demands for varying exercises. From a participant's perspective:

> "Golf-specific exercises improve the skills of the golf swing. You can either improve your fitness or improve your skill. Improving your fitness may or may not improve your golf game, but improving your skill can help you swing at a higher level."

Outlining the goal of each exercise is necessary to highlight the transferability of the exercise to the desired outcome. As one participant stated:

> "I see fewer limits on exercises. I don't look at something and say, 'Hey, that's a great golf-specific exercise!' I say, 'That's a great exercise!' If I can tweak different exercises to address certain limitations, that's what I'm looking for."

Confused connotations of golf-specific and golf specificity existed where a perception from multiple participants was that golf-specific exercises were exercises that look like the golf swing. As one participant said:

> "I think improving specific moving patterns, sequencing in the gym, where you take out the technicality and the mental side of actually hitting a ball and just allow the body to go

> through that pattern at an increased rate with varied loads, tensions, and intensities. I think that gives a player an opportunity to explore movement, to understand their position in space with proprioception, and awareness with the ground. I think working through patterns that allow that sequencing to occur can vastly improve potential in terms of a golf swing. In terms of everything else, I think everything can be beneficial if applied well and in the right setting and goal for the individual."

Although this participant had a different definition for a golf-specific exercise, he highlighted key characteristics that incorporate golf specificity with movement patterns, sequencing, and varying the loads in positions of the golf swing. In contrast, a different participant expressed:

> "The only sport you can lift specific in is Olympic weightlifting and powerlifting."

This was a vastly different outlook regarding specificity to incorporate "lifting" or strength and conditioning practices with golfers compared to the quote from the previous participant.

One area of debate was the transferability of exercises to the golf swing. If an exercise can transfer to the golf swing, does that make the exercise golf-specific? As one participant said:

> "I never say sport-specific. I say directly related. So, is a deadlift directly related to golf? 100%, and that's testing done by guys a lot smarter than I am. Is a squat? Yes. Bench Press? Yes, but if you look at some other research in the field, a standing chest press with a cable recruits more stability than bench press. From my stance, it's more of what is directly relatable."

The degree to which an exercise is "directly related" or transferrable to the sporting movement falls on a continuum, but the categorization of an exercise should either be sport-specific or not. However, as the same participant said about his philosophies for training golfers:

> "From my viewpoint to keep it simple, how can I train a lean defensive back in the NFL and make you a hell of a golfer."

The theme of building robust athletes through strength and conditioning practices to make them better golfers was a common thought. As a separate participant articulated:

> "If you walk past a gym and see athletes working out, you should have no clue what sport they're in."

This thought inferred athletes train similarly where the needs and demands for each sport were essentially the same. Likewise, a different coach stated:

> "A golf-specific exercise could look footballish, baseballish, or basketballish. It's all about what the individual needs are. If you need more strength, power, or speed there's only one way to train for it. Just make them more athletic."

In contrast, consider a comment from Question #4 from the survey, "Do you consider the following exercises golf specific? Agree (A)-1 or disagree (B)-0?" made by one of three participants who provided an in-depth review of a needs analysis for golf and matched many of the defined components regarding a golf-specific exercise:

> Interviewer: "Do you consider the following exercises to be golf specific? Agree (A) or disagree (B)?"
>
> Participant's Response: "Do they help something in the golf swing? Yes! But are they golf-specific? Absolutely not! I could get my grandma to do those."

Individualized Training Programs

Each participant mentioned they value an individualized approach where the needs of each golfer are the foundation of training. As one coach said:

> "Depending on why they're there with me, it's did we fix what was the problem. Are they improving the performance goals they had?"

The important distinction as to how the golfer improves is subjective to each person. As one coach stated:

> "The main goal of our training programs is to move more efficiently and effectively."

The means to accomplish these tasks can be different for each coach. Every golfer has strengths and weaknesses needing improvement for their unique swing. To identify individual swing strengths and weaknesses, four coaches analyzed individual swing kinematic data themselves. 10 coaches utilized swing kinematic data and relied on secondary sources for such information. Four coaches did not utilize swing kinematic data. One participant, who did not use swing kinematic data but used a wide variety of body analysis assessments, alluded to the potential importance of swing kinematic data:

> "If players do use it, they mainly use it with their swing coach. I'd love to see it utilized more. If a player's clubhead speed increases, I don't know why it's increased. I don't know if it's a change in pelvis-torso separation. I don't know if it's a change in ground reaction force. It's going to come down to technical work. It's difficult to isolate the variables to tell what's the cause."

Understanding the strengths and weaknesses of a golfer's swing can lay the foundation for the focus of the program to improve golf performance effectively and efficiently. Within an individualized training approach, the primary focus in helping a golfer improve may or may not be valid if the coach does not understand a golfer's swing. One participant who did use swing kinematic data explained their perspective as to how they utilized the data:

> "Something that we focus on and separates us from other coaches is the non-standardized approach. Each individual has their own program with their own specific needs. This allows for more goal-driven programs for our clients. We want to attack the individual phases of the swing. Our players already get enough work with the entirety of the golf swing. We'll let their technical work produce the golf-specific effect. However, we do pay attention more to be plane specific with rotational work."

Plane specificity of a movement can be an important distinction with unique individual golf swing planes. A general example outlining this thought is the similarity and difference between the downswing plane in baseball and golf swings. While both movements are performed in the transverse plane, and force is initiated from the ground up, the ball is hit at different heights for each sport causing the swing planes to differ [61]. In other words, the vertical and horizontal swing plane relationship during the downswings could indicate how a transverse plane exercise is or should be performed based on what the goals are. While the plane specificity of movement may appear to be a minute difference, the application of a steep versus shallow plane in the golf swing can drastically alter golf performance. Specific adaptations are made from the imposed demands, also known as the "SAID Principle."

Perceptions of Strength and Conditioning

Additionally, interviews determined the views golf strength and conditioning coaches had regarding their roles in helping golfers through training means. Not surprisingly, each coach perceived strength and conditioning as a necessary and important aspect of a golfer's performance. However, differences were found regarding the training means to achieve optimal golf performance. As one coach articulated on training:

> "Everything I do I don't look at as golf-specific, but I do look at it as golf-specific. Everyone needs essentially the same thing. Golfers just need to then work on their swing to have it transfer."

This coach implied that golfers need the same characteristics and training program to perform well at golf. In contrast, as one coach said:

> "You're hoping the golfer's body is in better physical condition to withstand the stresses that the sport imposes on it. So, for practice and play they have high swing volume, and we know for golf with having a high repetitive action, overuse injuries are common. Strength and conditioning has a role in increasing power output. Finally, depending on the technical change that they are struggling with physically, you may be able to provide interventions to help with those patterns."

This was a different viewpoint on the influence strength and conditioning can have on a golfer's game. For this coach, there was injury prevention, speed output, and technical change with a training program specific to each golfer. A college golf strength coach expressed a combination approach to both thoughts:

> "If my athletes are available, even if we don't see any performance gains, that's my job is to keep them on the course. We're building robust athletes. Working through the important movement patterns such as squat, hinge, lunge, push, pull, core, and single leg movements to give them a lot of what they don't see on the course."

Chapter 5- Discussion

The purpose of this study was to document and evaluate training programs implemented by golf strength and conditioning coaches. Furthermore, collected data provided context on coaches' beliefs regarding golf-specific exercises and the specificity of training. Discovered themes, beliefs, and practices were compared to prior golf-specific training research. A grounded theory developed, displaying coaches' misconceptions on what constituted a golf-specific exercise and coaches' lacking consensus for the utilization of such interventions. Based on the data, these errors were present due to the nonexistence of a previous "golf-specific" definition and held misconceptions about training theories and principles. Both concepts appear to have validity in contributing to the perception variance of golf-specific exercises among golf strength and conditioning professionals, although additional research is needed to evolve golf specificity.

The preeminent topic of discussion was a golf-specific exercise. Findings showed disunity between golf strength and conditioning coaches in classifying golf-specific exercises. When participants supplied their definition for a golf-specific exercise, the most popular belief was any exercise that "helps the golfer perform the golf swing more optimally." In theory, this concept seems practical to improve golf performance. However, the complexity of transfer of training and dynamic correspondence principles provides distinctions between training practices improving sport performance "more optimally" versus "most optimally." As seen throughout golf literature, a variety of training interventions can improve indirect golf performance measures in various populations [2, 4-6, 10, 13, 16, 17, 19-21, 24, 25, 32-36, 38, 39, 45-47, 49, 51, 53, 55-57, 64]. However, for an exercise and training intervention to follow the principles of transfer of training and dynamic correspondence, matching the demands of the sport to training will result in the best transfer to that sport's performance. In contrast, results from Question #5 of the survey, “On a scale of 1-10, 10 being extremely golf specific, 1 being extremely non-golf specific, how would you rate the following exercises?” indicated the exercises listed were believed to be at least moderately-to-very golf-specific with mean scores above five for each listed exercise. This was a misrepresentation by participants in classifying golf-specific exercises and training specificity. There is not a middle ground to classify and quantify exercise specificity to the sport. The exercise either is golf-specific or it is not. However, an argument could be made about the degree to which an exercise transfers to golf performance. These are different misunderstood topics that highlight the importance of exercise and training classification. Giving an exercise a score of five in terms of golf specificity refers to the strength and conditioning coaches’ beliefs concerning the transfer or applicability of the exercise to golf. Although strength and conditioning interventions such as “general” and “sport-specific” training are popularly used by coaches and scrutinized in the industry, the specific components of training styles and exercises are crucial distinctions when training for sport performance because of the SAID Principle. Seemingly insignificant small details of how a movement is performed are important considerations to match training to the desired adaptations.

Surprisingly, two participants reported all 10 exercises in Question #5 of the survey to be a 10, or completely golf-specific, signifying the belief that these two participants did not distinguish between “general” and “golf-specific.” This called attention to misguided knowledge about transfer of training and dynamic correspondence. For example, the bench press exercise, one of the listed exercises in the survey for participants to quantify the magnitude of golf specificity for each exercise, requires force generated predominantly from the upper body with movement primarily in the sagittal plane. In comparison, an efficient golf swing requires force generated predominantly from the lower body with movement primarily in the transverse plane.

The argument of a bench press exercise being golf-specific asserts that it is effective and efficient for improving golf performance is not only inaccurate, but also does not make intuitive sense.

Correspondingly, fewer than 20% of the participants (three participants) were able to provide an in-depth evaluation of what encompassed a needs analysis for golfers. Highlighted by the NSCA, a needs analysis is “Step 1” for the strength and conditioning professional before starting an athlete on a training program [50, p. 441]. While each participant was TPI certified, and several coaches called attention to utilizing TPI methods to assess and train golfers, TPI should be only one resource that is part of the research process. However, the responsibility of the golf strength and conditioning professional is to conduct their own research and seek knowledge to understand the sport of golf, the golf swing movement, and the evaluation of individuals to form their own interpretations concerning appropriate training practices for golfers.

In addition, data displayed the lack of consensus between golf strength and conditioning professionals when answering, “What perceptions do you have about golf-specific exercises in a training program with golfers?” with seven participants who had negative perceptions and 10 participants who had positive perceptions. One participant believed golf-specific exercises were both positive and negative depending on the individual and the desired outcomes. Considering the emergent themes “should focus more on transfer rather than specificity” and “people think exercises need to look like the golf swing” from the seven participants who negatively viewed golf-specific exercises, these themes do not seem to be logical or carry much merit. Considering transfer of training and dynamic correspondence, training directly for sport performance, the most applicable activity an athlete can do to improve performance is their sporting movement and other exercises that would match the characteristics of the sporting movement. While golf-specific exercises do not need to necessarily mimic the golf swing, it seems erroneous assumptions exist about an exercise that looks like the sporting movement not having positive implications on sport performance. Western civilization strength and conditioning ideals afford context to the negative perceptions of “sport-specific” interventions as further displayed in data regarding powerlifts. Powerlifting data from the provided training program examples resulted in all participants who utilized a squat variation, 16 participants who utilized a deadlift variation, and 13 participants who utilized a bench press variation. Additionally, agreement or disagreement on whether an exercise was golf-specific in survey Question #4, “Do you consider the following exercises golf specific? Agree (A)-1 or disagree (B)-0?,” five out of every six participants classified both a squat and deadlift as a golf-specific exercise. As commonly seen in Western civilization strength and conditioning, the philosophy to incorporate powerlifts as primary exercises in training programs exists in golf strength and conditioning programs.

An additional emergent theme displayed throughout the data was the reliance on indirect measures of golf performance for assessment purposes and validation of whether an intervention leads to golf performance improvement. Indirect golf performance measures are common in golf performance literature [2, 4-6, 10, 13, 16, 17, 19-21, 24, 25, 32-36, 38, 39, 45-47, 49, 51, 53, 55-57, 64]. Question #8 from the survey, “What data do you collect to evaluate the progress of your golfers? Please be thorough and specific. (Examples: 1 RM tests, balance test, vertical jump height, driving distance, etc.),” quantified how participants evaluated and assessed whether golfers were progressing while using their training program. Utilization of indirect golf performance measures commonly seen in golf performance literature was also used by participants with only one participant who mentioned using handicap or scoring average (a direct golf performance measure) as an evaluative measure. While other data measures such as vertical jump, TPI assessments, swing metrics, balance, power output, and strength tests were popular responses and had been shown to be correlated to elements of golf performance, the measures did not directly quantify golf performance on the course. Quantifying the influence of training on direct sport performance is difficult and nearly impossible to discern for dynamic sports. Three studies that analyzed training intervention influence on golf handicap had mixed results with one study that found statistically significant results in decreasing the handicaps of the participants. These studies primarily relied on “general” training exercises with few exercises fulfilling the “golf-specific” definition [4, 51, 58]. Two of the three studies provided an outline of the training intervention program plan with both studies primarily using plyometric, jump, balance, and other strength exercises [4, 51]. Future studies should evaluate the influence of various training interventions on direct golf performance.

While indirect golf performance measures are relatively easy to quantify changes and improvements as a result of training, in comparison to golf performance on the course, the validity of such measures must be considered. Several indirect golf performance measures such as anthropometric, flexibility, strength, endurance, clubhead speed, carry distance, and swing kinematic data have shown a correlative relationship with direct golf performance. This has led to common inferred causal relationships between these indirect measures with direct golf performance [31, 62]. Even TPI validates indirect performance measures of “power” with the vertical jump, medicine ball seated chest pass, and medicine ball sit-up and throw tests to predict a golfer’s clubhead speed. While the data displays golf strength and conditioning coaches’ utilization of indirect performance measures, consideration of golf performance assessments based on direct golf performance are more valid measurements compared to improving indirect exercise tests. Additionally, in comparing previous literature to the present study, a gap exists in the utilization of indirect golf performance measures to gauge improvements from the imposed intervention. As seen in prior golf literature, improvements with indirect golf performance measures can be impacted no matter what type of training intervention was used [2, 4, 6, 10, 13, 16, 17, 20, 21, 24, 32, 33, 35, 38, 46, 47, 49, 51, 53, 55-58, 64, 65]. However, indirect golf performance measures may or may not be a valid representation of overall golf performance. Concurrently, existing golf-specific exercise studies may or may not represent what golf-specificity training and golf-specific exercises are, therefore the validity can be questioned of such results [2, 10, 21, 24, 35]. Future studies are needed to explore golf-specific exercise and its impact on golf performance.

Limitations

"Qualitative research is a form of research in which the researcher or a designated coresearcher collects and interprets data, making the researcher as much a part of the research process as the participants and the data they provide" [12, p. 4]. As such, the qualitative grounded theory structure of the present study was a limitation. Although interpretations and theories made by the researcher involved a level of subjective reasoning and interpretation of the data, this was the design and goal of the practice to propel the golf strength and conditioning field forward to new and innovative ideas of discovery. While controversy remains over the application of training interventions for golfers, present data outlined the variance of characterizing and applying training. The structure of this study supplied data to evolve golf training discussions as the golf strength and conditioning field searches for effective training practices.

Additionally, a limitation of the present study was the focus on multiple topics within the golf strength and conditioning field. Part of the grounded theory process was to allow the theory to be “grounded” in the data and evolve during data collection. Without knowing prior to the interviews what theories would emerge, the time dedicated to discussing golf-specific exercises was sufficient but could have been a greater topic of exploration. A variety of questions pertaining to concepts within golf strength and conditioning took time away from gathering additional data about what appeared as the theory regarding golf-specific exercises. Additional limitations were the training program examples provided by the participants. Each participant sent one example for analysis. While this was a training program written and prescribed by participants, each was a singular example where the situation and context of different clients influenced the content of the training programs. However, each participant was able to select whatever program they wished to use as a reflection of themselves and was afforded opportunities throughout the interview to discuss any information and context to their training philosophies and programs. It is recommended that future research further analyze the application of practices being utilized in the golf strength and conditioning field.

Conclusion

This study outlined a grounded theory that golf strength and conditioning professionals held misconceptions regarding the definition of a golf-specific exercise. A lack of training characterization and categorization in the field coupled with the application of misguided knowledge concerning training intervention transferability to golf performance were probable factors for the theory formation. The present study was the first to define a golf-specific exercise to allow professionals in the field to characterize exercises and analyze the impact of various interventions on golf performance. Distinctions in defining and characterizing types of training and exercises are not to criticize the application of utilized practices; rather, it is to distinguish and to critically think about the validity of training practices with specific sport athletes. While exercises such as bench press, squat, and deadlift allow the athlete to get better at bench pressing, squatting, deadlifting, and other similar movements, this does not mean the athlete will improve performance or improve performance optimally in their specific sport. Strength and conditioning professionals should consider, “Are we training athletes to improve in the gym, or are we training athletes to improve at their sport?” If improving direct sport performance is the goal, training should match the needs of the sport and the demands of sporting movements. The utilization of the strength and conditioning concepts of transfer of training and dynamic correspondence can continually evolve the golf strength and conditioning field to optimize golf performance. Further research should explore golf-specific exercises and the use of such practices in training programs designed to improve golf performance.

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Appendix A

Standardized Participant Invitation Script

Dear (Participant),

My name is Philip Herder. I am a graduate student at the University of Wisconsin-River Falls and the Director of Research at Interlachen Country Club in Edina, MN. I am conducting research on golf strength & conditioning programs, and I am inviting you to participate. Participants must be responsible for training golf athletes, have at least 5 years of experience in the field, are TPI certified, and currently work in the field to partake in the study.

Participation in this research includes completing a virtual interview about the training programs you use with your golfer, which will take approximately 60 minutes. We ask you provide a copy of a training program or an annual training program example which is the focus of the research. Further analysis will be done on your training program example to describe training methods being used in the golf training industry in comparison to what past literature has concluded about golf training.

If you have any questions or would like to participate in the research, I can be reached via phone number, email, or social media.

Appendix B

Interview Structure

Figure B1. Survey Structure

1. Golf-specific exercises should be incorporated in a golf training program. Please circle one answer.

   Strongly Agree-5 Agree-4 Neutral-3 Disagree-2 Strongly Disagree-1

2. Golf-specific exercises are important in a golf training program. Please circle one answer.

   Strongly Agree-5 Agree-4 Neutral-3 Disagree-2 Strongly Disagree-1

3. How do you define a golf-specific exercise? Please provide your definition below.

4. Do you consider the following exercises golf specific? Agree (A)-1 or disagree (B)-0?

   a) Deadlift ______
   b) Overhead Medicine Ball Throw ______
   c) Vertical Jump ______
   d) Olympic Lifts ______
   e) Rotational Medicine Ball Toss ______
   f) Bench Press ______
   g) Back Squat ______
   h) Cable Wood Chop ______
   i) Medicine Ball Slam ______
   j) Seated Medicine Ball Throw ______

5. On a scale of 1-10, 10 being extremely golf specific, 1 being extremely non-golf specific, how would you rate the following exercises?

   a) Deadlift ______
   b) Overhead Medicine Ball Throw ______
   c) Vertical Jump ______

d) Olympic Lifts _____

e) Rotational Medicine Ball Toss _____

f) Bench Press _____

g) Back Squat _____

h) Cable Wood Chop _____

i) Medicine Ball Slam _____

j) Seated Medicine Ball Throw _____

6. Circle the percentage that best reflects the proportion of golf-specific exercises used in your training programs.

   0 25% 50% 75% 100%

7. Circle the number of months that best represents how long golf-specific exercises are the primary means in your training programs during an annual training program.

   0 1 3 6 9 12

8. What data do you collect to evaluate the progress of your golfers? Please be thorough and specific. (Examples: 1 RM tests, balance test, vertical jump height, driving distance, etc.)

9. Which of the following training goals do you prioritize throughout a golf training program? Please rank the following based on priority level. (Use Low-1, Medium-2, High-3, or N/A if not-applicable-0)

a) Max Lower-Body Strength _____

b) Max Upper-Body Strength _____

c) Max Power _____

d) Max Speed _____

e) Hypertrophy _____

f) Aerobic Conditioning _____

g) Anaerobic Glycolytic Conditioning _____

h) Repeated Sprint Ability _____

i) Rotational Strength _____

j) Rotational Power _____

k) Core Stability _____

l) Balance _____

m) Ankle Mobility _____

n) Hip Mobility _____

o) Torso Mobility _____

10. Are there any physical limitations that you focus on that seem specific to golfers? For instance, ankle dorsiflexion, thoracic mobility, etc.

Figure B2. Interview Questions & Answers

1. First, if you could provide background information on your career and your journey during your professional career.

Table 9

Participant Background Information

Characteristics	No. of Participants
Exercise & Sport Science Degree	13
Played collegiate golf	9
Physical Therapist	4
Originally from outside the U.S.	3

2. Describe your current position and the responsibilities you have with golfers.

Table 10

Participant Current Position

Occupation	No. of Participants
Owner (business, facility, etc.)	12
Head S&C Coach	4
Golf Trainer	2

Table 11

Participant Role with Golfers

Responsibilities	No. of Participants
Program & Coach	17
Developing App and/or YouTube Workouts	4
Clinically Treat Clients	2
Only Programming	1

a. What skill levels do you primarily work with?

Table 12

Participant Clientele Demographic

Skill Level	No. of Participants
Amateur	10
Professional	7
Collegiate	7
Seniors	7
Junior	7

3. How do you analyze the efficacy of your training programs?

Table 13

Measuring Validity of Training Program

Efficacy Analysis	No. of Participants
Improvement in movement patterns	10
Verbal feedback from clients	9
Swing metrics	9
Doing no harm	5
Did the client reach their goal?	3
Body composition	3
Analytic software with objective data	2

a. Is individual swing kinematic data utilized in creating and adjusting training programs? How so?

Table 14

Data to Create Training Programs

Utilization of Individual Swing Kinematic Data	No. of Participants
Yes	14
Yes, but use swing coach for knowledge	10
Yes, but only for initial client analysis	4
No	4
No, but hope to use in future	3

b. What strategies do you use to continually evolve and adjust your training programs to improve performance?

Table 15

Data to Evolve Training Programs

Strategies	No. of Participants
Learning from other professionals in the field	9
Learning through certifications	7
Experimentation	6
Research (seeking out and doing own analysis)	4
Feedback from Clients	3

4. What are some training philosophies you have?

Table 16

Strength and Conditioning Principles

Golf Training Philosophies	No. of Participants
Dependent on individual	17
Focus on functional movements to move in all planes	7
Necessity for "base strength" first to provide foundation	7
Do no harm	6
Mobility is key	5
No barbells	2
Feet are important to "build from the ground up"	2
1:2 ratio for push : pull exercises	1
3:1 ratio for lower : upper body exercises	1

a. What is your perception of the role of strength & conditioning with golfers?

Table 17

Role of Strength and Conditioning with Golfers

Perceptions	No. of Participants
Necessity to improve at golf	11
As important as golf practice	5
Useful to lengthen and improve career in golf	4
Should be utilized to improve mobility and to move better	3
Not as important as golf practice	3
Is both positive and negative	2

5. With analyzing the training program example you provided, what is your approach with designing an annual training program, mesocycles, and/or microcycles?

Table 18

Approach to Designing a Training Program

Characteristics	**No. of Participants**
Dependent on competition schedules + individuals	12
Periodization of cycles	10
Undulating cylces	6
Start higher rep counts and progress to lower rep counts	4
Continuous reevaluation of TPI screen	4

a. What training goals are focused on during a training program?

Table 19

Goal Prioritization in Training Program

Primary Training Goals	No. of Participants
Injury prevention	10
Improve the clients' goals	5
Move better	4
Bigger muscles	3
Increase rate-of-force development	2
Improve core function	2
Improve fundamentals for golf swing	2
Feel better before, during, and after a golf round	1

b. What types of training are primarily used?

Table 20

Types of Training

Utilized Training	No. of Participants
Mobility	12
Core	9
Plyometrics	8
Unilateral exercises	8
Power	7
Speed	5
HIIT	3
Balance	2
Cardio	2
Flexibility	1

i. What exercises/movements are the focus?

Table 21

Types of Exercises

Utilized Exercises	No. of Participants
Hinge	17
Squat	14
Lunge	10
Push/Pull	6
Rotation	5
Anti-Rotation	3
Bridges	1

6. What is your definition of a golf-specific exercise?

Table 22

Defining a Golf-Specific Exercise

Characteristics	No. of Participants
Helps perform the golf swing more optimally	5
Anything in the kinematic sequence	4
Anything that can keep golfers playing	4
Doesn't need to look like the golf swing	4
Mimics swing	3
Difficult to define/does not exist	3
Matches movement, speed, load, rate-of-force development, etc.	3
Fitness + functional movements	3
Unable to apply to another sport	1

a. What perceptions do you have about golf-specific exercises in a training program with golfers?

Table 23

Perceptions about Golf-Specific Exercises

Connotation	Characteristics	No. of Participants
Positive		11
	Help golf skills become more efficient	6
	Whatever will help a golfer adapt to the stresses of a round	2
	Helps build the tool-box	2
	Creates buy-in for golfers why fitness is helping their swing	1
	Can be great when used at the right time	1
Negative		8
	Need for focus on transfer rather than specificity	4
	People think exercises need to look like the golf swing	4
	Problem with overload not being same speed but same movement pattern	2

b. What is your perception on what a needs analysis for golf would encompass?

Table 24

Perceptions on Golfer Needs Analysis

Characteristics	No. of Participants
TPI has laid foundation	6
Up to coach to use information to help client for what they need	5
Move in sagittal, frontal, + transverse planes	4
Matches movement, speed, load, rate-of-force development, etc.	4
Squat/Lunge	2
Basic fundamental movements	2
Most people just need a fitness plan	1
Infinite number of ways to swing a golf club	1

c. What do you believe the goals of golf-specific exercises are?

Table 25

Goal of Golf-Specific Exercises

Characteristics	No. of Participants
Improve indirect golf performance measures	10
Move more efficiently	5
Improve a golfers' swing	5
Prevent injury	4
Strengthen aspects of the golf swing	2
Increase rate-of-force development for golf swing	1
Narrow gap between movements for training and hitting golf shots	1

d. What is the role of general exercises compared to the role of golf-specific exercises?

Table 26

Role of General Exercises Compared to Golf-Specific Exercises

Characteristics	No. of Participants
Move body in functional patterns	5
Goal is overall health + well-being	4
Create an ideal body image for people	3
Should always be the primary goal	3
Help transfer strength to speed	2
Helps more than people think	2
Add novelty	1

e. What are some pros and cons you see with golf-specific exercises compared to general exercises?

Table 27

Perceptions on Golf-Specific Exercise Utilization Compared to General Exercises

Connotation	Characteristics	No. of Participants
Pros		
	Can add to golf performance for the right person	2
	Helps golfers with technical pieces in the golf swing	2
	Strengthens certain tissues in certain swing positions	2
	Helps ability to rotate for golf swing	1
	Promotes golf posture	1
	Improves clubhead speed	1
	Improves certain movement patterns	1
	Can improve anything a golfer does	1
Cons		
	Too much focus on rotation/mimicking the golf swing	8
	Questionable transferability to the golf performance on the course	3
	Too much of the same pattern can lead to injury	2
	Bad information about practices in the industry regarding safety and optimization	2
	Too complex for most individuals	1
	Best way to score better is to actually play	1

f. How should golf-specific exercises be utilized?

Table 28

Utilization of Golf-Specific Exercises

Characteristics	No. of Participants
Help players improve on an individual basis	4
No right or wrong way	3
Job of professional to decide what's appropriate	3
Should be used during preseason phase for specificity	2
Use at the beginning of a session to develop plane specific power	1

g. Have your beliefs evolved through your career about training for golf-specific exercises? How so?

Table 29

Belief Evolution on Golf-Specific Exercises

Time	Characteristics	No. of Participants
Past		
	Had to look like the golf swing	4
	Focused more on sport training	3
	Basic programming	2
	Don't lift heavy	2
	More flexibility + mobility training	1
	1-rep max training	1
	Stability movements on "unstable" surfaces	1
	Stregnth + Conditioning will hurt your golf game	1
Present		
	Many different exercises can help the golf swing	4
	All exercises can transfer to the golf swing	4
	Need to find weaknesses in the chain	3
	Focus on fundamental movements	2
	More specific with programming	2
	Lift heavy + explosive	2
	Combination of strength + mobility	1
	Injury prevention	1
	More plane-specific for exercises	1
	Move to play golf + not vice versa	1
	Speed Sticks	1

h. What percentage of exercises used in your training program are golf-specific?

Table 30

Golf-Specific Exercise Utilization Proportion in Training Program

Did Participant's Answer Change?[a]	No. of Participants
Yes, from 75% to 100%	3
Yes, from 25% to 80%	1
Yes, from 75% to 30%	1
Yes, from 75% to 25%	1
No	12

Note. [a]Answer changed from Question #6 from the survey quantifying golf-specific exercise utilization proportion