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Minimizing Injuries and Enhancing Performance in Golf through Training Programs

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Minimizing Injuries and Enhancing Performance in Golf Through Training Programs

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Context: Golf is a popular sport, particularly in older populations. Regardless of age and skill level, golfers risk injury to the back, shoulder, wrist and hand, elbow, and knee. Because of the unique compressive, shear, rotational, and lateral bending forces created in the lumbar region during the golf swing, the primary sport-related malady experienced by amateurs and professionals is low back pain. Extrinsic and intrinsic injury risk factors have been reported in the literature. A growing body of evidence supports the prescription of strength training routines to enhance performance and reduce the risk of injury.

Evidence Acquisition: Relevant studies were reviewed on golf injuries, swing mechanics, training routines, and general training program design. The following electronic databases were used to identify research relevant to this report: MEDLINE (from 1950–November 2009), CINAHL (1982–November 2009), and SPORTDiscus (1830–November 2009).

Results: Injuries may be associated with lack of warm-up, poor trunk flexibility and strength, faulty swing technique, and overuse.

Conclusions: Implementing a training program that includes flexibility, strength, and power training with correction of faulty swing mechanics will help the golfer reduce the likelihood of injury and improve overall performance.

Keywords: golf; sports performance; injury prevention; swing mechanics; training program

Golf is a popular sport, particularly in older populations.[33] It is a great low-impact opportunity for many individuals to stay active. That is not to say that golfers are not at risk for injury. Common injuries have been documented in the lower back, elbow, shoulder, and knee.[13,28,30] These injuries have been associated with lack of warm-up, poor trunk flexibility and strength, faulty swing technique, and overuse.[§] A growing body of evidence in the literature suggests that participating in strength training routines will not only enhance performance but reduce injury incidence.[7,9,10,13,23,34]

METHODS

Selection of Articles

Table 1 presents the Medical Subject Headings used in the search strategy for this review. If we identified fewer than 250 articles by a search strategy, we reviewed the study abstracts from that category to identify potentially relevant articles. We also reviewed the reference list of each selected article to identify additional relevant publications.

[§]References 4, 8, 10, 11, 13, 17, 21, 23, 34.

Inclusion Criteria

The inclusion criteria were as follows: First, the report's study design must have been a randomized controlled trial, a quasi-experimental single-case design, a nonrandomized historical cohort comparison, a case series, or a case report. Second, the report had to be published in a scientific peer-reviewed journal. Last, the training program presented had to describe one of the following exercise components: warm-up, stretching (static or dynamic), flexibility training, strength training, or power training.

Exclusion Criteria

Articles that were not published in a peer-reviewed scientific journal or that failed to detail an exercise program were excluded from this study.

SWING MECHANICS OVERVIEW

The majority of injuries sustained by professional golfers relate to overuse.[25] However, the majority of injuries experienced by amateur golfers are due to faulty swing mechanics,[3,25,26,28] which

Table 1. Search strategy by heading and number of articles.

Medical Subject Headings	Articles, n		
	Identified	Determined as Potentially Relevant	Included in Critical Appraisal
golf	77 807	—	—
golf AND sports performance	1917	—	—
golf AND rehabilitation	271	—	—
golf AND strength	497	—	—
golf AND strength training	140	8	7
golf AND power	90	1	1
golf AND flexibility training	216	7	7
golf AND enhancement	55	0	0

makes understanding the golf swing necessary when trying to reduce injuries in the amateur population. The golf swing can be divided into the setup, backswing, transition, downswing, and follow-through.[31] Because of the large release of energy during the downswing and the deceleration of that energy during the follow-through, these phases are responsible for the majority of injuries during golf. Of course, the importance of the other phases cannot be overlooked because faulty mechanics during setup, backswing, and transition may contribute to faulty mechanics during the downswing and follow-through.

The following description of general swing mechanics is for a right-handed golfer: The left side of the body is the lead, whereas the right side of the body is back. The setup position, also known as the address, is the starting position of the golf swing. When one is in the proper setup position, the hips and knees should be slightly flexed, and the arms should hang loosely. The hips, feet, and shoulders should be aligned with the target. The feet should be situated so that the ball is generally closer to the left foot, although this somewhat depends on club length—given that the longer clubs, such as the driver, require the ball to be closer to the left foot than do shorter clubs, such as wedges. The left shoulder should be slightly higher than the right at the setup position.[31]

The backswing begins with the takeaway. During this phase, the arms and shoulders work together as a triangular pendulum to begin taking the clubhead away from the ball. As the clubhead rises, the golfer continues to rotate the knees, hips, and spine, shifting weight toward the right foot. The top of the swing is known as the transition phase (Figure 1). At this point, the lower body begins the downswing while the upper body and club continue rotating away from the ball, which builds potential energy into the biomechanical system to be released during the downswing. By the time the upper body and club begin the downswing, the pelvis has already progressed to a 45° position.[31]

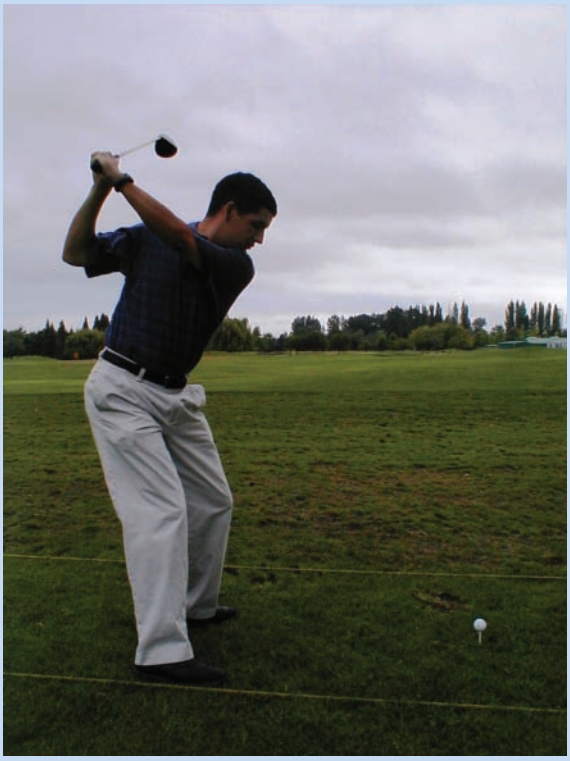

Figure 1. Transition phase of the golf swing. Hip internal rotation stretch.

Weight is shifted from the right foot to the left foot as the downswing progresses.[31] The potential energy stored

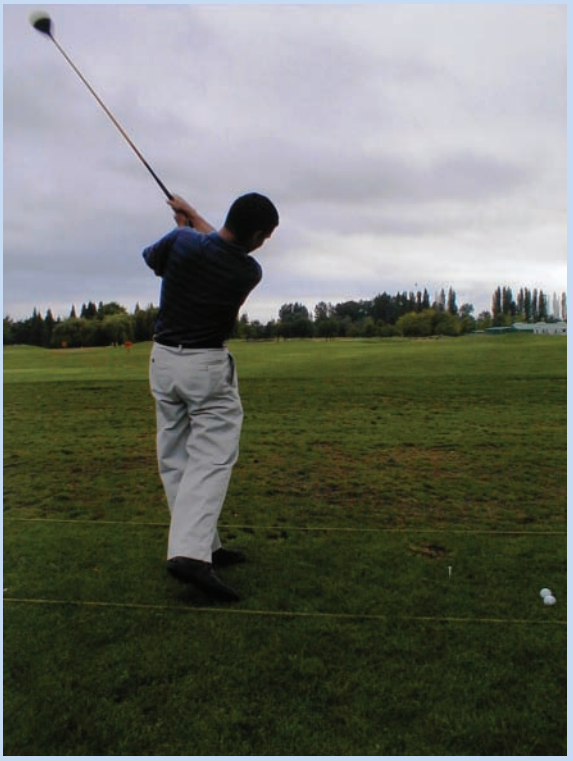

Figure 2. Follow-through phase of the golf swing.

during the transition phase is released from the ground up, culminating in the clubhead. This sequential release of energy is what gives the most power at the point of impact.[6] After impact with the ball, the body decelerates segmentally into the follow-through (Figure 2). During this phase, the hips extend while the spine and shoulders rotate past the original ball position.[31] For PGA Tour players, the average total swing time is 1.21 ± 0.14 seconds.[6]

Analysis of muscle activity during the golf swing reveals heightened activity of the scapular stabilizers, erector spinae, abdominal obliques, and hamstrings during the backswing. The scapular stabilizers, pectoralis major, gluteus maximus, gluteus medius, vastus lateralis, biceps femoris, adductor magnus, and abdominal obliques are the most active muscles during the downswing into impact.[19] During follow-through, the vastus lateralis, gluteus medius, abdominal obliques, adductor magnus, rotator cuff, and hamstrings all play a major role.[22,27]

DESIGNING A TRAINING PROGRAM FOR GOLF

Many studies have examined factors that may contribute to injuries in golf.[8,13,18,24,35] Gosheger et al[13] found that simple modifications reduce the incidence of injuries, such as using a bag cart and performing a 10-minute warm-up before game play. Other studies have identified that increased hip flexibility can be helpful as well.[8,35] Additional factors that increase the risk of sustaining a sports-related injury include decreased static trunk strength,[8] delay in trunk muscle recruitment,[18] and limited trunk endurance.[24]

A growing body of evidence has demonstrated that strength training programs specifically affect performance in golf (Table 2).[7,9,10,12,23,34] Fradkin et al[10] found that a warm-up of windmills, trunk twists, static stretching, and air swings with a club for 7 weeks increased the golfers' clubhead speed by 24% when compared with that of the control group. Thompson et al[34] focused on engaging older golfers (ie, in their 60s and 70s) in an 8-week progressive functional training program that included flexibility, core stability, balance, and basic resistance exercises. This group showed a significant increase in clubhead speed and Senior Fitness Test scores. Lephart et al[23] conducted an 8-week strength training program for middle-aged golfers. Those who participated in this golf-specific exercise routine (including trunk rotations, side bending, and resisted swings) 3 to 4 times per week demonstrated significant improvements in clubhead speed, ball speed, carry distance, and total distance. Fletcher et al[9] found that the use of free-weights and plyometrics may be more effective than machine weights in regard to clubhead speed and driving distance. Finally, the study by Doan et al[7] found significant improvements in National Collegiate Athletic Association Division I golfers not only in clubhead speed but in putting distance control with an 11-week training program that included many classic weight-lifting exercises.

These studies provide initial evidence supporting the prescription of strength training programs for preventing injuries and enhancing performance in golfers. This population may respond well to intervention because golfers are unlikely to perform even a simple warm-up.[11] The approach that we are suggesting follows 4 specific elements: flexibility, strength, power, and swing mechanics.

In the design of individual workouts, the order of the exercises should be considered (Table 3). Each should start with a dynamic warm-up,[29] then power exercises, followed by routines that use multiple joints and large muscles (ie, squats and bench press). As the athlete begins to fatigue, they should focus on transitioning from multijoint exercises to single-joint exercises, isolating the smaller muscles, such as the rotator cuff.[32] The workout should conclude with static stretching.[29]

FLEXIBILITY

For golfers, a lack of flexibility in the hip flexors and limitations of internal rotation correlate with injuries to the low back.[8,35] Golfers should therefore perform daily stretching of the hip flexors and internal rotation of the hip (Figures 3 and 4). They may also find it useful to stretch for trunk rotation and basic overall shoulder flexibility as well, given that these areas are also integral to the swing.[5] Stretching should be performed for 1 set of 30 seconds at least once a day.[1,2] Because static stretching during warm-up can be detrimental to performance,[12,29] we recommend dynamic stretching before an event, such as trunk twists and walking knee to chest.

Table 2. Summary of studies of golf-specific training programs.

Study	Grimshaw et al[14]
Study design; level of evidence	Case report; 5
Participants	Professional male golfer (age, 22 years)
Program frequency and duration	Core exercises performed 3 to 4 times per day; stretching exercises, 3 to 4 times per week
Training program	Core exercises: 3 to 4 times a day, 1 set of 10 repetitions, hold 5 seconds, increasing to 20 to 30 seconds Stretching exercises: 2 times per training session, 5-10 repetitions, 20- to 30-second holds
Outcomes	At the end of 3 months of rehabilitation, the professional golfer returned to play without symptoms. Kinematic changes were also noted.

Study	Fletcher et al[9]
Study design; level of evidence	Randomized controlled trial (experimental group: n, 6; control group: n, 5); 2
Participants	Eleven male golfers (mean age, 29 ± 7.4 years); mean handicap, 5.5 ± 3.7
Program frequency and duration	Two times a week for 8 weeks; duration, 90 minutes
Training program	Resistance exercises: 3 sets × 6-8 reps Plyometric exercises: 3 sets × 8 reps
Outcomes	Significant improvements for experimental group in clubhead speed (1.5% increase) and driving distance (4.3% increase)

Study	Fradkin et al[10]
Study design; level of evidence	Matched pairs randomized into experimental (n, 10) and control (n, 10) groups; 2
Participants	Twenty male golfers (mean age, 39.6 years; range, 23 to 64 years); mean handicap, 19.8
Program frequency and duration	Five times a week for 5 weeks
Training program	Warm-up routine consisting of 4 exercises (15 seconds each) for increasing body temperature, 9 static stretches, and 30 seconds of golf club air swings
Outcomes	Experimental group demonstrated significant improvements in clubhead speed (24%) and there was a significant difference between groups over time.

Study	Doan et al[7]
Study design; level of evidence	Nonrandomized concurrent cohort; 3
Participants	Collegiate golfers: 10 men (19.8 ± 1.7 years) and 6 women (18.5 ± 0.8 years); handicap not presented
Program frequency and duration	Three times a week for 11 weeks; duration, 90 minutes
Training program	Flexibility program, strength training routine, trunk-strengthening program.
Outcomes	Significant improvements in group clubhead speed (1.62% increase) and, for men, putting distance control (15-foot [5-m] putt). All groups demonstrated significant increases in strength, power, and flexibility measures.

(continued)

Table 2. (continued)

Study	Lephart et al[23]
Study design; level of evidence	Nonrandomized concurrent cohort; 3
Participants	Fifteen male golfers (47.2 ± 11.4 years); mean handicap, 12.1 ± 6.4
Program frequency and duration	Instructed to perform program 3 to 4 days a week
Training program	Stretching exercises (1 set, 1 rep, 30-second holds), strengthening exercises (3 sets, 10-15 repetitions), balancing exercises (1 set, 1 rep, 30-second holds)
Outcomes	Significant improvement in torso, shoulder, and hip flexibility; in 3 of 12 tests; and in average club velocity, ball velocity, carry distance, and total distance

Study	Thompson et al[34]
Study design; level of evidence	Randomized controlled trial (experimental group: n, 11; control group: n, 7); 2
Participants	Eighteen male recreational golfers (mean age, 70.7 ± 7.1 years)
Program frequency and duration	Three times a week for 8 weeks; duration, 90 minutes
Training program	Periodized training program consisting of spinal stabilization exercises, balance exercises, and strength training
Outcomes	Experimental group demonstrated significant improvements in clubhead speed. In addition, those in the experimental group demonstrated significant improvement in several components of the Senior Fitness Test.

Study	Gergley[12]
Study design; level of evidence	Nonrandomized counterbalanced design; 3
Participants	Fifteen male golfers (mean age, 20.6 ± 1.9 years); mean handicap, 2.5 ± 1.5
Program frequency and duration	Two sessions, nonconsecutive days
Training program	An active dynamic warm-up and a passive static stretching routine, plus the identical active dynamic warm-up
Outcomes	After the passive static stretching protocol, the golfers experienced significant decreases in clubhead speed and driving distance.

Table 3. Exercise order.

Dynamic warm-up
Power exercises
Multiple-joint, large-muscle exercises
Single-joint, small-muscle isolation exercises
Static stretching

STRENGTH

Although golf is known as a game dominated by technique, many studies have shown that strength training may be helpful in not only preventing injuries[8,13,24,35] but also having a great effect on performance.[7,9,10,23,34] Nearly all major muscle groups are highly active during the golf swing[27]; thus, it is best to first build overall strength capacity before initiating functional training. A basic routine addressing all major muscle groups should provide the foundation for the program. For the legs, this includes a combination of front squats[15] (Figure 5) and dead lifts.[16] It also includes variations of the bench press and rows for the upper body while setting aside time for the

Figure 3. Hip flexor and rectus femoris stretch.

Figure 4. Hip internal rotation stretch.

Figure 5. Front squat.

all-important scapular stabilizers and rotator cuff (Statue of Liberty exercise, Figure 6). A flexible bar overhead is oscillated for 30 seconds while holding the arm statically against a resistance band or tubing. Because muscular endurance

Figure 6. Statue of Liberty rotator cuff exercise.

Figure 7. Prone plank.

capacity is a major factor in golf,[24] all exercises should be performed in the 15-repetition range, focusing on maintenance of form over any other variable.

Although core strengthening is part of the above-mentioned activities,[16] the higher demand on the trunk during the golf swing justifies specific core stability exercises, such as planks (Figure 7) and rotations.[20,21] The ability to hold the plank position for 60 seconds is ideal for the amateur golfer.

POWER

Regarding movement analysis, the golf swing can be described as a power movement. Total swing time is 1.21 ± 0.14 seconds for PGA Tour players.[6] Power should be a major component of any golf training program. A delay in muscle recruitment is common in golfers with low back pain.[18] Power exercises are quick movements for short durations against resistance. Although sport-specific trunk plyometrics have been effective for golfers,[7,9] Olympic lifts may be useful.[17] The power snatch, power clean, and push jerk not only encourage explosiveness but may enhance coordination and control throughout the

Clinical Recommendations

SORT: Strength of Recommendation Taxonomy
A: consistent, good-quality patient-oriented evidence
B: inconsistent or limited-quality patient-oriented evidence
C: consensus, disease-oriented evidence, usual practice, expert opinion, or case series

Clinical Recommendation	SORT Evidence Rating
Implementing a training program for golf will reduce injuries and increase performance.	B
A training program for golf should include flexibility, strength, power, and swing training.	C

For more information about the SORT evidence rating system, see www.aafp.org/afpsort.xml and Ebell MH, Siwek J, Weiss BD, et al. Strength of Recommendation Taxonomy (SORT): a patient-centered approach to grading evidence in the medical literature. *Am Fam Physician.* 2004;69:549-557.

Figure 8. Push jerk.

body.[17] Power lifts are often added progressively as simpler free-weight exercises are mastered. The push jerk (Figure 8) is taught first, followed by the clean, because the former should be more intuitive to most athletes. For advanced or elite golfers, the power required for the snatch may be a competitive advantage.

SWING MECHANICS

Understanding swing mechanics is a fundamental component of training golfers. A short conversation with any teaching professional reveals that most success in golf comes from hitting the ball well. A golfer who hits the ball well will always outdrive a golfer who simply hits it hard. As a result of participating in a strength training program, the golfer will be able to swing the club harder while still maintaining control.

CONCLUSION

When working with golfers of all levels, from older recreational athletes to high level professionals, the sports medicine professional can provide useful insight. Through an understanding of basic swing mechanics, incidence of injuries, and human physiology, an ideal training program can be designed to enhance the game for any golfer. This training program can also be used as a rehabilitation guide for returning golfers to sport.

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