Optimizing the Benefits versus Risks of Golf Participation by Older People

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ABSTRACT

Currently a strong emphasis is being placed in North American public health messages on the value of an active lifestyle for all age segments, including older persons. However, seniors do not usually take up physical activities, even though they often have extensive leisure time. Thus the purpose of this paper is to review current knowledge regarding the key health issues for physical therapists to consider when dealing with an older person who wishes to participate fully in an active sport. We have chosen the example of golf because of its popularity among seniors, as well as its usefulness in illustrating both the overall benefits and risks of participation. Although playing golf provides a moderate intensity exercise stimulus for seniors, musculoskeletal injuries can also result from unsafe participation, as can the aggravation of pre-existing musculoskeletal problems. Strategies for targeted management of the senior golfer's typical concerns are summarized into 4 categories consisting of: injury rehabilitation coordinated by therapists, warm up routines; club-fitting/coaching on proper technique, and preseason conditioning programs. Educational programs for older people regarding the benefits of physical activity should also include information about injury prevention strategies that enhance long-term participation.

Key Words: physical activity, recreational golf, musculoskeletal injury, rehabilitation, aging

INTRODUCTION

Current public health messages for the North American population are very consistent in their emphasis on the value of an active lifestyle for all age segments, including older persons.[1,2] Indeed for the latter age group, there has usually been a shift in focus from employment and family needs to increased time for leisure,[3] which in part can involve regular participation in exercise programs and sports. However, estimates of general participation rates suggest that only about half of the population are habitually active, and approximately one-third of American seniors are classified as sedentary by the Centers for Disease Control and Prevention.[4] There is a clear need for health care professionals to become knowledgeable advocates for increasing the activity participation rates of the older population.

Therefore the purpose of this paper is to review current knowledge regarding the key health issues for physical therapists to consider when dealing with older persons who wish to participate in active sports. We have chosen the example of golf because of its popularity among seniors, as well as its usefulness in illustrating both the overall benefits and risks of participation. With regard to 'risk,' more specific information is provided later in the article about how musculoskeletal injuries can result from playing golf, and how participation can aggravate pre-existing musculoskeletal conditions. At this point we note that as with any active sport there are some periods of vigorous movement with potential stresses on the body, and the physical therapist can have a key influence on the older person's ability to participate in golf at an enjoyable level. A summary illustration of potential injury management strategies is provided in Figure 1.

North American analyses have indicated that while older golfers comprise only about 25% of the total population who play golf, this segment can account for more than half of the total games played each year if they remain healthy and are

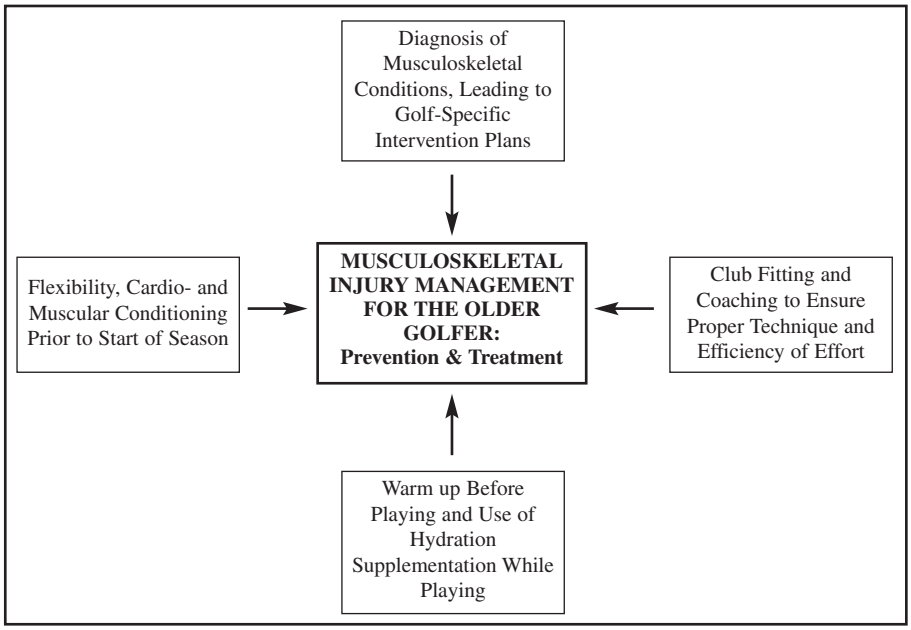

Figure 1. The "Foursome" of rehabilitation strategies to manage musculoskeletal injuries affecting participation of the older golfer.

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willing to make time to play.[5-8] Conversely, the trend for younger age groups that participate in sports is more towards team games such as soccer, baseball, and basketball.[9] Given the current demographics of the North American population, physical therapists whose practice involves older persons may well expect to see an increasing number of senior golfers in the future, as the 'baby boom' generation moves steadily forward into the retirement stage of the lifespan. Relevant questions about the older golfer that require up-to-date knowledge include:

(1) what are the physical demands of the sport of golf and related performance factors?
(2) what is the potential for aggravation of pre-existing musculoskeletal conditions, or causing new musculoskeletal injuries?
(3) what type of injury prevention strategies can be advocated (eg, warm up, conditioning, and advice on technique/equipment)?
(4) how can the health benefits related to walking golf courses, and swinging clubs, be optimized?

PHYSICAL DEMANDS OF THE SPORT OF GOLF

Golf can be viewed as a moderate intensity form of exercise for senior players,[10] involving intermittent bursts of activity conducted over a period of several hours. Each shot begins with the body "set-up" in an athletic, almost upright posture that is stable and biomechanically efficient, as shown in Figure 2. Adequate flexibility, muscle strength, and balance are needed to assume the initial body position, and then maintain stability while swinging the club. In addition, sufficient cardiorespiratory endurance is required to sustain the golfer throughout the game.

Wallace and Reilly calculated that the average male golfer burns about 900 calories per typical round of walking a course with 18 holes, whilst females consume about 700 calories (the total measured length of the combined holes varies between about 3 to 4 miles, but many extra steps are needed, thereby as much as doubling the usual distance walked during an outing). Carrying clubs adds about another 10% to 15% to these numbers.[11] When heart rates were monitored in a recent study of European recreational golfers, the women in the study tended to reach a peak of about 80% of their maximum heart rate while walking some of the uphill fairways.[12] For the men in this sample, the peak intensity reached was about 70% of their maximum heart rate, depending on whether the terrain was level or uphill, and also the age of the golfer. Dobrosielski et al[13] indicated that the metabolic demand during 9 holes of golf for 20 male golfers aged 49-78 was on average about 4.1 ($\pm$ 0.1) times the resting rate (METs). Interestingly, these golfers all had a previous history of heart disease and the recorded exercise intensity of approximately 57% of their peak functional capacity was indicative that they were performing adequate amounts and intensity of exercise for improving cardiovascular fitness. Parkkari et al[14] found increased aerobic performance during a walking treadmill test, as well as improved body composition and HDL serum cholesterol levels in a previously sedentary group of 55 healthy Finnish male subjects aged 48 to 64 who participated in a golf program 2 to 3 times per week over a 20-week season.

It should be noted that slow pace of play due to busy courses is a frequent concern among North American golfers,[8] thereby extending the time required for the sport, but limiting the potential exercise training effect due to extensive periods of idle standing or sitting. Another example of differing approaches to the sport that affect health benefits is that of the use of power carts for transportation around the course. This practice is much less prevalent in Europe, and often carts are restricted to just those players with documented physical disabilities (eg, in some areas of Scotland). Finally, it is important not to overlook the added benefits for seniors of participating in an outdoor activity that also involves extensive social opportunities.

Golf Swing Mechanics

A comprehensive knowledge of the golf swing is necessary for clinicians treating clients with interests in golf, because as noted in several epidemiological surveys, the swing itself is the most likely cause of injury for golfers.[15-18] Other sources of injuries such as being struck by clubs or balls, collisions between players and spectators or carts, and falls can be quite serious, but it is fortunate that they occur infrequently. The injury risk associated with the golf swing derives from the repetitious nature of the motions involved, motions that allow players to generate clubhead speeds of 160 or more km/hr. These movements are also highly ballistic

A biomechanically efficient set-up not only increases the efficiency that key golf muscles, such as the abdominals and hip muscles, are able to be used but also reduces the risk of injury to the lower back.

- During the set-up, the spine needs to be relatively straight (neutral). The trunk will still have to tilt forward 25-30˚ when setting up to hit the ball, but this movement should come mostly from the hip joints.
- In order for the hips to powerfully rotate through the backswing and follow-through, BOTH feet need to be turned out 25-30˚ at set-up.
- A knee bend of about 25-30˚ is necessary to allow the clubhead to be brought down to the ball without excessively flexing the spine.

Figure 2. Biomechanically efficient golf set-up posture.

in some parts of the swing, because the club acceleration phase before striking the ball can be as brief as 0.2 seconds.[19,20] The golf swing can also present further strain issues for unskilled recreational golfers who have less efficient swing styles, which are typically compensated for by greater muscular exertions.[21]

There are 4 key phases to the golf swing, consisting of 'Set-Up', 'Take Away', 'Return to Impact', and 'Follow-through.' In essence the ideal swing pattern allows the golfer to rotate the club away from the start position in a large arc, and then return it to an impact position in such a way that optimal launch conditions are achieved for the distance and accuracy requirements of the planned shot. Given the large momentum developed by the various body segments' rotational patterns at the point of impact, the final challenge for the player is to follow-through with sufficient braking efforts while still maintaining postural stability. The following section will review the mechanics of the golf swing in detail for a right-handed player.[22-25] The swing phases are illustrated schematically in Figure 3a-d, which also includes denotations of important points of stress on some of the joints.

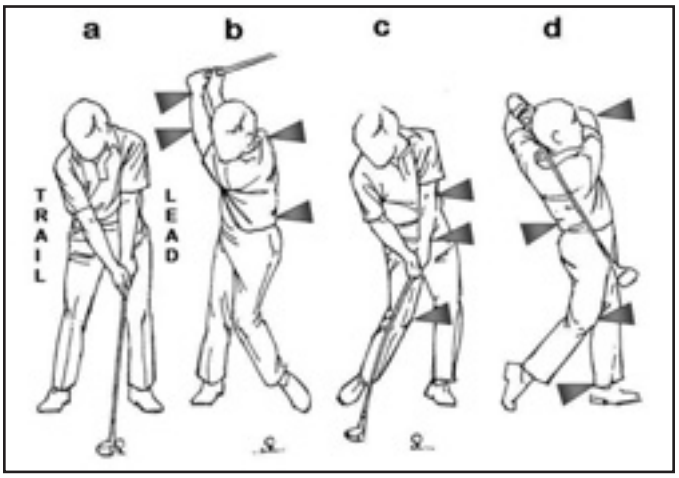

Figure 3. The main phases of the golf swing including: (a) set up, (b) take away, (c) return to impact, and (d) follow-through. The arrows indicate some key points of joint stress occurring throughout the golf swing. Figure 3a also illustrates the lead and trail sides of the body during the golf swing for right-handed golfer, where the lead side (left) faces the direction of play and the trail side faces the opposite direction.

The set-up position (Figure 3a, sometimes also referred to as ball address), occurs when the individual approaches the golf ball and assumes the typical golf stance, emphasizing equal weight distribution, with the feet shoulder width apart. The trunk is flexed forward with a slight right side bend and left rotation in order to compensate for the lower position of the right hand on the club. The backswing subphase of take-away then begins with the golfer maintaining a consistent spinal posture while shifting his or her weight to the right. The backswing itself involves the drawing back of the club using predominantly a rotary motion about the feet, hips, trunk, shoulders, and wrists while maintaining a steady position of the head. At the top of the backswing the trunk remains in flexion and near maximum right rotation. The pelvis also points away from the target placing the left hip in external rotation, while the right hip is in internal rotation. Less than 25% of swing related injuries occur during take-away, and the most commonly injured body structures during this phase are the back and wrist.[26]

Return to impact, the second phase of the golf swing, includes 2 subphases 'forward swing' (Figure 3b) and 'ball impact' (Figure 3c). The velocity and angle of contact between the clubhead's face and the golf ball are the critical determinants of performance, but this is also the phase that produces the majority of injuries.[26] Forward swing is initiated primarily with activation of the trail hip extensors and abductors in conjunction with the lead hip adductor.[27] The result of these contractions is a strong posterior, lateral, and external rotational force exerted by the right foot, which is coupled with an internal anterior rotational force exerted by the left foot.[28] These rotational forces result in a body shift towards the left side. Approximately 0.05 seconds after the hip and lower extremities initiate the forward swing, the trunk initiates its own powerful rotation with contractions of the oblique abdominal and erector spinae muscles producing a greater rotational velocity of the torso when compared to the lower extremities.

The next sequence of movements involves the contribution of the shoulders to the rotational velocity generated by the hip and trunk musculature. The lead infraspinatous, rhomboid, and middle trapezius contract to externally rotate the left shoulder and retract the scapula at the transition point between backswing and downswing. These powerful contractions occur with the muscles and shoulder joint in a fully stretched position at the top of the backswing which can lead to injury as movement direction reverses. Further contribution to shoulder motion on the downswing occurs as the trail subscapularis and serratus anterior contract to internally rotate the right shoulder and protract the scapula. Latissimus dorsi and pectoralis major are also bilaterally very active during this phase of the swing. As the forward swing progresses towards impact, the wrists remain cocked until approximately 0.02 seconds before impact. This delayed release of the wrists allows the angular acceleration of the club to be summed to the existing angular acceleration of the more proximal body segments, thus producing maximum clubhead speed immediately prior to impact with the golf ball.[29]

The position of the body at impact resulting from the rotary motions and subsequent centrifugal forces generated during forward swing results in a slight extension movement of the trunk from the flexed position adopted during ball address. The trunk is also side bent to the right and the pelvis slightly rotated towards the target. The most commonly injured body structures during the impact phase are the back, wrist, elbow and hand, and the prevalence of injuries in the upper limb reflect the stresses applied by the resisting forces of the ball and the ground at impact, transmitted through the club.[26]

The follow-through (Figure 3d) phase consists of the deceleration of both the club and body in its turning motion towards the left side. This braking is accomplished in part by activation of the muscles of the spine and the shoulders as

well as the powerful lateral and external rotation ground reaction forces produced under the left foot.[30] The ideal follow-through ends with the left hip in full internal rotation and the trunk in an upright position and a slight side-bend on the right side. Some release of the trunk's angular momentum in the follow-through phase is achieved by allowing the heel of right foot to rise and the right leg to rotate inwards (ie, a twisting motion on the ball of the foot). According to McCarroll et al[15] 25% of all golf injuries occur during follow-through, with the back, shoulder, ribs, knees and wrists most frequently injured. Also notable are the stresses on the lead side hip (as it moves into extreme internal rotation) , and also the structures of the feet which have remained as firm anchors to the ground to allow the rest of the body parts to twist through their elaborate motions to generate torques.[28]

MUSCULOSKELETAL INJURIES AND PRE-EXISTING ORTHOPAEDIC CONDITIONS

Risk of Injury in Older Golfers

Aging decreases the body's reserve capacity and reduces the ability of the individual to adapt effectively to stress. Not only does this lead to an increased risk of injury but the severity of injury and consequent rehabilitation time required may also be heightened in the older athlete.[31] Epidemiological surveys indicate some trends that older golfers may be more prone to injury, but as noted above the etiological picture involves a complex mix of player and environmental conditions.[32-34] Notable is that in our recent survey of injuries and orthopaedic problems amongst senior recreational players, half of the 100 respondents reported having musculoskeletal conditions in the last 3 years that affected their golf game—46% of these conditions affecting the upper extremity and 34% involving the spine.[35] Furthermore, approximately one-third had on occasion experienced notable discomfort in the lumbar region after playing. As a result of the prevalence of lumbar related spine injuries and the lack of research examining mechanisms of injury to other regions of the spine, this review paper will concentrate on the lumbar region. However, it should be noted that both the thoracic and cervical regions of the spine have also been associated with injury for those participating in golf (eg, injuries to the neck reported by amateur golfers make up approximately 4% of all reported injuries[15,16]).

Shoulder Soft Tissue Injuries

McNicholas et al[18] reported that amongst male golfers in Scotland of all ages, the 50- to 59-year-old category was the most prevalent age group with regard to those seeking medical intervention for upper limb injuries. For women, the 40-49 age group was the most prevalent, with those aged between 50-59 coming second. McCarroll and Mallon[32] also reported that most shoulder injuries from golf occurred in older players. The injury typically occurred on the lead shoulder (left shoulder for a right-handed golfer, via the high eccentric load that is applied to the shoulder muscles during the transition between the back and down-swing). Another mechanism of injury was 'hitting heavy' (ie, taking a deep divot) or hitting a buried object (eg, tree root). Although not specific to golf, the vulnerability of the shoulder to injury in aging athletic populations has been reported by other authors, and may lead to long-term rotator cuff problems, as well as glenohumeral arthrosis.[36,37]

Technique modifications for golfers suffering chronic shoulder pain include: shortening the back-swing, keeping the elbows in-close to the trunk during the back-swing, and finishing with the hands low and the club shaft horizontal on the follow-through. Keeping the elbows in and hands low helps promote a slightly flatter swing plane and reduces the chance of impinging the rotator cuff. Rotator cuff and scapular stabilizer strengthening programs should be a regular component of any senior golfer's rehabilitation or training program.

Osteoarthritis

Osteoarthritis is a common problem facing older golfers, given the high prevalence of significant osteoarthritic changes in even middle-aged persons.[33,37] Areas of special concern in golfers include the first metacarpal phalangeal joint of the top hand (left hand for a right-handed golfer), the facets of the lumbar and cervical spines, and the hip joints. Those with significant foot pain or deformities will also experience limitations to completing the arching motion onto the ball of the foot during the follow-through phase of the swing. However, it is encouraging to note that having to resort to arthoplastic procedures for treating these joints does not preclude future participation in golf, and can indeed lead to substantial improvement in performance when range of motion is restored.[38] The orthopaedic history of a well-known professional golfer such as Jack Nicklaus, who returned to successful competitive golf after a hip joint replacement, serves as inspiration for those players with advanced degeneration.

The degenerative changes associated with OA lead to pain and overall decreased biomechanical function during the golf swing. Protection, technique, equipment changes, and regular stretching are important for limiting progression of the disease as well as decreasing the compensations which could cause additional injuries. For example, an important technique consideration for golfers with thumb OA is to rotate (sometimes referred to as 'strengthen') the grip of the lower hand to ensure it does not excessively compress the underlying thumb of the top hand. Lighter clubs, graphite shafts, and thicker/softer grips can also benefit a golfer with thumb OA.

Low Back Pain

The most common injury site reported in a survey of senior Japanese professional golfers was to the lumbar region.[39] Low back pain was also the most common golf injury reported by a population of Canadian senior recreational players.[35] An extreme example of spinal problems is the evidence of vertebral compression fractures from playing golf that have been found in postmenopausal osteoporotic women aged between 58 and 66 years.[40] Poor posture, over-rotation, and decreased abdominal activity during the golf swing have been identified as risk factors for the development of low back pain from golf.[24] In another study, players

who had a history of low back pain demonstrated a significant restriction of lead side hip internal hip rotation as well as lumbar extension compared to the asymptomatic golfers. The authors speculated that as the body pivots onto the lead leg during the swing, the decreased amount of hip rotation might cause an increased force to be transmitted to the lumbar spine resulting in low back pain.[41] Education about backcare is highly recommended for all golfers, with increasing emphasis on set-up posture, swing adjustments, or club modifications for those at greater risk. Appropriate postural recommendations for the set-up of the golf swing are shown in Figure 2. It is also important to be aware of proper lifting and carrying techniques for the golf bag, which can become quite a heavy, awkward load when filled with clubs and accessories.[34]

AGE-RELATED MUSCULOSKELETAL CHANGES AND THE COUNTER-EFFECTS OF PHYSICAL CONDITIONING

Strength

Most tissues and systems of the body experience an age-related loss of physiological capacity, and the changes affecting neuromuscular function are summarized in Table 1. Strength is one of the more obvious physical parameters influenced by age. It increases up to one's early 20s, has a general plateau phase until the fifth decade, and then decreases by about 10% per decade thereafter.[31,42] The decline in strength is primarily the result of decreased muscle mass. Total muscle cross sectional area declines by 10% between the ages of 24 and 50, then drops another 30% between ages 50 and 80 years.[43] Equal amounts of both type 1 (slow twitch) and type 2 (fast twitch) muscle fibers are lost with old age. However, in addition to overall fiber loss, type 2 fibers also undergo a much greater decrease in size compared to their type 1 counterparts.[44] The resultant pattern of strength loss is such that a middle-aged golfer would not be expected to have any significant decrease in maximum isometric or concentric strength compared to a young player, but an 80-year-old would have only about half the strength of the young adult. It is quite interesting to note that golf performance tends to follow the same pattern, as evidenced by comparisons of average golf 'handicaps' versus age—handicap being a sport-specific, standardized way of monitoring a golfer's scores. Recreational golfers tend to reach their prime in the third decade and then begin to experience some loss of performance after their forties. However, they can still continue to play well and even compete with other age groups via the handicap system for the rest of their lives.[31] For example, Lockwood[45] observed in his survey that the average handicap of recreational golfers in England was about 19 for adolescents, dropped to 13 for young adults aged 20-39, and then increased by about one stroke per decade thereafter to again reach 19 for players in the 70-79 year old age bracket (note: a higher handicap indicates less proficiency). Thus the older golfer's 'net' score can be adjusted statistically to compare expected performance on a more equal basis.

With regard to physical conditioning, large gains in lower limb muscle strength and significant increases in maximal clubhead speed have been observed in recreational golfers over 50 yrs of age following 8 weeks of strength and flexibility exercises.[46] Recent research has shown that older individuals may be able to gain the greatest strength benefits through eccentric training, and this mode of exercise also causes less

Table 1. Age-related Changes in Physical Function Affecting the Senior Golfer's Performance and Participation

SYSTEM	CHANGES WITH AGING	EFFECTS OF ACTIVITY
MUSCLE	- max strength 25-50 years, then decline of 1.5% / year after sixty - ↓ number of motor units - ↓ number of muscle fibres - ↓ the size of Type II fibres - some lean muscle replaced with fat & connective tissue	- plays a key role in maintenance of muscle mass - over-load training ↑ muscular strength - changes in cross sectional area ↑ with training - early strength gains primarily by neurological adaptation then limited hypertrophy possible
NERVOUS SYSTEM	- muscle atrophy contributed to by neurological changes - 37% ↓ # of spinal cord axons - 10% ↓ nerve conduction velocity in older adults - ↓ sensory & proprioception - ↓ speed to respond to stimuli	- activity allows rapid response time to remain relatively unchanged in older adults - balance can be improved with specific strengthening exercises and postural manoeuvres
SKELETAL	- after 3rd & 4th decade ↓ mineralisation of 0.3-0.5% / year - over lifetime: 35% of cortical and 50% of trabecular bone is lost - men only lose 2/3 the bone mass which females lose - factors: diet, exercise, hormonal changes	- gravitational loading and muscular traction found to effect: thickness, strength, calcium concentration - physical activity found to partially counteract the demineralization
CONNECTIVE TISSUE	- altered proportions & properties of connective components - ↑ stability of cross-links in collagen, ↑ strength, become nonadaptive - ↓ water and ↓ plasticity - becomes non-pliable, brittle, weak - predisposition to tendon & ligament injury - ↓ ability to return to original length when injured—affects stress/strain properties	- physical activity known to increase turnover rate of collagen - ↑ pliability and ↓ formation nonadaptive connective tissue
CARTILAGE	- atrophies with age - proteoglycan subunits smaller - ↓ cartilage water content - ↓ lubrication of joint - vulnerability to injury	- weight bearing activity thickens cartilage and facilitates diffusion of fluid into joint space

↑ = increase in variable; ↓= decrease. Information in Table is based on research summarized by the authors in Lindsay et al[33]; Vandervoort[42]; Bellew et al.[56]

cardiovascular stress compared to concentric exercises.[47] Since there is evidence that motor learning does indeed occur during resistance training with skilled high velocity movements, it would seem logical to design exercises which simulate the golf swing with its various concentric and eccentric activation muscle patterns, thereby stimulating adaptation within the appropriate musculature and neural pathways.

Flexibility

A common complaint of older golfers is generalized stiffness in several of the key joints involved in the golf swing. From a physiological standpoint, much of this stiffness relates to connective tissue changes within the body, due to the significant water loss with age that contributes to a reduction in this tissue's plasticity.[33,48] Clinically, age-related changes in connective tissue are manifested by losses in flexibility. One study comparing spinal motion during the golf swings of players aged between 18-21 years and senior players (age 50+), showed that maximum trunk side bending range of motion was 25% less in the older group.[49] Mitchell et al[50] compared maximum golf swing shoulder ranges of motion between golfers aged between 18-24 years and those between 50-86 years, and found that the older players used about 15% less shoulder elevation and 30% less shoulder external rotation when swinging the club.

It is encouraging, however, that senior golfers were shown to improve flexibility and increase clubhead speed following an 8-week program of flexibility exercise.[46] Thompson and Osness,[51] who examined muscle strength and flexibility in older male recreational golfers (mean age = 65.1 years), determined that both strength training and flexibility exercises that emphasize trunk rotation were related to improvements in clubhead speed and flexibility for golf. Hetu et al also showed that fitness and performance measures improved amongst mature golfers (average age 52.4 yrs) after an 8-week conditioning program. Of note were a 47% increase in trunk rotation flexibility, and a 6% increase in clubhead speed at the end of the training program.[52]

In our recent survey of warm up behaviours amongst senior recreational golfers, three quarters of the total sample spent less than 5 minutes warming-up prior to playing whilst one third of the respondents reported spending less than one minute performing stretching exercises prior to teeing-off.[35] Similar observations were reported by Fradkin et al[53] in their study of Australian amateur golfers. They showed only 10% did any type of substantial warm up routine; the large majority of players simply took a few practice swings before their first shot and then started the round. A follow-up study by these investigators indicated that a brief warm up strategy involving calisthenics, static stretches, and practice swings led to significant increases in the maximal club head speed the subjects could achieve.[54] Despite the fact that a majority of the studies examining flexibility have used primarily strengthening interventions and as a result have the greatest effect on clubhead speed, educational programs directed at senior golfers about the potential injury prevention benefits of proper warm up can potentially contribute to improved performance on range of motion and sport performance.

Cardiovascular and Muscular Endurance

In terms of age-related changes to cardiovascular performance, cardiac output decreases by about 30% between the ages of 30 to 70 years.[55,56] In golfers, this decrease in endurance may cause premature mental and physical fatigue leading to performance inconsistencies, particularly towards the end of a round.[57] As noted above, there is a significant demand placed on the cardiorespiratory system by the prolonged duration of a typical round of golf. The effect of limited cardiovascular capacity on performance may further be compounded by localized muscle fatigue that can occur during walking up steep hills. Given that the overall ability of older adults to carry an absolute load over time is reduced compared to younger adults,[58] a common mechanism of many sports injuries—fatigue and associated neuromuscular incoordination—is a likely contributing factor to earlier onset of fatigue. However, fatigue resistance can be also built up with appropriate exercise strategies.

Research investigating the differences in endurance training methods between age groups is limited but it is expected that, as long as the intensity and duration of the endurance training are adequate, elderly persons can improve cardiovascular and muscular endurance in a similar manner to younger individuals. Senior golfers should be encouraged to participate in preseason training programs that include cardiovascular endurance. Overall reductions in the body's ability to maintain cardiovascular and muscular homeostasis also indicate that older players need to pay close attention to maintaining adequate hydration during their round, particularly in hotter climates.

MULTIDISCIPLINARY APPROACHES TO REHABILITATION

Golf clubs are a golfer's most important tools. They represent the critical link between the human body and the golf ball. When golfers use clubs that are not well suited to their particular physical dimensions or swing characteristics the body is forced to compensate. These compensations make it more difficult to swing efficiently and consistently, thereby increasing the risk of injury. Equipment recommendations for senior players often include the use of lighter clubs with more flexible graphite shafts.[19] Assistance from a properly credentialed golf professional, both in terms of appropriate matching and adjustment of the golfer's equipment to his or her body (called 'club fitting'), as well as instructing the individual on proper swing mechanics, also play a key role in increasing swing efficiency while further reducing the risk of injury.

Rehabilitation from golf-related injuries should incorporate multidisciplinary approaches and be centered on 4 key concepts: clinical rehabilitation of the injury itself, education on swing mechanics, specific warm up practices, and conditioning (Figure 1). An example is the recent report of Parziale[59] who developed a multidisciplinary golf rehabilitation program incorporating the expertise of a physical therapist, physiatrist, and golf professional for the purpose of providing the client with an effective return to sport strategy. Participants for this study consisted of 145 injured golfers of whom 80% were amateur males (mean age = 55.3 yrs), 5%

were professional males (mean age = 37.1 yrs), and 15% were amateur females (mean age = 55.9 yrs). The most commonly treated injury was low back pain for men followed relatively equally by injuries to the shoulder, elbow, neck, and knee. For women, the most common injuries were to the low back and shoulder. The outcome of their multidisciplinary rehabilitation program was observed to be highly successful, with a 98% rate of return to playing the sport of golf.

CONCLUSIONS

In summary, participation in the sport of golf has risen considerably particularly amongst senior players, whose age is usually categorized as 50 years or more. However, golf presents both potential health benefits and risks for this older group. The health risks are compounded because senior players' musculoskeletal systems may not be as efficient at withstanding the strains and stress of this type of repetitive exercise. However, there is encouraging evidence from the literature that many of the age-related changes affecting older players, as well as the injuries they incur, are preventable or treatable through exercise.

Once the individual is prepared to return to playing, professional teaching should also be considered to prevent reoccurrence of injuries resulting from poor swing mechanics. Education should also be given concerning adequate warm up practices and back care. Finally, the development of a conditioning program for golf, emphasizing the key body structures involved, should be designed and followed to prevent further injury and prepare for each new season. One recommended focus for future research is the development of effective educational strategies to disseminate information about injury prevention for senior players participating in lifelong sports such as golf, as well as highlighting the effectiveness of sport-specific training and equipment modification for improving their performance.

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