CAN A CONDITIONING PROGRAMME IMPROVE HANDICAP INDEX IN ADOLESCENT AMATEUR GOLFERS?

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Abstract

The implementation of off-links conditioning programmes for amateur golfers to enhance performance is often neglected. This study was conducted to determine the effects of a conditioning programme on body composition, flexibility, muscular strength, muscular endurance, cardiorespiratory fitness and handicap index as assessed by skinfolds measurements, sit-and-reach, push-ups and sit-ups, hand grip dynamometry, hamstring, quadricep and shoulder isokinetic dynamometry and physical work capacity test, respectively. Thirty-eight amateur male golfers aged between 16 and 19 years with an average handicap index of 5.1 ± 4.5 volunteered to participate in the study and were placed in a conditioning programme (CondG) (n = 31) or control group (CG) (n = 7) which only played their normal rounds of golf without a conditioning programme. The 14-week training programme consisted of a 60-minute supervised basic conditioning phase (Weeks 1-4: 9 resistance training exercises, 2-3 sets, 12-20 repetitions), a basic strength phase (Weeks 5-10: 9 resistance training exercises, 3-4 sets, 6-12 repetitions) and a maintenance phase (Weeks 11-14: 9 resistance training exercises, 2-3 sets, 8-15 repetitions) three times weekly. Each session began with a 10-15 minute warm-up and 12 static stretches held for 30-60 seconds each and concluded with a 5-10 minute cool-down. Significant ($p \leq 0.05$) improvements were found in body fat percentage, number of push-ups, right grip strength, left and right knee flexion, left and right knee flexion as a percentage of body mass, left and right shoulder internal rotation, left and right shoulder internal rotation as a percentage of body mass, maximum cardiorespiratory fitness and handicap index of the CondG group. No significant ($p > 0.05$) changes were found in sit-and-reach, number of sit-ups, left grip strength, left and right knee extension, left and right knee extension as a percentage of body mass and left and right shoulder external rotation and left and right shoulder external rotation as a percentage of body mass in the CondG. No significant changes were found in any of the measured variables in the CG from pre- to post-test. Thus, this study provides support that an off-links, conditioning programme for golf is both compatible and necessary to enhance performance in adolescent amateur male golfers.

Key words: Exercise, golf, handicap, physical conditioning, strength.

Introduction

Golf is a rapidly growing sport with increased levels of competition and prize money. Although it does not require extreme strength or flexibility, it does require coordinated movement of conditioned muscles throughout a wide range of motion. Although the improvements ascertained through practice are based in physiology, golf technique is often the primary focus of a golfer at the expense of an off-links physical conditioning programme (Hetu & Faigenbaum, 1996). This is problematic in that golf is similar to most sports. There are several ways to improve sports performance via both an improved technique and through improved physiological capabilities. Although the most conditioned golfers are not always the most proficient with regards to handicap (which is a numerical measure of a golfer's playing ability based on the tees played for a given course and is calculated as a net score from the number of strokes actually played) the minimum criteria for physiological conditioning capacities in golfers remain unclear. Improvements in physiological capabilities could improve golf performance directly as well as improve technique via improvements in biomechanics as a result of the enhanced muscle strength and flexibility, and ability to train longer and harder with the occurrence of fewer injuries (Doan, Newton, Kwon & Kraemer, 2006).

According to Russel and Owies (2000), the four main physiological capabilities for golf performance are body composition, flexibility, muscular performance and cardiorespiratory fitness. Body composition may affect golf performance in that increases in muscle mass can improve mechanical efficiency, force-velocity relationships, blood lactate clearance and buffering mechanisms and motor unit recruitment patterns while an increased body fat may lead to early fatigue in a round thereby influencing the number of shots per round (Russel & Owies, 2000; Shaw & Shaw, 2008). However, the summation of all the various forces to exert strength and power in golf swing actions is of little use without flexibility (Schilling & Stone, 2000). In this regard, flexibility is essential for a player to increase shoulder turn, increase swing speed, improve swing consistency and reduce the risk of injury (Alter, 1990). In turn, muscular strength can improve the control of the club head during the golf swing and ball impact (Wilmore & Costill, 1988; Wilmore & Costill, 1994; Russel & Owies, 2000) while muscular endurance can contribute to the prevention of fatigue during a round of golf. Russel and Owies (2000) have demonstrated that golfers require muscular endurance to enable them to successfully use their muscle strength and adequate muscle endurance will lead to a reduction in number of shots and energy consumption. Wilmore and Costill (1988) and Russel and Owies (2000) have suggested that one of the most important physiological capabilities in determining the outcome of a golf competition is the cardiorespiratory fitness level of the golfer. Although the golfer does not perform or need to perform at a high level of cardiorespiratory endurance (an average heart rate of ~ 108 beats per minute) (Yutaka, Sadatsugu & Tamotsu, 1989), it is still an essential component of a golf tournament. This is so since a lack of cardiorespiratory fitness will lead to increased levels of fatigue resulting in a loss of concentration, muscular strength and endurance and a negative shot-making ability (Wilmore & Costill, 1988; Wilmore & Costill, 1994; Russel & Owies, 2000). Thus, the purpose of this study was to determine the effects of a 14-week conditioning programme on body composition, flexibility, muscular strength, muscular endurance, cardiorespiratory fitness and handicap.

Materials and methods

Subjects

Thirty-eight amateur male golfers aged between 16 and 19 years (with an average handicap index of 5.1 ± 4.5) from the Golf Academy of the Tshwane University of Technology, South Africa volunteered to participate in the study and were placed in a 14-week conditioning programme (CondG) (n = 31) or control group (CG) (n = 7) which only played their normal rounds of golf without a conditioning programme. A larger number of subjects were placed in the CondG to allow for any unforeseen subject attrition (Thompson, Cobb & Blackwell, 2007). However, none occurred. The study made use of a quantitative, pre- and post-test research design. Descriptive characteristics of both groups are presented in Table 1. The study was approved by the Institutional Review Board of the Tshwane University of Technology. All subjects signed an informed consent form prior to participating in this study. Both groups participated in the same golf practice, playing and coaching routines throughout the study.

Table 1: Descriptive characteristics of subjects

Variables	Conditioning group (CondG) (n = 31)	Control group (CG) (n = 7)
Age (years)	19.6 ± 1.1	19.2 ± 1.6
Stature (centimetres)	180.3 ± 9.2	181.0 ± 7.4
Body mass (kilogrammes)	75.8 ± 4.3	77.1 ± 3.9

Measurement of variables

Anthropometric measurements were carried out according to the methods proposed by the International Society for the Advancement of Kinanthropometry (ISAK) (Marfell-Jones, Olds, Stewart & Carter, 2006). Body mass was measured on a calibrated medical scale (Mettler DT Digitol, Mettler-Toledo AG, Ch-8606 GreiFensee, Switzerland) to the nearest 0.1 kilogramme wearing light clothing. Stature was measured to the nearest 0.1 centimetres using a wall-mounted stadiometer with the subjects standing barefoot. Skinfolds were measured using a manual skinfold caliper (Harpenden John Bull, British Indicators Ltd., England). Percentage body fat was calculated from seven-skinfold measurements (triceps, subscapular, supra-iliac, abdominal, front thigh, mid-axilla and pectoral skinfolds) using the equation of Jackson and Pollock (1978): percentage fat = 100 (4.95/body density (Db) – 4.5), where Db (g/cc) = 1.120 – 0.00043499 (sum of the seven skinfolds in millimeters (Σ7SKFs)) + 0.00000056 (Σ7SKFs) – 0.00028826 (age).

In order to assess flexibility, subjects underwent a sit-and-reach test where they were required to sit on the floor without shoes. Subjects placed the bottom of their feet 30 centimetres apart against the side of the sit-and-reach platform with their knees fully extended and legs parallel. Subjects placed their hands over one another and reached as far as possible. Measurements over the zero mark of the ruler were recorded. The best of the three attempts was recorded (Heyward, 1997).

Muscular endurance was assessed using push-up and sit-up tests each performed for 60 seconds. When performing the push-up test, subjects were asked to place their hands approximately 10-20 centimetres wider than shoulder width and maintain a horizontal spinal position. Subjects were instructed to maintain a straight-leg and trunk position, with their knees off of the mat. All subjects were required to bend their elbows to lower their body until their chest was approximately 12 centimetres from the mat while maintaining the prescribed position with their backs. The subjects extended the elbows, returning to the starting position for a full count. The maximum number of correct repetitions accomplished in 60 seconds was recorded.

For sit-ups, the subjects were asked to lie on a mat, face up, in a supine position with the knees bent at right angles. The feet were placed flat on the mat and the subjects' arms were crossed at the chest, with the hands on the opposite shoulders. To complete a full repetition, each subject flexed his trunk, allowing the low back to come off the mat, until the subject's elbows made contact with his thighs. This movement was reversed to the starting position and the sequence was repeated for 60 seconds. The number of current repetitions was recorded for both tests (Esco, Olson & Williford, 2008).

Muscular strength testing included the assessment of left and right hand grip strength using a Takei Dynamometer (Takei Scientific Instruments Co., United Kingdom) (Baechle & Earle, 2000). Subjects were familiarised with the dynamometer and adjusted so that the middle phalanx of the third digit rested comfortably and squarely on the distal aspect of the gripping apparatus while the heel of the palm rested squarely on the proximal aspect of the dynamometer. The shoulder was adducted, the elbow flexed at 90 degrees and wrist flexed between 0 and 30 degrees. The subject was asked to give a maximal effort for three seconds on each trial, which was measured by a stopwatch. Both hands were tested three times, allowing at least a 60-second rest between trials. Three scores were obtained for each hand and a mean of these three was used for computing grip strength for each hand (Hughes, Lyons & Mayo, 2004).

Further, isokinetic strength of the hamstring, quadricep and shoulder muscle groups was determined using the Cybex 6000 Isokinetic Testing and Rehabilitation System (Ronkonkoma, NY) in terms of peak torques as a percentage of body mass (MacDougall, Wenger & Green, 1991; Kannus, 1994; Russel & Owies, 2000). At each testing session, subjects performed an initial warm-up consisting of light pedaling at a heart rate intensity of less than 100 beats per minute on a stationary cycle ergometer and five minutes of stretching using five exercises including, arm across chest, doorway stretch, arm held overhead with flexed elbow, angry cat, good morning stretch (Alter, 1990). This was followed by positioning and stabilising the subjects on the Cybex Norm System's testing bench and determining each subject's anatomical zero, range of motion and gravity effect torque according to the Cybex Norm Manual's (1997) parameters. The isokinetic strength of the hamstring and quadricep groups were evaluated using knee extension-flexion protocol at 60 degrees per second ($°\bullet sec^{-1}$) while shoulder internal and external rotation isokinetic strength was evaluated in the adducted position at $60°\bullet sec^{-1}$.

In order to test the cardiorespiratory fitness of the subjects in litres per minute ($\ell\bullet min^{-1}$), each subject completed a physical work capacity test on a cycle ergometer as descried by the American College of Sports Medicine (ACSM) (2000) (Monark 834E Ergomedic Cycle Ergometer, Monark, Vargberg, Sweden) to assess absolute maximum oxygen consumption (VO_{2max}). The exercise test protocol utilised was the graded YMCA Cycle Ergometry Protocol (ACSM, 2000). When seated on the ergometer, each subject had an approximate 2-3 degrees of knee flexion. In this test, each subject began pedaling at 50 revolutions per minute (RPM)) at a work rate of 150 $kpm\bullet min^{-1}$ (0.5 kilogrammes (kg) or 50 W. In this test, stages of three minutes were used with heart rate being measured during the last 15 seconds of the first, second and third minutes. In the case where heart rate differed by more than five beats per minute at the end of the second and third minute, additional minutes (in one-minute increments) were added to that stage until a steady state was achieved. The work rate for the subsequent stages was then determined according to the measured heart rate during the warm-up and the work rates as described by the ACSM (2000). All subjects were required to continue cycling until one of the indications for test termination was reached (i.e. decreasing or unchanging heart rate in response to increases in workload, a rating of perceived exertion of 20 (Heyward,

1997)) or until the subjects requested to terminate the test as a result of subjective severe leg muscle fatigue or any other cause. General (i.e. onset of angina or angina-like symptoms) and specific (i.e. acute myocardial infarction) indications of test termination were also adhered to. Each subject then performed an active cool-down at 50W for at least four minutes (ACSM, 2000).
Each subject's handicap index was determined from their national golf association handicap prior to the study and their handicap following, the minimum prescribed, five rounds of golf following the study. The handicap index was calculated according to the Royal and Ancient Golf Club authorised handicapping system (South African Golf Association (SAGA) Handicap Committee, 2010).

Training programme

The training programme was divided into a basic conditioning phase (Weeks 1-4), a basic strength phase (Weeks 5-10) and a maintenance phase (Weeks 11-14). The exercises were categorised into specific training phases in order to ensure that the muscles and joints were fully trained over the 14-week period. The phases were intended to progress sequentially and build on the previous phases to ensure optimal performance and injury prevention. All subjects were required to train three times weekly under supervision during the 14-week programme. This volume of training is consistent with the findings of Thompson *et al*. (2007) and represents an adequate training period to allow for adaptations in both fitness and performance. Each session began a 10-15 minute endurance-based warm-up consisting of stepping, cycling, rowing and/or walking on a treadmill and stretching. Twelve static stretches (Hetu & Faigenbaum, 1996) were performed for 30-60 seconds each and were designed to enhance shoulder, hip and trunk flexibility (Westcott, Dolan & Cavicchi, 1996). The stretching exercises required approximately 10 minutes. In phase 1, the subjects completed nine resistance training exercises per session for 2-3 sets utilising a mass load that permitted 12-20 repetitions and rested for 1-2 minutes between sets. Phase 2 included nine resistance training exercises per session and required the subjects to complete 3-4 sets of 6-12 repetitions. The final phase of the programme required subjects to exercise using nine resistance training exercises per session completing 2-3 sets of 8-15 repetitions with a 30-60 second rest period between sets. Training sessions were concluded with a cool-down of 5-10 minutes of stepping, cycling, rowing and/or walking on a treadmill. This resulted in a total session training time of approximately 60 minutes. The CG subjects were instructed to maintain their normal daily activities including playing their normal rounds of golf.

Statistical analysis

Dependent t-tests were used to determine whether a significant difference existed between pre- and post-tests within the groups while hetero/homogeneity of all tested variables were assessed between the groups at pre-and post-test. Alpha levels were set at $p \leq 0.05$ for establishing statistical significance. Statistical procedures were performed by using the Statistical Package for Social Sciences (SPSS) Version 14 (Chicago, IL).

Subjects in the CondG completed all of the 48 sessions, resulting in a compliance of 100%. Mean pre- and post-training values for body composition, flexibility, muscular strength, muscular endurance, maximum cardiorespiratory fitness and handicap index are shown in Table 2. No significant ($p > 0.05$) differences were found between the two groups at pre-test for any of the measured variables. The conditioning programme resulted in significant ($p \leq 0.05$) improvements in body fat percentage, number of push-ups, right grip strength, left and right knee flexion, left and right knee flexion as a percentage of body mass, left and right shoulder internal rotation, left and right shoulder internal rotation as a percentage of body mass, cardiorespiratory fitness and handicap index.

Table 2: Summary of the effects of the conditioning programme on body composition, flexibility, muscular strength, muscular endurance, maximum cardiorespiratory fitness and handicap index

	Conditioning group (CondG) (n = 31)		
Variable	Pre-test	Post-test	Sig.
Body fat percentage (%)	16.1	13.5*	0.001
Sit-and-reach (cm)	34.9	36.4	0.079
Push-ups (reps)	33.8	40.5*	0.003
Sit-ups (reps)	75.1	77.5	0.074
Grip strength - right (kg)	42.8	43.8*	0.045
Grip strength – left (kg)	67.6	67.4	0.088
VO_{2max} ($\ell \bullet min^{-1}$)	2.23	3.01*	0.000
Handicap index	6.96	4.70*	0.000
Isokinetic Performance Parameters			
Peak torque knee extension - right ($ft \bullet lbs^{-1}$)	143.4	129.9	0.067
Peak torque knee extension - left ($ft \bullet lbs^{-1}$)	140.7	126.7	0.059
% body mass peak torque knee extension - right (%)	79.8	68.5	0.066
% body mass peak torque knee extension - left (%)	76.7	66.7	0.071
Peak torque knee flexion - right ($ft \bullet lbs^{-1}$)	85.9	109.7*	0.000
Peak torque knee flexion - left ($ft \bullet lbs^{-1}$)	85.2	107.1*	0.001

% body mass peak torque knee flexion - right (%)	47.3	59.1*	0.000
% body mass peak torque knee flexion - left (%)	44.7	57.9*	0.003
Peak torque shoulder external rotation - right (ft•lbs^{-1})	27.9	35.3	0.074
Peak torque shoulder external rotation - left (ft•lbs^{-1})	31.9	35.2	0.063
% body mass peak torque external rotation - right (%)	16.5	20.6	0.088
% body mass peak torque external rotation - left (%)	18.8	20.6	0.067
Peak torque shoulder internal rotation - right (ft•lbs^{-1})	41.0	38.7*	0.045
Peak torque shoulder internal rotation - left (ft•lbs^{-1})	39.4	36.0*	0.037
% body mass peak torque internal rotation - right (%)	24.7	22.6*	0.029
% body mass peak torque internal rotation - left (%)	23.5	20.9*	0.038

* $p \leq 0.05$ compared to baseline; cm = centimeters; reps = repetitions; kg = kilogrammes; VO_{2max} = maximum oxygen consumption; ℓ•min^{-1} = liters per minute; ft•lbs^{-1} = foot pounds.

No significant ($p > 0.05$) changes were found in any of the measured variables in the CG from pre- to post-tests and the findings of this study demonstrated that the changes at post-test in the CondG were significant when compared to that of the CG.

Discussion

The findings of the present study demonstrate that the 14-week periodised conditioning programme resulted in significant ($p \leq 0.05$) improvements in body fat percentage, number of push-ups, right grip strength, left and right knee flexion, left and right knee flexion as a percentage of body mass, left and right shoulder internal rotation, left and right shoulder internal rotation as a percentage of body mass, cardiorespiratory fitness and handicap index in amateur male golfers aged between 16 and 19 years.

These findings elucidate the importance of an off-links conditioning programme since a golf player's kinanthropometric profile may be related to performance (Keogh *et al.*, 2009). Decreases in percentage body fat could contribute to an improved muscle endurance resulting in a more efficient swing by reducing fatigue (Russel & Owies, 2000).

Similarly, increased grip strength plays an important role in a more efficient swing by improving turnover and control of the club head throughout the golf swing (Nicklaus & Bowden, 1978). Greater strength in the knee extensors and flexors can enable golfers to hold their knees in a more stable, slightly bent position throughout the golf swing, improve overall movement and mass transfer, improve both lateral and medial rotation of the knee and increase stabilisation of the knee throughout the golf swing (Luttgens & Hamilton, 1997). Improvements in the strength of the internal and external rotator muscles can result in greater motor control and neuromuscular function (Lephart *et al.*, 2007).

Additionally, improvements in cardiorespiratory fitness can increase the ability of golfers to produce aerobic power, which in turn could lead to more energy produced aerobically effectively reducing fatigue and resulting in a more efficient swing (Russel & Owies, 2000). Even though cardiorepiratory endurance is one of the essential physiological capabilities required in golf performance, Yutaka *et al.* (1989) points out that golfers do not perform or need to perform at a high level of cardiorespiratory endurance (an average heart rate of ~ 108 beats per minute) (Yutaka *et al*., 1989), but a high level of cardiorespiratory endurance is essential to decrease fatigue which could result in a loss of concentration, muscular strength and endurance and a negative shot-making ability (Wilmore & Costill, 1988; Wilmore & Costill, 1994; Russel & Owies, 2000).

Previous conditioning programmes for golf have demonstrated that these physical fitness parameters are modifiable and have an effect on driving distance, driving consistency and putting distance control (Doan *et al*., 2006; Lephart *et al*., 2007). The results of the present study support previous findings by providing evidence for developing fitness and performance parameters that are required in golf. As such, a conditioning programme is essential to optimise performance, especially in amateur golfers.

Conclusion

Recreational and competitive golfers have limited time for practice and much of their time is spent on the golf course often neglecting the off-links conditioning for golf. Although integrated periodised training programmes are followed in various sports, only a few of such conditioning programmes are emphasised for the adolescent amateur golfer. The results of this study indicate that a conditioning programme can improve body composition, muscular strength, muscular endurance, cardiorespiratory fitness and handicap in this sample of amateur male golfers aged between 16 and 19 years.

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