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How to optimise the fidelity of exercises in an unsupervised golf injury prevention programme? A pilot study

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ABSTRACT

Background Golf is an individual sport that is usually done without the supervision of a trainer or coach. Therefore, an injury prevention programme in golf will primarily be performed without supervision and feedback. However, the effectiveness of any preventive exercise programme is determined by exercise fidelity.

Objective To investigate the different instruction options of an injury prevention programme on exercise fidelity in individual golfers.

Methods We randomly assigned golfers to one of three groups receiving different exercise instructions. One group received only instructional cards (A), one received only instructional videos (B) and a third group (C) received both instructional cards and videos. The golfers were allowed to familiarise themselves with the exercises based on the provided instruction option, after which we recorded their exercise execution on video. Two authors independently scored each exercise's fidelity from these recordings.

Results In total, 18 golfers (12 women and 6 men, average age of 61.94 years) were equally divided across the 3 study groups completed 108 exercises. In group A 73.7% of exercises were executed as intended, in group B 88.6% and in group C 86.3%. Significantly more exercises were conducted correctly in groups B and C compared with group A ($p<0.05$).

Conclusion Golfers who received instructions that included a video explanation had a higher exercise fidelity when compared to only written instructions.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ For optimal effectiveness, injury prevention exercises should be performed as intended. However, exercise fidelity is not often studied in evaluating intervention programmes.

⇒ If exercises are not performed as intended, an injury prevention programme may not work or will be counterproductive.

⇒ Exercise instructions are, in general, given by coaches or trainers who are qualified and trained to instruct and supervise the athletes during their warming-up and training. In individual sports, such as golf, qualified supervision is not present.

WHAT THIS STUDY ADDS

⇒ Our provided instruction allowed for a high rate of correctly performed preventive warm-up exercises in golfers.

⇒ Exercise fidelity was higher when instruction was provided in a video.

⇒ A video instruction should be added when disseminating the golf injury prevention programme.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ When developing a preventive exercise programme that caters for an individual sport, the most optimal instruction method should be investigated as part of the intervention development process to increase exercise fidelity.

⇒ Assessing exercise fidelity during the development stage will change the implementation and dissemination of a programme.

INTRODUCTION

Like any other sport, golf carries the risk of injury.[1 2] Specific warm-up programmes have been shown to lower the risk of injury in various sports.[3] Warm-up programmes and risk management approaches have been described in relation to golf performance and injury risk reduction.[4 5] However, their effectiveness in reducing injury rates remains to be evaluated. Using the knowledge transfer schema (KTS), we created the Golf Related Injury Prevention Programme (GRIPP) intervention for recreational golfers.[6] The full protocol for developing this intervention was previously published.[7]

The success of any programme designed to prevent sports injuries depends on how well it is disseminated and implemented.[8 9] Exercise fidelity is crucial to creating an optimal implementation outcome for an injury prevention programme. Exercise fidelity measures whether an athlete can perform the exercises with the correct technique and according to the instructions given.[9] Incorrect performance can under or overestimate the effectiveness of an intervention. To measure exercise fidelity, sporters needed to be instructed.

The way exercise instructions are given influences the performance and learning curve.[10] In trainer or coach-based sports, the instructors are mostly previously taught during an education meeting and supported with instruction manuals and videos.[9 11–15] They provide the exercises to their sporters with visual demonstrations and oral instruction.[16] An advantage can be that trainers give feedback and can differentiate between techniques such as internal or external focused instructions to improve performance.[10] While golf is an individual sport, mostly played without supervision, specific instructions and directions should target participants directly.[17 18] The performance of injury prevention programme by athletes in individual sports is challenging because of limited options for feedback and support. There is restricted interaction with trainers, less or no team support, primarily individual practice and social influence of team members.[19] In this pilot study, we compared various strategies to instruct individual golfers to perform golf-specific warm-up exercises correctly.

METHOD

Study design

This pilot study was a randomised pilot trial to investigate if golfers can correctly perform the unsupervised exercises of the GRIPP programme after being provided with different instruction forms. Participants were randomly assigned to one of three instruction methods: (A) only an instruction card, (B) an instructional video and (C) an instruction card and video. We published a detailed description of the development and content of the GRIPP exercise programme previously.[7]

Participants

Active golf players were asked to partake in this pilot study. We approached potential participants at random at a single golf club. When a player was interested in participating, we gave them our study's details verbally and in writing. All players who agreed to participate in the study provided written informed consent. We included players with a World Handicap System (WHS) handicap of 36 or lower; ≥45 years of age; a playing frequency of at least nine holes a week; willing to perform the GRIPP intervention and understanding of the Dutch language.

Sample size

In the absence of previous studies that describe the value of instruction methods for exercise fidelity in injury prevention programmes, we could not calculate an a priori power calculation. Hence, we included at least six players in each study group based on pragmatic considerations.

Randomisation

We randomly assigned players by drawing a ticket number from a bowl to one of three groups (A, B and C). After the group assignment, we provided each group with different exercise instructions. The instructions for group A consisted only of instructional cards, group B only received instructional videos and we presented group C with both the cards and videos.

Intervention

The exercises of the GRIPP programme were developed using the KTS. The exercises are provided in table 1. We refer to the previously published study protocol for further details on the exercises and programme development.[7] Based on their randomised group, the players received an instruction card on paper and/or an iPad to watch the instruction video. A similar voice text was used in the instruction video as on the instruction card, with small additional instructions in the video (table 1). No corrections were given during the practice and performance time by the researcher (SG). The players individually practised each exercise using their assigned instructional method until they declared to be familiar with the exercise. The player then performed the exercise, which SG recorded on video. This procedure was repeated until all six exercises were recorded. All exercises were performed and recorded once on the same day. During the assessments, we minimised interaction between the researcher and the players. There was no interaction possible between participants while all exercises were practised individually.

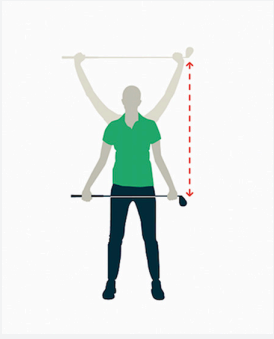
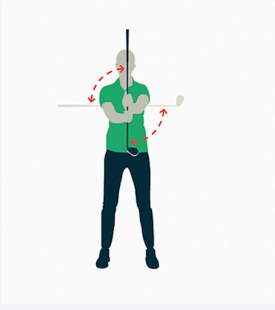
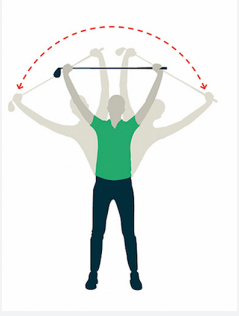
Outcome measures

A survey collected general demographic information such as gender, age, handicap and the number of holes per week. We developed an assessment tool based on the process of Fortington *et al*[9] and adapted this to our exercises. The assessment tool is provided in online supplemental file A. We used the instructions on the instructional card as a foundation for the assessment tool's criteria. This provided us with fidelity criteria for each exercise, ranging from 4 to 10 criteria depending on the exercise. Based on the performance video recordings of each participant each criterion was scored from the exercise independently by two assessors (SG and JvTS), as performed correctly (yes) or performed incorrectly (no).

Blinding

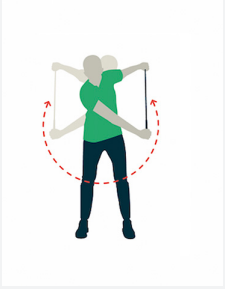
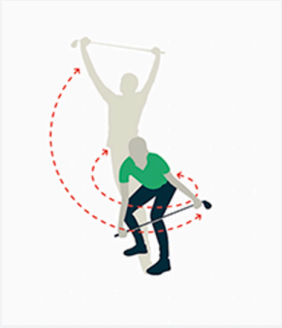
Due to the instruction methods' nature, we could not blind the players for their group allocation. The primary assessor (SG) was also not blinded because she distributed the exercise instruction to the participants. However, the second assessor (JvTS) was blinded for group allocation. In case of a difference in scoring, the two assessors conferred and reviewed the exercise a second time. After that, the second assessor decided if there was still disagreement.

Table 1 The GRIPP intervention for golfers[7]

General instructions	
► Perform the movements in a controlled manner ► Repeat all exercises 10 times for both sides ► Use a short club (iron 7–9) ► Stop the exercises if you feel any pain	
Exercise 1—Leg swing	
	Position the club on the side of the swing leg. Swing the leg forwards and backwards slowly and gently. The free arm is moving in the opposite direction. The upper body stays still while moving the arm and leg. Focus: Hip and shoulders. Additional explanation in the exercise video: Pointed extra on the upper body that must stay still during the performance.
Exercise 2—Arms in the air!	
	Stand upright with your feet shoulder-width apart and hold the club with both hands at the ends. Bring your arms above your head without bending the elbows, then slowly lower the arms. It is important to stay upright in your torso. Focus: Shoulders and back. Additional explanation in the exercise video: Keep the club straight. When you have difficulty with lifting, just move within your ability.
Exercise 3—Arm rotations	
	Hold the club vertically with both hands next to each other. Rotate the club anti-clockwise and return to the original position to rotate clockwise. It is important to hold arms straightened. After 10 repetitions, switch hands. Focus: Forearms and shoulders. Additional explanation in the exercise video: Keep arms straight and hold hands together.
Exercise 4—Sidewards bending	
	Hold the club with both hands at the end and bring it overhead. While breathing out, move sidewards gently with the club to the left and back to a neutral position. On the next breath, move out to the right. Focus: upper body. Additional explanation in the exercise video: Don't move forwards or backward during sideward bending.

Continued

Table 1 Continued

General instructions	
Exercise 5—Rotation of the upper back	
	Assume the golf stance and hold the club at the far end. The upper body and club will be turned to the left and right (semicircle). It is important to keep the lower body still. Focus: Upper body and lower back. Additional explanation in the exercise video: None
Exercise 6—Powerful rotation	
	Stand firm with feet shoulder-width apart and hold the club at the far end with both hands. The club will be 'pushed' from the lower left (left knee height) to the high right by rotating and pushing with the legs. After 10 repetitions, switch to the other side and move from low right to high left. Focus: Whole body. Additional explanation in the exercise video: None

GRIPP, Golf Related Injury Prevention Programme.

Data analysis

We performed the analyses in IBM SPSS Statistics for Mac (V.28) and Microsoft Excel for Mac (V.16.73). We compared groups' baseline characteristics with a χ^2 independence test and a one-way analysis of variance. We assessed the inter-rater agreement between the two assessors with a Cohen's kappa to provide insight into the reliability of the assessment tool.[20] Descriptive statistics were used to describe the study population and exercise fidelity. We calculated exercise fidelity as the percentage of correctly performed criteria for each of the six exercises by dividing the total number of exercise criteria performed correctly by the total number of criteria. A χ^2 independence test was used to compare groups. If a significant difference ($p \leq 0.05$) was found, a χ^2 pairwise Z-test was performed to identify which groups differed.

RESULTS

Participants and recruitment

In this randomised pilot study, eigtheen golfers (12 females and 6 males) were included during three enrolment days in April 2021. During the enrolment day, the assigned intervention was immediately performed, and all participants completed the intervention of their specific group. The baseline characteristics were similar between the groups. The average age of the included golfers was 61.94 years (SD 11.41), the average WHS handicap was 17.12 (SD 6.13) and the average number of holes played per week was 36.79. (SD 12.35). Gender distribution was equal across all groups. Thirteen of eighteen golfers did some form of exercise before playing (table 2).

Table 2 Baseline characteristics

	Overall	Group A Card	Group 2 Video	Group 3 Card and video
Male/female (N)	M=6/F=12	M=2/F=4	M=2/F=4	M=2/F=4
Age (mean±SD)	61.94±11.41	64.4±12.99	64.33±9.56	57.5±12.39
Handicap (mean±SD)	17.12±6.13	19.08±7.86	17.28±3.9	15.00±6.39
Holes per week in the last month (mean±SD)	36.79±12.35	37.8±7.53	42.75±17.02	30.00±7.35
Performing some form of exercise before playing golf (N)	Yes=13/No =5	Yes=4/No=2	Yes=5/No=1	Yes 4/No= 2

F, female; M, male; N, Number; SD, Standard Deviation.

Table 3 Total percentage of correct performed items per study group

	Total percentage of correct performed items (SD)						
Exercise	1	2	3	4	5	6	Average
Group A Instructional card	73.6% (6.2)*†	86.7% (4.2)	78.3% (9.8)	94.4% (3.5)	61.1% (14.1)*	48.1% (11.0)*†	73.7% (4.3)*†
Group B Instructional video	90.3% (5.5)*	90.0% (6.8)	78.3% (8.7)	100.0% (0)	91.7% (5.7)*	81.5% (8.4)*	88.6% (2.7)*
Group C Instructional card and video	92.0% (4.3)†	90.0% (4.5)	81.7% (6.5)	91.7% (3.7)	83.3% (10.5)	79.6% (9.7)†	86.3% (2.8)†

*indicates a significant difference between group A (instructional card) and group B instructional video (p<0.05)
†indicates a significant difference between group A (instructional card) and group C (instructional card and video) (p<0.05).
SD, Standard Deviation.

Inter-rater agreement

In total, 864 criteria were scored between both assessors and immediate agreement was reached for 832 of these (96.2%). This resulted in an inter-rater agreement of 0.88 (Cohen's kappa), which indicated almost perfect agreement.

Fidelity assessment

Exercise 4 had the highest exercise fidelity for all three groups, exercise 6 had the lowest for groups A and C and exercise 3 had the lowest for group B (table 3).

Between-group differences

Overall, we found a significant difference (p<0.001) between the groups, and there was a difference between group A (instructional card) and group B (instructional video), and group A (instructional card) and group C (instructional card and video) (p<0.05). Differences between the study groups differed between the individual exercises, with no group differences for exercises 2, 3 and 4 (table 3).

DISCUSSION

In this study, we found that golfers who received explanatory video instruction with or without printed card instructions performed better on exercise fidelity than those who received only an instruction card.

Individually performed unsupervised exercises reflect daily golf practice.[17] Little is known about the correct performance of exercises in unsupervised sports settings. Unsupervised exercise programmes have previously been studied in randomised controlled trials for tennis and athletics.[17 18 21] Following an ankle sprain, unsupervised exercise instructions were compared with exercising with an app or printed booklet instructions in preventing recurrent ankle sprains in athletes.[22] The instruction methods produced comparable in terms of compliance and recurrence rates results.[22] In treating knee osteoarthritis, a self-directed online guided programme with supported text messages improved knee pain and function.[23]

In a physical therapy setting, illustrated instructions of exercises were compared with video instructions. The performance of exercises with video instructions outperformed illustrated instructions regarding performance quality.[24] This is consistent with the findings of our study. Unsupervised video instruction increases the percentage of exercises performed correctly compared with only card instruction. Our study found a significant difference in exercises with more complex movements, such as rotations and diadochokinetic. This could be due to the video instruction as visual cues while learning a new task enhances motor learning.[16 24–26] Observing a model decreases the trial-and-error process and enhances increased performance.[27 28] However, there is little evidence on how a visual cue or written task will affect motor learning and how a task needs to be presented.[27 29] We previously tested the instruction readability and understandability of the exercise instructions during development.

Measuring the correct performance of exercises is rarely studied in team sports studies. It is assumed that coaches/trainers in team sports give adequate instructions to perform the exercises correctly.[9 11–13] Fortington *et al*[9] developed an assessment tool to monitor the correct performance of exercises to address this. Their observational checklist showed a high inter-rater reliability score. The scoring system of Fortington *et al*[9] was scored with two assessors during a training session, while we used video records to score. The assessors in our study might be able to score more precisely because they could repeat the recordings. However, the scoring system of correct performance of exercises is similar in individual sports and is, therefore, transferable to our study.

LIMITATIONS

We need to be aware of the Hawthorne effect.[30] Our participants knew that the goal of our study was on exercise execution and their exercises were being recorded. They may have performed the exercises more conscientiously than they would have done in a 'normal' warm-up

situation. This may have shown us an overestimation of the correct performed exercises. In contrast, the participants might be nervous and experience tension because of being watched. Hence, we did limit our interaction with the participants to account for any effects the above might have had.

PRACTICAL APPLICATION

If a sports injury prevention programme is not implemented properly, its effectiveness may be underestimated or limited. It is not sufficient to simply complete exercises and monitor them during a trial. Exercise fidelity, or the correct performance of exercises, must also be evaluated. Correct performance is rarely studied in intervention programmes. Our programme differs from previous studies in that we provide unsupervised exercises. Future studies need to be aware that assessing the exercise fidelity of a programme is the final stage before investigating the intervention effectiveness of an unsupervised programme. The development of a programme consists of several stages. A development tool such as the KTS can be assistive for real-life practicality.[6] During the development stages, in which end-users are involved, attention is necessary for how sporters want to be instructed. If the instructions and the goal are clear, it will likely improve the correct performance of exercises and future programme implementation.

CONCLUSION

The effectiveness any preventive exercise programme is determined by the programme's exercise fidelity. Golfers who received an instructional video or an instructional video in combination with an instructional card had a significantly improved performance of the exercises compared with only an instructional card.

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Contributors AB conceived the study. AB, DE and SG contributed to the conceptualisation of the study. SG collected the data. SG, LvB and EV contributed to data analysis and interpretation. The first draft was written by SG. All authors critically revised and contributed to the manuscript. All authors approved the final version of the manuscript.

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Competing interests EV is the editor in chief of BMJ Open Sports and Exercise Medicine.

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Supplementary file A: Checklist for scoring

Video number:
Date:
Reviewer:

Exercise 1: Leg Swing

		Right leg stand	Left leg stand
1.	The club is positioned on the side of the swing leg.	Yes / No	Yes / No
2.	The body stays upright	Yes / No	Yes / No
3.	The swing leg moves slowly and gently forwards and backwards.	Yes / No	Yes / No
4.	Upper body stays still	Yes / No	Yes / No
5.	The free arm is moving in the opposite direction of the leg	Yes / No	Yes / No
6.	Is the exercise performed safely?	Yes / No	Yes / No

Exercise 2: Arms in the Air!

1.	Feet are standing shoulder-width apart	Yes / No
2.	The club is held with both hands at the end.	Yes / No
3.	Two arms are straightened above the head.	Yes / No
4.	No major lordosis of the lower back	Yes / No
5.	Is the exercise performed safely?	Yes / No

Exercise 3: Arm rotations

		Right hand up	Left hand up
1.	Club is hold vertically	Yes / No	Yes / No
2.	The hands are placed next to each other.	Yes / No	Yes / No
3.	Rotation until horizontal	Yes / No	Yes / No
4.	Arms are held straightened	Yes / No	Yes / No
5.	Is the exercise performed safely?	Yes / No	Yes / No

Exercise 4: Sidewards bending

1.	The club is held with both hands at the end.	Yes / No
2.	Two arms are straightened above the head. (Or as far as possible for the individual. At least the arms are brought above)	Yes / No
3.	The club is moved sidewards to the left.	Yes / No
4.	The club is moved sidewards to the right.	Yes / No
5.	The body is moving sidewards and not to much forward or backwards.	Yes / No
6.	Is the exercise performed safely?	Yes / No

Exercise 5: Rotation of the upper back

1.	Golf posture	Yes / No
2.	The club is held with both hands at the end.	Yes / No
3.	The upper body is rotated to the left.	Yes / No
4.	The upper body is rotated to the right.	Yes / No
5.	Line of rotation is held. The club is not moved to much up or down while moving.	Yes / No
6.	Is the exercise performed safely?	Yes / No

Exercise 6: Powerful rotation

1.	Feet are standing shoulder-width apart	Yes / No
2.	The club is at the lower left (horizontal at left knee height)	Yes / No
3.	The club is at the high right	Yes / No
4.	Hips are twisted in the end position (Right internal rotation, hip in a straight line)	Yes / No
5.	Is the exercise performed safely? The other side	Yes / No
6.	The club is at the lower right (horizontal at right knee height)	Yes / No
7.	The club is at the high left	Yes / No
8.	Hips are twisted in the end position (Left internal rotation, hip in a straight line)	Yes / No
9.	Is the exercise performed safely?	Yes / No