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Strength and balance in recreational golfers aged over 80 years

Running Head - GOLFERS AND NON-GOLFERS AGE 65+ STRENGTH BALANCE

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Abstract

Background/Objective: Muscle strength and balance decrease with age, particularly in those over 80. Playing golf is associated with greater strength and balance in 65-79 year-olds, but it is not known if this occurs in the over 80s. **Methods:** Strength and balance of golfers aged over 80 years were assessed and compared with data obtained by the same research group on golfers and non-golfers aged 65-79 years. **Results:** Over 80 golfers (n=38) had similar normalised grip strength, single leg balance and leg power calculated from the 30s sit to stand test, to the 65-79 non-golfers (n=17). Composite Y Balance Test and anterior reach distances were significantly lower (right and left $p<0.001$) for the over 80 golfers compared to the 65-79 non-golfers. The over 80 golfers had significantly lower reach distances for the Y Balance Test, single leg stance times, lower limb power and grip strength on the left side than the 65-79 golfers (n=62). **Conclusion:** Playing golf may help slow the decline in grip strength, lower limb power, and static balance associated with ageing but this needs to be determined in a prospective trial. Dynamic balance, however, does not appear to be maintained, as it was significantly lower in the golfers over 80 compared with the 65-79 golfers and non-golfers. **Significance/Implications**. Although golfers over 80 had similar strength and static balance scores compared to the 65-79 non-golfers, prospective intervention studies are needed to ascertain whether preservation of strength and balance were due to playing golf or other factors.

Keywords:

physical activity, healthy ageing, leg power.

Introduction

Muscle strength and balance are known to decrease with ageing (Curcio et al., 2019; Howe et al., 2011; Stel et al., 2003; Sugiura et al., 2013; Takeshima et al., 2014) which increases the risk of falling for many older adults (World Health Organization., 2018). The World Health Organisation (WHO) recommends that people over 65 years undertake activities to enhance strength and balance on at least two days a week (World Health Organization., 2018). Maintaining muscle strength is particularly important in those over 80 years to reduce morbidity and mortality (Granic et al., 2016). However, Marzuca-Nassr et al. (2023) suggested there is limited research on strength training in adults over 80 years. Although age is a factor in decreasing strength and balance, Peterson et al. (2010) suggested that reduced physical activity could have more of an effect than ageing. Being physically active and maintaining muscle strength and balance throughout life and in older age has the potential to reduce the risk of falls and frailty in older adults (Power et al., 2014; Strain et al., 2016), especially those over 80 years in whom the decline in function is greater (Dodds et al., 2014; Dombrowsky, 2023).

Golf is a popular physical activity among older adults (Murray et al., 2017). According to The R&A (2023) there were 5.6 million on-course adult golfers in 2022 in Great Britain and Ireland. A recent systematic review of golf and physical health (Sorbie et al., 2022) presented some evidence for the benefits of playing golf on strength and balance in older people but there was limited research in those over 80 years (Sorbie et al., 2022; Tsang & Hui-Chan, 2010). In relation to the WHO strength and balance recommendations mentioned above, playing golf could facilitate older adults over 80 to meet these requirements but evidence is required. A measure of strength and balance is the 30 second chair sit to stand. In relation to golf, the number of repetitions during the 30-s sit to stand test increased by 15.9% following a 12-week golf training programme in military veterans with a mean age of 70 years (Du Bois et al., 2021). There is some evidence that golf can improve performance in tests that assess strength and balance. However, further research is needed in both males and females over 80 years.

Hand grip strength is commonly used as a measure of overall strength, which decreases with age and is a key component of sarcopenia and frailty (Cai et al., 2021; Navarrete-Villanueva et al., 2021). Maximal grip strength in golfers aged 65-79 was reported significantly higher than in age-matched sedentary non-golfers (right, p=0.042, r^2 = 0.06 left, p=0.047, r^2 = 0.05; (Wilson et al., 2022)). Similarly, in those over 80 years, grip strength normalised to body weight was greater in female golfers over 80 years (0.33 ± 0.06 kg/kg) than non-golfers (0.29 ± 0.06 kg/kg; (Stockdale et al., 2017)). However, the difference was not statistically significant (p=0.051) (Stockdale et al., 2017). There is a need to examine the association between playing golf and grip strength in both males and females aged over 80 years.

In relation to balance, older male golfers had significantly longer single leg stance (SLS) times compared to non-golfers (28.1 ± 3.6 s, vs 17.1 ± 11.9 s; p=0.020 (Tsang & Hui-Chan, 2010)). Maximal single leg stance times were also significantly longer in golfers aged 65-79 compared to non-golfers (right, p=0.021, r^2 = 0.07 ; left, p=0.001, r^2 = 0.13; (Wilson et al., 2022)). Considering dynamic balance, the Y Balance Test (YBT) has been shown to be a valid and reliable assessment with older adults (Sipe et al., 2019). In participants aged 65-79, significantly higher composite normalised reach distances on the YBT were found in golfers compared to non-golfers on both the right (p = 0.005, r^2 = 0.10) and left (p = 0.002, r^2 = 0.13) sides (Wilson et al., 2022). Further research is warranted on the association between playing golf, and static and dynamic balance in golfers over 80 years.

Aim

To examine the grip strength, leg power, and static and dynamic balance of recreational golfers aged over 80 years who play a minimum of 18 holes per week. To compare data from the golfers over 80 with existing data obtained by the same research group from golfers and non-golfers aged 65-79 years.

Null Hypothesis

There will be no difference in strength and balance between the over 80 golfers and the 65-79 non-golfers.

Alternative Hypothesis

Strength and balance will be lower in the over 80 golfers that the 65-79 non-golfers.

Methods

A cross-sectional design was used to examine the association between playing golf and various aspects of strength and balance in healthy people aged 80 years and over. The intention was to compare golfers with age-matched non-golfers, therefore golfers were recruited first. Recruitment of non-golfers was challenging and incomplete when the Covid-19 pandemic halted the project. Comparator data were therefore used for the same tests obtained previously by the same research group (Wilson et al., 2022) for golfers and non-golfers aged (65-79 years), to assess functional decline in golfers over 80 years. The methods are outlined briefly below and further details can be found in an earlier study (Wilson et al., 2022).

A convenience sample of 38 recreational golfers aged over 80 years (20 females; 18 males) was recruited from golf clubs in Hampshire, United Kingdom (Wilson et al., 2022) To qualify as golfers, for the purposes of the present study, participants were required to play a minimum of 18 holes per week and walk the course rather than use a buggy, and were permitted to take part in other activities, so they were representative of this group (Department of Health, 2009). Exclusion criteria (Wilson et al., 2022) were: musculoskeletal injury or surgery in the last five years involving immobility for more than one week;

uncontrolled diabetes or blood pressure; known neurological disorder; arthritis restricting everyday activities; undergoing treatment for cancer; taking medication affecting muscle function, total hip replacement surgery (due to the potential risk of dislocation with the movements required for testing dynamic balance).

Ethical approval was obtained and all participants provided written informed consent.

All data collection took place at participating golf clubs, using portable equipment, as described by Wilson et al. (Wilson et al., 2022). Briefly, physical activity was assessed using the self-reported General Practice Physical Activity Questionnaire (GPPAQ) (Department of Health, 2009). Body mass and height were measured to calculate Body Mass Index (BMI; kg/m^2). Procedures were carried out in standardised order: grip strength, single leg balance, Y Balance Test (YBT) and 30 second chair sit to stands (STS) Grip strength was measured using a MIE digital grip analyser (MIE®, Medical Research, Leeds, UK) on the right and then left side, with the participant seated (Wilson et al., 2022)The best of three maximal efforts was used in the analysis (Wilson et al., 2022). Static single leg balance was measured with the participant standing barefoot with the arms folded across the chest (Springer et al., 2007). The test ended when either the maximum of 60 seconds was reached or balance had been lost, indicated by the participant: 1) uncrossing their arms; 2) using the raised foot (moving it toward or away from the standing limb or touching the floor); 3) moving the weight-bearing foot. The longest of two efforts on each lower limb was used for analysis.

The Y Balance Test (YBT) was carried out using a YBT kit (Move2 perform, Evansville, IN USA) with the participant bare foot to eliminate additional stability from shoes (2022). A maximum of three practice trials in each direction and on each leg was permitted, prior to three trials being recorded in a set order of direction (Lee et al., 2015; Plisky et al., 2009; Sipe et al., 2019; Wilson et al., 2022). Reach distance was normalised within participants using the mean of the right and left lower limb length. A normalised composite maximised distance (%MAXD) incorporating all three reach directions was calculated for each side, using the formula: (3 excursion distances/lower-limb length x 3) x 100 = %MAXD.

The STS test involved the participant being seated in an armless chair, without leaning on the chair back and their arms crossed with hands placed on the opposite shoulders (Lee et al., 2022). When instructed to “Go”, the participant stood up fully and then sat down again, then repeated the cycle as many times as possible in 30 seconds. The time taken to perform the first 10 sit to stands was used to calculate the Muscle Quality Index (Takai et al., 2009). This gave a power output (P) in Watts and was calculated as:

$$\mathbf{P}\ \mathrm{sit-stand} = \frac{(\mathrm{L} - \mathrm{CH})\ \mathrm{x\ body\ mass\ x\ g\ x\ 10}}{\mathrm{T}}$$

In this equation, L represented leg length, CH chair height, g the acceleration of gravity (9.81 m/s^2) and T the time taken to achieve 10 sit to stands.

Data Analysis

Data were analysed using SPSS version 26. Median and interquartile ranges were used for descriptive statistics. Due to the difference in number of participants between the groups, the non-parametric Mann-Whitney U test was used for comparison. Effect size was calculated using the formula $r^2 = \frac{Z^2}{n}$ where Z = Z-score, n = total number of observations on which the Z-score is based. (Tomczak & Tomczak, 2014). According to Cohen (1992) r^2 0.2 should be considered a 'small' effect size, 0.5 represents a 'medium' effect size and 0.8 a 'large' effect size.

Results

The 38 golfers over 80 years studied were aged between 80 and 90 years and their demographic characteristics are shown in Table 1. Apart from age and body mass, their characteristics did not differ significantly from those of younger non-golfers and golfers aged 65-79 years from an earlier study (Wilson et al., 2022), with whom data from some of the present outcome measures were also compared.

When categorised as either inactive or active using the GPPAQ, the over 80 golfers and 65-79 years non-golfers had similar proportions of inactive and active participants, with <40% active (Table 2). However, the 65-79 golfers were more active than the other two groups, with 50% of the younger golfers being active.

Normalised grip strength was significantly lower on both right and left sides in golfers over 80 than 65-79 years (Table 3). However, the r^2 were below 0.32, indicating a small effect size. Golfers over 80 years had slightly higher grip strength than the 65-79 non-golfers on both sides, but this was not statistically significant (Table 3).

Single Leg Stance times were significantly lower in golfers over 80 than those aged 65-79 years but were not statistically different from non-golfers 65-79 years, despite lower times notably on the left side (Table 4). The r^2 were below 0.61 indicating a moderate effect size for the significant difference in single leg stance times for the over 80 golfers compared to those aged 65-79 years.

Y Balance Test reaches normalised to lower leg length were significantly lower in golfers over 80 than 65-79 non-golfers for composite scores and in the anterior reach direction (Table 5) but were only lower than non-golfers 65-79 for composite and anterior reach scores (Table 5). The r^2 for the significant differences between the over 80 golfers and 65-79 golfers ranged between 0.40 and 0.59, indicating medium effect sizes. All golfers 65-79 years were able to complete measurements for all reach directions. One non-golfer (6%) aged 65-79 was unable to successfully record a measured reach in all the directions for the YBT due to being able to maintain their balance during the test. More golfers over 80 were unable to record distances (8-24%) in various directions (Table 6). Of the three directions, the posterior reach had the highest number of participants unable to record a reach score in the over 80 golfers (Table 6).

Similar lower limb power for the STS test was estimated from both the number of repetitions completed in 30 seconds (STS-30) and time taken (seconds) to complete 10 repetitions (STS-10) in each age group (Table 7). Lower limb power was lowest in the over 80 golfers, which was significantly lower than the 65-79 golfers, but was not significantly lower compared with 65-79 non-golfers (Table 7). The r^2 was below 0.34 for the significant differences between the over 80 golfers and 65-79 years golfers, indicating a small effect size.

Discussion

The present study indicated that recreational golfers over 80 years had similar grip strength, leg power and static balance to younger non-golfers aged 65-79 years. However, compared with golfers aged 65-79, golfers over 80 had significantly poorer static and dynamic balance, and lower grip strength. The findings between the two age groups of golfers are consistent with the expected decline in function with ageing but comparison with the younger non-golfers indicated some preservation of function in the golfers over 80, apart from dynamic balance.

Grip strength (normalised to body mass) was slightly higher, but not significantly, for the over 80 golfers compared to the 65-79 non-golfers, suggesting that grip strength was preserved in the older golfers in the current study, who might have been expected to decline in strength over 80 years due to the consensus that strength, including grip strength decreases with age (Kozakai, 2017). Therefore, it could be expected that the over 80 golfers would have lower grip strength than the younger 65-79 non-golfers. The present findings are similar to those of previous studies, suggesting that playing golf is associated with higher grip strength in older adults (Stockdale et al., 2017; Wilson et al., 2022). While this is the case for grip strength, Samuel et al. (2012) suggested that quadriceps strength may decrease more rapidly than grip strength with ageing, so greater grip strength in the golfers may not correspond with lower limb strength (see leg power findings below). Similarly, playing golf may purely train grip strength, therefore intervention studies are required to compare changes in grip and lower limb strength that may be attributed to playing golf.

The chair STS test is one method of assessing functional strength which is linked to frailty (Millor et al., 2013). The over 80 golfers had the lowest leg power of the three groups compared in the present study, although they were not statistically weaker than the non-golfers aged 65-79. The lower power in the over 80 golfers is consistent with Alcazar et al. (2021) who reported that power decreased with ageing. However, it is not possible to compare power outputs between the data obtained in the present study and Alcazar et al. (2021) due to the different formulae used to calculate power. Playing golf may not slow the decline in lower limb power due to ageing as much as it appears to do for grip strength. Examining 30 sec STS power following an intervention study of novice older golfers could examine this relationship between changes in lower limb power and grip strength.

Similar maximal SLS times in the present over 80 golfers and 65-79 non-golfers contrasts with the significant differences found between maximal SLS times ($p<0.001$, mean difference 12.1s) in the 80-99 year old group vs 70-79 year old group reported by Springer et al. (2007). The maximal SLS times for the over 80 golfers (right 11.0s, left 10.3s, Table 4) were similar to those reported by Springer et al. (2007) for the 80-99 year old group (mean = 9.4s). However, the SLS times for the 65-79 non-golfers (right 11.0s, left 21.0s, Table 4) appear to be lower than the mean of both the 60-69 and 70-79 groups; 32.1s and 21.5s respectively (Springer et al., 2007). A potential reason for the higher normative values reported by Springer et al. (Springer et al., 2007) could be that their participants may have been more active than the general population due to being staff, patients and family members who worked or presented to the United States military medical centre. However, it is not possible to be certain, as no physical activity levels were reported by Springer et al. (Springer et al., 2007). In relation to SLS, playing golf appears to be associated with better balance in over 65-79 year olds but not over 80.

The importance of dynamic postural control was highlighted by Howe et al. (2011) as it may be more important than static balance in relation to falls prevention. In contrast to static balance, results for the YBT composite and anterior reaches were significantly lower in the over 80 golfers than the 65-79 non-golfers (Table 5). The over 80 golfers had significantly lower reach distance in all directions compared to the 65-79 golfers (Table 5). In agreement Lee et al. (2015) reported middle-aged females (53.9±5.0 years) having significantly greater reach distances than older females (77.5±2.7 years). Lee et al. (2015) reported significantly lower strength in lower limb muscles in the older females vs the middle-aged group which the authors suggested could explain the corresponding decreased YBT scores. Similarly, in the present study, lower limb power was lower in the over 80 golfers compared to the 65-79 non-golfers. The YBT and lower limb power results of the present study, combined with those from Lee et al. (2015) , suggest a correlation between strength and balance. Therefore, assessing dynamic balance in those over 65 years is important and may be more sensitive to detect deficits in balance than static tests, such as the SLS.

The amount of golf played was not measured in either the present study or other studies on older golfers, other than being a minimum of 18 holes per week (Gao et al., 2011; Stockdale et al., 2017; Tsang & Hui-Chan, 2010). Future studies on strength and balance should report the amount of golf and physical activity to aid comparisons between studies.

Playing golf appears to be beneficial for strength and balance in those under 80. However, given that balance, particularly dynamic balance, is poor in those over 80, despite playing golf, additional balance exercises or activities (such as Tai Chi) could be recommended, before reaching 80 years to help slow the decline.

Limitations

The main limitation in aiming to assess the association of playing golf in people over 80 years with over 80 non-golfers available to enable direct comparison within the age group. Using the data from younger golfers and non-golfers aged 65-79 only allowed indirect comparisons. No definitive conclusion could therefore be drawn from the present findings and only indications of association could be found. Future research could look at a larger sample involving participants with varying levels of physical activity. Some of the golfers over 80 and most of the non-golfers over 80 found the YBT too challenging to complete, so a more feasible measure of dynamic balance that would be appropriate for those with a wider range of abilities needs to be found for future studies. Recruitment of older non-golfers proved difficult and strategies for improving uptake among sedentary older adults need to be considered for future studies. The cross-sectional design of the present study did not enable cause and effect to be examined, which would require a longitudinal intervention design, but the findings indicate that such a study is warranted.

Conclusions

Playing recreational golf over the age of 80 years may help slow the decline in grip strength, lower limb power and static balance with ageing. However, dynamic balance was significantly lower in the over 80 golfers compared with the 65-79 non-golfers, suggesting specific balance activity in addition to playing golf is required to reduce loss of balance ability. A prospective interventional study is warranted to investigate the impact of playing golf on preserving or improving strength and balance in people over 80 years.

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Table 1: Demographic characteristics of the study group (golfers >80 years), two comparator groups (non-golfers and golfers aged 65-79 years) from a previous study (Wilson et al., 2022) (median, IQR)

	Age (years)	**Body Mass** (kg)	**Height** (cm)	**BMI** (kg/m²)
>80 Golfers (n=38); 20 females	82.0 (4.0)	67.6 (16.7	164.5 (16.0)	25.2 (3.9)
65-79 Golfers (n=62)/ 31 females	71.0 (5.0)	74.0 (25.0)	165.0 (16.0)	26.4 (6.3)
65-79 Non-Golfers (n=17)/ 9 females	71.0 (8.0)	73.8 (21.4)	167.0 (15.0)	26.4 (4.2)

Table 2: General Practice Physical Activity Questionnaire (GPPAQ) scores for all three groups of participants

	Inactive	**Active**
>80 Golfers (n = 38)	23 (62%)	14 (38%)
65-79 Golfers (n=62)	31 (50%)	31 (50%)
65-79 Non-Golfers (n=17)	11 (65%)	6 (35%)

Table 3. Grip strength normalised to body weight in aged 80 and over and golfers and non-golfers aged 65-79 years (median (IQR)

		>80 Golfers (n=35[+])	**65-79 Golfers** (n=57*)	**p vs >80 Golfers**	**65-79 Non-Golfers** (n=17)	**p vs >80 Golfers**
Normalised grip strength (N/kg)	Right	3.65 (1.05)	4.33 (1.19)	0.054	3.32 (1.93)	1.0
	Left	3.35 (1.38)	4.05 (1.33)	0.008	3.04 (1.88)	1.0

*due to a fault with the hand grip dynamometer, data from five of the 62 golfers aged 65-79 were not recorded, plus 3 of the >80 golfers.

Table 4. Single leg stance times (secs) in golfers >80 years and golfers and non-golfers aged 65-79 years (median, IQR)

	>80 Golfers (n=38)	**65-79 Golfers (n=62)**	**p vs >80 Golfers**	**65-79 Non- Golfers (n=17)**	**p vs >80 Golfers**
Right	11.0 (22.75)	32.0 (42.3)	<0.001	11.0 (33.5)	0.853
Left	10.3 (13.5)	37.0 (38.3)	<0.001	21.0 (24.5)	0.426

Table 5. Y Balance Test distance as a percentage of leg length for all directions in golfers > 80 years compared to golfers and non-golfers aged 65-79 years (median, IQR)

		>80 Golfers (n=29-35[‡])	**65-79 Golfers (n=62)**	**p vs >80 Golfers**	**65-79 Non-Golfers (n=16[a])**	**p vs >80 Golfers**
Composite	Right	68.6 (18.6)	81.7 (13.3)	<0.001	74.4 (14.9)	0.021*
	Left	69.6 (14.3)	82.9 (9.6)	<0.001	75.4 (14.3)	0.024*
Anterior	Right	51.9 (13.3)	59.3 (10.8)	<0.001	58.6 (13.0)	0.033*
	Left	55.7 (11.7)	61.3 (8.6)	<0.001	61.4 (10.5)	0.017*
Postero-medial	Right	66.7 (24.4)	89.1 (16.9)	<0.001	74.6 (17.3)	0.110
	Left	69.9 (17.0)	89.4 (14.2)	<0.001	77.3 (13.5)	0.068
Postero-lateral	Right	81.8 (17.1)	96.7 (14.1)	<0.001	87.5 (9.4)	0.084
	Left	84.3 (13.2)	98.9 (14.0)	<0.001	86.9 (19.1)	0.382

‡Composite scores excluded if a participant failed to complete at least one test for that leg

a1 female 65-79 non-golfer was unable to carry out YBT so removed from analysis.

Table 6. Number and percentage of participants unable to complete sections of Y-Balance Test

		>80 Golfers (n=38)	65-79 Golfers (n=62)	65-79 Non-Golfers (n=17)
Composite	R	**‡7 (18%)**	0	1 (6%)
	L	**‡9 (24%)**	0	1 (6%)
Anterior	R	**3 (8%)**	0	1 (6%)
	L	**4 (11%)**	0	1 (6%)
Posteromedial	R	**6 (16%)**	0	1 (6%)
	L	**8 (21%)**	0	1 (6%)
Posterolateral	R	**6 (16%)**	0	1 (6%)
	L	**6 (16%)**	0	1 (6%)

‡Composite scores excluded if a participant failed to complete at least one test for that leg

Table 7. Lower limb power during the 30 sec sit to stand test (STS)

Power (watts)	>80 Golfers	65-79 Golfers	p vs >80 Golfers	65-79 Non-Golfers	p vs >80 Golfers
STS-30	282.4 (166.5)	412.3 (205.5)	<0.001	346.1 (175.4)	0.515
STS-10	290.2 (162.2)	401.1 (224.5)	0.001	363.1 (207.0)	0.377

STS-30: reps completed in 30 seconds, STS-10: time taken (secs) to complete ten reps.