Fall risk factors in older female lawn bowls players and controls.

Katherine Brooke-Wavell and Victoria C. Cooling
Department of Human Sciences, Loughborough University

Full address
Katherine Brooke-Wavell, PhD
Department of Human Sciences,
Loughborough University,
Loughborough, LEICS, LE11 3TU UK
Phone +44 1509 222749
Fax +44 1509 223940
e-mail k.s.f.brooke-wavell@lboro.ac.uk

Running heading
Lawn bowls and fall risk factors

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Abstract

Fall risk factors were compared between older women who regularly participate in lawn bowls and controls. Participants were 74 healthy women aged 60-75y. Postural stability, timed ‘up and go’ score, isometric knee extensor strength, reaction time, range of motion and calcaneal broadband ultrasonic attenuation were assessed. Bowlers and controls were similar as regards mean age, height and weight. Regular bowlers had significantly lower timed ‘up and go’ times, reaction times, and sway whilst standing on a compliant surface. They had significantly higher knee extensor strength, range of motion at ankle and shoulder, and calcaneal broadband ultrasonic attenuation. Whilst targeted strength and balance training may be necessary in treatment of the physical frailty that may contribute to falls and fractures in older people, it is possible that long term participation in activity such as lawn bowls may help to prevent this frailty.
Introduction

Falls are prevalent and have potentially debilitating consequences in older people. Decline in physical function may contribute to falls: risk of falling is associated with poor muscular strength (Lord, Sambrook et al., 1994; Moreland, Richardson, Goldsmith, & Clase, 2004) and postural stability (Lord, Sambrook et al., 1994; Stel, Smit, Pluijm, & Lips, 2003). Exercise interventions that are targeted to treat these declines by improving balance and muscular performance have been found to reduce fall incidence in older people (Chang et al., 2004; Gillespie et al., 2003). Modified Tai Chi interventions, that involve slow controlled movement of the centre of gravity and rotations, have been found to reduce fall risk in some (Li et al., 2005; Wolf, Barnhart, Ellison, & Coogler, 1997) although not all (Wolf et al., 2003) studies.

Whilst targeted strength and balance training has been shown to be effective in the prevention of falls amongst older people at risk of falls (Chang et al., 2004; Gillespie et al., 2003), it is possible that less targeted activity could have some benefit in maintaining physical function and preventing the physical frailty that may lead to falls. Older people who are active as little as once each week have better postural control and muscular power (Kuh, Bassey, Butterworth, Hardy, & Wadsworth, 2005), and higher habitual levels of activity are associated with better postural stability (Brooke-Wavell, Prelevic, Bakridan, & Ginsburg, 2001). However, the prevalence of inactivity is high amongst older people in the UK: although 95% of older people believed that physical activity can improve your health, 53% did less than 2 hours leisure activity per week and 36 % did none at all, with the most powerful deterrent being lack of interest (Skelton, Young, Walker, & Hoinville, 1999). Maintaining
physical activity may maintain physical function – but a substantial proportion of older people do not maintain formal activity.

Lawn bowls is one of the most popular activities amongst older people in the UK (Crombie et al., 2004), with 4% of men and 1% of women aged 70-79 reporting having participated in the last four weeks (Skelton et al., 1999). The aim of the game is to roll a bowl as close as possible to a target (jack). The bowling action involves a forward lunge to allow the bowl to be released close to the grass. Once all players have released their bowls the distance from each to the jack is measured, following which players deliver bowls to the end of the green, often by “toeing”- balancing on one foot whilst gently rolling bowls with the other foot. The controlled movement of the centre of gravity during bowling and balance control required during toeing could potentially have a role in maintaining postural stability. Even the activity involved in walking up and down, and getting to the green may have a role in reducing any inactivity-related decline in physical function.

The aim of this study was thus to compare postural stability and other fall risk factors in older bowls players with a group of similar controls.
Methods

The experiment was cross-sectional in design with risk factors for falls being compared between lawn bowls players and controls. Participants provided written informed consent for the study which was approved by the University Ethical Advisory Committee.

❖ Participants

Participants were healthy, community dwelling women aged between 60 and 75y. Women were required to be at least 5 years past menopause. Exclusion criteria were: problems with bones or joints; disturbance of balance/co-ordination; numbness in hands or feet; disturbance of vision or ear problems. Bowls players (n=34) were recruited through local bowls clubs and local media. Control participants (n=40) were recruited through bowls players (non-bowls playing friends/relatives), other local community groups and local media.

❖ Measurements

Postural stability was assessed using a simple swaymeter, which measured displacement at the waist (Lord, Ward, Williams, & Strudwick, 1995). Body sway was measured for 60 seconds in each of the following four conditions: (I) eyes open, standing on a firm surface; (II) eyes closed, standing on a firm surface; (III) eyes open, standing on a compliant surface; (IV) eyes closed, standing on a compliant surface. The compliant surface was 0.15 m thick piece of foam, as reported in
previous studies (Lord et al., 1995). In all test conditions, participants were requested to stand as still as possible, with feet 10cm apart, arms at the sides. Sway was calculated as the product of maximal anteroposterior and mediolateral sway. The square root of this value was taken to yield a normally distributed variable.

Dynamic balance and gait speed was assessed using a standardised timed ‘up and go’ test (Podsiadlo & Richardson, 1991). Participants were asked to stand up from a 45cm chair, walk forward three metres, turn, return to the chair and sit down, as quickly as possible.

Maximal isometric knee extensor force was measured in the dominant (stronger) leg in a seated position (hip and knee in 90° flexion). A purpose built seat with adjustable height and depth was used. A padded restraint was connected to a force meter that was securely fixed to the seat frame. Participants were encouraged to warm up the leg muscles before the test to prevent muscle strain. They sat in the chair, with the restraint positioned superior to malleoli. They were then instructed to kick out as hard as possible against the restraint for 5 seconds. The participants were verbally encouraged to exert maximal effort on each attempt. Participants were allowed three consecutive attempts, from which the highest force exerted was used.

Broadband ultrasonic attenuation (BUA) of the calcaneus was measured using an Osteometer DTU-one (Osteometer MediTech, Denmark).

Reaction time was assessed with a simple reaction time task, using a light as the stimulus and depression of a switch by the hand as the response. The stimulus was
given 5 times consecutively at random spacing. After one practice attempt, the mean of 5 scores from the second attempt was used as reaction time.

Maximal range of motion was measured at both the shoulder and ankle using a clinical goniometer (Cranlea, Birmingham, UK). At the shoulder, the maximum range of motion in the sagittal plane was determined. The maximal range of motion of the ankle in dorsi/plantarflexion was measured with the participant seated and knee flexed at 90°.

A questionnaire was used to assess physical activity, using questions on duration of physical activity participation. Women were also asked retrospectively whether they had fallen in the previous six months.

❖ **Statistical analyses**

Statistical analyses were performed using SPSS. Comparisons between bowlers and controls for continuous variables were made using unpaired t-tests. Analysis of variance was used to determine whether differences persisted after inclusion of age and weight as covariates. Comparisons between the control and bowling groups for physical activity level, participation in other organised sports and previous falls were made using Mann-Whitney U tests.
Results

Mean age, height, weight and body mass index, were all similar in bowlers and controls, with no significant differences between groups (Table 1). Duration of physical activity participation (including bowling) was greater in bowlers than controls (p<0.001). Most (30 of 34) bowlers participated in over 3 hours of physical activity (including bowling) per week, with the remaining four reporting 2-3 hours per week. Of the controls, all reported less than 3 hours per week. A greater proportion of bowlers than controls reported participating in activities other than bowling (35 vs 13%; p=0.03).

Bowlers had significantly better performance in timed ‘up and go’, reaction time, knee extensor force tests and had greater range of motion at shoulder and ankle and higher calcaneal broadband ultrasonic attenuation (Table 2). Furthermore, they demonstrated significantly better postural stability in the most challenging of the four measurement conditions (Table 2).

The proportion of women who reported having fallen in the previous six months was lower in bowlers (11.8%) than controls (30.0%), although this difference was not statistically significant (p=0.088).
Discussion

This study observed that women who participate in bowling have significantly better postural stability, muscular strength and flexibility than a similar group of women who did not regularly bowl. As these are factors that have been associated with risk of falling (Lord & Clark, 1996; Lord, Ward, Williams, & Anstey, 1994; Moreland et al., 2004; Rose, Jones, & Lucchese, 2002; Shumway-Cook, Brauer, & Woollacott, 2000; Stel et al., 2003), it is possible that the bowlers are at lower risk of falls.

The difference in postural stability between bowlers and controls is similar in magnitude to differences that have been reported between women participating in brisk walking and controls (Brooke-Wavell, Athersmith, Jones, & Masud, 1998). That the difference in sway was most evident whilst standing on a compliant surface is consistent with changes following interventions including strength, balance and aerobic training (Lord et al., 1995). Timed 'up and go’ score was 17% lower in bowlers than controls. All but one of the women (a control) had scores less than 12 seconds as might be expected in community dwelling women (Bischoff et al., 2003). The differences in postural stability and timed ‘up and go’ score are consistent in indicating that bowlers had better balance and mobility.

Isometric knee extensor strength was 16% greater in bowlers than controls. In bowlers, mean strength was similar to that reported in a population based survey of physically able older people (Skelton, Greig, Davies, & Young, 1994), whilst values for controls were lower. The difference between the groups is comparable in magnitude to average differences between women differing in age by more than a
decade (Skelton et al., 1994). Differences in strength of this magnitude might not only increase fall risk, but also have important functional correlates (Rantanen, 2003). Furthermore, physical activity in middle age is associated with better physical function 8.8 years later (Hillsdon, Brunner, Guralnik, & Marmot, 2005), indicating more active individuals experience less later functional decline. Whilst the differences in strength can not be attributed to the bowling on the basis of this cross-sectional study, it is possible that recreational activities could play some role in maintaining physical function in older people.

Calcaneal BUA was also higher in bowlers than controls. This finding is consistent with the observation that regular walking reduces the loss in calcaneal BUA and BMD (Brooke-Wavell, Jones, & Hardman, 1997). As calcaneal BUA has been reported to predict hip fracture (Hans et al., 1996) this could indicate that activity such as bowling might be associated with lower fracture risk. However, in the previously mentioned study, walking reduced calcaneal bone loss but did not significantly influence hip BMD, so it is possible that exercise induced improvements in bone at the heel might not necessarily imply improvements at other sites.

There are various possible explanations for the better fall risk profile observed in regular bowlers. It could be that the movements involved in bowling impose a neuromuscular challenge, hence either improving or maintaining neuromuscular function. This effect would be consistent with the improvements is balance, strength and reaction speed seen in response to interventions including balance, strength and aerobic training (Lord et al., 1995) as well as with effects seen from the slow co-ordinated movements observed with Tai Chi, which is reported to improve static
balance (Li et al., 2005) and to be associated with higher muscle torques (Tsang & Hui-Chan, 2005).

There are, however, other possible explanations for our findings. It is possible that some selection bias is operating: i.e. that those women with better balance and coordination are more likely to take up or maintain bowls. Women who participated in lawn bowls were also more active in other activities, so it is possible that it is these other activities rather than the lawn bowls that contributed to the better fall risk profile. Other health related behaviours may also differ between bowlers and controls. Alternatively, it is possible that the time spent outdoors during bowls playing is increasing sunshine exposure and hence improving vitamin D status. Supplementation of vitamin D in older people can improve body sway (Pfeifer et al., 2000) balance and muscular function (Bischoff-Ferrari, Dietrich et al., 2004) and may reduce falls (Bischoff-Ferrari, Dawson-Hughes et al., 2004). Endogenous 25-hydroxy vitamin D concentrations are related to timed ‘up and go’ performance (Dukas, Staehelin, Schacht, & Bischoff, 2005) and it is possible that the increased endogenous production in response to higher sunshine exposure would have a similar effect.

There are some limitations to the study. The main limitation is that the cross-sectional design means that we can not conclusively determine whether the better performance in bowlers is due to bowling. Other differences between groups (e.g. participation in other physical activities or health related behaviours) could contribute to the observed differences in fall risk factors. It is possible that those women with better physical function were more likely to have ability to participate and/or be successful at lawn bowls, whilst women with poorer function may have been less likely to pursue the sport. The study was not sufficiently powered to determine whether fall incidence
differed between groups, and falls were only monitored retrospectively. However, this study does indicate a need for further prospective studies on effects of recreational physical activities, such as lawn bowls, on fall incidence.

This study indicates that women who participate in bowling have better balance, strength and reaction time than less active controls, as well as reporting fewer falls. It is possible that recreational physical activities such as bowling could have a role in preventing the loss of physical function that can contribute to physical frailty and falls.
References


Table 1: Characteristics of participants

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<tr>
<th></th>
<th>Bowlers (n=34)</th>
<th>Controls (n=40)</th>
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<tr>
<td>Age (y)</td>
<td>68.0 ± 4.8</td>
<td>68.6 ± 4.5</td>
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<tr>
<td>Height (m)</td>
<td>1.604 ± 0.052</td>
<td>1.603 ± 0.065</td>
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<tr>
<td>Body mass (kg)</td>
<td>69.1 ± 8.8</td>
<td>69.3 ± 11.4</td>
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<td>Body mass index (kgm⁻²)</td>
<td>26.9 ± 3.4</td>
<td>27.0 ± 4.4</td>
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Table 2: Fall and fracture risk factors in bowlers and controls

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<tr>
<th></th>
<th>Bowlers</th>
<th>Controls</th>
<th>P</th>
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<tbody>
<tr>
<td>Timed up-and-go (s)</td>
<td>6.5 ± 1.6</td>
<td>7.8 ± 2.6</td>
<td>0.011</td>
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<tr>
<td>Reaction time (s)</td>
<td>0.68 ± 0.15</td>
<td>0.78 ± 0.17</td>
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<tr>
<td>Knee extensor force (N)</td>
<td>315 ± 50</td>
<td>271 ± 66</td>
<td>0.005</td>
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<td>Shoulder range of motion (°)</td>
<td>242 ± 20</td>
<td>224 ± 21</td>
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<tr>
<td>Ankle range of motion (°)</td>
<td>98 ± 22</td>
<td>87 ± 21</td>
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<td>Calcaneal BUA (dB/MHz)</td>
<td>49 ± 7</td>
<td>45 ± 8</td>
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<td>Sway (mm)</td>
<td></td>
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<td>Condition I</td>
<td>8.0 ± 5.2</td>
<td>11.8 ± 8.1</td>
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<td>14.4 ± 9.8</td>
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<td>Condition III</td>
<td>24.8 ± 10</td>
<td>25.2 ± 10.3</td>
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<tr>
<td>Condition IV</td>
<td>40.8 ± 12.5</td>
<td>57.1 ± 23.2</td>
<td>&lt;0.001</td>
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