Predicting Habitual Physical Activity Using Coping Strategies in Older Fallers Engaged in Falls-Prevention Exercise

Anne H. Laybourne, Simon Biggs, and Finbarr C. Martin

One third of adults over 65 yr old fall each year. Wide-ranging consequences include fracture, reduced activity, and death. Research synthesis suggests that falls-prevention programs can be effective in reducing falls by about 20%. Strength and balance training is the most efficacious component, and the assumed method of effect is an improvement in these performance domains. There is some evidence for this, but the authors have previously proposed an alternative method, activity restriction, leading to a reduction in subsequent falls through a reduction in exposure. The aim of this study was to examine physical activity in older fallers, applying a theory of adaptation, to ascertain predictors of habitual physical activity. Referrals to hospital- and community-based exercise programs were assessed for (a) habitual walking steps and (b) coping strategies, falls self-efficacy, social support, and balance mobility. There was no average group change in physical activity. There was high interindividual variability. Two coping strategies, loss-based selection and optimization, best explained the change in physical activity between baseline and follow-up. Notwithstanding some limitations, this work suggests further use of adaptation theory in falls research. A potential application is the creation of a profiling tool to enable clinicians to better match treatment to patient.

Keywords: falling, activity restriction, rehabilitation

Each year, one in three adults over the age of 65 years falls. Physical, psychological, and social consequences include physical injury—for example, fractures or bruising—fall-related fear, and reduced self-efficacy. Any or all of these can result in first-time institutionalization, hospitalization, reduced social and physical activity, decreased confidence, or death (Martin, 2009). A number of countries have developed policies and clinical guidance for the prevention of falls in older people, such as the National Service Framework (Department of Health, 2001) and NICE guidance CG21 in England (National Institute for Clinical Excellence [NICE], 2004), which have been followed by widespread development of multidisciplinary falls services (Lamb et al., 2007).
Although the research quality is highly variable, synthesis suggests a potential effectiveness of about 20% in falls reduction, for example, multifactorial programs by 22% as reported in *The Cochrane Review* (Gillespie et al., 2008) and strength- and balance-training programs by 18% (Sherrington et al., 2008). Strength- and balance-exercise training is the most efficacious component of multifactorial interventions (Campbell & Robertson, 2007). This, along with the evidence of a dose-response relationship (Sherrington et al., 2008), suggests that reduction of strength and balance impairments explains part of the effect. The Yale FICSIT trial showed some direct evidence for this in a marginal association between reduced fall rates and improvements in balance, lower extremity strength and range of motion, step length, ease of bathing, and toilet transfers, along with other domains such as postural blood-pressure change (Tinetti, McAvay, & Claus, 1996), but the magnitude of association suggests that other factors must also be at work.

We have previously proposed that for some individuals, activity restriction after falls-prevention exercise is an alternative explanation for a reduction in falling (Laybourne, Biggs, & Martin, 2008). Activity restriction commonly follows a fall and is perceived by some individuals as a legitimate fall-prevention strategy (Yardley, Donovan Hall, Francis, & Todd, 2006). The incentives for restricting activity also include enhancing pain-free recovery from injury and protection of social identity from embarrassment or stigmatization (Yardley & Smith, 2002). Reduced habitual activity in healthy older women is associated with slower times on the timed up-and-go (TUG) test (Bruce, Devine, & Prince, 2002) but also independently with nonphysical domains such as reduced falls efficacy and fear of falling (Bruce et al., 2002; Kressig et al., 2002). In addition, the care culture and safety messages provided by multiprofessional falls-prevention programs may encourage passivity in attendees (Ballinger & Payne, 2002), perhaps amplified by peer or carer suggestions to “take care.” The level of support provided by a social network could influence activity in either direction, although network size and social interactions with friends showed significant negative associations with mobility and strength-task disability in North Americans (Mendes de Leon, Gold, Glass, Kaplan, & George, 2001).

Reduced activity levels are, however, predictive over the medium term of an increased risk of falling and functional decline (Bruce et al., 2002). Furthermore, psychological well-being is negatively affected by health stressors that restrict engagement in routine activities (Williamson, 1998), and injurious falls may be stressful enough to induce activity restriction sufficient to diminish well-being.

Individuals vary considerably in their coping strategies in response to stress generally and to the challenges associated with aging, such as experiencing a fall. The theory of selection, optimization, and compensation (SOC) is a general lifespan psychological-theoretical model of adaptation. It describes the use of three coping strategies to enable continuity of secure identity in daily life: selection, optimization, and compensation (Baltes & Baltes, 1990), used in variable combinations. According to this model, selective strategies narrow the range of activities engaged in in response to reduced functional capacity. In the case of falls, this might lead to activity restriction. Optimization strategies enable an individual to engage in behaviors and activities that augment and enrich existing function and resources. This might lead to enthusiastic uptake of and adherence to balance-improving exercise programs and ongoing physical activity. Compensation strategies arise
when an individual’s ability to adapt to reductions or fluctuations in resource levels decreases to a personally unacceptable level. Thus, compensation strategies use alternative methods to achieve a goal. This might, for example, lead to preferred use of a walking aid to maintain usual activity, albeit at reduced intensity. We have speculated previously on the value of applying the SOC theory to explain activity levels in fallers undergoing falls rehabilitation (Laybourne et al., 2008).

Although programs such as the OTAGO program promote adoption or preservation of walking and an active lifestyle (Campbell et al., 1997), ongoing habitual physical activity is not routinely monitored in falls-prevention programs. Without specific intervention, it is likely that there is significant heterogeneity in patients’ responses. In this study we investigated factors predictive of changes in physical activity levels, to determine whether there may be a need for a differential approach to this objective of falls-prevention programs.

This study therefore aimed to examine (a) habitual physical activity levels in patients after their participation in a falls-prevention program incorporating therapeutic strength and balance training (falls-prevention exercise [FPE]) and (b) the main predictors of habitual physical activity.

### Methods

This study was approved by COREC at the Research and Ethics Committee of Lewisham Hospital NHS Trust in June 2006 and was funded by an ESRC CASE studentship. All participants gave informed written consent before participation.

### Setting and Study Population

This was an observational study of patients participating between February 2007 and July 2008 in FPE programs provided through the Southwark and Lambeth Integrated Falls Pathway (SLIPS) service, which employs an evidence-based, streamlined, and standardized falls-prevention-service pathway fed by assessment clinics. Participants were recruited from three clinics operating within this integrated service.

Falls-clinic patients eligible for inclusion in this study were community dwelling, age 65 years or older, and able to give informed consent; had an Abbreviated Mental Test score of ≥7/10 (Hodkinson, 1972); and had received a clinical recommendation to attend one of two FPE programs between February 2007 and July 2008. The FPE programs provided are (a) a community-based, group exercise program of 40 one-hour weekly sessions, based on the Falls Management Exercise program (Skelton, Dinan, Campbell, & Rutherford, 2005; Skelton & Dinan, 1999), provided by technical instructors who had been formally trained, completing the Postural Stability Instructors course provided by Later Life training (http://www.laterlifetraining.co.uk), and (b) a hospital-based, group exercise program of 16 one-hour twice-weekly sessions including an educational component, provided by physiotherapists using a manual based on the OTAGO framework of exercises (Campbell et al., 1997) with encouragement and training to continue the exercises thereafter. Referral to either program is determined after clinic assessment according to predefined clinical criteria, and the hospital-based group is generally more mobility impaired or less able to adhere to an individual program. The purpose was not to compare the FPE groups but to provide a broad case mix with which to
examine habitual physical activity and its determinants. No measures of exercise-class attendance or home-exercise adherence were available for this research.

**Hospital-Based Exercise Program**

Participants complete each exercise simultaneously, with one instructor providing a demonstration and another providing individualized guidance to allow each participant to progress his or her capabilities and to ensure safe and effective exercising. Instructors add specific exercises to individuals’ programs at their discretion. Exercises include warming up, strengthening exercises using weights, balance exercises, and a walking plan (http://www.slips-online.co.uk). Patients are encouraged at 2 weeks predischARGE to take the exercise booklet and individualized program home to practice once a week between group sessions. An assessment is made to ascertain how able a patient is to do home exercise. Progress is checked by a nurse at 3 months postdischarge.

**Community-Based Exercise Program**

The Falls Management Exercise program provides practitioners with a framework from which to select specific, tailored, progressive exercises that can be adapted to suit the needs of older people with a wide range of physical abilities. It is organized to improve balance, functional capacity, bone and muscle mass, and confidence. Exercises include sustained three-dimensional Tai-Chi-based movement, targeted strengthening and stretching exercises, dynamic postural and gait training, and functional floor and standing activities to improve postural skill and confidence. Components include flexibility, muscle strengthening, balance and endurance exercises, and elements of Tai Chi, together with strategies for getting up off the floor (http://www.slips-online.co.uk). The exit strategy for all participants involves encouragement to continue being physically active and to join a community-based exercise class.

**Outcomes and Data Collection**

Patients were assessed at home within 1 month of exercise referral, at program completion, and at 6-month follow-up. The primary outcome for this study was objective habitual physical activity. Secondary outcomes included coping strategies, social support, balance mobility, and falls self-efficacy. Walking, assessed by accelerometry, was used to indicate habitual physical activity (Stepwise Activity Monitors [SAMs], Cyma, http://orthocareinnovations.com/stepwatch_trade) and was collected at all three time points. The SAM units were worn on the ankle using a Velcro strap and were provided at each assessment meeting when the researcher provided a demonstration and provided a detailed information sheet with a contact number for any problems encountered. The units count steps based on acceleration of the leg as opposed to mechanical movement. Steps were chosen to represent habitual physical activity because walking is one of the most commonly reported activities of older people and requires no special equipment or training. A SAM was given to each patient to wear on the ankle during waking hours for 7 days. We chose this method of unbroken data collection for 7 days because it was considered
Determinants of Physical Activity in Older Fallers

Coping strategies were assessed using the SOC Questionnaire (scored from 0 to 3 across four scales: elective selection, loss-based selection, optimization, and compensation; Freund & Baltes, 2002). The Social Support Questionnaire (Sarason, Levine, Basham, & Sarason, 1981) measured the number of people in an individual’s social network whom they perceived as providing help and support (up to nine individuals). Balance mobility was used to demonstrate physical function and was assessed using the TUG test (Podsiadlo & Richardson, 1989). Falls self-efficacy was assessed using the Falls Efficacy Scale (score of 0–64; Tinetti, Richman, & Powell, 1990).

Analyses

Linear mixed-effects (LME) modeling was used to model the data because this technique allows for both random effects, for example, individual differences that cannot be estimated, and fixed effects, for example, stable individual differences such as age, to be modeled; LME modeling can accommodate small, unbalanced datasets; and the temporal nature of longitudinal data is explicit in LME modeling. The target population for this study was expected to be highly heterogeneous, making LME the most appropriate analytical technique. Software used included the Statistical Package for Social Scientists (SPSS) version 15.0, R, and S-Plus. The random effect modeled was “patient.” Fixed effects were falls self-efficacy, social support, loss-based selection, optimization, and interaction effects between months and intervention, social support and loss-based selection, and social support and optimization. The TUG test was a fixed effect used in the final modeling. Associations between SOC subscales and habitual physical activity were investigated at baseline with correlation tests.

Results

Patient Characteristics

Clinical staff identified and recruited 98 men and women referred to falls-prevention exercise were. There was a high dropout rate from the study: 40% (40) dropped out at program completion (6 moved, 19 failed to respond to telephone or postal contact, 3 through illness, 10 refused because of lack of time, and 2 refused to use the accelerometer) and 36% (33) at 6-month follow-up (3 moved, 15 failed to respond to telephone or postal contact, 12 refused because of lack of time, 1 through illness, and 2 refused to use the accelerometer). The group of individuals who dropped out did not differ significantly from those who did not across age, balance mobility, social support, or habitual physical activity ($p > .05$). In all, 22 participants completed the study; their mean age was 78.9 years ($SD$ 7 years) and 64% were women. The program-based splits are presented in Table 1. As expected, research
participants in the hospital-based program were older and less active at baseline and had poorer mobility (TUG) than participants referred to the community-based program but had similar falls efficacy.

### Primary Outcome

Habitual physical activity data are presented in Figure 1. There was large variance in each group at baseline (Table 1). Variance increased by 50% at program completion for the 10 community-based FPE participants (min/median/max [steps] 1,430/2,930/5,193 at baseline and 1,322/3,076/8,752 at program completion). Variance remained large for the 12 hospital-based FPE participants (min/median/max 538/2,780/4,687 at baseline and 609/2,492/5,198 at program completion). Some participants increased their habitual physical activity during and after the program, some reduced it, and some increased but did not sustain it. Overall, there was a small increase in habitual physical activity at program completion with a larger increase 6 months later.

Although at all assessment points the community-based FPE program group walked more than the hospital-based FPE group, these differences were not significant ($p = .24$; Model 1 in Table 2). The differences over time were also not significant for either intervention group.

Determinants of habitual walking were explored in Models 2 and 3. LME modeling demonstrated that the TUG test ($p = .08$) and social support ($p = .02$) were weak, independent predictors of habitual physical activity, both in the direction of lower habitual physical activity. Falls self-efficacy had almost no effect. This model clearly showed the strongest predictors of habitual physical activity to be the coping strategies of loss-based selection (lower habitual physical activity, $p = .02$) and optimization (higher habitual physical activity, $p = .06$; Model 2 in Table 2). There was an interaction effect between loss-based selection and social support ($p = .02$).
Figure 1 — Habitual physical activity data at (1) baseline, (2) program completion, and (3) 6-month follow-up for the hospital-based (upper panel) and community-based falls-prevention-exercise group (lower panel). Median values are shown as bold, dotted lines. Each line represents one individual’s habitual physical activity response over time.
### Table 2  Linear Mixed-Effects Modeling of Habitual Physical Activity Data

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Model 1</th>
<th>Model 2: TUG Data Included</th>
<th>Model 3: TUG Data Excluded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>2,489 (371.17)</td>
<td>-186.4 (135.1)</td>
<td>-27.9 (142.8)</td>
</tr>
<tr>
<td>Time (months)</td>
<td>23.9 (42.64)</td>
<td>2.3 (17.6)</td>
<td>-31.9 (17.0)</td>
</tr>
<tr>
<td>Intervention</td>
<td>676.1 (560.86)</td>
<td>-937.4 (300.2)</td>
<td>-316 (220.8)</td>
</tr>
<tr>
<td>Time: intervention</td>
<td>22.3 (55.17)</td>
<td>-937.4 (300.2)</td>
<td>-316 (220.8)</td>
</tr>
<tr>
<td>Falls self-efficacy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social support</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss-based selection (LBS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optimization (O)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social support: LBS</td>
<td>375 (128.8)</td>
<td>173.7 (91.8)</td>
<td>-177.6 (100.2)</td>
</tr>
<tr>
<td>Social support: O</td>
<td></td>
<td>173.7 (91.8)</td>
<td>-177.6 (100.2)</td>
</tr>
<tr>
<td>Balance mobility</td>
<td>-34.7 (16.4)</td>
<td>-2.1157 (.08)</td>
<td></td>
</tr>
</tbody>
</table>

**Note.** TUG = timed up-and-go test.

*Approaching significance, <.05 and >.1. **Significant, <.05.
Data were remodeled excluding the TUG-test data because of the very limiting effect of these data in the first model (Model 3 in Table 2) as a result of small numbers. Falls self-efficacy approached significance as an independent predictor of habitual physical activity ($p = .08$) here, although it remained a weak contributor to the model. Social support was lost as a significant independent predictor ($p = .17$). Finally, optimization approached significance as an independent predictor ($p = .06$). Loss-based selection was a strong, significant predictor ($p = .02$).

The interaction effect between social support and loss-based selection remained in Model 3, although it was a weaker and less significant effect ($p = .07$). Model 3 also modeled any interaction effects between social support and optimization. Although a nonsignificant predictor at the traditional level of .05, the effect was of a similar magnitude in the direction opposite that of the interaction effect between social support and loss-based selection.

**Discussion**

Maintaining or increasing habitual physical activity is an intended and supposedly beneficial outcome of rehabilitation after falls and of FPE programs but not a common outcome measure in either clinical trials or clinical-practice evaluation. We have proposed that a self-imposed reduction in activity levels may account for avoidance of falling in some individuals after FPE programs. Although, overall, habitual physical activity levels rose in this combined cohort, activity levels were highly heterogeneous, and for some individuals they fell. The greater mobility impairment of the hospital exercise group may explain why their habitual physical activity was less variable, their scope being restricted by their capacity. Although, as expected, balance mobility and falls self-efficacy were associated with habitual physical activity, their effect was less than the adaptive strategies of loss-based selection and optimization, which worked in opposite directions. Thus, higher scores on loss-based selection were associated with less walking, possibly because of self-regulated activity restriction or interpretation of “take care” messages from trainers or peers. Higher optimization scores were associated with more walking, indicating that physical activity is congruent with a preferred identity. Social support also had an association.

Thus, for this small mixed sample of participants, there was no overall increase in ongoing physical activity, suggesting that this desired outcome cannot be assumed from participation. The average increase in walking from baseline to follow-up in the hospital-based FPE group was very small, approximately 130 m/week, based on a stride length of 0.65 m (Judge, Davis, & Ounpuu, 1996). For the community-based group, the average increase during the equivalent period was 450 m. These increases would confer only modest or no physiological health benefits. In terms of social participation, small increases may have been entirely indoors; we cannot tell from these data, but the greater average increase of the community-based group could reasonably represent an additional trip out of the house each week.

**Limitations**

These results are derived from a small data set, with high attrition because of the challenges imposed when carrying out applied health research. However, LME modeling is a robust technique, chosen specifically to limit the influence of few,
unbalanced data. We did not have information on adherence during the supervised or home-exercise component of the program and so could not investigate the association of these factors with habitual physical activity outcome. We acknowledge the case-study nature of this work and recognize the need to repeat it across different populations and settings. Finally, we note that walking is only one form of activity in which older adults participate. Nonambulatory activity such as swimming would not be picked up by these monitors. However, in measuring walking we are targeting the most common and measurable source of physical activity for this age group.

**Clinical Implications**

This is an important study and the first to our knowledge to examine the role that behavioral coping strategies play in determining physical activity of older fallers. Coping strategies can be used to preserve continuity in life and maintenance of identity, particularly in later life when these are challenged by the aging process. This study demonstrated that two specific coping strategies best predicted habitual walking in this group of elders. With individual coping strategies largely explaining the various patterns of activity change—one of the clinical program outcomes—it may be important in multifactorial programs to adapt and agree on individual targets with participants to maximize the effectiveness of their preferred approach. For example, an exercise group composed predominantly of optimizers may be able to progress exercise intensity more effectively. Loss-based selectors may benefit more in terms of falls prevention and quality of life by a hazard-avoidance approach.

Identity, in part, determines how older people view falls-prevention interventions (Ballinger & Clemsen, 2006). Given the high attrition rate of patients participating in FPE, this work would seem to suggest a mechanism for falls services to better target patients using knowledge of the coping strategies employed to maintain identity. It may be futile to refer a patient with high loss-based selection to an exercise-based intervention because increasing activity may not be congruent with their identity and how they choose to maintain it.

The results here, although limited, have a clear clinical message. It has been said elsewhere that how people choose to live should be built into the provision of health and social services (Tanner, 2007). We would agree with this and, indeed, with our work demonstrating a relatively strong role for self-selected coping strategies, have provided evidence that this should be the case in falls services.

**Conclusion**

Exercise programs are a commonly used approach to reduce the rate and chance of older people falling and have a degree of success. Although physical activity is promoted by these programs, rarely is it an explicitly measured outcome. Activity restriction by some individuals may contribute to the average reductions in fall rates, and improved stability through reducing mobility impairments may be the mechanism for others. Our study aimed to explore physical activity levels and their determinants in at-risk older people participating in two evidence-based systematic National Health Service programs. Overall, significant increases in habitual physical activity did not occur and can probably not be assumed to occur in other clinical services. This study was novel in its application of Baltes’s SOC theory...
to examine the habitual physical activity of older fallers, with loss-based selection and optimization evidenced as the best predictors. Thus, how older fallers chose to cope with falling and its consequences determined habitual physical activity more than balance mobility, self-efficacy, or social support. Despite this study’s limitations, these results raise important clinical questions for falls-prevention services and merit further investigation in larger prospective cohorts.

Acknowledgments

We thank Daniel Vieira for his statistical support. We would also like to thank the reviewers, in particular the independent statistical reviewer, for their helpful comments on this manuscript.

References


