Randomized Trial of Domiciliary Versus Center-based Rehabilitation: Which is More Effective in Reducing Falls and Improving Quality of Life in Older Fallers?

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Background. To compare the effect of two modes of delivering a falls prevention service in reducing the rate of falls and improving quality of life, activity levels, and physical status among older adults with a history of recent falls.

Methods. A randomized controlled trial was conducted with a total of 107 participants with blinded baseline and follow-up assessments. The participants were older community-dwelling adults referred for a falls prevention service located in Brisbane, Australia. The intervention was a multiple component falls prevention service delivered in either a domiciliary or center-based mode of delivery. Both programs were similar apart from setting and consisted of three components, a balance and strength component, falls prevention education, and functional tasks. Physical and psychosocial assessments were administered at baseline, 8-week follow-up and 6-month follow-up. Falls data were collected by monthly telephone contact and by interview at 8 weeks and 6 months.

Results. The center-based service demonstrated significantly better results in preventing falls over the home-based service. Clients in the center-based arm of the trial experienced fewer total falls and this group also had a greater reduction in the total number of fallers after the intervention.

Conclusion. This research demonstrates that delivering a similar service in different settings—home based or center based—impacts upon the effectiveness of the service. Community-dwelling older adults with a history of falls should be provided with center-based programs in preference to home-based programs where they are available.

Key Words: Falls—Frailty—Community Rehabilitation.

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INTRODUCTION

Falls in older adults are a major physical, social, and economic burden to both the individual and society as a whole. Multidisciplinary falls prevention services in the community aim to address the multiple factors that lead to physical decline and falls and return people to their normal activities. A recent systematic review and meta-analysis of interventions to prevent falls in the community includes 111 studies and concludes that multiple component group exercise, Tai Chi, and individually prescribed home exercise programs have been proven to reduce the rate of falls and risk of falling (1).

Falls interventions described in the literature have looked at many different aspects of falls prevention and include interventions provided in either a home or a center-based group format. However, no head-to-head comparison of which setting is the more effective—home or center—has been identified in older community-dwelling adults. It is important to determine which of these settings is the more efficacious method of service delivery and which is the more cost-effective so that maximum value for limited health care inputs can be obtained. One trial has previously compared home training to a combination of home and center-based settings (2). This study with a comparable patient population found improvements in the mental health component of the medical outcomes short form 36 (SF-36) quality of life measure and ambulatory capacity measured by walking speed and number of walks outdoors in the combination home-center-based program over the home-based program. No differences were found in falls rates between groups or other physical measures.

For center-based interventions, the stepping on program, a multifaceted community approach using small groups reduced falls by 31% (3). An intervention including group-based exercise, vision management, and home hazard reduction found that the exercise program was the most potent single intervention and that the combination of all three interventions was the most effective at reducing falls (4). A
weekly community-based group exercise has been shown to reduce falls by 40% versus a control group of no exercise over a 12-month period (5). For home-based interventions, a variety of exercise programs in different patient groups have had positive effects in reducing falls versus a control or usual care group (6–8).

Even if both services are equally effective in preventing falls and improving quality of life, there may be economic advantages in conducting a service at home or in a center. It is commonly believed that center-based therapy offers cost reductions for the health provider due to increased throughput of patients per staff member and transferring transport costs to the consumer. A recent break-even analysis of community rehabilitation falls prevention services found that both home-based and center-based services were able to break even and thus be worth implementing from a societal perspective. The center-based service however offered better value for money due to lower variable costs associated with providing the service (9). Another study comparing home to day hospital rehabilitation following hospital discharge found that although both groups recorded significant improvements in all functional measures from baseline to 3 months, the day hospital group was twice as likely to be readmitted (10). The authors of this study postulated that the differences in admission could possibly be due to factors such as increased access to medical staff for the day hospital group and/or increased mastery and self-management in the home-based group and suggested that home rehabilitation should be offered ahead of day rehabilitation services.

**Objectives**

To compare whether a falls prevention service delivered either at home or in a group setting is better for improving falls rates and health-related quality of life. In addition, activity levels, balance and strength measures, and carer strain as secondary outcomes of interest will be compared between the two settings.

**Methods**

**Design**

Randomized clinical trial with blinded assessment at baseline, 8 weeks and 6 months follow-up. Participants were allocated to one of two groups, a domiciliary (home-based), individual community rehabilitation service or a center-based (hospital gym), group community rehabilitation service. Comprehensive details of the methodology including the power analysis of this trial have been previously reported (11).

**Participants and Setting**

Participants were community-dwelling older adults aged >60 years who were referred to the Metro South Community Rehabilitation Service by one of the three local hospital emergency departments (presented following fall but not admitted) or by their general practitioner for falls or unsteadiness. Participants were eligible for the trial if they were referred to the service for falls or functional decline, were aged 60 years and older and were able to complete a timed up and go test. Participants were excluded if they resided in high-level care, were nonambulant, or were assessed by an occupational therapist or physiotherapist as being unable to participate in a community program due to cognitive or physical function.

**Interventions**

The program was a multiple intervention as defined by the Prevention of Falls Network Europe (ProFaNE) (12) with a fixed combination of interventions delivered to all participants. These interventions were selected according to best available evidence (1, 13), demonstrating the effectiveness of similar programs in preventing falls, and included exercise, home safety assessment, and education. Both groups received an 8-week program delivered once a week and a home exercise program of three exercises tailored to the client’s ability given by a physiotherapist. The exercises were balance specific (eg, tandem stance, open eyes, shut) and were to be performed twice daily for around 10 minutes at each session.

Both exercise programs consisted of balance and strength exercises and functional tasks. The center-based program consisted of a warm-up of modified Tai Chi (14–16), balance workstations, lower limb strengthening exercises, indoors walking circuit, and upper limb functional activities (3, 4). The home program was identical apart from substituting outdoors walking for the indoor walking circuit and activities of daily living for the upper limb circuit. In the center-based intervention, functional training was conducted in standing and included shoulder arc, peg-board, climbing board, and putty exercises. In the home-based program, functional tasks included cooking, hanging out washing, and cleaning. In addition, all participants received recommendations for home modifications by an occupational therapist (17). Education was identical in both groups and consisted of 30 minutes of verbal presentation from the treating therapist (occupational therapist or physiotherapist) with handouts. The information covered falls prevention, promoting physical activity, goal setting and review, medication management, continence, relaxation, stress management, and accessing community services similar to that used in previous studies (18, 19).

**Primary Outcome Measures**

Falls after the intervention commenced were collected monthly by telephone contact and at interview at the 8-week and 6-month follow-up assessments. The number of falls in the previous 6 months prior to the intervention was recorded.
by retrospective recall from the client at the initial assessment. Health-related quality of life was collected using the European quality of life tool (EQ-5D), a widely used, reliable, and validated tool for measuring quality of life in similar populations (20, 21).

Secondary Outcome Measures
Demographic and health assessments contained within the Ongoing Needs Inventory (22) were used to collect demographic data and basic health data (by self-report). Variables included age, gender, number of falls within the last 6 months, urinary incontinence, nutrition status, and mental health (Kessler psychological distress K10 scale; (23). Cognition was assessed using the Abbreviated Mental Test Score (24).

A battery of physical assessments was used to assess underlying physical functioning. Mobility was assessed using the timed up and go (25). Balance was assessed using the step test and the Romberg Balance assessment (26), testing balance for up to 30 seconds with eyes shut. Walking aid used for indoor mobility was also recorded. The 9-Hole Peg Test was used to measure upper limb function (27). The Frenchay Activities Index is a self-report functional participation scale and was used to assess participation in a combination of activities of daily living, leisure (social and participative), and work to measure overall function and participation (28). Body mass index was calculated from weight and height measurements.

Procedure
An initial home visit was conducted by an occupational therapist and physiotherapist for each potential participant. Descriptive data were collected on demographic and social information (including sex, age, type of housing, and availability of carer) and baseline measures were also collected at this visit. Participants who met the inclusion and exclusion criteria were asked to participate in the study and informed consent was obtained.

Participants were allocated to domiciliary or center-based services by a computer-generated list of random numbers. The randomization sequence was placed into sealed, opaque numbered envelopes by administration staff not connected with research. Following consent, the assessing therapist contacted administration staff who opened the next envelope in the sequence and informed the therapist of the participant’s group allocation.

Following allocation, participants were enrolled in the center-based or home program starting the following week. The center-based program was a rolling entry so that participants could enter and exit at any week. After 8 weeks of intervention, participants were given a revised home exercise program similar to that given in the program as a maintenance measure. All outcome measurements were then collected in the participant’s home by an assessor blinded to group allocation. Participants were followed up by monthly telephone contact for falls data and reassessed 6 months after initial randomization again by a blinded assessor.

Statistical Analysis
All data were analyzed according to initial group allocation on an intention to treat basis. For the analysis of falls, total falls were compared between groups using negative binomial regression with robust 95% confidence intervals adjusted for the time the participant remained in the trial. Negative binomial regression is recommended for analysis of falls data as it often follows an overdispersed Poisson distribution (29). This allowed assessment of between-group differences while allowing for dropouts and missing data. In addition, the difference in the proportion of fallers between groups was compared using logistic regression.

Health-related quality of life was compared between groups using a generalized estimating equation (GEE) with an exchangeable working correlation structure and robust variance estimates. The GEE is similar to repeated measures ANOVA/ANCOVA. The design of the study is longitudinal with repeated measurements, which are correlated with one another in an individual. The GEE is a flexible way of analyzing this type of design and can be adapted for a range of data distributions for the dependent variable and produces relatively precise and unbiased estimates even in presence of missing data (missing at random, missing completely at random, or missing not at random) without need for data imputation (30, 31).

Group (center vs home), assessment point, and group-by-assessment point interaction terms were entered as independent variables. A positive effect of one of the intervention approaches at one or more of the assessment time points was revealed by one or more significant group-by-assessment interaction terms.

Secondary outcome measures were also analyzed with a GEE with Gaussian distribution. Where there was evidence of skewness, Gaussian distribution was investigated; however results did not diverge considerably from those based on the Gaussian distribution, hence the Gaussian distribution results are reported. Analyses were performed with STATA version IC 9.2. (STATA Corporation, College Station, TX).

Results
Sample Characteristics
Recruitment of the 107 participants took place between June 2004 and June 2008 with follow-ups completed by January 2009. The flow of participants through the trial and the reasons for dropouts are presented in Figure 1. Seventy-six participants completed all the follow-up points (8 weeks and 6 months postrecruitment). The loss to follow-up was marginally higher for the center-based group (18 participants) than the home-based service (14 participants). Dropouts...
were minimized as follow-ups were conducted in the patient’s home by a visiting therapist. Despite this, there was still a reasonable loss to follow-up (20% at 8 weeks and 29% at 6 months).

Comparisons of baseline characteristics between groups are presented (Table 1). Groups were similar at baseline for demographic characteristics and the primary outcome measures. There was a significant difference in the secondary outcomes of step test and Frenchay Activities Index (Table 2) with the domiciliary cohort performing poorer on these two measures. As baseline measurements were already included in the GEEs, no further strategies were employed to adjust for this imbalance.

Figure 1. Flow of participants through the study.

Clinical Outcomes

Primary outcomes.—The center-based service demonstrated a significant improvement in overall falls rates compared with the domiciliary service. The rate of falls was 1.1 falls per patient-year in the center-based program as compared with 2.3 falls per patient-year in the domiciliary program. Negative binomial regression analysis of rate of falls with adjustment for time followed-up, identified that the incident rate ratio of falls in the center-based group compared with the domiciliary group was 0.46 (0.22, 0.96), \( p = .038 \), indicating that participants allocated to the center-based group service reported approximately half as many falls as
comes were not significantly different between the groups 6 months.

groups, although the group program did score slightly higher than the domiciliary service. For the 6 months postimplementation of the program, levels had returned to initial levels by 6 months in both programs.

**Discussion**

These results support previous research, which showed the efficacy of multiple component programs that are targeted at high risk and multiple fallers. In addition, the results are unique in demonstrating that a center-based program can be superior in preventing falls to a similar service provided in the home.

Previous studies have established a minimum clinically important difference threshold of 0.074 for the EQ-5D instrument utility component (35). The center-based group reported an improvement in their EQ-5D scores well in excess of this threshold over the 6-month follow-up period, as did participants in the domiciliary group. A difference of 0.12 was modeled in favor of the center-based group when contrasting the relative amount of improvement between these groups over this time period. However, this difference was not statistically significant providing argument for a larger replication study to be conducted.

This study is in concordance with most studies as it required a self-reported method of falls recording. This method is limited as it is unlikely that all falls will be recalled even if different timeframes and methods (eg, diary) are used. The use of monthly reported as opposed to daily diary recording could mean that falls rates were underreported by up to 20% (36); however, this should be consistent across groups and thus not affect the between-group comparison. Improving the reliability of current health technology, such as falls monitoring devices, (37, 38) will enable researchers to more accurately record the rates and causes of falls in future trials, particularly where clients with cognitive decline are included in the study design.

The loss to follow-up of participants within this trial was of concern and could potentially bias the results in favor of the group program. Previously published guidelines on conducting research with frail older persons have noted that other trials have similar problems with high dropout rates hampering clinical trials (39). In addition, the trial was a pragmatic research design with clinicians responsible for the recruitment and treatment phases. Potentially the use of clinical staff contributed to the loss to follow-up due to a lack of understanding of the importance of pursing participants allocated to the domiciliary service during the 6-month follow-up period. To allow for the difference in dropout rates between the two programs, a further analysis was conducted assuming a scenario where every client without full follow-up data was assumed to have fallen at the average follow-up rate of falls of 1.14 falls per person. This did not change the significance of the results (p = .046) but altered the incident rate ratio to 0.61 (0.38, 0.99). The proportion of fallers for the 6 months pre program was n = 49 (89%) for domiciliary and n = 41 (79%) for the center-based service. For the 6 months postimplementation of the service, the proportion of fallers was substantially lower in the center-based cohort, 12 (32%) as opposed to 25 (61%) in the domiciliary group (odds ratio [OR] 0.31 [0.14,0.72], p = .006). Given the results indicated there could be a slight difference at baseline (although this did not reach significance at p = .05), the faller at baseline variable was included as a covariate in the logistic regression. This changed the odds ratio point estimate of effect and 95% confidence interval; 0.33 (0.14–0.75), p = .009; however, the difference between the groups was still significant. The result indicates that the group service is significantly better at reducing the proportion of fallers as well as the total number of falls over the home-based service.

Quality of life as measured by the EQ-5D is reported in Table 2. Results were not significantly different between groups, although the group program did score slightly higher than the domiciliary program at both 8 weeks and 6 months.

Secondary outcomes are also presented in Table 2. Outcomes were not significantly different between the groups with the exception of the center-based intervention performing better on the upper limb dexterity test. Both groups improved on the baseline physical measures for the timed up and go, step test, and reaction time tests. The measure of activity (the Frenchay Activities Index) also improved in both programs approximately equally. Carer strain was recorded initially at low to moderate levels according to the carer strain index (34). There was a slight reduction in both groups at the 8-week mark immediately following the program, but levels had returned to initial levels by 6 months in both programs.

**Table 2. Results were not significantly different between the groups**

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Domiciliary (n = 55)</th>
<th>Center (n = 52)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body structure and function</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, mean (SD)</td>
<td>78.7 ± 8.0</td>
<td>79.2 ± 7.4</td>
<td>.65</td>
</tr>
<tr>
<td>Female, n (%)</td>
<td>37 (67)</td>
<td>34 (65)</td>
<td>.84</td>
</tr>
<tr>
<td>Number of health conditions, mean (SD)</td>
<td>3.8 ± 2.9</td>
<td>4.2 ± 2.5</td>
<td>.30</td>
</tr>
<tr>
<td>Number of medications, mean (SD)</td>
<td>6.3 ± 4.4</td>
<td>6.7 ± 3.9</td>
<td>.42</td>
</tr>
<tr>
<td>Urinary incontinence, n (%)</td>
<td>27 (49)</td>
<td>29 (55)</td>
<td>.72</td>
</tr>
<tr>
<td>Body mass index, mean (SD)</td>
<td>25.8 ± 6.2</td>
<td>27.7 ± 6.2</td>
<td>.92</td>
</tr>
<tr>
<td><strong>Activity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uses walking aid, n (%)</td>
<td>33 (60)</td>
<td>24 (46)</td>
<td>.12</td>
</tr>
<tr>
<td>Falls, median (IQR)</td>
<td>2 (1–4)</td>
<td>2 (1–3)</td>
<td>.46</td>
</tr>
<tr>
<td>Falls, mean (SD)</td>
<td>2.3 ± 1.8</td>
<td>2.15 ± 2.0</td>
<td>.59</td>
</tr>
<tr>
<td>Fallers, n (%)</td>
<td>49 (89)</td>
<td>41 (79)</td>
<td>.15</td>
</tr>
<tr>
<td><strong>Participation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currently driving, n (%)</td>
<td>9 (16)</td>
<td>15 (28)</td>
<td>.15</td>
</tr>
<tr>
<td><strong>Personal factors</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Drinks alcohol, n (%)</td>
<td>20 (37)</td>
<td>18 (35)</td>
<td>.85</td>
</tr>
<tr>
<td><strong>Global factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality of life, mean (SD)</td>
<td>0.55 ± 0.32</td>
<td>0.57 ± 0.30</td>
<td>.90</td>
</tr>
</tbody>
</table>

*Falls compared using Mann–Whitney test and generalized estimating equation, continuous variables compared using t tests and proportions compared using Pearson’s chi-squared. Mann–Whitney used to compare total medications and comorbidities.*
<table>
<thead>
<tr>
<th>Construct</th>
<th>Descriptor</th>
<th>Measurement name</th>
<th>Initial assessment</th>
<th>Eight week follow-up</th>
<th>Six-month follow-up</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Domiciliary mean (SD)</td>
<td>Center mean (SD)</td>
<td>GEE coefficient (95% CI), p value</td>
</tr>
<tr>
<td>Body structure and function</td>
<td>Muscle power</td>
<td>Quads strength (kg)</td>
<td>14.8 (6.8)</td>
<td>13.5 (4.5)</td>
<td>−1.45 (−3.80 to 0.90) / p = .23</td>
</tr>
<tr>
<td></td>
<td>Muscle power</td>
<td>Lateral pinch test (kg)</td>
<td>5.4 (2.3)</td>
<td>5.8 (1.7)</td>
<td>0.14 (−0.66 to 0.93) / p = .74</td>
</tr>
<tr>
<td></td>
<td>Mental functions—cognition</td>
<td>AMTS (24)</td>
<td>8.7 (1.1)</td>
<td>8.6 (1.3)</td>
<td>−0.09 (−0.55 to 0.36) / p = .68</td>
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<tr>
<td></td>
<td>Mental functions—depression</td>
<td>K10 scale (23)</td>
<td>16.4 (6.4)</td>
<td>17.1 (5.8)</td>
<td>0.88 (−1.51 to 3.27) / p = .47</td>
</tr>
<tr>
<td>Activity</td>
<td>Mobility</td>
<td>Timed up and go (32)</td>
<td>22.1 (12.1)</td>
<td>19.0 (16.1)</td>
<td>−3.05 (−8.46 to 2.35) / p = .27</td>
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<tr>
<td></td>
<td>Balance</td>
<td>Step test (26, 33)</td>
<td>5.4 (4)</td>
<td>7.7 (3.7)</td>
<td>2.25 (0.79–3.70) / p = .002*</td>
</tr>
<tr>
<td></td>
<td>Reaction speed</td>
<td>Simple reaction time test (ms)</td>
<td>379 (174)</td>
<td>356 (135)</td>
<td>−23.2 (−46.5 to 40.02) / p = .47</td>
</tr>
<tr>
<td></td>
<td>Upper limb dexterity</td>
<td>9-Hole Peg Test (s) (27)</td>
<td>31.7 (9.9)</td>
<td>30.4 (12.2)</td>
<td>−1.32 (−5.57 to 2.91) / p = .54</td>
</tr>
<tr>
<td>Participation</td>
<td>Global</td>
<td>Frenchay (28)</td>
<td>17.5 (9.1)</td>
<td>21.5 (8.0)</td>
<td>3.99 (0.75–7.23) / p = .02*</td>
</tr>
<tr>
<td></td>
<td>Environmental factors</td>
<td>Support and relationship</td>
<td>5.0 (2.2)</td>
<td>3.8 (3.1)</td>
<td>−1.17 (−3.16 to 0.82) / p = .25</td>
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<tr>
<td></td>
<td>Personal factors</td>
<td>Lifestyle</td>
<td>6.8 (3.5)</td>
<td>7.0 (2.9)</td>
<td>0.12 (−1.12 to 1.37) / p = .35</td>
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<tr>
<td></td>
<td>Global</td>
<td>Quality of life</td>
<td>62.4 (15.2)</td>
<td>61.1 (16.1)</td>
<td>−1.33 (−7.37 to 4.71) / p = .67</td>
</tr>
</tbody>
</table>

Notes: AMTS = Abbreviated Mental Test Score; EQ-SD = European quality of life tool; GEE = generalized estimating equation; V AS = visual analogue scale.
* Significant difference at baseline.
† Significant difference at follow-up assessment.
follow-up assessments for noncompliant participants. However, the use of a pragmatic design such as this allows the demonstration of the model in real clinical situations and is therefore directly transferrable to clinical practice (40). More participants in the group cohort were lost to follow-up for refusal to participate further (13 of 16) than in the home setting (three participants). It may be possible that factors such as the effort involved in traveling to a center play a role in whether older people are willing to attend and travel to a center-based setting. A British survey of more than 5,000 older people’s attitudes to preventing falls found that 36.4% were definitely willing to do strength and balance training programs at home to prevent future falls, whereas only 22.6% would definitely attend a group (41). It may also be possible that the participants who dropped out represented a sicker cohort than the overall population. Analyses of the subset of dropouts give a mean for the EQ-5D of 0.53 (0.32), which is lower but not significantly different from the sample mean of participants remaining in the study of 0.57 (0.30) by two sample t test (p = .55). The Frenchay Activities Index showed a trend for reduced participation at baseline in the group that dropped out; 17.9 (8.5) versus 20.1 (8.9), p = .23 and timed up and go was slower, 24.0 (21.8) versus 19.1 (9.2), p = .10. As the results were not significant, it is not expected that this would influence the overall results of the study. Imputation of missing falls information from the clients who dropped out resulted in a smaller effect size for the group program over the home program; however, the overall result was still significant.

Secondary measures did not reflect the differences found in falls rates between the groups. Timed up and go, reaction time, and step test have been found to be predictors of risk of future falls (25, 42, 43) and although these measures improved in the group program over the time period, they also improved somewhat equally in the home program. As the study was not powered to detect differences in these secondary measures, a larger cohort or a longer follow-up period may be needed to detect differences in these measures. There may also be other factors involved in attending a group over a home program, which improve falls risk such as reducing fear of falling that was not measured in this study.

Hence, although the group program performed better on the primary outcome measures, it is not appropriate for all community-dwelling clients. Indeed, the cohort recruited often have difficulty mobilizing and have transportation issues, so domiciliary programs are often the only method of delivering a program to these people. Many potential participants declined to participate in the trial as they preferred to have a program delivered at home.

**Implications**

The results indicate that for superior efficacy, where possible, participants should be enrolled in center-based falls prevention programs; however, participants need to be physically able to complete the program and have available transportation. Many people living in the community are not able to access center-based services and from previous research, both domiciliary and center-based programs have a positive effect for this cohort. Given this, it is important that any service planning to undertake a community program consider providing a combined service delivery model to ensure equity in access for clients who may be unable to attend a center-based service. In addition, subsidized transport should be considered as an option to enable older adults to attend center-based rehabilitation services.

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