Evaluating the Effectiveness of a Home-Based Fall Risk Reduction Program for Rural Community-Dwelling Older Adults

Shawna M. Yates and Tim A. Dunnagan

Department of Health and Human Development, Montana State University, Bozeman.

Methods. Complete data were collected on 37 community-dwelling subjects, aged 67 to 90, who participated in a 10-week fall risk reduction program. The subjects were randomly assigned to an intervention group or to a control group. The intervention group received fall risk education, home-based exercise programming, nutrition counseling, and environmental hazards education. Both groups completed a variety of physiologic, psychometric, and environmental fall-related risk assessments before and after the intervention period.

Results. The intervention group showed statistically significant improvement in balance, bicep endurance, lower extremity power, reduction of environmental hazards, falls efficacy, and nutritious food behavior during the study period.

Conclusions. The low-cost, home-based fall risk reduction program for community-dwelling older adults was effective in reducing some of the studied fall-related risk factors over a 10-week period.

As one ages, the complex postural control system is often compromised, making it more and more difficult to avoid falls. Approximately 30% of the noninstitutionalized people over the age of 65 fall each year (1,2). Of those who fall, one third suffer moderate to severe injuries (3). Nearly 200,000 Americans fracture their hips each year, usually as a result of a fall (4). The National Safety Council (5) has cited death due to unintentional injuries, such as those resulting from falls, as the sixth leading cause of death among those age 65 and older. Furthermore, fall-related injuries often require medical attention.

A study done by Kiel and colleagues (6) found that older adults who have fallen use the health care system more than older adults who have not fallen. Falls impinge on the economics of the health care system and of the victims of falls. Urton (7) reported that between $75 and $100 billion are associated directly or indirectly with the cost of falls each year. Other costs include physical suffering, mental anguish, days in the hospital, transfers to extended care facilities, and the loss of an independent lifestyle.

Once an older person falls, a downward spiral often begins. They may live in constant fear, become less active, less independent, and less confident. One of the most common fears among elderly adults is the “fear of falling” (8). Fear may have a tremendous impact on quality of life and physical decline (9).

To reduce the consequences of falls for both the individual and society, it is imperative that preventive steps be taken to reduce the risk of falls. Studies have shown that the incidence of falls is related to the number of fall-related risk factors (2,10). Reducing just one fall-related risk factor can have a great impact on the frequency and morbidity of falls. Tinetti and colleagues (2) found that the risk of falling increased linearly with the number of risk factors, from 8% with no risk factors to 78% with four or more risk factors. Reducing the incidence of falls among older adults will potentially reduce the high health care costs for the individuals, their families, and U.S. taxpayers. More importantly, reducing the incidence of falls suffered by older adults may improve the quality of life for these individuals.

The following fall risk reduction investigation was designed to reduce fall risk factors in a group of rural community-dwelling seniors. Unlike other fall prevention programs geared for community-dwelling elderly persons [e.g., Tinetti and colleagues’ multifactorial intervention program (11)], the fall risk reduction program presented in this study was designed to be low cost and easily implemented by any trained caregiver. Primarily, the simplicity is beneficial for rural communities, which most often lack health care services. Furthermore, the study was designed to investigate a home-based intervention that incorporates fall risk education, exercise, nutrition, and environmental hazards programming within a rural setting. This combination of factors makes the investigation unique and an important pilot study into the area of fall risk reduction within elderly populations.

Methods

Subjects

Forty subjects over the age of 65 were recruited from four rural southwest Montana towns. To recruit these partici-
pants, the researcher visited each of the senior centers in these communities and presented the home-based fall risk reduction research project. A brochure describing the fall prevention intervention was given to older adults who participate in programs at each of the four senior centers. Brochures were also given to area clergy, who agreed to distribute the information to seniors in their congregation. Next, a recruitment notice was distributed through the local newspaper, and an article describing the entire fall prevention program was printed in the Prime Time News (a statewide senior news publication). Last, a public service announcement was run on the local public broadcasting television channel.

Eligible subjects were (i) over the age of 65; (ii) living independently within the community; (iii) not currently enrolled in a structured exercise program; and (iv) free from chronic neurological or muscle disease, an inability to walk, or terminal illness.

All subjects gave written informed consent as well as permission to complete all testing procedures in their home. A physician’s approval to participate in the study was also obtained for each subject. The subjects were randomly assigned either to the intervention group \(n = 20\) or to the control group \(n = 20\).

**Baseline Data Collection**

All subjects underwent a home-based interview and physical assessment by one of the researchers. Through the interviews, selected demographic, health status, psychometric, physiologic, and environmental data were collected. Demographic data included age, gender, education, and living arrangements. Health status data included vision, hearing, alcohol use, tobacco use, blood pressure, sedative use, foot conditions, level of physical activity, number of prescription medications, and previous hospitalization utilization.

Psychometric evaluations included ordinal measures for the Falls Efficacy Scale (FEC) to assess the subject’s confidence in performing common activities of daily living and the Hopkins Symptom Checklist to screen for depression symptoms. The FEC designed by Tinetti and colleagues (12) is a 14-question scale with a three-item Likert scale to measure the level of confidence. The 11-question depression measure developed by Derogatis and colleagues (13) uses a five-item Likert scale to report subclinical symptoms of depression.

The physiological tests were all interval measures and included tests for bicep endurance, body mobility (Get Up and Go), shoulder range of motion (Scratch Test), ankle dorsiflexion, lower extremity power, and balance. Bicep endurance was measured by counting the number of repetitions through the full range of motion with a 5-lb dumbbell during a 30-second period (14). Get Up and Go performance, previously determined by Tinetti (15) to be a significant predictor of falling, requires that the subject begin in a seated position, stand, walk an 8-ft course, and return to the original seated position. The course is a timed event. The Scratch Test used to measure shoulder range of motion was conducted by measuring the distance between the fingers when one hand is reached behind the head and the other behind the back (14). Ankle dorsiflexion was determined in the basic planes by standard goniometric techniques (16).

Balance was assessed using the Tinetti Balance Assessment (15), which requires the subjects to perform nine maneuvers. Each maneuver receives a score of 0 to 2, and the final balance score is summed. Lower-extremity power was calculated by the subjects’ ability to generate power from a seated to a standing position using the following formula:

\[
P = F(H_1 - H_2)/t,
\]

where \(P\) is power, \(F\) is force, \(H_1\) is height standing, \(H_2\) is height seated, and \(t\) is time.

Two ordinal scales were used to assess measures associated with nutrition, which included nutritious food behavior and locus of control for nutrition (17). The Nutritious Food Behavior scale measures food selection and consists of nine questions, each based on a three-item Likert scale. The Locus of Control for Nutrition scale consists of five questions also based on a three-item Likert scale. This scale was designed to measure locus of control expectancies in food behavior. For example, a person with an internal locus of control believes eating habits are within his/her control.

An ordinal environmental hazards checklist was developed by the researchers to evaluate the number of environmental hazards in the house. The 40-item list reviewed risks in the kitchen, bathroom, stairways, bedroom, yard, and entrances and was developed from available literature (1, 12, 18). A score of 1 was given for each environmental hazard. The scores were summed at the completion of the evaluation to provide a composite score of environmental hazards.

**Intervention**

The intervention group received a four-part program by one of the researchers throughout a 10-week period to help reduce fall-related risk factors. The intervention consisted of fall risk education, exercise programming, nutritional counseling and/or referral, and environmental hazard education. The control group received a delayed intervention following the 10-week intervention period.

Prior to the initiation of the exercise program, all of the subjects in the intervention group were briefed on the importance of fall prevention and risk reduction. The researcher spent 20 minutes educating the subjects about the association between falling and poor vision, poor hearing, sedative use, multiple medications, orthostatic hypotension, depression, and lack of physical activity.

The 10-week exercise program used in this intervention adhered to the guidelines of the Movement Matters: Home Based Exercise Program (19). The program, presented in a four-page brochure, focuses on improving strength, coordination, balance, and mobility through 19 chair-based exercises. The subjects were given an hour-long introduction to the exercise program. During this time they were taught how to properly perform each exercise and were allowed to ask questions. The subjects were encouraged to complete the entire program three times a week by following the text and visuals in the brochure. Each exercise session took approximately 15 minutes once the subjects became comfortable with the routine. To facilitate muscular strength and endurance development, each subject was given a set of 5-lb
adjustable weights. The subjects recorded how often they performed the exercises using log sheets provided by the researchers. Log sheets were completed daily and mailed to the researchers every week to track exercise compliance.

Adherence to the exercise program was defined as performing the exercises at least 12 times during the 10-week intervention. The researchers adopted this liberal definition because minimal amounts of physical activity can produce substantive changes in measures of physical fitness within nonactive populations (22). However, the subjects were encouraged to exercise three times a week so that the more motivated subjects would benefit from additional exercise.

Nutrition education and screening were facilitated through the Nutritional Screening Initiative (20), which is a multifaceted national effort to promote nutrition screening and better nutritional care for older adults. Improving an individual’s nutrition habits may help reduce factors that lead to fall-related risk such as orthostatic hypotension, depression, lack of energy and physical activity, and physiological decline. Consequently, the subjects completed the Nutritional Health Checklist and received a score ranging from 0 to 25. If their score ranged from 3 to 5, they received a Level I screen, which includes nutrition education in the form of handouts and a list of community resources that can provide help with nutrition. If their score was 6 or more, they received a Level II screen, which involves a referral to a registered dietician at no cost to the subject.

During the pretest visit an environmental assessment was made of the subject’s home. The 40-question environmental in-home assessment was specifically designed to determine environmental risk within the bathroom, kitchen, living room, bedroom, stairwells, and yard. Any of the environmental hazards identified were noted, and appropriate safety modifications were outlined for each subject to address. For example, if a stairwell was steep and dimly lit, the suggested modifications included night lights and/or new bulbs in the overhead lights, fluorescent tape marking the stairs, and banisters extending the length of the stairwell.

Post-Testing Data Collection

Both the intervention group and the control group were post-tested upon completion of the 10-week intervention. One subject was excluded due to a preexisting illness (multiple sclerosis), and two subjects did not finish the study (5% attrition). The remaining 37 subjects underwent a post-test evaluation. All data collection was performed by the same researcher, who was blinded to the pre-test scores during the post-test evaluation.

Analysis

Chi squares and unpaired $t$ tests were conducted to identify baseline differences between the intervention and the control groups. To determine changes in the physical outcome measures, one-tailed $t$ tests were conducted on the mean change scores. The physical outcome measures included balance, ankle flexion, bicep endurance, upper body flexibility, mobility, and lower extremity power. The ordinal measures were ranked data; therefore, nonparametric statistics were used to analyze the results. Specifically, a one-tailed Mann-Whitney test was used to analyze changes in nutritious food behavior, locus of control for nutrition, falls efficacy, depression, and environmental hazards.

Correlation matrices and scatterplot matrices were performed on mean change scores. Correlation was found between the left and right upper body flexibility; furthermore, the matrix plot revealed patterned data between these two variables. Consequently, the left upper body flexibility was eliminated from the analysis. No other variables showed significant correlations or patterned data.

Statistical significance was determined at the 0.1 level. This level was selected prior to the intervention period because of the exploratory nature of the study and the small sample size, which limited the power of the analysis. Also, the study contained 13 independent contrasts (dependent variables) that dramatically increased the risk of committing a Type I error. Hence, for this analysis the alpha was adjusted according to the Bonferroni inequality (21). The alpha adjustment was calculated by dividing the original alpha of .10 by the number of contrasts. Therefore, the physical outcome measures were tested at $\alpha = .014 (1/7)$, the psychometric and nutrition outcome measures were tested at $\alpha = .05 (1/2)$, and the environmental hazards were tested at $\alpha = .10$.

Results

The following analysis was based on a sample of 37 subjects (18 intervention subjects and 19 control subjects). The chi square and $t$ tests performed on the baseline data revealed no significant differences between the intervention and control groups on measures of age, gender, education, marital status, living arrangements, falls, and fall-related risk factors. The baseline characteristics of the study sample are described in Table 1.

On the basis of the liberal definition for adherence, 72.2% of the subjects exercised at least 12 times during the

<table>
<thead>
<tr>
<th>Variable</th>
<th>Intervention Group (n = 18)</th>
<th>Control Group (n = 19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (median)</td>
<td>76</td>
<td>78</td>
</tr>
<tr>
<td>Range</td>
<td>67–90</td>
<td>69–88</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Female</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Completed high school</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>Did not complete</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Married</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Widowed</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Divorced</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Living Arrangements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With someone</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Alone</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Fell in the Last Month</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>No</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Median Number of Fall-Related Risk Factors (range)</td>
<td>3–10</td>
<td>2–12</td>
</tr>
</tbody>
</table>
10-week period. In addition, 55% of the intervention group performed the exercise program at least three times a week for the duration of the 10 weeks.

**Between Group t Tests**

The results of the one-tailed t tests comparing mean change scores between groups for the physical measures are shown in Table 2, which shows that the change scores for the intervention group moved in a favorable direction in all areas except for the scratch-test measure. Conversely, all of the control group scores moved in an unfavorable direction. Statistically significant differences in change scores were observed for balance (p = .000), bicep endurance (p = .000), and lower extremity power (p = .001) when compared with the Bonferroni alpha of .014. However, the mean change scores between the groups were not significant for the Scratch Test (p = .15), dorsiflexion left (p = .097), dorsiflexion right (p = .199), or the Get Up and Go Test (p = .019).

**Mann-Whitney Test**

The results of the Mann-Whitney test comparing mean rank scores between groups for the nutrition, psychometric, and environmental hazards measures are shown in Table 3. A statistically significant difference in mean rank scores was observed for nutritious food behavior (p = .009) when compared with the Bonferroni alpha of .05. However, changes in locus of control for nutrition (p = .315) were nonsignificant. A statistically significant difference in mean rank scores was observed for Falls Efficacy (p = .023) at the .05 level; however, the difference in mean rank scores for Depression (p = .082) was not statistically significant. Finally, statistically significant differences in mean rank scores were observed in the number of environmental hazards (p = .002) when compared with the Bonferroni alpha of .10. Overall, the mean scores of the intervention group moved in a favorable direction, whereas the controls moved in a nonfavorable direction. The exception to this trend was seen in the decrease of environmental hazards within both groups. However, the difference was only significant for the intervention group.

**Discussion**

The purpose of this study was to determine if a home-based fall risk reduction program consisting of fall risk education, exercise programming, nutrition education, and environmental hazard reduction decreased selected fall-related risk factors. The analysis revealed statistically significant changes for the intervention group on balance, bicep endurance, lower extremity power, falls efficacy, reduction of environmental hazards, and nutritious food behavior. No statistically significant positive changes were observed in the control group.

The results of the study are meaningful for a number of reasons. First, the quasi-experimental design controlled for many threats to internal validity, such as history and maturation (23). Additionally, the researchers showed that the intervention group and the control group were similar in a variety of important demographic and health status variables. These two considerations support the conclusion that the differences between the groups were due to the program intervention. Second, although the sample size was small, the investigators were able to obtain detailed and accurate data on each subject during the 3-hour pre- and post-test home visits. Third, after employing the conservative Bonferroni statistical estimation, a number of significant changes were observed in the intervention group as a result of the programming. Consequently, the methods used in this study lend credibility to the outcomes of the home-based fall risk reduction intervention.

One weakness of the investigation is related to the nutrition intervention. Specifically, only one subject qualified for the nutritional consultation services. A possible reason for this outcome is that the subjects were primarily recruited from the local senior centers. These senior centers provide active nutrition services with noon lunches, educational seminars, and home-delivered meals. Therefore, future studies should employ recruitment techniques that reach more isolated home-bound seniors who are truly in need of nutritional counseling.

It is also important to consider that the changes seen within the intervention group occurred over a 10-week period. Therefore, the investigators were not able to establish whether the changes represented long-term or transient
changes in the selected outcomes. It would be interesting to observe the effects of this intervention over an extended period (i.e., 2 to 3 years).

Finally, the multifactorial nature of the intervention makes it difficult to tell which aspects of the program facilitated the significant changes. Therefore, future reports of risk reduction would benefit by examining each component of this multifactor fall risk reduction intervention. A study that separates the four intervention components could determine which piece has the greatest effect on reducing fall-related risk and the incidence of falls.

ACKNOWLEDGMENT

Address correspondence to Tim A. Dunnagan, Department of Health and Human Development, Room 122 PE Complex, Montana State University, Bozeman, MT 59717. E-mail: uhdt@montana.edu

REFERENCES


Table 3. Mann-Whitney Tests for Rank Scores Between Groups for the Nutrition, Psychometric, and Environmental Hazards Outcome Measures

<table>
<thead>
<tr>
<th>Outcome Variable</th>
<th>Mean Rank Score for Intervention Group</th>
<th>Mean Rank Score for Delayed Intervention Group</th>
<th>Z</th>
<th>One-Tailed p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locus of control for nutrition</td>
<td>18.18</td>
<td>19.86</td>
<td>−.482</td>
<td>.315</td>
</tr>
<tr>
<td>Nutritious food behavior</td>
<td>14.92</td>
<td>23.31</td>
<td>−2.375</td>
<td>.009*</td>
</tr>
<tr>
<td>Falls efficacy score</td>
<td>15.61</td>
<td>22.58</td>
<td>−1.994</td>
<td>.023*</td>
</tr>
<tr>
<td>Depression</td>
<td>16.61</td>
<td>21.53</td>
<td>−1.390</td>
<td>.082</td>
</tr>
<tr>
<td>Environmental hazards</td>
<td>14.21</td>
<td>24.06</td>
<td>−2.940</td>
<td>.002†</td>
</tr>
</tbody>
</table>

*Significant at the Bonferroni α = .05.
†Significant at the Bonferroni α = .1.