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Protective and Risk Factors for Physical Activity and Falls Among Oldest-Old Adults Enrolled in an Evidence-Based Fall Risk Reduction Program

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This study is an examination of protective and risk factors associated with weekly physical activity and number of falls among oldest-old participants enrolled in A Matter of Balance/Volunteer Lay Leader (AMOB/VLL) model. Poisson mixed regression models were used to assess potential protective (falls efficacy and self-rated health) and risk (pain, fatigue, and health interference) factors for weekly physical activity and number of falls from baseline to post-intervention after controlling for sex, race/ethnicity, age, education, living alone, and number of chronic conditions. Weekly physical activity and number of falls improved significantly from baseline to post-intervention. Falls efficacy scores and self-rated health (as protectors) as well as fatigue, health interference scores, and pain (as risk factors) at baseline were significantly related to weekly physical activity and number of falls among oldest-old participants. Findings indicate that program elements of AMOB/VLL are effective in improving physical activity and reduce falls among the oldest-old population.

Increased life expectancy in recent years has resulted in a growing number of older adults in the United States and around the world (Ailshire & Crimmins, 2011; Bell & Miller, 2002; Oeppen & Vaupel, 2002; Vaupel et al., 1998); furthermore, the proportion of oldest-old adults (i.e., those aged 85 years and older) is one of the fastest growing segments of the U.S. population. Although longevity is a known indicator of successful aging, it does not guarantee high levels of quality of life (Ailshire & Crimmins, 2011). A large proportion of oldest-old adults experience declines in physical functioning and struggle with comorbidities, leading to loss of independence as well as increased healthcare use and costs (Strunk, Ginsburg, & Banker, 2006; Yeaworth, 2002).

Falls among older adults are among the most significant public health problems in the United States (Sleet, Moffett, & Stevens, 2008). Approximately 25% of older adults aged 80 years and older experience at least two falls per year (Lundebjerg et al., 2001; Rubenstein, 2006; Tinetti, 2003). Falling during later life years is directly related to the increased likelihood of morbidity, hospitalization, institutionalization, and annual medical care costs (Persad, Cook, & Giordani, 2010; Roudsari, Ebel, Corso, Molinari, & Koepsell, 2005; Stevens, Corso, Finkelstein, & Miller, 2006). To acknowledge the severity of falls and related consequences among the older adult population, preventive strategies are needed to reduce the incidence of falls among older adults.

Physical activity has been reported to reduce the fear of falling, a leading risk factor for falls among older adults (Forkan et al., 2006; Goodman & Ballou, 2004; Resnick, Orwig, D'Adamo et al., 2007. Previous studies have shown the benefit of physical activity to enhance muscle strength, reduce fracture risk, and improve balance among older adults (Cesari et al., 2009; Kato, Takagi, Sakurai, & Hoshi, 2012; Persad et al., 2010); nevertheless, sedentary behavior, or having a physically inactive lifestyle, is common among older adults. Specifically, 23.7% of those aged over 65 years old reported engaging in less than 10 minutes of moderate or vigorous activities per week (e.g., house chores, transportation, or leisure time activity) relative to only 10.7% of their counterparts aged 35 and 44 years (Centers for Disease Control and Prevention [CDC], 2010). Although greater levels of physical inactivity are expected among the oldest-old, particular attention should be given to understanding factors associated with physical activity in this population.

A number of researchers have explored barriers to and motivators for physical activity and falls among older adults. For example, a recent systematic review used a social-ecological perspective to identify motivators and barriers regarding physical activity among individuals aged 80 years and older (Baert, Gorus, Mets, Geerts, & Bautmans, 2011). Regarding intrapersonal factors for physical activity, physical barriers included health and physical impairment (Belza et al., 2004; Forkan et al., 2006; Vaughn, 2009; Weeks et al., 2008; Whitehead & Lavelle, 2009), pain (Conn, Libbus, Thompson, & Kelley, 1994; Vaughn, 2009; Wilcox, Bopp, Oberrecht, Kammermann, & McElmurray, 2003), and being too tired (Conn, TrippReimer, & Maas, 2003; Heesch, Brown, & Blanton, 2000; O'Neill & Reid, 1991; Vaughn, 2009; Wilcox et al., 2003); whereas psychological benefits serving as motivators for physical activity included self-efficacy (Damush, Perkins, Mikesky, Roberts, & O'Dea, 2005; Dye & Wilcox, 2006; Resnick, Orwig, D'Adamo et al., 2007, Resnick, Orwig, Hawkes et al., 2007; Wilcox et al., 2003) and better health status (Belza et al., 2004; Hardy & Grogan, 2009; Raviv & Netz, 2007; Vaughn, 2009; Whitehead & Lavelle, 2009). In addition to physical inactivity, falls are also associated with demographic factors such as age, sex, and chronic disease. For instance, individuals of older age, women, and those who have more chronic diseases are more likely to experience falls (Baker, O'Neill, Ginsburg, & Li, 1991; Biderman, Cwikel, Fried, & Galinsky, 2002; Jacobsen et al., 1990; Nevitt, Cummings, Kidd, & Black, 1989; Oliver, 2007; Robbins et al., 1989; Rubenstein, 2006; Steinman, Pynoos, & Nguyen, 2009; Tideiksaar, 2002). Furthermore, those who reported their health to be of poor status could be at greater risk of falls (Friedman, Munoz, West, Rubin, & Fried, 2002).

Given what is known from previous studies, a need exists to enhance physical activity and reduce falls among older adults. Although numerous evidence-based programs have been implemented and disseminated in community settings and have successfully accomplished these goals (e.g., Active Living Every Day [ALED], Fit and Strong!, A Matter of Balance [AMOB], and Otago) (National Council on Aging, 2012), less is known about the effectiveness of these programs in improving physical activity and reducing falls among the oldest-old population. Previous studies have shown effective-
ness among participants in the AMOB/VLL program regarding overcoming
fear of falling and increasing physical activity levels (National Council on Aging, 2012), but prior studies have not focused on fall outcomes, especially among the oldest old. Placing additional emphasis on the oldest-old group can contribute to existing knowledge of the effectiveness of evidencebased programs among this more vulnerable subgroup, characterized by decreased physical functioning and increased age-related disability. Thus, this study is an examination of physically active and number of falls among oldest-old adults enrolled in an evidence-based fall risk reduction program implemented in Texas.

Using data from A Matter of Balance/Volunteer Lay Leader (AMOB/VLL) model, this study was designed to (a) assess the changes in weekly physical activity and number of falls from baseline to post-intervention and (b) explore protective and risk factors associated with weekly physical activity and number of falls with a targeted focus on oldest-old participants. To achieve these aims, we addressed three hypotheses based on previous studies. First, we hypothesized significant improvement in weekly physical activity and significant reduction in number of falls between baseline and post-intervention among oldest-old participants. The second hypothesis focused on protective and risk factors related to weekly physical activity and number of falls. We hypothesized that weekly physical activity is positively related to protective factors but negatively related to risk factors; in addition, we hypothesized that number of falls is positively related to risk factors and negatively related to protective factors.

A MATTER OF BALANCE VOLUNTEER LAY LEADER (AMOB/VLL)

Fall Risk-Reduction Program

A Matter of Balance (AMOB), established at the Roybal Center for Enhancement of Late-Life Function at Boston University, is an evidence-based program to reduce risk of falls among older adults (Lachman, Weaver, Bandura, Elliott, & Lewkowicz, 1992). The effectiveness of the AMOB program delivered by health professionals was originally tested in a randomized clinical trial (RCT), which showed positive improvements in physical activity and mobility control (Tennstedt et al., 1998). The major outcome variables of the program included significant improvements of perceived capacity to manage the risk of falling and confidence in everyday activities without falling (Tennstedt et al., 1998).

Since the original RCT, AMOB has been translated to a volunteer lay leader (AMOB/VLL) model for widespread community dissemination in various health and aging sectors (Healy et al., 2008; Smith et al., 2012). Delivered by trained lay-led facilitators, AMOB/VLL is presented in two-hour sessions for eight weeks. Each session includes specific goals for older adults to reduce the risk of falling and continue remaining active and independent (Ory, Smith, Wade, Wright, & Parrish, 2010). The major goals of the program are as follows: to enhance participants' perceived control, to increase their confidence, and to learn that falls are controllable. The design of intervention targets behavior change and emphasizes building fall self-efficacy and setting goals for increasing physical activity through lectures, group discussions, various problem-solving and role-playing activities, exercise and assertiveness training, and individual assignments (Ory et al., 2010). A successful class completion is defined as attending five or more of the eight sessions, and an ideal class includes 8 to 12 participants (Smith, Hochhalter, Cheng, Wang, & Ory, 2011). Many previous studies have shown the effectiveness of the AMOB targeting a variety of population groups, such as older participants, diverse ethnic groups, and rural residents (Smith, Ahn, Mier, Jiang, & Ory, 2012; Smith et al., 2012, 2011); yet few researchers have examined benefits specifically among oldest-old participants, comparing this group to the younger-old group.

METHODS

Participants

As reported in previous studies (Smith et al., 2012; Smith, Ory, & Larsen, 2010), the Texas AMOB/VLL partnered with 19 of 28 local Area Agencies on Aging (AAA) and other community-based organizations over two years from September 2007 to April 2009. Participants numbered 3,276 enrolled in 243 intervention classes through 18 AAA regions during that period. The authors obtained Institutional Review Board approval at Texas A&M University to analyze these secondary data.

Procedures and Instruments

A paper-based questionnaire including 28 items was completed by participants at baseline and after completion of the intervention. The questionnaire items included various formats (e.g., Likert-type scales, yes-no, closed-response, and open-ended) and were used to gather information about participants' fall history, health care utilization, protective behaviors, health indicators, and personal characteristics. Aging and public health research experts in a national consortium of studies established a common database and helped guide the selection of measures for evaluation of program effectiveness (Ledford, 2008). Approximately 15 minutes were needed for participants to complete the both baseline and post-intervention instruments.

Measures

Personal characteristics

Six personal characteristic variables included age, sex, race or ethnicity, education, living status, and number of chronic conditions. Age was calculated based on a participant's birth date and used as a continuous variable. For the sex variable, female was scored 1 and male was scored 0. Race or ethnicity was scored 1 if non-Hispanic White, 2 if African American, and 3 if Hispanic. Education was scored 1 if a participant's highest level of education was less than completion of high school, 2 if graduated from high school, and 3 if more than a high school education. Living status was scored 0 if participants lived alone and 1 if they lived with others. The number of chronic conditions was based on self-report and considered as a continuous variable. The number of chronic conditions could range from 0 to 7.

Physical activity

Participants reported the number of days they were physically active in the previous seven days at a moderate intensity level. Examples of physical activities were provided to participants to help them understand the concept of moderate intensity activity (e.g., "brisk walking, bicycling, vacuuming, gardening, or anything else that causes one to breathe faster"). The scores of physical activity ranged from 0 to 7 days. Physical activity was measured at baseline and post-intervention.

Number of falls

Participants reported the times that they had fallen in the previous 30 days.

Protective factors

Two protective factors (i.e., falls efficacy and self-rated health) were included in this study. Falls efficacy was used with the scale consisting of five items ($\alpha = 0.87$) measuring participants' perceived ability to manage risk of falls or actual falls (Tennstedt et al., 1998). Participants reported the following statements: (1) you can find a way to get up if you fall, (2) you can find a way to reduce falls, (3) you can protect yourself if you fall, (4) you can increase your physical strength, and (5) you can become more steady on your feet. A 4-point Likert scale was used for ratings: 1 = not sure at all, 2 = not very sure, 3 = somewhat sure, and 4 = absolutely sure. Scores ranged from 5 to 20. Higher score indicated higher levels of managing risk of falls. Participants assessed their health with the following question: Would you say that in general your health is poor (= 1), fair (= 2), good (= 3), very good (= 4), excellent (= 5)?

Risk factors

Three risk factors were used: fatigue, health interference, and pain. Fatigue was assessed with the item measuring whether participants were affected by fatigue in the past week. Scores could range from 1 to 10, and higher scores indicated severe fatigue. Pain was assessed with the item measuring whether participants were affected by pain in the past week. Scores could range from 1 to 10, and higher scores indicated severe pain. Health interference was measured with a composite score of four items: social activities, hobbies, chores, and shopping. Participants reported the extent to which health interfered with these items with a 5-point Likert scale: 1 = not at all, 2 = slightly, 3 = moderate, 4 = quite a bit, and 5 = almost totally. Health interference scores could range from 5 to 20 with higher scores indicating that health interfered with the activities ($\alpha = 0.92$).

Data Analysis

Frequencies were calculated for personal characteristics, average days of physically active, and average number of falls. Pearson's chi-square tests were conducted to examine the independence between categorical participants' characteristics (e.g., sex, living status) (Chernoff & Lehmann, 1954). Independent sample *t*-tests were employed to examine the equality of means for continuous participants' characteristics (e.g., age, number of chronic conditions, physically active days, number of falls) between two age groups (i.e., young-old group vs. oldest-old group). Generalized linear mixed models with a Poisson distribution using SAS Proc Glimmix (Littell, Milliken, Stroup, Wolfinger, & Schabenberger, 2006) for the oldest-old group were used to evaluate the associations between days of physically active and protective/risk factors and between number of falls and protective/risk factors. Three models were fitted as specified below. In the first model, time (two time points: baseline and post-intervention) was included as the only independent variable (Model 1). Age, sex, race/ethnicity, education, living status, and number of chronic conditions at baseline were added as covariates in the second model (Model 2). Two protective factors (i.e., falls efficacy scale, self-rated health) and three risk factors (i.e., fatigue, health interference scale, pain) were included in the third model, predicting physically active days and number of falls after controlling time and covariates (Model 3).

RESULTS

Sample Description

A total of 3,276 participants enrolled in the Texas AMOB/VLL fall risk-reduction program (Figure 1). Participants who were younger than 65 years old were excluded ($n = 978$). Almost 40% of 2,298 participants ($n = 899$) did not complete post-intervention survey instruments. Finally, 1,399 participants who were 65 years or older and completed both baseline and post-intervention assessments were included in this study. Those aged 85 years and older were categorized as the oldest-old group and were a target group

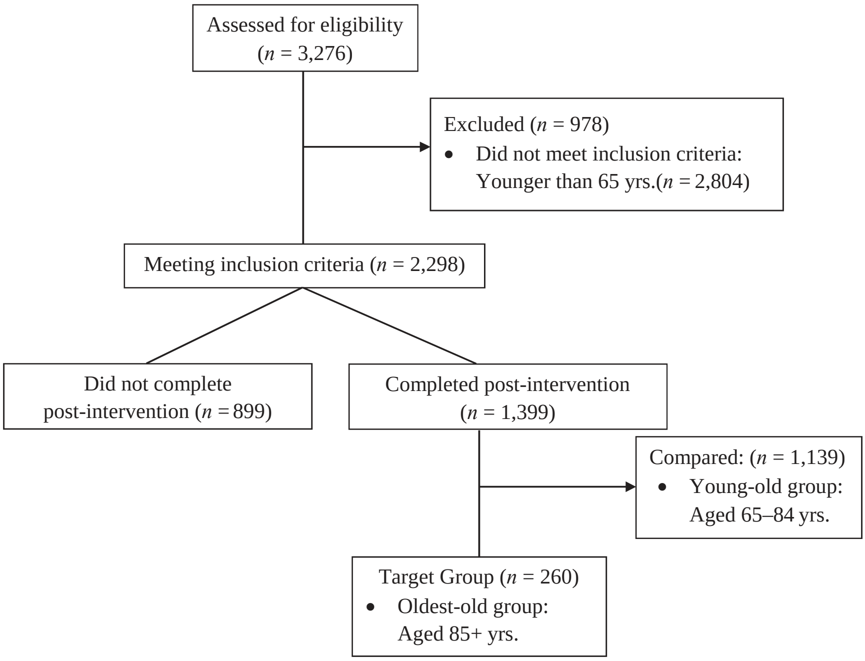

FIGURE 1 Diagram for participants' inclusion.

for this study (n = 260); those aged from 65 years to 84 years represented the young-old group and served as a comparison age group (n = 1,139).

Baseline Characteristics

As shown in Table 1, participants' characteristics of the oldest-old and young-old groups were compared at baseline. For the oldest-old group, the mean age was 87.84 (*sd* 3.56) years old and ranged from 85 to 100 years old; 76.4% were female, and 70.2% of the group lived alone. The majority of the group (86.5%) was non-Hispanic White, and about half the group (55.5%) completed education beyond high school. Over 90% of the group (94.6%) attended five or more workshop sessions. The average number of self-reported chronic conditions was 1.64 (*sd* 1.14). Participants in the oldest-old group engaged in physical activities on three or more days on average (*M* 3.55, *sd* 2.56). In addition, their average times falling was

.41 (*sd* 1.01). Statistically significant differences existed in age, living status, and ethnicity between oldest-old and young-old groups. For the young-old group, the mean age was 76.43 ± (*sd* 5.24) years old; 80 % were female, and about half (52.4%) lived alone.

TABLE 1 Participant Characteristics at Baseline

	Oldest-old Group (*n* = 260)	Young-old Group (*n* = 1,139)	F/χ^2
Age[1]	87.84 (± 2.84)	76.43 (± 5.24)	1, 156.67***
Sex			1.59
Male	59 (23.6)	216 (20.0)	
Female	191 (76.4)	863 (80.0)	
Living status			26.53***
Living alone	177 (70.2)	575 (52.4)	
Living with one or more others	75 (29.8)	523 (47.6)	
Ethnicity			21.21***
White not Hispanic	212 (86.5)	775 (72.5)	
African American	21 (8.6)	202 (18.9)	
Hispanic	12 (4.9)	92 (8.6)	
Education levels			.21
Less than High School	45 (17.6)	196 (17.6)	
High School Graduate	69 (27.0)	285 (25.6)	
More than High School	142 (55.5)	632 (56.8)	
Number of sessions attended			
Less than 5 sessions	14 (5.4)	47 (4.1)	.78
5–8 sessions	246 (94.6)	1, 087 (95.9)	
Ave. number of chronic conditions[1]	1.64 (± 1.14)	1.75 (± 1.20)	1.58
Ave. days of physically active[1] (0–7)	3.55 (± 2.56)	3.46 (± 2.29)	.23
Ave. number of falls[1] (0–30)	.41 (± 1.01)	.40 (± .84)	.93

[1]Means (±SD) reported for continuous variables. ** $p < .01$ *** $p < .001$.

Changes in Days of Physically Active and Number of Falls

Table 2 shows the results of generalized linear mixed models with a Poisson distribution in oldest-old participants regarding days physically active. As addressed above, the focus of this study is changes in days physically active and number of falls among oldest-old participants enrolled in an evidence-based fall risk reduction program. Three models were fitted into the analysis. Time was statistically significant for change in days physically active in Model 1 (B .14, $p < .01$). In other words, the average days of physically active significantly improved from baseline to post-intervention. When including covariates (i.e., sex, ethnicity, age, number of chronic conditions, education) in Model 2, age was also significantly related to days of physically active (B -.03, $p < .05$). This indicates that older participants had significantly fewer days physically active at baseline.

Table 3 presents the results of generalized linear mixed models with a Poisson distribution for number of falls in oldest-old participants. Again, four models were fitted into the analysis. Time was statistically significant for change in number of falls in Model 1 (B -.35, $p < .05$). This suggests that average number of falls among the participants significantly decreased from baseline to post-intervention. No covariates (including sex, ethnicity, age, number of chronic conditions, education), however, were found to be significantly related to the number of falls in Model 2.

TABLE 2 Improvements in Days Physically Active from Baseline to Post-intervention Among Oldest-old Participants

	Model 1						Model 2						Model 3[a]					
Variables	B	SE	z	95% CI		AIC	B	SE	z	95% CI		AIC	B	SE	z	95% CI		AIC
Time	.14	.05	2.85**	.04	.24	2084.66	.15	.05	2.93**	.05	.25	1880.28	.13	.06	2.24*	.02	.24	1700.03
Covariates																		
Sex (Female = 1)							−.13	.10	−1.29	−.32	.07		−.09	.10	−.97	−.29	.10	
Ethnicity (White = 1)																		
African American							−.22	.19	−1.18	−.59	.15		−.18	.19	−0.96	−.55	.19	
Hispanic							−.15	.20	−0.74	−.54	.25		−.17	.20	−0.81	−.57	.24	
Age							−.03	.02	−2.27*	−.07	−.00		−.03	.02	−2.00*	−.06	−.00	
N. Chronic Conditions							−.07	.04	−1.90	−.14	.00		−.05	.04	−1.50	−.13	.02	
Live alone (Living together = 1)							−.04	.09	−0.42	−.23	.15		.03	.09	0.31	−.16	.21	
Education (HS+ = 1)																		
HS graduation							−.18	.10	−1.85	−.37	.01		−.19	.10	−1.96	−.38	.00	
Less than HS graduation							−.31	.13	−2.37	−.57	−.05		−.31	.13	−2.32*	−.57	−.05	
Protective Factors																		
Falls Efficacy													.03	.01	2.95**	.01	.05	
Self-Rated Health													.16	.05	3.33**	.06	.25	1857.06
Risk Factors																		
Fatigue													−.07	.02	−3.76***	−.10	−.03	1816.98
Health Interference													−.05	.01	−4.69***	−.07	−.03	1742.89
Pain													−.03	.02	−2.00*	−.06	−.00	1812.26

*$p < .05$, **$p < .01$, ***$p < .001$

[a] Model 3 included two protective factors and three risk factors separately. Coefficients for time and covariates in this table are only when including falls efficacy. Different sets of coefficients for other variables are not available in this page.

TABLE 3 Improvements in Number of Falls from Baseline to Post-intervention Among Oldest-old Participants

	Model 1						Model 2						Model 3[a]					
Variables	B	SE	z	95% CI		AIC	B	SE	z	95% CI		AIC	B	SE	z	95% CI		AIC
Time	−.35	.16	−2.17*	−.67	−.03	688.56	−.47	.18	−2.63**	−.83	−.12	598.59	−.47	.21	−2.28*	−.87	−.06	542.85
Covariates																		
Sex (Female = 1)							.25	.37	.69	−.47	.98		.08	.37	0.23	−.65	.82	
Ethnicity (White = 1)																		
African American							1.01	.60	1.69	−.17	2.19		.77	.65	1.19	−.51	2.04	
Hispanic							.57	.71	.81	−.83	1.98		.78	.72	1.08	−.64	2.20	
Age							−.03	.05	−.54	−.13	.08		−.07	.05	−1.26	−.18	.04	
No Chronic Conditions							−.03	.13	−.23	−.29	.23		−.11	.14	−0.78	−.37	.16	
Live alone (Living together = 1)							.25	.34	.72	−.43	.92		.18	.34	0.53	−.50	.86	
Education (HS+ = 1)																		
HS graduation							.30	.34	.88	−.37	.97		.26	.35	0.74	−.43	.94	
Less than HS graduation							−.42	.51	−.83	−1.42	.58		−.39	.52	−0.74	−1.42	.65	
Motivators																		
Falls Efficacy													−.08	.04	−2.25*	−.15	−.01	
Self-Rated Health													−.54	.18	−3.06**	−.89	−.19	589.67
Barriers																		
Fatigue													.22	.06	3.46***	.09	.33	529.11
Health Interference													.11	.03	3.17**	.05	.11	534.04
Pain													.13	.06	2.22*	.01	.25	538.45

*$p < .05$, **$p < .01$, ***$p < .001$

[a]Model 3 included two protective factors and three risk factors separately. Coefficients for time and covariates in this table are only when including falls efficacy. Different sets of coefficients for other variables are not available in this page.

Significant Protective and Risk Factors for Days Physically Active and Number of Falls

Two protective factors (i.e., falls efficacy scale and self-rated health) and three risk factors (i.e., fatigue, health interference scale, and pain) were included in Model 3 of Table 2. Each protective and risk factor was included one at a time after controlling for time and covariates. For days physically active, all protective and risk factors were significant. Those who had higher levels of falls efficacy (B .03, $p < .01$) reported better health (B .16, $p < .01$), felt less tired (B -.07, $p < .001$), reported fewer health issues interfering with life (B -.05, $p < .001$), and felt less pain (B -.03, $p < .05$) showed more physically active days at baseline.

Two protective factors and three risk factors were included for number of falls in Model 3 of the Table 3. Again, each protective and risk factor was included one at a time after controlling for time and covariates. Similar to the model of physically active days, all protective and risk factors were significantly related to the number of falls among oldest-old participants. In other words, those who had higher levels of falls efficacy (B -.08, $p < .05$) reported better health (B -.54, $p < .01$), felt less tired (B .22, $p < .001$), reported fewer health issues interfering with life (B .11, $p < .01$), and felt less pain (B .13, $p < .05$) experienced fewer number of falls at baseline.

DISCUSSION

Using a sample of oldest-old participants enrolled in A Matter of Balance/Volunteer Lay Leader (AMOB/VLL) model, we examined the improvement of weekly physical activity and number of falls. In addition, we assessed protective and risk factors for weekly physical activity and number of falls. Participants who enrolled in the AMOB/VLL program showed significant increase in days physically active and decrease in number of falls from baseline to post-intervention, which is consistent with findings from other studies (Smith et al., 2012, 2012, 2011, 2010; Tennstedt et al., 1998). Moreover, as hypothesized, all protective factors (i.e., falls efficacy scale and self-rated health) were positively associated with days physically active and negatively with number of falls; all risk factors (i.e., fatigue, health interference scale, and pain) were negatively associated with days physically active and positively with number of falls.

The significant decrease in number of falls and increase in the level of physical activity confirmed the effectiveness of the AMOB/VLL fall risk reduction program, especially for oldest-old adults aged 85 years and older. In addition to evidence of the effect of AMOB/VLL on improvement of overall health status as well as falls efficacy among older adults (Ory et al., 2010; Smith et al., 2012; Smith, Ory, Ahn, Bazzarre, & Resnick, 2011; Smith et al., 2010; Smith, Quinn, Gipson, Wilson, & Ory, 2011), benefits in physical activity and everyday routines as a result of participation in the program have been demonstrated not only in Texas in other states, including Florida and South Carolina (Batra, Melchior, Seff, Frederick, & Palmer, 2012; Ullmann, Williams, & Plass, 2012). Prohaska and colleagues (2006), however, noted a dearth of studies on unique factors for physical activity in the oldest-old adults, who seem to be least active, at greatest risk of adverse health outcomes, and in greatest need of the program. They also stated that relatively few researchers have focused on the benefits of health promotion programs for the oldest-old population (Prohaska et al., 2006). Thus, because the current study shows the consistent effectiveness of evidence-based programs in weekly physical activity and number of falls among the oldest-old population, it may contribute to the increased confidence needed to avert fall events, which has the potential to improve quality of life and prevent unnecessary isolation, loss of independence, and expenditures for healthcare utilization.

Second, our finding that protective and risk factors were significantly associated with weekly physical activity and number of falls is consistent with previous studies (Weeks et al., 2008; Whitehead & Lavelle, 2009; Wilcox et al., 2003). This finding confirms the importance of health status and reducing health indicators associated with falls in this population. As with older age groups, confidence to avoid falls, having a positive outlook on life, and minimizing health interference associated with disease (e.g., pain and fatigue) remain exceedingly important. Maintaining a positive mental outlook may help oldest-old participants to reduce fear of falling and avoidance of certain activities. This may make these individuals more physically and socially active, which prevents muscle atrophy (i.e., reduction in muscle strength and balance). Although younger-old participants are likely to be healthier and improve as a result of participation in evidence-based prevention programs, it is important to recognize the benefits of AMOB/VLL for oldest-old participants because of the potentially more severe ramifications of falls (e.g., institutionalization or death) among this population. Stereotypically, oldest-old adults are thought incapable of benefiting from these programs (Fry et al., 1997), but our study indicates that they can benefit. Their younger counterparts benefited at rates higher than the oldest-old participants, but this study is encouraging in that it shows promise for AMOB/VLL among frail individuals and those deemed to be more vulnerable and at risk for falling.

Third, one of the most significant contributions of this study is to apply the generalized linear mixed models with a Poisson distribution for days physically active and number of falls. The generalized linear mixed models with a Poisson distribution have a number of benefits over traditional methods, such as OLS regression. Commonly, OLS regression is applied to a count outcome with minimal difficulty (Coxe, West, & Aiken, 2009); however, if the mean of the outcome is low, OLS regression may result in biased standard errors and misleading significance tests (Gardner, Mulvey, & Shaw, 1995). In this case, previous experts recommended transforming count outcomes to make them more appropriately useful for OLS regressions, such as the square root of the outcome or the natural log of the outcome (Coxe et al., 2009). Although this strategy is very simple, transforming the outcome is not the best way to remove heteroscedasticity (Coxe et al., 2009). Coxe and colleagues (2009), therefore, suggested Poisson regression analysis, which is more appropriate for outcome variables with low counts or skewed counts, because it allows selection of the correct error structure accommodating the heteroscedeasticity. As shown in Table 1, the mean scores of number of falls was .41 in the oldest-old group; furthermore, the distribution of days physically active was also skewed (data not shown). In fact, OLS regression was initially employed in this study; however, no significant protective or risk factors for days physically active and number of falls were detected. Therefore, findings using a Poisson regression method in this study provided a better understanding of count outcomes.

Limitations

Several limitations in this study should be acknowledged. First, its focus was participants aged 85 years and older. The participants enrolled the AMOB/VLL program may have been relatively healthier and less dependent compared to their counterparts who did not enroll in the intervention because functional limitations are often observed in this population (i.e., a main reason to be institutionalized). If more vulnerable and sedentary participants were enrolled in the program and provided evaluation data in future research, we may maximize our ability to identify the impact of the program (i.e., related to risk and protective factors associated with physical activity and falls). Second, the two outcome variables, weekly physical activity and number of falls merely provide frequencies or counts of these measures. The effectiveness of AMOB/VLL may become more pronounced if evaluation instruments collected more detailed information about fall classifications (e.g., recurrent falls, injurious/non-injurious falls, severity, indoor/outdoor falls) and physical activity (e.g., minutes per activity). Thus, future studies should consider including a more robust set of predictor variables to capture the complexities of factors related to physical activity and falls among older adults. Third, findings emphasized that all protective and risk factors showed significant association with physical activity and number of falls at the intrapersonal level. Interpersonal factors, such as support from family members or healthcare providers, and environmental factors, such neighborhood safety, existence of facilities, or transportation, were not available in the dataset. Items regarding social support (Hardy & Grogan, 2009; Vaughn, 2009; Wilcox et al., 2003) or environmental setting (Lord, Menz, & Sherrington, 2006; Stevens, Teh, & Haileyesus, 2010; Tinetti & Williams, 1998) were not included, which may contribute to prevention of falls and to enhancing physical activity among oldest-old adults.

Future Research and Practical Implications

Findings from this study have practical implications for practice and future research. First, as addressed previously, these study findings demonstrate protective and risk factors at the individual level. Specific investigation of factors at interpersonal and community levels could contribute to expanding the knowledge and benefits of falls risk reduction programs with various populations and settings among oldest-old adults. Second, our results show the importance of falls efficacy for physical activity and number of falls. Falls efficacy is modifiable and amenable to change through interventions or training. Therefore, delivering specified interventions aimed to improve falls efficacy and enhance muscle strength and balance targeting to the oldest-old is needed. Such interventions may refine or tailor existing effective interventions (such as A Matter of Balance) or include clinical health professionals to create multi-level interventions expand fall-related risk screening, treatment, and referrals (such as the Otago Education Program or STopping Elderly Accidents, Deaths, and Injuries [STEADI] Toolkit) (Shubert et al., 2015; Stevens & Phelan, 2013) and engage older adults over time in a variety of settings. Third, future investigations using longitudinal designs could provide a better understanding of long-term intervention effects on physical activity and falls among the oldest-old population. Such studies may enhance their cadre of measurements to include objective measures of physical activity and functioning (e.g., Timed Up-and-Go Test, Chair Stand Test, 4-Stage Balance Test) and/or accelerometers to more accurately track activity.

CONCLUSION

Results of this study demonstrate potential benefits in health, health care, and cost ramifications among oldest-old participants who enroll in AMOB/VLL. This study may foster greater efforts to change age-related stereotypes depicting older adults as incapable of benefiting from programs intended to reduce health risks or improve physical activity. As such, this study (and others like it) has policy implications that may influence funding decisions within governmental agencies and within organizations serving oldest-old populations to support fall risk reduction programs in community settings.

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