Predictors of and health- and fall-related program outcomes resulting from complete and adequate doses of a fall risk reduction program

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Abstract

Falls are dangerous and costly for older adults. The A Matter of Balance/Volunteer Lay Leader (AMOB/VLL) program is an evidence-based fall risk reduction program that could help reduce this burden. This study introduced a door-through-door transportation program to improve program delivery ($N = 126$). Characteristics predicting completion of all eight AMOB/VLL sessions were identified using logistic regression. Individual growth models were employed to determine the immediate, intermediate, and long-term goal outcomes resulting from receiving an adequate dose of the program (five to eight sessions). Self-restriction of activities due to fear of falling (OR 5.04, 95 % CI 1.86–13.69) and a lower frequency of moderate and vigorous physical activity (OR 1.14, 95 % CI 1.04–1.27) were significantly predictive of receiving a complete dose. Three outcome goals were significant, including (1) immediate—improved self-efficacy of managing medications and treatments, (2) intermediate—reduced activity limitations, and (3) intermediate—reduced physical disability. Self-restriction of activities due to a fear of falling and physical activity levels may be simple and effective screening questions to prevent AMOB/VLL attrition. In our study, those who did receive the program improved on a specific type of self-efficacy and on self-reported physical functioning.

Keywords

Fall prevention, Fall risk reduction program, Older adults, Evidence-based programs, Program adherence, Community-based interventions

INTRODUCTION

Falls among adults aged 65 and older create a tremendous burden for society, with fall-related injury costs projected to reach \$43.8 billion by 2020 [1]. A parallel projection posits that by 2020, one in six individuals in the USA will be 65 or older [2]. The rate of injury from a fall doubles in older adults over the age of 75, and fatal falls increase especially for those aged 80 or older [2, 3]. One third of older adults fall at least once each year; of these, one half will fall more than one time [2–4]. Falls are the leading cause of injury mortality in older adults and are the cause of approximately 60 % of non-fatal injuries [2]. In the USA in 2006,

Implications

Practice: Understanding factors that encourage individuals to complete the AMOB/VLL program and understanding if incomplete, yet adequate attendance can still have the same anticipated positive health effects can help inform program developers and deliverers about how to handle attrition concerns.

Policy: The AMOB/VLL program has proven its worth for older adults who complete the program to adopt fall prevention strategies, but knowing if the program can still benefit individuals with incomplete attendance will help inform program delivery sites when tough financial decisions must be made regarding which programs to continue offering.

Research: The reality of community-based health promotion programs, particularly those focused on falls prevention, is that complete attendance from all participants is unlikely even when transportation is provided, so future research on program success should continue to investigate the impact that varying programmatic session attendance levels can have for program participants. The authors do hereby declare that the findings presented here have not been previously published and that this manuscript is not being simultaneously submitted elsewhere. The data reported here have been previously presented in a 2015 late breaking poster session with the Society of Behavioral Medicine.

The authors hereby declare that they have full control over all primary data and agree to allow *Translational Behavioral Medicine* to review the data if requested after appropriate approvals have been received.

approximately one third of older adult falls resulted in moderate to severe injuries requiring physician care and restricted activity for at least 1 day [2, 5].

Fall risk factors include a history of falls; multiple medications; gait, balance, and mobility problems that

may require an assistive device; poor vision; other neurological impairments; muscle weakness; cardiovascular disorders; postural hypotension; feet and footwear problems; and environmental hazards [6, 7]. Although effective fall prevention strategies and programs exist, there are major barriers to adoption of these programs, including low self-efficacy, sedentary behavior, belief the program will not work, low health expectations, denial of risk, not wanting to be stigmatized as a participant in a fall program, and failure to change behavior by not adopting fall prevention strategies even after experiencing a fall and fear of falling [2, 8, 9]. Fear of falling, fall-related self-efficacy, and falls are naturally interrelated [3]. Fear of falling is reported in about half of fallers, which can lead to further decline in activity and eventual loss of independence [3, 8, 10].

The A Matter of Balance/Volunteer Lay Leader (AMOB/VLL) program has been identified as the best program for priming older adults to adopt fall prevention strategies because of its gradual behavioral change approach—research suggests exercise programs need to be started slowly in sedentary people with limited mobility or else the fall prevention intervention could actually increase the rate of falls [6, 11]. The AMOB/VLL program uses cognitive-behavioral techniques to reduce fear of falling and improve health indicators associated with falling risks, rather than targeting falls directly as a clinical outcome. The original AMOB program was found to be efficacious in a 1998 randomized controlled trial that demonstrated improved fall efficacy, better fall management, and increased activity levels [12]. The lay leader version was adapted from the original and demonstrated improved fall-related self-efficacy, fall management, and fall control at 6 weeks, 6 months, and 12 months; improved physical activity levels at 6 weeks and 6 months; improved social activity levels at 6 weeks; and a decreased number of falls at 6 and 12 months [13].

Translational research is still needed to overcome barriers to the adoption of programs like AMOB/VLL beyond research settings by ensuring the infrastructure for effective delivery exists, especially for more frail older adults [2, 6, 14]. One example of building appropriate infrastructure for evidence-based program delivery is by facilitating the availability of door-through-door transportation services. Door-through-door transportation services help to satisfy serious transportation needs of some older persons and allow them to be better connected with their community, to maintain their support network, and ultimately to age in place. This is vital for older adults who live on a fixed income and would otherwise be homebound [15].

Smith and colleagues examined personal and delivery site characteristics predictive of intervention adherence based on AMOB/VLL session attendance among 6922 older adults between 2006 and 2009 and 3092 older adults between 2007 and 2009 in Texas [16, 17]. They developed a conceptual framework linking the personal and site characteristics to immediate program goals such as less health interference. These were

followed by intermediate (e.g., reduced functional impairment) goals and long-term (e.g., reduced healthcare utilization and costs) goals, both of which began to address the program's public health impact (Fig. 1).

Similar to and expanding on Smith and colleagues' main objectives, this dissemination project served two main objectives. First, by facilitating the infrastructure for evidence-based program delivery with a new delivery channel (a door-through-door transportation program), we identified participants' baseline personal, health-related, and fall-related characteristics predicting completion of all eight of the AMOB/VLL sessions. Building on the conceptual framework of Smith and colleagues shown in Fig. 1 [16], whose data only addressed the correlates and intervention intensity portions (i.e., the first black box) of the framework, our second objective addresses the program outcomes and public health impact portions of the framework among those participants completing at least an adequate dose (considered five to eight sessions) of AMOB/VLL.

METHODS

The project was presented at a Washington Heights Inwood Coalition on the Aging community meeting in December 2012 and the results were presented at follow-up meeting in June 2016.

Interventions

AMOB/VLL program—Four appropriate Action for the Retired Community or ARC XVI Fort Washington, Inc. (ARC) staff members were recruited with the following eligibility criteria including (a) bilingual in English and Spanish, (b) commitment to completing the AMOB/VLL training program certificate, (c) commitment to conducting two coaching sessions twice (each 4-h sessions), and (d) commitment to teaching two AMOB/VLL classes at Columbia University's CTSA Community Engagement Resource or ARC in the spring of 2013. The Master training was conducted in January 2013 at Columbia University's CTSA Community Engagement Resource. A lead trainer for the AMOB/VLL program trained 20 Master trainers, who in turn trained eight trainers via the train-the-trainer model less than a month later. Both Master trainers and trainers completed the AMOB/VLL training program certificate and conducted AMOB/VLL sessions.

There were eight 2-h AMOB/VLL sessions provided, with 8 to 12 participants attending each session. Program sessions and pre-post follow-up were completed between March and July 2013.

Coordinated Older-Adult Senior Transportation Services (COASTS)—Participants in our AMOB/VLL program were recruited from an ongoing program called Coordinated Older-Adult Senior Transportation Services (COASTS), which was provided by ARC senior center. ARC received a grant through the Department of Transportation, which provides door-through-door

transportation services throughout Northern Manhattan, from West 110th Street to West 220th Street, Hudson River to Harlem River. COASTS' round-trip, door-through-door transportation consists of help out of the front door of an older adult's home, in and out of the vehicle, "through the door at the destination," and then back to the front door of the participant's home [15]. COASTS is available to those aged 50 or older with mobility disability or visual or audio impairments and to those 60 and older with mobility disability.

Eight COASTS mobility facilitators (or MoFas) completed a week-long COASTS training module in September 2011 including training on coordinated transportation organizational policies; emergency protocols and escalation; pre-trip inspection; defensive driving; driver safety; passenger service and safety; older adult, low-income, and disabled sensitivity training; customer service policies and protocols; crisis management containment; CPR and basic first aid; drug and alcohol policies; and Americans with Disabilities Act transportation policies and protocols. The COASTS training for the MoFas was further supplemented with two 4-h in-service trainings based on the *Fall Prevention Awareness: Enhanced Training for Home Health Aides* curriculum, which was jointly designed by the National Council on Aging and the Paraprofessional Healthcare Institute, with funding from the US Department of Labor Education and Training Administration. This curriculum was created for persons with a broad range of learning abilities including non-high school graduates with limited English-language skills (from <http://phinationa.org/training/resources/phi-curricula/fall-prevention-awareness>; accessed December 30, 2015).

Participants, design and procedures

The study consisted of a single-arm intervention (AMOB/VLL) offered to participants of the COASTS with MoFas program with a pre-post comparison. Data collection was completed at baseline, 8-week, 6-month, and 12-month time points.

The first 126 participants of the COASTS program who were eligible, interested, and who provided informed consent were enrolled. Informed consent was obtained from all individual participants included in the study. The inclusion criteria for participation included (1) 60 or greater years old; (2) qualifying members of COASTS with MoFas program and the ARC senior center; (3) cognitively competent; (4) ambulatory (independently or walker/canes); (5) no contraindications to exercise as listed on the physical activity readiness questionnaire (PAR-Q); and (6) Spanish- or English-speaking. All necessary study documents were developed, translated, and back translated into Spanish (e.g., consent forms, surveys). Bilingual research assistants were trained on the assessment protocols.

The data collection instruments were designed using the Patient-Reported Outcomes Measurement Information System (PROMIS) Assessment Center. The

data were collected on paper, and the PROMIS Assessment Center was used for data entry. All PHI was not entered into the PROMIS Assessment Center, but study PHI was entered and kept on a secured server at the Mailman School of Public Health. This study was approved by the Columbia University Institutional Review Board.

Measures

Personal characteristics—Participant sociodemographic variables recorded at baseline included age, sex, race/ethnicity, highest level of education received (i.e., 0–5, 6–12, >12 years), marital status, living situation (i.e., live alone, live with others), and health insurance.

Health-related characteristics—At baseline, comorbidities, daily alcohol consumption, smoking status, BMI, recent weight loss or gain, previous lower extremity surgeries in the last year, taking four or more medications, and use of assistive devices were collected.

Longitudinally, we measured health interference by three PROMIS measures. The NIH began the PROMIS in 2004 and has been developing item banks for measuring health domains without attribution to a specific chronic illness (e.g., pain, physical function). The PROMIS v1.0 instruments related to health interference included measures of depression (Emotional Distress Depression—Short Form 4A), fatigue (Fatigue—Short Form 4A), and sleep disturbance (Sleep Disturbance—Short Form 4A).

The Community Healthy Activities Model Program for Seniors (CHAMPS) was the physical activity measure collected longitudinally. This self-report measure is designed specifically for older adults and covers 41 activities ranging from low to high demand [18, 19]. Hours per week spent in moderate and vigorous physical activity ($\text{MET} \geq 3$) and total hours spent per week in any physical activity (light, moderate, or vigorous) were collected [18]. Additionally, calorie expenditure per week from any physical activities and calorie expenditure per week from moderate and vigorous physical activities ($\text{MET} \geq 3$) were also calculated. The psychometric properties of this instrument are strong, including validity and detection of change [18–21]. In addition, there is evidence to support the use of CHAMPS in culturally diverse populations [22]. Reduced functional impairment was measured with the eight-foot Timed-Up-and-Go (TUG) test, which was conducted as a physical performance measure at baseline and at follow-up points. This standardized functional test measures lower extremity strength and dynamic balance and has been demonstrated to be psychometrically sound in this population [23–26].

Reduced activity limitations measured over time consisted of the following two PROMIS items: pain behavior (Pain Behavior—Short Form 7A) and pain interference (Pain Interference—Short Form 4A). Reduced disability was measured by one PROMIS item: physical function (Physical Function—Short Form 4A).

Reduced healthcare utilization was measured over time by the following four medical care questions asking about utilization during the past 6 months: (1) How many times did you visit a physician?; (2) How many times did you go to a hospital emergency department?; (3) How many times were you hospitalized for one night or longer?; and (4) How many total nights did you spend in the hospital?

Fall-related characteristics—Please refer to Fig. 1 and “Improved Fall-Related Efficacy” under Immediate Program Outcomes. We will start by operationally defining how “Improved Fall-Related Efficacy” should be conceptualized in future studies. We expanded Smith and colleagues’ model in Fig. 1 with input from this study and from a review article by Moore and Ellis on “fall-related psychological constructs” [27]. We are proposing three broader categories to cover related constructs. Following along with Fig. 2, the first box is called *Falls Specific* and contains six subdomains: (1) fall-related self-efficacy or fall self-efficacy, (2) fear of falling, (3) balance confidence, (4) consequences of falling, (5) perceived control over falling, and (6) perceived ability to manage falls [27–29]. A second box is called *Self-efficacy of Managing Chronic Disease*, a domain that in the future should be measured by the new PROMIS self-efficacy item banks including five subdomains: (1) self-efficacy of managing symptoms, (2) self-efficacy of managing emotions, (3) self-efficacy of managing daily activities, (4) self-efficacy of managing medications and treatments, and (5) self-efficacy of managing social

interactions [30]. The third box is called *Other Fall-related Self-efficacy* and contains four constructs: (1) self-efficacy of physical activity, (2) self-efficacy of neighborhood barriers, (3) self-efficacy of gait, and (4) self-efficacy of mobility [27, 31, 32].

At baseline, we measured previous falls in the past 3 months, self-restriction of activities due to fear of falling, fear of falling, and the Falls Management Scale (FMS). Turning again to Fig. 2 in the *Falls Specific* box, we measured three out of the six subdomains. To measure fall self-efficacy, which “refers to the confidence in one’s ability to perform activities of daily living (ADL) without falling,” we used a single-item: Do you restrict your activities because you are afraid you might fall? [27, 33]. To measure fear of falling, we again used a one-item instrument: Do you have a fear of falling? Perceived ability to manage falls was the third subdomain that we measured at baseline [27]. The five-item scale that Tennstedt et al. developed for the original AMOB program efficacy trial was used with a Cronbach’s alpha ranging from .76 to .84 [12].

In our study, we longitudinally measured improvements in the subdomain “self-efficacy of managing medications and treatments,” including how often individuals reported doing the following when they visited their doctor: (1) prepared a list of questions for the doctor; (2) asked questions about the things the individual wanted to know and did not understand about his or her treatment; and (3) discussed any personal problems that may be related to his or her

Fig 1 | Conceptual framework linking correlates and intervention intensity to program outcomes and public health impacts (reprinted from [16])

Fig 2 | Defining fall-related psychological constructs (expanded and renamed from improved fall-related efficacy)

illness. All medical care questions came directly from Appendix C of the 2007 Chronic Disease Self-Management Program Evaluation, which can be obtained from the Agency for Healthcare Research and Quality's website: <http://www.ahrq.gov/sites/default/files/wysiwyg/research/findings/final-reports/aoa/aoachronic-apc.pdf>.

Regarding fall incidence, participants were given a calendar with instructions on daily self-reporting of falls. Falls were defined as "landing on the ground or at some other level, such as a chair or bed" [34]. This information was retrieved monthly by phone, in person, and by mail from baseline to 12 months, with the fall outcome being the number of falls reported.

Attendance—Participant attendance was obtained by standardized class attendance rosters utilized by the program deliverers and linked to each participant's survey data. We categorized attending <5 sessions as an inadequate dose, ≥ 5 sessions as an adequate dose, and all 8 sessions as a complete dose in accordance with prior research and the recommendation of program developers that attending at least five sessions be considered "adequate" or "successful completion" and attending less considered "inadequate" or "non-

successful completion" [16, 17]. Supporting our classification system, Smith and colleagues previously found that receiving an adequate dose was significantly associated with improvements in certain health indicators, with even greater improvements observed with receiving a complete dose [17].

The immediate, intermediate, and long-term goal outcomes

Immediate goals—Immediate goals included the following categories of health- and fall-related characteristics or direct program outcomes according to Fig. 1: improved fall-related efficacy (i.e., the subdomain of self-efficacy of managing medications and treatments), less health interference (i.e., PROMIS depression, fatigue, and sleep disturbance measures), and increased physical activity (i.e., CHAMPS).

Intermediate goals—Intermediate goals included the following measures (or health- and fall-related characteristics) of public health impact according to Fig. 1: reduced functional impairment (i.e., TUG test), reduced fall incidence (i.e., measured by the fall calendar), reduced activity limitations (i.e., PROMIS pain behavior and interference measures), and reduced disability (i.e., PROMIS physical function).

Long-term goals—The long-term goal assessed in this study was the health-related characteristic of reduced healthcare utilization (actual questions are described earlier in the “Measures” section).

Statistical analysis

All analyses were completed using SAS version 9.3. Univariate analyses of all variables were conducted looking for missing data and allowable ranges, along with creating a description of this population. Bivariate analyses were performed, including checking for collinearity between predictor variables. For the first research objective, logistic regression modeling was employed to determine characteristics predicting a complete dose of AMOB/VLL. The Hosmer and Lemeshow goodness-of-fit test was used with the final model. The second research objective used individual growth models (linear, logistic, or negative binomial as appropriate) to determine the immediate, intermediate, and long-term goals for the outcomes resulting from receiving at least an adequate dose (≥ 5 sessions) of AMOB/VLL.

RESULTS

Participant characteristics

Baseline characteristics of participants in the AMOB/VLL program are reported in Table 1. The average age was 74.2 years, and participants were largely female (78.4 %) and Hispanic (91.3 %). A majority of participants reported they had spent 6–12 years in school (61.8 %), with 27.6 % reporting only 0–5 years in school and 10.6 % reporting being in school for greater than 12 years. Most participants were either widowed (29.4 %), single (23.8 %), or married (19.1 %). Nearly half of the participants (46.8 %) reported living alone.

Many chronic conditions were represented at baseline including diabetes (53.6 %), asthma (12.0 %), cancer (7.3 %), emphysema or COPD (2.4 %), other lung diseases (5.6 %), and other chronic conditions (35.3 %). Roughly one fifth of the participants (20.6 %) reported falling during the 3 months preceding the beginning of the program. A little more than half of the participants (54.0 %) reported restricting their activities because they are afraid they might fall. The average fall management scale score (from 1 to 4) was 1.3. A lower score represents less confidence, so most participants reported they were not very sure that they could manage a fall or prevent future falls. Almost one third (29.3 %) of the participants reported using an assistive device (a cane or walker). Individuals kept track of their monthly falls for 14 months. Sixty-six falls were reported by the end of the program.

Correlates of intervention intensity

Roughly half of the participants ($n = 69$) completed all eight classes, which was considered to be a complete dose of the program. There were 40 participants who

completed an adequate dose (five to seven classes), with 25 completing seven classes, 10 completing six classes, and 5 completing five classes. The remaining participants ($n = 17$) were considered to have received an inadequate dose, with 2 completing four classes, 3 completing three classes, 1 completing one class, and 11 completing zero classes.

Baseline personal, health-related, and fall-related characteristics predicting receiving a complete dose of the program were evaluated (Table 2). Many factors determined the final predictive model, including a limited sample size, collinearity among the baseline variables, the bivariable analysis, and personal characteristics from the Smith et al. conceptual framework [16]. There were two variables significantly predictive of receiving a complete dose in the final model that was adjusted for age, education, gender, living situation, and physical (TUG) and mental (PROMIS emotional distress/depression measure) health. These variables were self-restriction of activities due to fear of falling (OR 5.04, 95 % CI 1.86–13.69, $p = 0.002$) and a lower frequency per week of engaging in moderate and vigorous physical activity (MET ≥ 3) (OR 1.14, 95 % CI 1.04–1.27, $p = 0.033$). Participants who self-restrict their activities due to fear of falling have 5.04 times the odds of receiving a complete dose (attending all eight sessions) of the AMOB/VLL program compared to participants who do not self-restrict their activities due to fear of falling (adjusted for the variables mentioned above). For every one less hour of participation in moderate and vigorous physical activity (MET ≥ 3), a participant has 1.14 times the odds of receiving a complete dose (attending all eight sessions) of the AMOB/VLL program (adjusted for covariates). The data fit the model well as indicated by the Hosmer and Lemeshow goodness-of-fit test (chi-square 9.27, DF 8, $P > \chi^2$ 0.32).

The immediate, intermediate, and long-term goal outcomes—Individual growth models were employed to determine the immediate and intermediate outcomes resulting from receiving at least an adequate dose of the AMOB/VLL program (≥ 5 sessions) (Table 3). Each individual growth model was adjusted for age, education, living alone, and self-restriction of activities due to fear of falling.

Immediate outcomes—To turn to our second main objective, and in terms of immediate outcomes, all self-efficacy of managing medications and treatment questions had significant results. Participants who completed at least an adequate dose of the AMOB/VLL program improved each month on two self-efficacies of managing medications and treatment measures. Over time, they were more likely to prepare a list of questions for the doctors ($p = 0.0287$) and to ask questions about the things they wanted to know and did not understand about their treatment ($p = 0.0003$). However, they were also significantly less likely over time to discuss any personal problems that may be related to their illness ($p = 0.0005$). No health interference or physical activity outcomes were significant.

Intermediate outcomes—Regarding intermediate outcomes, participants who completed at least an

Table 1 | Baseline personal, health-related, and fall-related characteristics of the Coordinated Older-Adult Senior Transportation Services (COASTS) cohort participating in A Matter of Balance/Volunteer Lay Leader (AMOB/VLL) program ($n = 126$)

Characteristics	Mean or percent
Demographics	
Age ($n = 122^a$)	74.2 $\pm$ 0.8
Female gender, % ($n = 125^a$)	78.4
Hispanic race, % ($n = 126$)	91.3
Education, % ($n = 123^a$)	
Primary school (0–5 years)	27.6
Middle or high school (6–12 years)	61.8
College/university (≥ 12 years)	10.6
Marital status, % ($n = 126$)	
Married	19.1
Single	23.8
Separated	11.9
Divorced	15.9
Widowed	29.4
Living status, % ($n = 124^a$)	
Live alone	46.8
Live with one person	33.1
Live with more than one person	20.2
Health conditions	
Diabetes, % ($n = 125^a$)	53.6
Asthma, % ($n = 125^a$)	12.0
Emphysema or COPD, % ($n = 125^a$)	2.4
Other lung disease, % ($n = 125^a$)	5.6
Cancer, % ($n = 124^a$)	7.3
Other chronic conditions, % ($n = 119^a$)	35.3
Previous fall (in the past 3 months), % ($n = 126$)	20.6
Health behaviors	
Uses an assistive device, % ($n = 123^a$)	29.3
Self-restriction of activities due to fear of falling, % ($n = 126$)	54.0
Falls management scale score ^b ($n = 124^a$)	1.3 $\pm$ 0.1
Medical care	
Prepares a list of questions for doctor ^c ($n = 123^a$)	1.47
Asks questions about treatment ^c ($n = 125^a$)	2.99
Discusses personal problems related to illness ^c ($n = 125^a$)	2.57
Times visiting physician (in the past 6 months) ($n = 123^a$)	3.17
Times visiting an ED (in the past 6 months) ($n = 126^a$)	0.42
Times hospitalized (in the past 6 months) ($n = 123^a$)	0.20
Total nights spent in hospital (in the past 6 months) ($n = 80^a$)	1.13
PROMIS measures	
Emotional distress-depression ($n = 126$)	48.2 $\pm$ 0.8
Fatigue ($n = 126$)	46.3 $\pm$ 0.8
Pain behavior ($n = 126$)	51.2 $\pm$ 0.9
Pain interference ($n = 122^a$)	51.6 $\pm$ 0.9
Physical function ($n = 126$)	42.7 $\pm$ 1.0
Sleep disturbance ($n = 126$)	51.6 $\pm$ 0.9
CHAMPS	
Calorie expenditure per week with physical activities ($n = 118^a$)	2216.4 $\pm$ 140.5
Calorie expenditure per week with MET ≥ 3 physical activities ($n = 118^a$)	1831.8 $\pm$ 119.3
Frequency per week for physical activities (in hours) ($n = 126$)	10.4 $\pm$ 0.4
Frequency per week for MET ≥ 3 physical activities (in hours) ($n = 126$)	8.2 $\pm$ 0.3
TUG score (in seconds) ($n = 120^a$)	14.6 $\pm$ 0.4

Values are the mean $\pm$ SE unless otherwise indicated. A higher PROMIS score represents more of the concept being measured. An average score is 50. A MET value ≥ 3 indicates an activity of at least moderate intensity. TUG assesses the time it takes for a participant to rise from a chair, walk 3 m, walk back, and sit back down in the chair

PROMIS Patient-Reported Outcomes Measurement Information System, CHAMPS Community Healthy Activities Model Program for Seniors, MET metabolic equivalent, TUG Timed Up and Go

^a N values smaller than 126 reflect missing data for specific covariates

^b 0–4 scale of confidence in personal ability to manage actual falls and the risk of falls with 4 = very sure, 3 = sure, 2 = somewhat sure, and 1 = not at all sure

^c 0–5 scale with 0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, 4 = very often, and 5 = always

Table 2 | Personal, health-related, and fall-related characteristics predicting a complete AMOB/VLL dose (all 8 sessions) ($n = 112$)

	OR	95 % CI
Age ^a	1.01	0.97–1.05
Female	0.81	0.29–2.25
Primary school education	3.64	0.78–17.04
Middle/high school education	2.20	0.56–8.69
College education	1.00	–
Living alone	1.64	0.93–2.88
Self-restriction of activities due to fear of falling	5.04	1.86–13.69*
Lower frequency per week of MET ≥ 3 physical activities ^a	1.14	1.04–1.27*
Depression ^a	0.98	0.93–1.04
TUG score ^a	0.93	0.82–1.06

*Indicates significance at $p < 0.05$ ^a Denotes a continuous variable

adequate dose of the AMOB/VLL program improved significantly each month on one reduced disability and one reduced activity limitation outcome, respectively: physical function ($p = 0.0253$) and pain behavior

Table 3 | Immediate, intermediate, and long-term goals (from the Smith et al. conceptual framework and used in this study) for each additional month for those receiving an adequate AMOB/VLL dose (≥ 5 sessions) ($n = 109$)

	Month ^{c,d}	
	Beta (SE)	Pvalue
Immediate goals		
<i>Improved self-efficacy of managing medications and treatment efficacy</i>		
Prepare a list of questions for your doctor	0.04 (0.02)	0.0287**
Ask questions about treatment	0.06 (0.02)	0.0003**
Discuss personal problems related to illness	−0.07 (0.02)	0.0005*
<i>Less health interference</i>		
Depression ^a	0.10 (0.06)	0.1148
Fatigue ^a	0.03 (0.07)	0.6435
Sleep disturbance ^a	−0.11 (0.06)	0.0756
<i>Increased physical activity</i>		
Calorie expenditure per week with physical activities ^b	−13.45 (14.18)	0.3439
Calorie expenditure per week with MET ≥ 3 physical activities ^b	−6.26 (12.44)	0.6154
Frequency per week for physical activities ^b	−0.02 (0.04)	0.6316
Frequency per week for MET ≥ 3 physical activities ^b	0.03 (0.03)	0.3224
Intermediate goals		
<i>Reduced functional impairment</i>		
TUG score	−0.02 (0.02)	0.4182
<i>Reduced fall incidence</i>		
Falls	0.09 (0.04)	0.0125*
<i>Reduced activity limitations</i>		
Pain behavior ^a	−0.32 (0.08)	0.0001**
Pain interference ^a	−0.10 (0.07)	0.1890
<i>Reduced disability</i>		
Physical function ^a	−0.15 (0.07)	0.0253**
Long-term goals		
<i>Reduced healthcare utilization</i>		
Times visiting a physician (last 6 months)	0.01 (0.03)	0.7258
Times going to a hospital ED (last 6 months)	−0.01 (0.01)	0.0921
Times hospitalized (last 6 months)	0.00 (0.00)	0.4274
Nights spent in the hospital (last 6 months)	0.17 (0.12)	0.1845

A MET value ≥ 3 indicates an activity of at least moderate intensity. TUG assesses the time it takes for a participant to rise from a chair, walk 3 m, walk back, and sit back down in the chair

MET^a metabolic equivalent, TUG Timed Up and Go

*Indicates significance at $p < 0.05$; **indicates significance at $p < 0.05$ in the correct direction

^a Denotes a Patient-Reported Outcomes Measurement Information System (PROMIS) measure

^b Denotes a Community Healthy Activities Model Program for Seniors (CHAMPS) physical activity measure

^c Covariates in the models include age, education, living alone, and self-restriction of activities due to fear of falling

^d Most models are linear. A negative binomial model was used for the fall outcome

(0.0001). For fall incidence, these participants were more likely to experience a fall ($p = 0.0125$). The rest of the outcomes (TUG score as a measure of reduced functional impairment and pain interference as a measure of reduced activity limitations) were not significant.

Long-term outcomes—None of the four questions measuring the long-term outcome of reduced healthcare utilization reported significant results.

DISCUSSION

Pairing AMOB/VLL with a transportation program aimed at older adults with limited mobility is an important first step to ensuring that these vulnerable individuals become more receptive to multicomponent exercise fall-prevention programs. In the COASTS population, the implementation of an AMOB/VLL program may be a feasible and safe first step prior to the adoption and dissemination of other evidence-based programs [11].

It has been posited that completion of all sessions in an AMOB/VLL program is important for achieving the best possible health outcomes [16]. In addition, an earlier study by Smith and colleagues that, in part, investigated health outcome improvements based on participant attendance found that perfect attendance (completing all eight sessions of AMOB/VLL) was associated with improvements in fall efficacy and activity limitations, when compared to a referent group of those attending an adequate number of sessions (five to seven) [17]. Our current study found that self-restriction of activities due to fear of falling was significantly predictive of attending all sessions, indicating that those who are more likely to restrict their activities due to a fear of falling are more likely to be program completers. Perhaps individuals are likely to self-restrict their activities if they self-assess themselves as being at high risk of falling, and those who consider themselves to be at high risk are more inclined to complete a fall risk reduction program they believe they need. A lower frequency of moderate and vigorous physical activity per week was also predictive of attending all sessions. It is possible that more active individuals may self-assess themselves as not needing a fall risk reduction program as much as others, or perhaps they may sometimes choose to engage in certain physical activities during the time that classes are offered.

It is notable that non-modifiable demographic factors were not significantly associated with completion, possibly indicating that most older adults, regardless of their background, are, when properly self-motivated, capable of program completion. Smith et al. had found in 2012 that individuals who had graduated from high school were actually less likely to receive an adequate dose of the AMOB/VLL program, despite generally prevailing knowledge that higher levels of education tend to translate into better program adherence [16, 35, 36]. Although educational level was not a

significant predictor of program completion in this study, the results indicated trends that would support Smith et al.'s findings. The confidence intervals for primary and middle/high school education were wide with high upper limits, and the inclusion of 1.0 in these confidence intervals may be due in part to our small sample size, with a potential magnitude of effects suggested.

Adoption of the AMOB/VLL program can result in a variety of positive outcomes. This study found that over time, participants receiving at least an adequate dose of the program (five or more sessions) improved on two intermediate outcomes: self-reported pain behavior and physical function. Individuals were also more likely to prepare a list of questions for their doctor and to ask questions about their treatment. Further translational research on AMOB/VLL supports these findings that other health improvements can arise from the program's implementation. In approximately 1200 participants, positive outcomes were found in fall-related self-efficacy and the number of days of physical activity [14].

Not unexpectedly in this group of older adults with mobility disability utilizing a door-through-door transportation program, we found that falls increased over time for those receiving an adequate number of sessions. Mobility disabilities observed in our population were significant, which can be evinced by the subjects' TUG scores measuring physical functioning. In a study aiming to describe a usual range of performance among older adults lacking disabilities, Steffen et al. found that mean scores ranged from 8 s for those 60–69 years old to 10–11 s for those 80–89 years old (with scores varying on gender) [37]. Our mean age was 74.2, and yet the mean TUG score in our population was a comparatively very high 14.6 s. The increase in falls stands in contrast to the research of Miller et al., which determined that implementing ten AMOB/VLL classes for 140 participants (100 completers) should show a positive return on investment with an estimate of at least seven falls averted [38]. A review on fall risk and TUG use found that the fall risk in among older adults can range from 7.5 to 60 %, with TUG score cutoff values separating fallers and non-fallers ranging from 10 to 32.6 s [39]. Our average recorded TUG score (14.6 s) was indicative of fall risk, and our observed fall risk was 52 %, with a total of 66 falls reported. It is possible, since this risk value did not reach the upper bounds of what has been recorded previously, that the AMOB/VLL program actually did lower the overall fall risk from what it would have been otherwise. Still, since our study design did not include a control group in this high fall risk population with significant mobility disabilities, we are unable to conclude that the AMOB/VLL program actually did lower the overall fall risk from what it would have been otherwise. As mentioned in the Conclusion of the original efficacy RCT paper, the AMOB program could have no effect or, since the program increases participant's overall physical mobility, it may have the unanticipated negative outcome of increasing the risk

of falls [12]. As mentioned in our “Introduction” section, research suggests that mobility programs in older adults with limited mobility need to be started at a low intensity to prevent increasing the rate of falls [6, 11]. The AMOB/VLL program is one of the most promising programs for increasing mobility gradually. It is further important to recall that the AMOB/VLL program does not specifically target falls as an outcome; rather, the program focuses on addressing attitudes and behaviors that are risk factors for falls among older adults. Falls are an intermediate outcome, and it may take more time for changed attitudes and behaviors to begin contributing to real change regarding actual falls.

It is important when evaluating community-based interventions to consider the costs as well as the returns of the programs. A practical cost-benefit analysis conducted by Miller and colleagues on the AMOB/VLL program implemented on a large scale in Texas determined a positive cost-benefit ratio and a positive return on investment that exceeds 25 % [38]. In summary, they estimated a positive return on medical cost avoidance if an agency taught ten classes to 140 participants in order to prevent seven falls in the first year [38]. One programmatic advantage that helps make AMOB/VLL a viable investment for communities is its reliance on volunteers as lay leaders, helping to keep programmatic costs low [38].

By linking an evidence-based practice to a community transportation program, the project creates an innovative model for reaching older adults with decreased mobility who currently do not use senior centers and other community services. This translational project can be replicated in older adult communities with transportation programs to promote the health-improving benefits of other efficacious interventions.

Limitations

Generalizability of the results to other populations due to the high proportion of Hispanic (91.3 %) and female (78.4 %) participants, and the generally low education attainment levels, may be limited. As mentioned above, our study design did not include a comparison group. Our population may be unique enough that it warrants its own efficacy trial. However, this may also be a strength with regards to adding to the literature for this underserved population. Further, Smith and colleagues [16] suggested it may be valuable to study outcomes based on specific AMOB/VLL sessions missed, rather than simply focusing on the total number of sessions attended. This was not included in the scope of our study, but could be a valuable research to pursue in the future to determine if some AMOB/VLL sessions include more valuable content than others.

A limitation of this study and the Smith and colleagues conceptual model is how to operationalize the box called “improved fall-related efficacy” [16]. We outlined earlier our recommended breakdown of fall-related psychological constructs [Fig. 2], which we think is a positive outcome of this study to prevent limitations in measurement around fall-related

efficacy. A clear limitation of this study is that only self-efficacy of managing medications and treatments was collected at the follow-up time points in this study. At baseline, fall self-efficacy and fear of falling were measured with a single item. It is not uncommon for researchers to use a one-item instrument for at least fear of falling, but this subdomain is not unidimensional and other multidimensional measures should be used for both of these subdomains [27]. Perceived ability to manage falls was the third subdomain that we measured at baseline; validation studies were not found [12].

CONCLUSION

In summary, this is the first evidence-based fall-prevention program targeting more frail older adults with mobility disability using a transportation program. The project responds to a call for collaborative projects building on all currently available scant resources [2]. The use of transportation services to overcome barriers to dissemination and adoption of AMOB/VLL for seniors is innovative and capacity-building. The pairing is an efficient way for the delivery of fall prevention programs to potentially be available for all older adults using a transportation program.

When considering attrition concerns, it is important for program delivery sites to know which participant characteristics predict full completion of a program. This study has found that one characteristic predicting program completion was self-restriction of activities due to a fear of falling, indicating that personal behaviors and attitudes about falling can predict completion of a fall prevention program, perhaps more so than non-modifiable sociodemographic characteristics. This is good news for program sites that may wish to take action to decrease attrition. A lower frequency of moderate and vigorous physical activity was also predictive of program completion, which may indicate to program sites that more active individuals may need additional motivation in order to recognize the value of program completion in their own lives.

Further, it is a reality that full completion from all participants is unlikely, so it is crucial to know if adequate program attendance will result in positive health outcomes. This study has determined that both positive immediate and intermediate outcomes are possible with an adequate dose of program attendance.

While more research is needed to further understand what factors promote completion of a fall prevention program such as AMOB/VLL and what benefits can be obtained from an adequate dose of program attendance, we believe that this study provides encouraging evidence to indicate that effective means of preventing attrition are possible and, yet, that participants do not have to attend every session in order to reap many of the program’s benefits.

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Compliance with ethical standards

Conflict of interest: All authors declare that they have no conflict of interest.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and the national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Welfare of animals: This article does not contain any studies with animals performed by any of the authors.

Informed consent: Informed consent was obtained from all individual participants included in the study.

IRB approval: This study was approved by the Columbia University Institutional Review Board.

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