Preventing Disability and Managing Chronic Illness in Frail Older Adults: A Randomized Trial of a Community-Based Partnership with Primary Care

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BACKGROUND: Effective new strategies that complement primary care are needed to reduce disability risks and improve self-management of chronic illness in frail older people living in the community.

OBJECTIVE: To evaluate the impact of a 1-year, senior center-based chronic illness self-management and disability prevention program on health, functioning, and healthcare utilization in frail older adults.

DESIGN: A randomized controlled trial.

SETTING: A large senior center located in a northeast Seattle suburb. The trial was conducted in collaboration with primary care providers of two large managed care organizations.

PARTICIPANTS: A total of 201 chronically ill older adults seniors aged 70 and older recruited through medical practices.

INTERVENTION: A targeted, multi-component disability prevention and disease self-management program led by a geriatric nurse practitioner (GNP).

MEASUREMENTS: Self-reported Physical function, physical performance tests, health care utilization, and health behaviors.

RESULTS: Each of 101 intervention participants met with the GNP from 1 to 8 times (median = 3) during the study year. The intervention group showed less decline in function, as measured by disability days and lower scores on the Health Assessment Questionnaire. Other measures of function, including the SF-36 and a battery of physical performance tests, did not change with the intervention. The number of hospitalized participants increased by 69% among the controls and decreased by 38% in the intervention group ($P = .083$). The total number of inpatient hospital days during the study year was significantly less in the intervention group compared with controls (total days = 33 vs 116, P = .049). The intervention led to significantly higher levels of physical activity and senior center participation and significant reductions in the use of psychoactive medications.

CONCLUSIONS: This project provides evidence that a community-based collaboration with primary care providers can improve function and reduce inpatient utilization in chronically ill older adults. Linking organized medical care with complementary community-based interventions may be a promising direction for research and practice. **J Am Geriatr Soc 46:1191–1198, 1998.**

With growing evidence of modifiable risk factors for disability, new strategies are needed to apply what is known about disability prevention in older adults. Smoking and physical inactivity are known to contribute to the onset of disability.[1–5] Other factors, such as psychotropic medication use, may be less well studied in relation to disability; however, research findings suggest that psychoactive drug use may be associated with functional loss as well as with risk for falls and fractures.[6–10] Prevalent chronic conditions may predispose older adults to disability,[11] but there are manageable aspects of chronic illness that moderate the impact of disease on functioning. Self-management interventions for arthritis, heart disease, and diabetes have been shown to reduce the burden of chronic diseases effectively and to reduce healthcare costs and utilization.[12–14]

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Translating our knowledge of disability risks into effective approaches for prevention has been a challenge for researchers and clinicians. Exercise-based randomized trials have demonstrated improvements in strength and mobility and reduced risks for falls.[15–19] Our own earlier work using a population-based approach in a large group of community-living older persons demonstrated how a short-term, tailored, health promotion intervention based on a modest health behavior assessment reduced numbers of falls and disability days in 1 year although effects were not sustained during the

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second year with no further intervention.[20] With a more sustained and intensive intervention, a 3-year, home-based geriatric prevention program reduced nursing home admissions and declines in activities of daily living significantly.[21] Although clinic or home-based approaches are appealing for their relative ease in reaching frail older people, interventions based in community senior centers may reach more people and prove to be more self-sustaining and cost-effective.[22]

In the present study, we evaluate the impact of a 1-year, senior center-based, chronic illness self-management and disability prevention program on health, functioning, and healthcare utilization in chronically ill older adults. Using a collaborative model, we sought to extend the efforts of the patient's primary medical team with the senior center-based supervised program involving individually tailored interventions and follow-up. The goals of the program were threefold: to reduce risk factors for disability, especially through increased physical activity; to promote social activation; and to enhance medical management and self-management of chronic illness.

METHODS

The randomized controlled trial was a collaborative project involving two independent health maintenance organizations (HMO) in the Pacific Northwest and a large senior center serving a predominantly white suburban area northeast of Seattle. HMO physician practices located in the catchment area of the senior center were invited to participate in the study, referred to as the Health Enhancement Project (HEP). Primary care providers referred patients aged 70 years and older who were receiving treatment for at least one chronic condition, excluding dementias and terminal disease. Transportation to and from the senior center was provided when needed. Written informed consent was obtained from each participant before randomization. The study was approved by the institutional review committee of Group Health Cooperative and by the executive staffs of PacifiCare of Washington and Senior Services of Seattle/King County, and the Northshore Senior Center.

Letters of invitation to participate in the study were sent from their physicians to 891 patients. Study staff then telephoned each patient to assess eligibility and interest. Eligibility criteria included nonparticipation in the senior center and self-reported ability to walk and perform activities of daily living without help. A total of 275 patients (31%) refused to participate, 297 (33%) were ineligible, and 45 (5%) were unreachable via telephone during the recruitment period. The most common reasons for ineligibility were current regular senior center use (35%), plans to be away for more than 1 month in the coming year (24%), and needing assistance to walk (18%). Of the 274 interested and eligible older adults who made baseline appointments, 219 (80%) came to the senior center for their scheduled visit. Of these, 11 refused to join the study after learning more about the project during their visit, and seven were ineligible for the following reasons: evidence of significant cognitive impairment by a score of 18 or lower on the Mini-Mental Status Examination (3), or by a score of 19–26 and an evaluation by the nurse practitioner (3), or current active senior center participation (1). A total of 101 screenees were randomized to the intervention group, and 100 to the control group, through participants' random selection of labeled ping pong balls from a box.

Data Collection

The evaluation of the study intervention was based on the conceptual model by Buchner and Wagner describing disability as an outcome of frail health.[23,24] In the model, frailty is composed of deficits in neurologic and musculoskeletal function and energy metabolism. Data collection targeted both the outcome of disability and intermediate measures of physical functional performance.

Mailed questionnaires were reviewed for completeness at the time of the assessment visits at the senior center, which occurred at baseline and 6 and 12 months after baseline. Questions addressed health and functional status, health behaviors, self-efficacy measures, and demographics. Restricted activity days and bed disability days were measured using items from the National Health Interview Survey.[25,26] The questions on disability days and the categorization of these variables have been described in detail previously.[20] Briefly, the distributions of these two disability days measures are highly skewed, and reported days were grouped as follows: 0, 1 to 7, 8 to 30, 31 to 179, and ≥180 days. The disability days measures have been shown to have construct validity and to be responsive to clinically significant change.[27,28] Four scales from the Medical Outcomes Study Short Form-36 (SF-36) were used to measure role limitations caused by physical health and emotional problems, physical functioning, and general health.[29] The Health Assessment Questionnaire (HAQ) was used to measure performance of activities of daily living,[30] and depressive symptoms were assessed using the 20-item Center for Epidemiologic Studies Depression Scale (CES-D).[31]

Chronic conditions were assessed by the following question, "Has your doctor ever told you you've had (chronic condition list)?" Health behaviors measured on the questionnaire included smoking, nutrition,[32] alcohol use, home safety, and a battery of physical activity questions. The Physical Activity Scale for the Elderly (PASE) was used to measure total leisure and work activity through a weighted scoring of hours per activity in the previous 7 days.[33] This comprehensive scale has been shown to have construct validity with health status measures and test-retest reliability.[34] Attitudes and behaviors related to physical activity were assessed using the Physician-based Assessment and Counseling for Exercise (PACE) scoring form developed by the Centers for Disease Control and Prevention.[35]

Subjects were asked to bring all of their current medications to their study visits, at which time a nurse recorded all medications, including psychoactive drugs (antidepressants, anxiolytics, antipsychotics, sedative-hypnotics, narcotics, and sedating antihistamines).

The battery of physical performance tests included: the 6-minute walk,[36,37] usual paced 50-foot walk,[38] timed "Up & Go" test,[39] quadriceps strength tests using the 1 repetition maximum,[40] 5 chair stand test. Usual gait speed was calculated as minutes per meter walked, based on a timed 50-foot walk (15.24 meters). The Physical Performance and Mobility Exam (PPME) measures a series of basic mobility tasks, including sitting up in bed, transferring from bed to chair, going up and down a step, and a series of standing balance tests.[41] The instrument measures a broad range of function and has been shown to perform well in hospitalized patients; however, there was a moderate ceiling effect in our population that had generally higher functioning than we had ini-

tially anticipated. None of the research staff involved in data collection participated in the delivery of the intervention.

Information about hospital and outpatient utilization in the 12 months before and after the month of randomization was derived from administrative databases maintained by the health care plans. Total outpatient utilization included primary and specialty care visits, home health visits, mental health and emergency room visits, and ancillary outpatient services excluding radiology and laboratory services.

Of the 201 participants randomized for the study, six in the intervention group and seven in the control group did not complete the study. Two controls and one intervention participant died, and five persons from each group dropped out of the study. Seventeen people completed the mailed questionnaire at the 12- month follow-up but did not complete the performance tests (4 intervention; 13 controls).

Intervention

The GNP contacted each intervention participant's primary care physician to obtain information about the patient's current health problems and the provider's goals for the patient. At the core of the intervention was a meeting between the participant and the GNP to develop a targeted health management plan that addressed risk factors for disability if present (inactivity, smoking, alcohol misuse, psychoactive drug use, depression, poor nutrition) and self-management of chronic illness. Risk factors were identified initially from the baseline health assessment at the time of study enrollment. Reports on their patients' participation were sent to all referring physicians; seldom did acute situations arise in which the GNP needed to contact the MD by telephone (15 calls).

All participants attended the initial session with the GNP at the senior center, and follow-up visits and phone contacts were used to monitor participants' progress toward health goals. The median number of visits with the nurse practitioner was 3.0 per participant ($\bar{x}$ = 3.0, range 1–8), and the median number of phone calls by the GNP was nine per participant ($\bar{x}$ = 9.2, range 1–22). Volunteer mentors, who were senior center participants trained in a 12-session health promotion course, provided peer support to participants.

Two key components of the intervention were emphasized with all participants: physical activity and chronic illness self-management. Participants were encouraged to select from a menu of physical activities available at the senior center that included walking, swimming, dancing, tai chi, and a supervised endurance, strength, and flexibility training program that met 3 times a week. Home exercise options were recommended for those who preferred not to participate in group exercise activities at the senior center. In addition to individual counseling by the GNP in chronic illness self-management, participants were encouraged to attend the Chronic Illness Self-Management Course, a 7-week series that combined peer support with health promotion information and disease self-management concepts. The weekly 2-hour classes were attended by 35 intervention participants and were conducted by trained lay leaders. The accompanying text for the course was the self-management workbook, *Living a Healthy Life with Chronic Conditions*.[42]

Opportunities for reducing or eliminating unnecessary psychoactive medications were identified and discussed with the primary care physician. The few persons who smoked (4) or had excessive alcohol use (1), as measured on the CAGE test,[43] were referred to established senior center or community programs. All participants were given a set of nutrition tip sheets developed in consultation with registered dietitians. The 19 participants who scored more than 12 on the CES-D were referred to the social worker for further evaluation and/or very brief counseling.[19]

Persons randomized to the control group were given a tour of the senior center and a schedule of senior center activities. They did not meet with the GNP; however, they had access to all senior center activities that were available to the intervention group.

Statistical Analysis

The sample size was based on effect sizes observed in the physical function and physical limitations subscales of the SF-36 in a group of older participants from an earlier 6-month intervention trial at the same senior center.[44] With 100 participants per group, we had 80% power to detect a between-group difference of 6.8 points (9%) on the physical function subscale or 14 points (25%) on the physical limitations subscale (two-tailed test, alpha = .05).

Baseline differences between the study groups were tested using *t* tests for continuous variables and chi-square tests for categorical variables. The statistical analysis was designed to adjust for observed baseline differences between the two study groups. The distributions of bed and restricted activity days were classified according to four categories of change (sustained high function, sustained limited function, improved, worsened). The intervention and control groups were compared, stratified on baseline function (high vs limited) to control for baseline differences in disability days.[45]

For continuous outcomes, unadjusted mean changes from baseline to 6 months and from baseline to 12 months are shown by treatment group. The intermediate outcomes of health behaviors are presented as adjusted least square means averaged over 6- and 12-month follow-ups. All conclusions regarding the effect of the intervention are based on an intention-to-treat analysis comparing groups on the basis of the overall 6-month and 12-month follow-ups. To account for the correlation between the 6- and 12-month data, we used mixed model analysis of covariance (SAS Mixed Procedure[46]) with continuous measures of disability and functional performance, and adjusted for age, sex, and baseline value of the outcome measure. Between-group differences in adjusted least square means averaged over the two follow-ups and 95% confidence intervals for the differences were calculated as a percent of the adjusted least square means of the control group averaged over the 6- and 12-month follow-ups. Mantel-Haenzsel chi-square statistics were used to test for group differences in number of persons hospitalized during follow-up, adjusting for hospitalization in the year before baseline. Between group differences in change from baseline to 12 months for all other utilization variables were tested using analysis of covariance adjusting for age, sex, and insurer. Differences in change from baseline to follow-up, including 95% confidence limits, were calculated as percent of adjusted least squares mean for the control group.

Group differences in categorical risk factor variables, such as smoking status and senior center attendance versus non-attendance, were tested using logistic regression adjusting for age, sex, and baseline measurements. Additional adjustment for all baseline differences, including marital status, living alone, and self-reported diabetes, did not change the findings materially, and, thus, the findings presented are

adjusted for age, sex, and baseline status on the outcome of interest.

Subgroup analyses were performed to determine whether subjects with specific characteristics had more gains than others as a result of the intervention. The analyses revealed no consistent subgroup effects in any of the categories of outcomes (disability, performance, and utilization) when stratified on age, gender, diagnosis of arthritis, living alone versus with others, and using more than two prescription drugs versus two or fewer prescriptions. Therefore, subgroup analyses are not presented.

RESULTS

Participants in the intervention and control groups were similar in regard to age, income, and education (Table 1). More of the intervention participants (64/101) than controls (48/100) were women, and they were less likely to be married or living with others. Although self-rated health was similar in the two groups, significantly more intervention participants had diabetes compared with controls. No other significant differences were observed in self-reported chronic conditions. Controls were less likely than intervention participants to report restricted activity days in the baseline year.

There were substantial between-group differences in the proportions of participants who either improved or remained stable with respect to disability days from baseline to follow-up (Table 2). The intervention group had significantly fewer bed days than the control group during follow-up, and only the intervention group showed improvements in bed days during follow-up. Although modest differences were observed between the study groups in changes in restricted activity days, the differences were not statistically significant.

The scores on the SF-36 scales did not differ between the two groups (Table 3). After adjustment for age, sex, and baseline score, the adjusted average HAQ scores were 26% lower during follow-up in the intervention group compared with the controls, indicating reduced ADL difficulty (0.23 ± 0.02; 0.17 ± 0.02, respectively, $P = .014$). Depressive symptoms, measured by the CES-D, were not altered as a result of the intervention. Among the performance measures, only the timed up-and-go test showed modest improvements in the intervention group compared with controls, indicated by shorter time to perform the test, with the difference approaching significance ($P = .075$). There were no other differences between the treatment groups at follow-up in any other tests of physical performance, including the 6-minute fast paced

Table 1. Characteristics of Participants at Baseline by Treatment Group, Health Enhancement Project

Characteristics	Intervention n = 101	Control n = 100	P Value*
Age (mean + SD)	77.2 (5.2)	76.9 (5.2)	.700
Female (%)	63.4	48.0	.028
Income < $15,000/yr (%)†	29.5	27.1	.717
High school graduate (%)	84.2	89.0	.314
Lives alone (%)	39.6	25.0	.030
Married or living as married (%)	53.5	71.0	.032
Fair/poor self-rated health (%)	20.8	21.0	.242
No bed disability days (%)	74.3	84.0	.089
No restricted activity days (%)	53.1	72.9	.005
Hospitalized in past 12 months (%)‡	21.0	13.0	.132
Self-reported medical conditions (%)			
Heart disease	33.7	41.0	.258
High blood pressure	55.5	57.0	.824
Arthritis or rheumatism	62.4	64.7	.739
Cancer	17.8	25.0	.215
Stroke	8.1	9.2	.783
Diabetes	16.0	7.0	.046
Current smoker (%)	4.0	9.0	.146
Past smoker (%)	44.6	48.0	.624

*Between group comparisons tested using *t* tests for continuous measures and chi-square tests for dichotomous measures.
†Data on income not provided by 14% of participants.
‡Derived from insurers' computerized utilization databases; data unavailable for one intervention participant who died within 1 month of enrollment.

Table 2. Change in Disability Days from Baseline to 12 Months by Treatment Group

Disability Days Change Status†	Intervention %(N)	Control % (N)	P Value*
No Bed Days at Baseline			
Bed disability days			
Sustained high function	100.0 (71)	94.8 (73)	
Worsened	0.0 (0)	5.2 (4)	
≥1 Bed Days at Baseline			
Bed disability days			
Sustained limited function	66.7 (16)	93.3 (14)	
Improved	29.2 (7)	0.0 (0)	
Worsened	4.1 (1)	6.7 (1)	.019
No Restricted Days at Baseline			
Restricted activity days			
Sustained high function	77.5 (38)	83.1 (54)	
Worsened	22.5 (11)	16.9 (11)	
≥1 Restricted Day at Baseline			
Restricted activity days			
Sustained limited function	60.5 (26)	65.2 (15)	
Improved	39.5 (17)	26.1 (6)	
Worsened	0.0 (0)	8.7 (2)	.549

*Cochran Mantel Haenszel chi-square test adjusting for baseline disability days status.
†Categories of disability days were defined as follows: 1 = 0 days, 2 = 1–7 days, 3 = 8–31 days, 4 = 31–180 days, and 5 = 180–365 days. A change of 2 or more categories was required for a change in classification to improved or worsened. "Sustained high function" indicates no disability days in the 12 months before baseline and changed by no more than 1 category during follow-up. "Sustained limited function" indicates any disability days in the 12 months before baseline, and changed by no more than 1 category during follow-up.

ble 3. Health and Functional Outcome Means* at Baseline and Change Scores at 6 and 12 Months by Treatment Group

Self-Report Measures	Baseline		Change from Baseline to 6 Months†			Change from Baseline to 12 Months†			Adj. Avg. % diff. (95% CI)‡	*P* Value Contr. vs Inter.‡
	Intervention Mean (SD)	Control Mean (SD)	Inter.	Contr.	% Diff.	Inter.	Contr.	% Diff.		
dical outcomes										
tudy scales										
Physical Function	66.4 (22.7)	62.9 (22.7)	0.6	1.0	−1	1.0	0.8	3	2 (−4, 8)	.461
Role limitations										
Physical	53.2 (40.9)	50.0 (42.2)	2.4	−3.3	11	−2.9	0.2	−5	4 (−12, 20)	.610
Emotional	70.6 (40.1)	76.1 (36.6)	−2.1	−2.4	0	0.4	1.5	−1	−3 (−13, 7)	.530
General health	66.2 (17.4)	64.4 (19.2)	0.9	−1.3	3	−1.4	1.3	−4	−1 (−6, 4)	.751
epression: CES-D§	10.1 (8.0)	8.7 (7.3)	0.6	0.4	2	−0.03	0.06	−1	5 (−10, 20)	.526
ealth Assessment Q§	0.24 (0.32)	0.23 (0.34)	−0.05	0.02	−33	−0.04	0.03	−41	−26 (−46, −5)	.014
formance measures										
-Minute Walk (feet)	1393 (358)	1362 (393)	−12.4	31.4	−3	18.3	−8.7	2	0 (−4, 4)	.964
ait speed (m/min.)	67.2 (13.8)	67.0 (15.0)	−0.5	−1.4	1	−2.3	−3.3	1	1 (−2, 5)	.449
med Up & Go§ (secs)	11.8 (3.5)	11.9 (5.0)	−1.5	−0.8	−6	−1.0	−0.21	−7	−6 (−12, 1)	.075
hair Stand time§ (secs)	13.9 (4.8)	15.1 (7.7)	0.6	−0.8	9	1.1	1.3	−1	2 (−5, 9)	.610
eg Strength (lbs)	31.7 (10.3)	34.5 (12.9)	6.4	6.3	0	−0.16	−1.9	5	4 (−3, 11)	.275
sical Performance and obility Exam	9.9 (2.2)	9.8 (2.4)	0.01	−0.15	2	−0.5	−0.1	−4	1 (−4, 6)	.756

adjusted baseline means and standard deviations.
adjusted change in measures from baseline to follow-up: 6- and 12-month change scores include only persons with data at both baseline and 6 months or baseline and nths, respectively. Negative difference indicates higher score in controls than in intervention group.
ween-group difference in the adjusted means averaged over 6 and 12 month follow-ups and 95% confidence interval as a percent of average adjusted control group -up means. Means and *P* values are from mixed model analysis of covariance adjusted for age, sex, and baseline value of outcome; *P* values represent comparison of e of 6 and 12 month results between intervention and control groups.
wer score indicates better health or function; in all others, higher score indicates better function.

, usual gait speed, chair-stand time, leg strength, and the E.

There was a 38% drop in the number of intervention cipants hospitalized from the year before baseline to the nonths of the study compared with a 69% increase ng the controls ($P = .083$) (Table 4). The total number of tal days decreased markedly in the intervention group, 116 to 33 days (72% decrease), whereas there was a increase in the total number of inpatient days in the control group, from 96 to 116 days ($P = .049$). Observed differences in hospitalizations at baseline between the study groups were not statistically significant but were controlled for in the analysis. Between group differences in total number of hospital days in the study year occurred primarily among those who had not been hospitalized in the year before baseline (intervention: 23 days/100 persons, control: 113 days/100 persons). The intervention did not seem to influence whether persons hospitalized before baseline were rehospi-

4. Comparison of Changes in Healthcare Utilization from Baseline to 1-year Follow-up Between Treatment Groups*

Utilization	Intervention Group (n = 100)†		Control Group (n = 100)		% Difference in Mean Change (95% CI)	P Value
	Baseline Year	Follow-up Year	Baseline Year	Follow-up Year		
nber hospitalized	21	13	13	22	−41 (−91, 5)‡	.083
al hospital days	116	33	96	116	−101 (−201, −0.2)§	.049
al emergency room visits	17	15	21	13	46 (−86, 177)§	.476
patient visits (mean)	11.6	11.6	10.7	12.1	−12 (−35, 12)§	.302

ween-group difference in number hospitalized during follow-up was tested using Mantel-Haenszel chi-square test controlling for hospitalization before baseline. from baseline to 12 months in all other utilization outcomes were tested using analysis of covariance adjusting for age, sex, and insurer.
person in intervention group died within 2 weeks of enrolling in the study and was not included in the utilization analysis.
een-group difference in proportion hospitalized during follow-up adjusted for baseline hospitalization and 95% confidence limits, as percent of proportion of control ospitalized during follow-up, calculated using regression methods.
een group difference in

talized during the study year. In the intervention group, four of the 21 people (19%) who were hospitalized before baseline were hospitalized during the study year. Among the controls, three of 13 (23%) were hospitalized again in the study year.

An investigation of health behavior changes during the study revealed that the intervention group improved in their attitudes and behaviors with respect to physical activity, measured by the PACE score, compared with controls (Table 5). The overall level of physical activity, measured by the PASE, was significantly higher in the intervention group compared with controls at follow-up ($P = .031$). There were no significant between-group differences in alcohol use, smoking status (data not shown), or nutrition risk as a result of the intervention. Intervention group participants more than tripled their rates of reported participation in any senior center (including other senior centers), from 13 to 44%, from baseline to follow-up, whereas controls increased their participation from 11 to 19%. Greater reductions in psychoactive medication use were seen in the intervention group compared with controls (36% vs 20% reduction in mean number of psychoactive drugs, $P = .039$).

Program Costs

The primary costs of the intervention were the salaries for the GNP (50% FTE for 1 year) and the social worker (20% FTE for 6 months), amounting to approximately $300 annually per participant. Overhead expenses and supply costs did not need to be added to the program costs because they were part of the senior center's existing operating budget. Total costs for hospital days based on data available for hospitalized GHC study participants averaged more than $2000 per day (median $1800/day) in the baseline and follow-up years. Without consideration of posthospitalization costs such as rehabilitation or home care, based on figures in Table 4, there was a reduction of 83 hospital days in the intervention group, yielding a savings of approximately $1200 per participant.

DISCUSSION

The findings provide evidence that a senior center-based approach to disability prevention and chronic illness self-management was effective in reducing major disability and hospitalizations in chronically ill older adults. The impact of the intervention was most evident in the more basic measures of functioning, i.e., activities of daily living and days of restricted activity. Overall, measurements of higher levels of physical functioning and physical performance were not altered by the intervention. Measures related to emphasized areas of the intervention program — more physical activity, less use of psychoactive medications, and greater participation in senior center activities — showed definite improvement.

Previous studies of disability prevention have demonstrated a variety of modest improvements in health, function, and healthcare utilization. A review of randomized trials of in-home geriatric assessments showed that such interventions have generally led to reduced mortality and lower rates of institutionalization, though rarely have these interventions prevented measurable ADL declines.[47] A 3-year trial of in-home geriatric assessment with follow-up led to reduced IADL disability, but there was little effect on ADLs.[21] The intervention in that trial did not reduce hospitalizations, though it did result in fewer nursing home placements. A recent in-home exercise trial found modest improvements in leg strength that were not accompanied by changes in physical functioning measured by SF-36 scales.[16] The mixed findings that often occur in disability trials point to the difficulty of developing interventions and appropriate measures to evaluate them in a population with complex needs and health problems.

Our study intervention was a significant departure from the many previous multicomponent studies because the program provided not only a set of recommendations based on a thorough health and behavioral assessment but also substantial follow-up and a comprehensive set of health-promoting and disease-management activities through a senior center. Rather than a case-management approach, we used a risk-factor reduction strategy, working in consort with providers' stated goals for each participant. Our previous research found that older people who used senior centers regularly were willing to engage in senior center-based health promotion and exercise programs.[44] In the present study, we tar-

Table 5. Comparison of Health Behaviors Averaged over 6- and 12-month Follow-up Between Treatment Groups*

Behavior	Intervention Follow-up Mean (SE)†	Control Follow-up Mean (SE)†	% diff.‡	*P* Value
PACE score¶	5.60 (0.19)	4.97 (0.20)	13	.028
PASE activity score¶	125.1 (4.1)	112.1 (4.2)	12	.031
No. alcoholic drinks/day when drinking	0.78 (0.05)	0.89 (0.05)	−12	.171
Nutrition risk scores§	2.25 (0.17)	1.91 (0.18)	18	.186
No. psychoactive medications	0.25 (0.05)	0.40 (0.05)	−38	.039
Senior center participation	44.1%	18.9%	22	<.001

*For continuous measures, differences between groups in change from baseline to follow-up was tested using mixed model analysis of covariance. For senior center participation, chi-square test was used comparing 12-month means between the two groups, adjusted for age, sex, and baseline values, with logistic regression.

†Least squares means and standard errors, average of 6 and 12 month results adjusted for age, sex, and baseline value.

‡Percent difference calculated as difference between control and intervention adjusted means as percent of control means. Negative value reflects higher mean in controls compared with intervention group. With senior center participation, percent difference represents absolute difference in percent differences from baseline to 12 months between groups, including only those with data at baseline and 12 months.

¶Higher score indicates greater physical activity.

§Higher score indicates greater nutritional risk, measured using the Nutrition Screening Initiative instrument.[32]

geted frailer older people who had not used the senior center previously to see whether they would participate in a senior center-based program and, with encouragement, avail themselves of its exercise classes and other activities. With the support of the GNP and the volunteer mentors, nearly one-half of intervention participants reported attending activities at the senior center, in addition to the HEP program, during the study. Basing the program in a senior center gave emphasis to a preventive health rather than a medicalized or illness-oriented approach to self-care and to integrating healthy behaviors and chronic illness self-management into daily living.

Although intervention subjects were reasonably willing to attend senior center programs, and did so more than the controls, participation in the more rigorous exercise programs was lower than expected. Many intervention participants engaged in moderate level physical activity sessions available at the senior center or at home, as evidenced by the significant changes in the PASE and PACE physical activity scores among intervention participants compared with controls. These increases in moderate exercise may not have led to detectable improvements in performance tests; however, other observed health benefits may have been related to increased activity. Recent studies have reported substantial benefits to older adults in reduced risks for disability and cardiovascular disease events as a result of moderate activity such as walking,.[48,49]

Psychoactive drug use declined by 36% in the intervention group compared with a 20% decline in use among the controls from baseline to the 12-month follow-up. This change in the intervention group was attributable not only to a reduced number of participants using psychoactive medication but also to a reduction in number of psychoactive drugs used by individual patients (data not shown). These results showed that the intervention had an impact on those at high risk of adverse consequences, users of multiple psychoactive medications.[9,50]

Few studied interventions have integrated a social activation component within a disability prevention program despite evidence showing the importance of socialization in the maintenance of health and function.[51,52] Changes in social activation were evident by the more than 3-fold increase in senior center participation. However, the depression intervention, including referrals to very brief individual counseling (1–3 sessions) and support groups did not lead to measurable differences in the CES-D scores between the treatment groups. Depressive symptoms observed in older populations may represent a more chronic condition that is less likely to be affected by the intervention employed or measured by the instrument used. Reducing depressive symptoms may require more intensive interventions such as interpersonal psychotherapy.[53]

The observed benefits measured by the HAQ and measures of disability days must be interpreted with caution inasmuch as we did not observe comparable benefits in measures of higher levels of function, such as the SF-36. The HAQ has been found to be sensitive to change in other studies.[54] Seemingly small changes in the HAQ score (0.007 points) were found to be predictive of additional outpatient visits in a 6-month period in patients with rheumatoid arthritis.[55] In our study, the changes detected by the HAQ were consistent with other major outcomes such as hospitalizations and disability days. Alternatively, recent reports published after the start of this trial point to poor comparability between the SF-36 and other function measures, as well as limitations in sensitivity of the SF-36 to change.[56,57] It is unclear whether the lack of a measurable change in the SF-36 in our study was related to a lack of an effect or to limited responsiveness of the measure in a more chronically ill population. The disability days measures were found previously to be somewhat more responsive to clinically meaningful changes than was the MOS physical function scale, closely related to the SF-36 scale used here.[27] Our findings suggest that the intervention may have worked at a more basic level of functioning that is better measured by the HAQ than by the SF-36. A longer follow-up may have revealed more discrete effects across a broader spectrum of physical functioning. It is also possible that the observed baseline differences in a relatively small study sample may have hindered our ability to detect effects that might ordinarily have been evident.

The decline in hospitalizations among the intervention group is striking, although some of the observed differences in hospitalizations between the groups could be attributed to a regression to the mean effect since there was a notable baseline intergroup difference in the number of participants hospitalized. However, the marked difference in the number of hospital days during the study year suggests that the intervention had a substantial impact on hospital use. The level of significance of these observed differences was borderline because of the small sample size, and confidence limits were wide as a result of the high coefficients of variation. There was no evidence that the findings were caused by outliers.

The estimated cost savings, based on the absolute reduction in the number of inpatient days by intervention participants, were substantial. If the number of hospital days saved was only 50% of the observed reduction, the intervention would still yield a savings of more than $400 per participant per year, based on the median costs of inpatient days. These findings in regard to inpatient costs alone are very encouraging and suggest a sizeable cost benefit to healthcare insurers from this approach to disability prevention.

This study provides evidence of the effectiveness of a new model of preventive care, which used a prevention-oriented assessment and self-management program within the therapeutic milieu of an active neighborhood senior center to supplement primary medical care for frail older people. Further research is needed to evaluate the potential benefits of this community-based intervention. In addition, further studies could determine the impact of the intervention in more diverse communities and in different health plans. With economic and legislative changes leading more and more older adults into managed care systems at a time when healthcare costs need to be restrained, creative cost-saving ways of maintaining the independent functioning of a growing older population are essential.[58] Linking organized medical care with complementary community-based interventions may be a promising direction for research and practice.

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