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Research Report

Three-Year, Postintervention, Follow-up Comparison of Health Care Resource Utilization and Costs in the Lifestyle Interventions and Independence for Elders (LIFE) Study

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Abstract

Background: The Lifestyle Interventions and Independence for Elders (LIFE) Study physical activity (PA) intervention was found to be cost-effective compared to health education (HE). However, long-term effects postintervention are unknown.

Method: This was a secondary analysis of LIFE Study data linked to Medicare claims data (2014–2016). Participants were linked via Social Security Numbers to Medicare claims data. Utilization and cost variables were analyzed using generalized linear models with negative binomial and Tweedie distributions. Unadjusted means and 95% confidence intervals were compared by year and overall stratified. Each model compared PA versus HE and adjusted for other baseline characteristics and stratified by study site. Additional models were stratified by baseline physical functioning assessment scores.

Results: Of the 1,635 LIFE Study participants, 804 (53.5%) were linked to Medicare claims with an average of 33 months of follow-up time during the 3-year data linkage period. Mean outpatient (6.6 vs 6.8), inpatient (0.40 vs 0.40), and other utilization metrics were similar between PA and HE groups. Costs were also similar for each group and each type of service, for example, outpatient: $2,070 versus $2,093 and inpatient: $4,704 versus $4,792. Regression results indicated no statistically significant differences between PA and HE groups.

Conclusions: While the LIFE Study demonstrated that PA reduced mobility disability in older adults and was cost-effective, it did not appear to affect long-term health care utilization costs posttrial. These findings suggest that it remains challenging to affect long-term health care costs using PA interventions effects.

Keywords: Physical function, Older adults, Health care costs, Health care utilization

The population over 65 years of age in the United States is expected to nearly double from 43 million to roughly 84 million by 2050 (1). Those 65 years and older currently represent around 13% of the population while accounting for 36% of all health expenditures (2). The combination of the overall aging of the population resulting in higher rates of physical and cognitive disability is expected to lead to high health care expenditures in the near future. This poses a serious concern for the U.S. health care system as these patients live longer in a disabled state.

Promoting healthy behaviors that maintain physical and cognitive function in late life has potential to curb the expected growth in health care spending among seniors. One facet of healthy aging is the promotion and prescription of increased physical activity (PA) among seniors to increase independence and overall health by fostering resilience against medical conditions that contribute to physical disability (3). Increased PA may have beneficial effects in a number of disease-specific (osteoarthritis, cardiovascular, respiratory, cancer, metabolic) and nondisease-specific conditions (muscle

and cardiovascular fitness) (1,4–8). Increased PA can delay physical disability and improve cognition (2,9), which play a critical role in maintaining independence and high quality of life in the late years of life. Despite some claims that PA would reduce health care cost (10), there remains a lack of clear evidence for long-term benefit.

A cost-effectiveness analysis was conducted for the Lifestyle Interventions and Independence for Elders (LIFE) Study during the trial time frame. Compared to health education (HE), the PA intervention was found to be cost-effective, costing <$50,000 per major mobility disability (MMD) avoided and per quality-adjusted life year (QALY) gained (11). Despite the knowledge gained from the LIFE Study, there are still uncertainties of the long-term health care cost benefits of PA interventions. The LIFE-Pilot Study showed that there are long-lasting differences in activity levels and physical functioning assessments among the PA intervention arm compared to the HE control arm (12). This contradicted results from the main LIFE Study, which showed no lasting behavioral changes in a 12-month posttrial follow-up visit (13). Therefore, while LIFE-Pilot suggests long-term changes that may accumulate long-term beneficial effects on participant health, the LIFE Study did not support this notion. The objective of this study was to evaluate other metrics related to long-term benefits of the PA intervention versus the HE control related to health care utilization and costs among the main LIFE Study participants to further evaluate this research question (14).

Method

LIFE Study Overview

The LIFE Study was a multicenter, single-blind, parallel randomized trial conducted across eight centers in the United States between February 2010 and December 2013 (14). The study protocol was approved by the institutional review boards of each institution. Written informed consent was obtained from all study participants. The LIFE Study was registered with www.clinicaltrials.gov prior to participant enrollment in the trial (NCT01072500). Details of the study design, rationale, and characteristics of the full study population are described elsewhere (14,15).

Intervention

The PA intervention involved walking, with a goal of 150 minutes per week, strength, flexibility, and balance training. The intervention included attendance at two center-based visits per week and home-based activity three to four times per week for the duration of the study. The HE control intervention included weekly educational workshops during the first 26 weeks, and then monthly sessions thereafter. Workshops included topics relevant to older adults, such as how to effectively negotiate the health care system, how to travel safely, preventive services and screenings recommended at different ages, where to go for reliable health information, nutrition, etc. The workshops did not include any topics related to exercise or PA.

Linkage to Medicare Claims Data

The original LIFE Study informed consent included voluntary consent for collection of Social Security Numbers (SSNs) and long-term use for research purposes. Data were held by the data management coordinating site (Wake Forest University) who served as an honest broker for this study. SSNs were sent to the Center for Medicare and Medicaid Services' (CMS) third-party data vendor for linkage. A cross-walk file between SSNs and Medicare beneficiary identification numbers was returned and a final cross-walk between de-identified LIFE Study identifiers was created. Linked files included all inpatient, outpatient, skill nursing, and hospice administrative claims data for the 2014, 2015, and 2016 calendar years which represented the first full year after LIFE Study termination (December 2013) and the most recent data available.

Linkage success was evaluated based on calendar year enrollment for 12 months or by enrollment until date of death. Participants were required to have Medicare Parts A and B to ensure adequate capture of inpatient and outpatient utilization. Those enrolled in Medicare Part C (Medicare Advantage plans) and those with only Part A were considered not linked.

Health Care Utilization and Cost Analyses

Health care utilization and associated costs were divided by the type of service and included: home health care, hospice, skilled nursing facility, inpatient, and outpatient services. Utilization and costs were evaluated by calendar years, which started in January 1 and followed participants through the whole year or until they were lost to follow-up due to death or disenrollment in Medicare health insurance. All analyses were corrected for differential follow-up using a time offset. The summed total utilization and costs were cumulative for each category. Health care utilization variables were analyzed using a generalized linear model with a log link function and a negative binomial distribution. Health care costs were analyzed using a generalized linear model with a Tweedie distribution.

The primary exposure of interest was the intervention arm assignment (PA or HE) coded as a binary variable. Baseline characteristics included age, sex, race, medical history of heart attack, heart failure, cardiovascular disease, diabetes, arthritis, and chronic lung disease as well as baseline Short Physical Performance Battery (SPPB) score were adjusted and were compared via chi-squared or *t* tests where appropriate. The base regression models included all study participants and additional subgroup analyses included stratification by baseline SPPB score (≤7 or >7) and whether participants experienced the primary outcome (MMD) during the trial. All analyses were conducted using PROC GENMOD or PROC GLM in SAS version 9.4 (SAS Institute, Cary, NC) with an alpha level of 0.05 for statistical testing.

Results

Of the original 1,635 LIFE Study participants, N = 1,502 (91.9%) consented for SSN use for research purposes and were alive at the end of their follow-up period in the LIFE Study (Figure 1). Of these, 183 (12.2%) did not have a Medicare ID match or were not enrolled in the Medicare program. A further 489 were enrolled in Part C plans and 26 (1.7%) were enrolled only in Part A—all of which were excluded due to inability to link to Medicare claims and missing utilization information, respectively. Successful linkages, that is, those with at least one calendar year enrollment in Parts A and B between 2014 and 2016, included 782 participants enrolled for the entire calendar year and 22 participants that were enrolled until they switched plans or died during the year for a total of 804 (53.5%) successful linkage to Medicare claims. Patterns of linkages during this 3-year period included 699 participants enrolled all 3 years (Figure 1).

The original LIFE Study intervention arms were compared on baseline information to determine if the randomization of the original trial was still apparent (Table 1). There were few observed differences including slightly higher proportions of diabetes (28.2% vs 21.9%, p = .042) and heart failure (7.4% vs 4.1%, p = .045) in the HE group compared to the PA group. There were no other

Linkage Criteria in 2014*	N (%)	Linkage?
Missing "bene_id" (no link with SSN in Medicare)	169 (11.3%)	No
Enrollment status unclear (missing)	14 (0.9%)	No
Enrolled Medicare Parts A & B for 12 months or until death	783 (52.1%)	Yes
Enrolled in Medicare Part C	489 (32.2%)	No
Enrolled in Medicare Part A only	26 (1.7%)	No
Switch between Medicare Parts A/B and C	21 (1.4%)	Yes**
Total	1502	804 (53.53%)

*Linkage criteria were applied in each calendar year.
**Considered linked until switch occurred. SSN=Social Security Number

Pattern of yearly linkage among cohort

Linked in 2014	Linked in 2015	Linked in 2016	N
1	1	1	699
1	1	0	58
1	0	0	42
1	0	1	5
0	1	1	19
0	1	0	4
0	0	1	12
0	0	0	663

Figure 1. Cohort selection, linkage criteria, and linkage pattern for integration of Lifestyle Interventions and Independence for Elders (LIFE) Study trial data and Medicare administrative claims data.

differences between the two intervention groups and the cohort was interpreted as generally maintaining randomization after data linkage. Follow-up time in the linked data was also similar during the extended follow-up time in linked data at roughly 33 months in each group of the whole 36-month follow-up period. We also compared baseline characteristics among linked and unlinked groups. These groups differed in age, sex, race, and education status (Supplementary Table 1).

Mean utilization and costs for each type of utilization are reported for the overall group and among those with that type of utilization (Figure 2). Complete summary data overall and by each year with regression estimates are provided in Supplementary Materials. Negative binomial regression models included the main exposure variable of trial intervention group, age, sex, race, medical conditions at baseline, and SPPB score at baseline. Consistently across all measures of utilization, intervention arm (ie, PA vs HE) showed no statistically significant differences. A model with a Tweedie distribution for health care costs also showed no statistically significant differences for the primary comparison between PA and HE groups. Individual year comparisons for utilization and costs further showed no differences. Similar findings were observed when the sample was restricted to participants with SPPB ≤7 or >7 at LIFE Study baseline.

Table 1. Comparison of Select Baseline Characteristic Between Physical Activity (PA) and Health Education (HE) Trial Groups Who Were Successfully Linked to Medicare Claims Data

Patient characteristics	PA (*N* = 393)	HE (*N* = 411)	*p* Value
Age, mean (*SD*)	79.1 (5.3)	79.4 (5.2)	.3722
Subgroup age			.9084
70–79	211 (53.7%)	219 (53.3%)	
≥80	182 (46.3%)	192 (46.7%)	
Female	264 (67.2%)	267 (65.0%)	.5079
Race			.5229
Black	59 (15.0%)	53 (13.0%)	
White	317 (80.7%)	333 (81.4%)	
Other	17 (4.3%)	23 (5.6%)	
Education, >high school	282 (71.8%)	287 (70.0%)	.5842
Smoking			.0826
Never	184 (47.4%)	222 (55.0%)	
Former	191 (49.2%)	167 (41.3%)	
Current	13 (3.4%)	15 (3.7%)	
Body mass index	29.7 (5.6)	29.9 (6.1)	.6376
Cerebrovascular disease	106 (27.0%)	128 (31.1%)	.1930
Diabetes	86 (21.9%)	115 (28.2%)	.0417
Heart attack	33 (8.4%)	48 (11.7%)	.1195
Heart failure	16 (4.1%)	30 (7.4%)	.0450
Arthritis	74 (19.0%)	88 (21.5%)	.3812
Chronic lung disease	69 (17.6%)	65 (16.0%)	.5480
SPPB ≤7	169 (43.0%)	185 (45.0%)	.5661
Gait speed (m/s)	0.76 (0.2)	0.76 (0.2)	.7224
Cognitive assessment (3MSE), mean (*SD*)	91.8 (5.1)	91.8 (5.4)	.9063

Notes: PA = physical activity intervention; HE = health education control arm; *SD* = standard deviation; SPPB = Short Physical Performance Battery; m/s = meters per second; 3MSE = Modified Mini Mental State Examination.

Discussion

This long-term posttrial follow-up, enabled via linkage of LIFE Study data to Medicare claims data, showed no long-term effect of the PA intervention versus HE on health care resource utilization or costs. These findings persisted for stratifications by year and by SPPB stratification.

Based on findings from the LIFE-Pilot Study and from an analysis in a nationally representative cohort (12,16), the current study hypothesized that these long-term effects may lead to long-term cumulative health benefits which could be captured via surrogate outcomes of health care utilization and cost. While utilization and cost outcomes are nonspecific and all-cause, long-term benefits associated with PA in cardiovascular disease, reduced falls, and other health and well-being effects should translate to reductions in these metrics. Further, outcomes related to utilization and costs are more relevant to health care payers (ie, health insurance providers, Medicare) as stakeholders and evidence from this perspective could lead to broader implementation of PA interventions (10).

Cost-effectiveness analyses of both LIFE-Pilot and LIFE Study data found that PA was cost-effective compared to HE using common cutoff metrics (17). However, health care costs did not significantly differ between the two intervention groups despite differences in mobility disability. Although costs were based on self-reported utilization is those analyses, the results of those prior health economic analyses suggest that health care costs may be hard to affect with PA interventions in older adults.

In a separate analysis of LIFE Study data, participants in the PA arm did not have significantly improved activity levels (behavioral

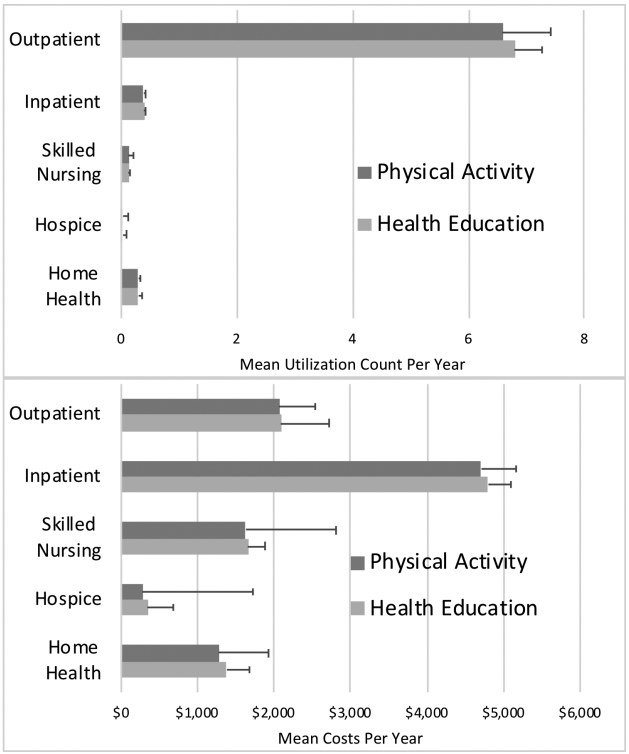

Figure 2. Mean health care utilization and costs stratified by Lifestyle Interventions and Independence for Elders (LIFE) Study intervention by type of health care service. All comparisons between the physical activity and successful aging trial arms were not statistically significant in unadjusted analyses as well as adjusted regression models controlling for baseline characteristics. Full details are available by year and overall in Supplementary Materials.

change) and showed similar physical functioning (functional change) at a 1-year extended follow-up compared to those in the HE control arm (13). The authors pointed out differences between the intervention and study population in LIFE-Pilot and LIFE including key differences in the intervention such as transition to home-based intervention after initial group sessions, and the much longer (24 vs 12 months) intervention which could have led to waning interest. Using accelerometry data, which has been suggested as a means to measure the intensity of PA in older adults for utilization outcomes (18), larger differences in moderate PA were noted between the comparison arms in LIFE-Pilot compared to LIFE (12,13). This led to a pattern of waning PA in the LIFE trial that was not observed in the shorter LIFE-Pilot Study that could have contributed to the lack of long-term benefits (13).

While this long-term extension of the LIFE study via linkage to administrative claims data showed similar effects of the interventions on health care utilization and costs, this does not imply lack of impact of PA. With a 24-month intervention, mean follow-up of 2.9 years, a postintervention follow-up roughly 12 months after that, the length of time between intervention and data linkage here was up to 2–5 years postintervention (2). Thus, any impact of the PA, which was demonstrated for primary and secondary outcomes, may have diminished over this extended period of time. It also suggests that consistency and maintenance of the PA treatment is needed to promote and ensure its long-term benefits (13,19). Further health care utilization and costs are surrogate outcomes for overall health and may not be sensitive enough measures to capture effects of PA interventions.

Limitations

This analysis linked LIFE Study participants who had Medicare FFS benefits. Those that were not linked differed with the linked group in age (1-year mean difference), sex (5% fewer females in linked group), race (more white in linked group), and education (more college educated in linked group). This is likely indicative of the demographic differences in those who enroll in Medicare FFS versus Medicare Advantage plans. We would not expect any other differences between these groups nor for results to be different among those who were not linked after controlling for these characteristics. Lastly, while we measured health care utilization and costs, these measures were all-cause and not cause-specific. A PA intervention may not be suitable for prevention of all conditions in older adults. However, as many events were rare and we had a smaller sample size after linkage, focusing on cause-specific events (eg, falls, fractures, cardiovascular disease) was not possible.

Conclusion

Long-term follow-up of LIFE trial participants via linkage to Medicare claims data did not reveal any differences in health care utilization and costs between a HE and PA intervention. These results imply that effects of such interventions may wane over time, that HE provides similar benefits to PA, or that potential differences are not detectable using utilization and cost metrics.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

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Conflict of Interest

None reported.

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