Older Adults' Physical Activity and Healthcare Costs, 2003–2014

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Introduction: Research has documented the health benefits of physical activity among older adults, but the relationship between physical activity and healthcare costs remains unexplored at the population level. Using data from 50 U.S. states and the District of Columbia, this study investigates the extent to which physical activity prevalence is associated with healthcare costs among older adults.

Methods: Twelve-year state-level data (2003–2014) were obtained from five secondary sources (n=611). Healthcare costs were captured by Medicare Parts A and B spending. Fixed-effect models were estimated in 2019 to assess the relationship between the state-level physical activity prevalence and Medicare costs. The potential lagged associations were captured by lagged variables of physical activity prevalence (i.e., $t - 1$, $t - 2$, and $t - 3$).

Results: Physical activity prevalence was not associated with Medicare costs occurring in the concurrent and subsequent year (p>0.05); however, the 2-year lagged variable (p=0.03) and the 3-year lagged variable (p=0.01) for physical activity prevalence were negatively associated with Medicare costs, indicating a time-lagged relationship. It was estimated that a 10–percentage point increase in physical activity prevalence in each state is associated with reduced Medicare Parts A and B costs of 0.4% after 2 years and 1.0% after 3 years.

Conclusions: Results revealed a time-lag effect highlighted by a delayed inverse relationship between state-level physical activity prevalence and healthcare costs among older adults. This evidence offers governments and communities new insights to guide policymaking on long-term public investment in physical activity intervention programs.

INTRODUCTION

The cost of health care continues to rise in the U.S. In 2017, national healthcare spending was $3.5 trillion, which equals 17.9% of the gross domestic product.[1] This issue will likely intensify in coming decades, as the number of people aged 65 years and older is projected to reach 95 million in 2060.[2] Average health spending also increases with age, and people aged 65 years and older accounted for 34% of U.S. healthcare spending in 2015.[3] Considering the ongoing debate to change the Affordable Care Act and policy initiatives to expand health insurance coverage to all (e.g., Medicare-for-All), it is important for policymakers to find possible solutions to mitigate healthcare costs for older adults.

A potentially effective way to address the rising healthcare costs for older adults is to promote physical activity.[4] Promoting physical activity for older adults is important because this population is the least physically active of any age group.[5] Increased physical activity in older adults could reduce depression, address preventable health problems, lower all-cause mortality rates, slow age-related cognitive decline, and improve quality of life.[6–10] Although the proportion of older adults reporting physical activity increased from 60% in 1994 to 68% in 2017,[11,12] the prevalence of physical activity decreased with age for adults aged 18–44 years (77%), 45–64 years (71%), and 65 years and older (68%).[12] Research has examined the relationship between physical activity participation and healthcare costs using large databases,[13–20] revealing that the global cost of physical inactivity to the healthcare systems is estimated at $53.8 billion internationally in 2013.[21] Studies addressing the relationships between physical activity and healthcare costs among older adults are scarce, with two notable exceptions. Wang and colleagues[4] analyzed cross-sectional individual-level data of 42,520 retired employees aged 65 years and older in a U.S. manufacturing corporation. They found that physically active retirees tended to have lower healthcare costs than their sedentary counterparts. Using cross-sectional county-level data, another study reported that older adults' physical activity prevalence was negatively associated with the county's healthcare costs of these adults.[22]

To date, most research has focused on the associations between individual physical activity and healthcare costs. However, this relationship can be influenced by multilevel factors, such as social environments, physical environments, and policies.[23,24] For instance, more than 2,500 state regulations and policies on physical activity were enacted between 2001 and 2017, such as constructing off-road walking paths and granting access to recreational facilities in communities.[25] These policies might promote older adults' physical activity participation and their health. Consequently, it is critical for policymakers to consider environmental and regional differences across communities using macro-level indicators and assess the extent to which the physical activity prevalence of various communities is associated with their healthcare costs.

Previous research often utilizes a cross-sectional research design to examine the relationship between physical activity and healthcare costs. However, it is reasonable to assume that this relationship has a time lag.[13,26–28] For instance, if governments or communities implement physical activity initiatives today, the effect of these initiatives on healthcare costs could take 1 year, 2 years, or more. A longitudinal research design can provide a more holistic assessment of physical activity benefits to inform public policies on a potential time-lag effect, which represents the amount of time it may take to observe reduced healthcare costs resulting from higher physical activity prevalence.

Using longitudinal data from 50 states and the District of Columbia in the U.S., this study investigates the extent to which state-level physical activity is related to healthcare costs among older adults. A negative and lagged association between the physical activity prevalence of a state's older population and that population's healthcare costs is expected. Medicare costs are used as indicators of healthcare costs for older adults. This study extends and adds new knowledge to the public health literature on the relationship between physical activity and healthcare costs[4,13–20] by investigating macro-level factors, while accounting for potential time-lag effects.

METHODS

Research Design and Data

The analysis relied on 12-year state-level data (2003–2014) from five secondary sources. Healthcare cost data were obtained from the Dartmouth Atlas of Health Care, which provided age, sex, race, and regional price differences–adjusted Medicare reimbursements (Part A and Part B) per enrollee.[29] The Dartmouth Atlas data, which are based on Medicare claims that capture the temporal and regional patterns of healthcare utilization by Medicare enrollees, offer the advantage of focusing on documenting variations in healthcare use across regions.[30] Behavioral Risk Factor Surveillance System (BRFSS) survey data were used to calculate the state-level physical activity prevalence among adults aged ≥65 years. The reliability and validity of physical activity measures in the BRFSS survey have been documented.[31] Data for additional state-level variables shown to predict healthcare costs in previous research[13,15,32,33] were acquired from the BRFSS, Current Population Survey, Small Area Income and Poverty Estimates

Program data, and National Bureau of Economic Research data. These variables were aggregated at the state level and served as control variables for analysis.

The sample covered 50 states and the District of Columbia during a 12-year period, resulting in 612 observations. One observation was removed from the analysis because of missing data on physical activity prevalence. The final sample size consisted of 611 observations.

Measures

This study focused on the mean Medicare costs of Part A (inpatient care) and Part B (outpatient care) per enrollee in each state. Medicare is the main payer for healthcare services of the population aged ≥65 years in the U.S.,[34] and Parts A and B represent the largest share of Medicare costs.[35] Accordingly, the current measure represents a key indicator of healthcare costs for older adults. Following prior research,[32,36,37] all analyses used log-transformed Medicare costs, which allow to estimate the semi-elasticities of Medicare costs with respect to simultaneous and lagged physical activity prevalence.

The physical activity prevalence in each state was extracted from the BRFSS survey. In the survey, participants were asked to indicate whether they had participated in leisure-time physical activities or exercise during the past 30 days outside their regular employment. Based on responses, physical activity prevalence was calculated as the percentage of adults aged ≥65 years who had participated in leisure-time physical activities or exercise in each state. The analysis further included ten state-level time-varying control variables. Table 1 gives a description of each variable used in the study.

Statistical Analysis

The following fixed-effect model was estimated for the main analysis:

$$\text{Log}(Cost_{s,t}) = \beta_0 + \beta_1 PA_{s,t} + \beta_2 PA_{s,t-1} + \beta_3 PA_{s,t-2} + \beta_4 PA_{s,t-3} + \theta X_{s,t} + \alpha_s + \lambda_t + \mu_{s,t},$$

where the dependent variable log($\text{Cost}_{s,t}$) is the natural log transformation of Medicare costs in s^{th} state at time t. $\text{PA}_{s,t}$ is the physical activity prevalence at the s^{th} state at time t. β_1 measures the simultaneous association between physical activity prevalence and Medicare costs. To capture potential lagged correlations, $\text{PA}_{s,t-1}$, the physical activity prevalence at the s^{th} state at time $t-1$, was added, with β_2 being the 1-year lagged correlation. More lagged physical activity variables ($t-2$ and $t-3$) were added in further specifications. $X_{s,t}$ includes time-variant state-level characteristics that might influence the relationship between physical activity prevalence and Medicare costs (Table 1). State fixed effects (α_s) control for time-invariant differences across states, such as climate, culture, and political system. Year fixed effects (λ_t) control for nationwide time trends (e.g., state of the economy, healthcare market) experienced by all states. Finally, $\mu_{s,t}$ is the random error term, which captures unobserved random factors that might explain Medicare costs. The fixed-effect model was chosen based on the Hausman test ($p<0.01$). All p-values were two-sided and considered statistically significant if $p<0.05$. All analyses were conducted in 2019 using Stata, version 14.

RESULTS

Descriptive statistics of the sample are shown in Table 2. The average Medicare costs in each state between 2003 and 2014 were \$8,254 per person (SD=\$1,378, range=\$4,967−\$11,670). Additionally, physical activity prevalence was 67% (SD=5%, range=49%−81%), suggesting that, on average, two thirds of older adults were involved with leisure-time physical activity in each state during the study period.

Table 3 shows results from the fixed-effect models using different lagged variables for physical activity prevalence. Adjusted R^2 values of the full model (Column 4) were 0.56, suggesting that the independent variables explained more than half of the variation in Medicare costs. The results of the full model suggest that physical activity prevalence was not associated with Medicare costs in the concurrent and subsequent year (p>0.05). However, both the 2-year lagged variable ($\beta_3 = -0.08$, p=0.03) and 3-year lagged variable ($\beta_4 = -0.09$, p=0.01) for physical activity prevalence were negatively associated with Medicare costs, indicating a time-lagged inverse relationship exists. To determine the cumulative associations over time, the coefficients of the current and lagged physical activity prevalences were summed.[36] The estimates from the three lagged variables model indicated that a 10–percentage point increase in physical activity prevalence in a state is associated with reduced Medicare costs of 0.4% after 2 years and 1.0% after 3 years.

Results from the main analysis provide evidence that a higher prevalence of physical activity is associated with reduced Medicare costs 2 and 3 years later at the state level. In this analysis, other health-related variables, such as smoking prevalence and obesity prevalence, were unassociated with Medicare costs; however, they might also have a lagged relationship with Medicare costs. To validate the time-lagged association between physical activity and Medicare costs, time-lagged variables for smoking and obesity were added to the models. The results from Table 4 show that estimates on physical activity prevalence were not altered by lagged smoking and obesity prevalence. Additionally, none of the lagged variables for smoking and obesity were significantly associated with Medicare costs.

To further validate the current results, this study estimated a generalized linear model with the log link function and the gamma distribution, the most frequently used specifications in healthcare costs studies.[38,39] The results from the generalized linear model analysis remained similar, which confirms the statistically significant time-lagged association between physical activity prevalence and Medicare costs among older adults.

DISCUSSION

This study provides a macro-level perspective on the potential role of physical activity in reducing healthcare costs for older adults at the state level. Previous studies have documented the benefits of physical activity for reducing healthcare costs among older adults[4,22]; however, these studies have focused on individual-level factors or used cross-sectional research designs. The current findings indicate that as the percentage of older people engaging in physical activity increases, a reduction occurs in average Medicare costs at the state level within a lag time of 2–3 years. The model suggests that a 10–percentage point increase in physical activity prevalence in each state is associated with reduced Medicare costs of 0.4% after 2 years and 1.0% after 3 years. For instance, if these results are applied to the state of Maryland where there were 862,000 older people in 2014 with average Medicare costs of $9,127 and physical activity prevalence of 71%, a 10–percentage point increase in physical activity prevalence might be associated with savings of $31 million after 2 years ($37 per person aged 65 years and older) to $79 million after 3 years ($91 per person aged 65 years and older) in Medicare costs.

Comparing existing findings to prior research is difficult given that different data sources, measures, methods, and populations to assess the relationship between physical activity and healthcare costs were used. Wang et al.[4] conducted a cross-sectional study of Medicare retirees who participated in an indemnity or preferred provider insurance plan, reporting that moderate-to-active retirees aged 65 years and older had lower annual inpatient and outpatient costs, ranging from $809 to $2,321, than their sedentary counterparts. A key methodological difference between the current study and that of Wang and colleagues[4] that may explain cost reduction differences is the level of analysis and the research design. Although this study examined state-level relationships, Wang et al.[4] adopted an individual-level analysis. Additionally, the 12-year data allowed for the adjustment for time invariant heterogeneity across states and nationwide trends experienced by all states. By contrast, the cross-sectional analysis by Wang and colleagues[4] does not allow for adjustment in unobserved factors. The current findings add to the literature by providing new evidence for a time-lag effect representing the inverse relationships between physical activity and Medicare costs for older adults at the state level.

Although this study focused on the relationship between physical activity and Medicare costs for older adults, comparing the current results to findings utilizing individual-level or cross-sectional analyses to examine relationships between other health-related factors and healthcare costs is useful. Although smoking and obesity are considered leading risk factors associated with higher healthcare costs at the individual level,[40] the current results indicated that both smoking prevalence and obesity prevalence in each state had no association with healthcare costs for older adults. One potential explanation for the findings is a survivor effect.[4,41,42] As nonsmokers tend to live longer than smokers, they might outweigh smokers who have higher healthcare costs.[43] Similarly, fewer people with obesity are likely to reach advanced ages and those who do may have adjusted to harmful effects of obesity.[41] The marginal association between obesity and healthcare costs is corroborated by Wang et al.,[4] who found that this association was smaller than the association between physical inactivity and healthcare costs among populations aged 65 years and older.

The importance of physical activity for older adults is well documented.[6–10] As the U.S. population ages, the growth of healthcare costs will remain a key policy challenge.[3,44] Results from the current state-level analysis offer valuable insight into funding allocation to promote active lifestyles for older adults at multiple levels of government. For example, federal and state governments, as well as communities and other stakeholders, can make a case for increased investment in physical activity intervention programs by highlighting the longer-term health benefits of physical activity and its relationship to lower healthcare costs for older adults.

The current data indicate that a higher percentage of active older adults in a state is associated with lower Medicare Parts A and B costs and provide healthcare stakeholders with actionable results. Some private health insurance companies offer financial incentives to increase participation and engage in wellness programs to potentially reduce risk of chronic disease and healthcare costs.[39,40] Medicare could also offer extra financial incentives for being physically active. For instance, although some Medicare supplement insurance and Medicare Advantage plans contain features including free or discounted gym membership, such features could be extended to all Medicare enrollees. Additionally, governments and communities could work together to offer incentives to participate in sport programs and events as part of their physical activity initiatives.[45] However, stakeholders must keep in mind the time-lagged effect that reducing healthcare costs through physical activity programs may take time, at least 2–3 years, as suggeted in the current study. An implication is that successful prevention and wellness initiatives should be sustained over time.

Limitations

Several limitations of this study should be considered. First, this study focused on the costs of Medicare Parts A and B, which cover two main types of services utilized by the population aged 65 years and older. Although Medicare Parts C and D have grown over the study period (2003–2014), they still represent small proportions of enrollment and spending.[46] By 2014, Medicare Parts A and B included 70% of the total Medicare enrollment. Similarly, Parts A and B spending amounted to more than two thirds of the total Medicare spending between 2003 and 2014.[46] Furthermore, the time-fixed effect included in the current model partly adjust for changes over time, such as the growth in Medicare Advantage and Medicare Part D. Future work should consider costs of prescription drugs, Medicare Advantage, as well as healthcare costs covered by other payers such as Medicaid and private insurers.

Second, this study used the percentage of adults who participated in leisure-time physical activity in the 30 days preceding the survey to measure the physical activity prevalence in each state. This assessment is more inclusive than 2018 federal physical activity guidelines of 150–300 minutes of moderate-intensity aerobic activity per week, 75–150 minutes of vigorous-intensity aerobic activity per week, or an equivalent combination of moderate- and vigorous-intensity aerobic activity.[5] When compared with the average physical activity prevalence of 67% in the current study, in 2013 in the U.S., 44% of older adults reported a minimum of 150 minutes per week of moderate or 75 minutes per week vigorous-intensity activity.[11] This discrepancy is expected because of the inclusiveness of the physical activity measure used in this study. The present results represent minimal estimates, and the more stringent definition of physical activity would likely lead to larger associations with healthcare costs. Following the approach by Carlson and colleagues,[13] using measures of physical activity based on the public health officials' recommended guidelines should be considered in future work.

Third, the current estimation provides correlations between physical activity prevalence and Medicare costs across states. The results neither provide causal relationships nor reveal the relationship between physical activity and healthcare costs at the individual level. Fourth, although the fixed-effect models controlled for several time-varying factors and time-invariant state-specific factors, some unmeasured state-level time-varying factors could confound the estimates. Finally, future work is needed on local communities to understand how lower-level macro-level factors relate to healthcare costs.

CONCLUSIONS

The results from the current study indicate that a higher prevalence of physical activity is associated with lower Medicare Parts A and B costs for older adults in each state, with a time-lag effect of 2–3 years. Long-term investments in policies and interventions focusing on promoting physical activity may contribute to control healthcare costs if the programs are sustained over time.

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Table 1. Variable Description

Variable	**Description**	**Data source**
Healthcare cost	Mean Medicare costs (Parts A and B) per enrollee	Dartmouth Atlas of Health Care
Physical activity prevalence	Percentage of adults aged $\geq$65 years reporting leisure-time physical activity or exercise	Behavioral Risk Factor Surveillance System
Smoking	Percentage of adults aged $\geq$65 years reporting currently smoking	Behavioral Risk Factor Surveillance System
Obesity	Percentage of adults aged $\geq$65 years reporting BMI $\geq$30	Behavioral Risk Factor Surveillance System
Married	Percentage of adults aged $\geq$65 years who reported being married	Current Population Survey
College graduate	Percent of adults aged $\geq$65 years who reported a bachelor's degree or more	Current Population Survey
Female	Percentage of female population for those aged $\geq$65 years	Current Population Survey
White	Percentage of white population for those aged $\geq$65 years	Current Population Survey
Age $\geq$65 years	Percentage of the population aged $\geq$65 years	Current Population Survey
Poverty	Percentage of the total population living below the federal poverty level	Small Area Income and Poverty Estimates Program
Income	Median household income	Small Area Income and Poverty Estimates Program
Unemployment	Percentage of adults age $\geq$16 years unemployed and looking for work	National Bureau of Economic Research

Table 2. Descriptive Statistics of the Sample (*n*=611)

Variables	**Mean**	**SD**
Healthcare cost ($)	8,258.32	1,378.13
Physical activity prevalence	0.67	0.05
Smoking	0.09	0.02
Obesity	0.23	0.03
Married	0.56	0.06
College graduate	0.21	0.06
Female	0.56	0.03
White	0.87	0.14
Age ≥65 years	0.13	0.02
Poverty	0.14	0.03
Median household income ($)	49,501.73	8,602.53
Unemployment	0.06	0.02

Table 3. Relationship Between Physical Activity and Healthcare Costs in U.S. States

	DV: log (healthcare costs)			
Variables	**(1)**	**(2)**	**(3)**	**(4)**
Physical activity prevalence	0.04 (−0.07, 0.16)	0.05 (−0.05, 0.15)	0.06 (−0.04, 0.16)	0.06 (−0.04, 0.16)
Physical activity prevalence (*t*-1)		−0.02 (−0.11, 0.08)	0.01 (−0.08, 0.09)	0.02 (−0.07, 0.10)
Physical activity prevalence (*t*-2)			**−0.10* (−0.19, −0.02)**	**−0.08* (−0.16, −0.01)**
Physical activity prevalence (*t*-3)				**−0.09* (−0.16, −0.02)**
Smoking	0.07 (−0.13, 0.28)	0.07 (−0.13, 0.28)	0.06 (−0.15, 0.26)	0.06 (−0.14, 0.26)
Obesity	0.03 (−0.12, 0.18)	0.03 (−0.12, 0.18)	0.04 (−0.10, 0.19)	0.05 (−0.10, 0.19)
Married	0.01 (−0.07, 0.10)	0.01 (−0.07, 0.10)	0.01 (−0.07, 0.09)	0.01 (−0.07, 0.09)
College graduate	−0.03 (−0.11, 0.04)	−0.03 (−0.11, 0.04)	−0.03 (−0.11, 0.04)	−0.04 (−0.12, 0.04)
Female	0.02 (−0.11, 0.14)	0.02 (−0.11, 0.14)	0.02 (−0.11, 0.14)	0.02 (−0.11, 0.14)
White	0.05 (−0.07, 0.17)	0.05 (−0.07, 0.17)	0.06 (−0.06, 0.17)	0.05 (−0.06, 0.17)
Age ≥65 years	−0.15 (−0.45, 0.15)	−0.15 (−0.45, 0.16)	−0.15 (−0.45, 0.15)	−0.14 (−0.45, 0.16)
Poverty	**0.63* (0.15, 1.11)**	**0.64** (0.17, 1.11)**	**0.64** (0.18, 1.10)**	**0.63** (0.18, 1.09)**
Log (income)	0.01 (−0.11, 0.12)	0.01 (−0.11, 0.13)	0.01 (−0.11, 0.13)	0.00 (−0.11, 0.12)
Unemployment	−0.06 (−0.30, 0.18)	−0.06 (−0.30, 0.18)	−0.06 (−0.31, 0.18)	−0.07 (−0.31, 0.17)
State fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	611	610[a]	609[b]	608[c]
R^2	0.53	0.53	0.55	0.56

Note: Boldface indicates statistical significance (*p<0.05; **p<0.01). The numbers in parenthesis represents 95% CIs, which are based on robust SEs.

[a]One observation was removed from the analysis due to missing data in physical activity prevalence at *t*-1.

[b]Two observations were removed from the analysis due to missing data in physical activity prevalence at *t*-1 and *t*-2.

[c]Three observations were removed from the analysis due to missing data in physical activity prevalence at *t*-1, *t*-2, and *t*-3.

Table 4. Robust Analysis of the Relationship Between Physical Activity and Healthcare Costs in U.S. States

	DV: log (healthcare costs)		
Variables	**(1)**	**(2)**	**(3)**
Physical activity prevalence	0.05 (−0.05, 0.15)	0.06 (−0.03, 0.16)	0.06 (−0.03, 0.16)
Physical activity prevalence (t-1)	−0.01 (−0.10, 0.08)	0.01 (−0.07, 0.09)	0.02 (−0.06, 0.10)
Physical activity prevalence (t-2)		**−0.12** (−0.20, −0.03)**	**−0.10* (−0.17, −0.02)**
Physical activity prevalence (t-3)			**−0.09* (−0.16, −0.01)**
Smoking	0.05 (−0.13, 0.23)	0.04 (−0.15, 0.22)	0.04 (−0.14, 0.22)
Smoking (t-1)	0.13 (−0.09, 0.34)	0.14 (−0.06, 0.34)	0.12 (−0.08, 0.31)
Smoking (t-2)		−0.01 (−0.24, 0.21)	–0.03 (−0.24, 0.19)
Smoking (t-3)			0.08 (−0.22, 0.37)
Obesity	0.02 (−0.12, 0.17)	0.05 (−0.10, 0.19)	0.05 (−0.09, 0.20)
Obesity (t-1)	0.00 (−0.13, 0.14)	0.01 (−0.12, 0.14)	0.02 (−0.10, 0.15)
Obesity (t-2)		−0.09 (−0.23, 0.05)	−0.09 (−0.22, 0.04)
Obesity (t-3)			−0.04 (−0.17, 0.08)
State fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Controls[a]	Yes	Yes	Yes
Observations	610[b]	609[c]	608[d]
R^2	0.54	0.55	0.56

Note: Boldface indicates statistical significance (*p<0.05; **p<0.01). The numbers in parenthesis represents 95% CIs, which are based on robust SEs.

[a]Controls included married, college graduate, female, white, age ≥65 years, log (population), poverty, log (income), and unemployment.

[b]One observation was removed from the analysis due to missing data in physical activity prevalence at *t*-1.

[c]Two observations were removed from the analysis due to missing data in physical activity prevalence at *t*-1 and *t*-2.

[d]Three observations were removed from the analysis due to missing data in physical activity prevalence at *t*-1, *t*-2, and *t*-3.