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Research Article

Physical Inactivity as a Predictor of High Prevalence of Hypertension and Health Expenditures in the United States: A Cross-Sectional Study

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Abstract

Purpose: *To examine the association between physical activity, prevalence of hypertension, and total healthcare and pharmaceutical expenditure in the United States of America (US).*
Methods: *In this cross-sectional study, adult United States residents were included from the Medical Expenditure Panel Survey (MEPS) for 2002. In the MEPS, physical activity was defined as spending at least 30 min 3 times a week in moderate to vigorous physical activity and the diagnosis of hypertension was based on the patient's self-report. Logistic and multiple linear regression models were used to calculate the risk of prevalent hypertension in physically inactive individuals and examine the association between physical activity and healthcare expenditure after controlling for confounders.*
Results: *Hypertensive patients who were physically active accounted for 46 % and the risk of hypertension was higher in physically inactive individuals than in those who were physically active (Odds ratio, 1.1; 95 % Confidence interval, 1.07 to 1.12, $p < 0.0001$). Physical activity in all individuals was associated with a decrease in total healthcare expenditure by US\$592 per person ($p < 0.0001$) and pharmaceutical expenditure by US\$125 per person ($p < 0.0001$).*
Conclusion: *Total healthcare and pharmaceutical expenditures were significantly lower for physically active than physically inactive individuals.*

Keywords: *Physical inactivity, Hypertension, Healthcare expenditure.*

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INTRODUCTION

Seven million deaths every year worldwide may be attributed to hypertension [1]. In the United States, about one in three adults have high blood pressure [2]. Hypertensive patients are at higher risk of myocardial infarction, heart failure, stroke, and kidney disease [1]. Blood pressure control in hypertensives is essential to prevent morbidity and mortality, reduce health care utilization, and ultimately lower health care costs [3]. Only 35 % of hypertensive patients have adequate blood pressure control [2]. In the United States, inadequate blood pressure control in hypertensive patients has been estimated to result in about 40,000 cardiovascular events, more than 8,000 cardiovascular deaths, and direct medical expenditure of one billion US dollars per year [4,5].

Randomized clinical trials have demonstrated that physical activity is associated with lower levels of blood pressure in both hypertensive and normotensive individuals [6-9]. Also, studies have shown that the relative risk of developing hypertension decreased in individuals who were physically active [10-14]. Some of these studies were conducted outside the United States [12,14] and others did not provide a national estimate [10,11,13]. The current guidelines for the treatment of hypertension recommend that all patients with hypertension engage in physical activity for at least 30 min a day for most days of the week [1]. Physical activity lessens the effects of diseases, which includes hypertension, and the use of healthcare services. Studies that were previously undertaken to explore the effect of physical activity on health costs were small or did not provide a national estimate [15-18]. In the United States, antihypertensive medications account for 70 to 80 % of the total cost of hypertension care [19]. The reduction in the use of these medications may lower total pharmaceutical expenditure. No studies have estimated the effect of physical activity on pharmaceutical expenditures.

Using the Medical Expenditure Panel Survey (MEPS), the primary objectives of this study were the following: 1) obtain a national estimate for the risk of prevalent hypertension in physically inactive individuals compared to that in physically active individuals and 2) examine the association between physical activity and total healthcare and pharmaceutical expenditures for all individuals and for hypertensive patients.

METHODS

Data source

MEPS was sponsored by the Agency for Healthcare Research and Quality (AHRQ) and provided the estimates of healthcare use, expenditures, sources of payment, and insurance coverage for individuals across the United States. The Household Component of MEPS for the year 2002 was used in this study. Individuals were included in the study if their age was 18 years or older and information was available about their physical activity. Since the data are available online anonymously, no ethical approval or patient consent was required.

Dependent variables

To estimate the risk of the prevalence of hypertension in physically inactive individuals compared with that in physically active individuals, a logistic regression model was generated using a diagnosis of hypertension as the dependent variable. To examine the association between physical activity and health expenditures, an ordinary least squares model was used. The dependent variables were the total healthcare expenditure or the pharmaceutical expenditure.

In MEPS, the diagnosis of hypertension was based on the patient’s self-report. The total healthcare expenditure is the sum of direct payments for care provided during the year, including out-of-pocket payments and payments that were made by private insurance, Medicaid, Medicare, and other sources. The total healthcare expenditures included expenses for office and hospital-based care, emergency room visits, inpatient hospital stays, dental visits, home health care, prescribed medications, vision aids, and others. The total pharmaceutical expenditure is the sum of all of the amounts paid out-of-pocket and by third-party payers for each prescription purchased in 2002. The total healthcare expenditure and the pharmaceutical expenditure were included as continuous variables. The logarithmic functional form of these continuous dependent variables was tested using the Bera-McAleer and Box-Cox tests, which did not fit the data better than the linear form. Therefore, the linear functional form for the dependent variables is reported.

Key independent variable

The key independent variable in this study was physical activity. In the survey, all individuals who were aged 18 years or more were asked whether they spent at least 30 minutes in moderate to vigorous physical activity at least three times a week.

Covariates

Several factors could affect the risk of developing hypertension, limitation of individuals from physical activity could affect the use of medications and access to care, or affect healthcare charges. On the basis of previous literature, these factors were included in the model [14,17]. The factors of interest were age, gender, race, insurance status (measured by whether or not the individual had any type of insurance), income (person's total annual income was used), smoking status (individuals were asked whether they currently smoked), education (measured by the number of years of education), and body mass index (BMI). BMI was calculated on the basis of the reported weight and height.

Individuals were asked if they had ever been diagnosed with diabetes, asthma, arthritis, high blood pressure, coronary heart disease, angina or angina pectoris, heart attack or myocardial infarction, any other type of heart disease or condition, or stroke or transient ischemic attack (TIA or ministroke). When the association between physical activity and health expenditures was examined, hypertension was included as an independent variable only when all of the individuals in the study were examined as a group.

Statistical analysis

The statistical software STATA (version 8, StataCorp LP, College Station, Texas) was used in the analysis. Several tests were used to examine the model assumptions and to test the significant of the independent variables that were included in the models. Multi-collinearity between the variables in the model was examined using a pairwise correlation. Cut-off values of < 0.3 were considered very low. Correlation was very low between all variables, with the exception of a multicollinearity value of 0.48 between coronary heart disease and myocardial infarction. The variance inflation factors were examined. This examination revealed that none of the factors were higher than 10 (the highest was 1.59, and the average was 1.21). Therefore, collinearity was not a significant problem in these models.

The MEPS used a complex survey design. Therefore, the analyses were adjusted for stratification, primary sampling units (PSUs), and weight before running the models. Individual weight, PSU, and strata for the year 2002 were used in the models whenever possible. When restricting the sample to hypertensive patients, no more than one PSU was found in each stratum, which will result in that the regression model could not run. Therefore, the data from hypertensive patients did not include stratification. Not controlling for stratification only increased the standard error of the estimate.

The odds ratio of having hypertension among physically inactive individuals was calculated using the logistic regression model. A complete-case analysis was used to analyze observations with missing data, which were dropped from the models using the statistical software.

RESULTS

In 2002, the prevalence of physical inactivity in the entire US population was 46.1 %. The characteristics of patients who were physical activity are presented in Table 1. Both groups are statistically different in all of the variables that were included. In hypertensive patients, only 45.6 % spent at least 30 min in moderate to vigorous physical activity at least three times a week. After controlling for other covariates in the model, the risk of hypertension was higher in those who were physically inactive compared with those who were physically active (Odds Ratio: 1.1, 95 % Confidence Interval: 1.07 to 1.12, $p < 0.0001$).

After controlling for covariates, physical activity in all individuals was associated with a decrease in the annual total healthcare expenditure of $592 US dollars (t = –6.06, $p < 0.0001$) (Table 2) and in the pharmaceutical expenditure of $125 US dollars (t = – 6.15, $p < 0.0001$) (Table 3). As expected, the diagnosis of all diseases was associated with an increase in total healthcare and pharmaceutical expenditures (Table 3).

In hypertensive patients, physical activity was associated with a statistically insignificant decrease in the total healthcare expenditure of $1011.30 US dollars (t = – 3.61, P = 0.069) (Table 4) and in the pharmaceutical expenditure of $195.80 US dollars (t = – 3.77, P = 0.064) (Table 5).

DISCUSSION

This is the first study in the United States to estimate the effect of physical activity on healthcare expenditures on a national level and to analyze the effect of physical activity on pharmaceutical expenditures. The participants who completed the MEPS were from different geographic areas and minorities, and this diversity increases the external validity and the generalizability of this study. The analyses controlled for factors

Table 1: Weighted characteristics by physical activity (sample = 27,053; population = 211,577,002)

Variable	**Physically active** (sample=14,586; population= 119,700,000)	***Physically inactive*** (sample=12,467; population= 91,877,002)
Age (mean, yr)	43.9	47.3
Gender (%)		
Female	48.6	56.3
Race (%)		
White	84.1	80.3
African-American	10.0	12.8
Other race	5.9	6.9
Education (%):		
Grades 0-8	5	10.2
Grades 9-12	44.8	49.2
College	39.3	33.1
5 years college or more	10.9	7.5
Total individual income (mean, $)	32,001	26,829
Presence of insurance (%)	87.1	86.6
BMI mean	26.3	27.9
Smoking (%)	20.6	24
Total health care expenditure ($) mean	2,605	3,961
Pharmaceutical expenditure ($) mean	517	839
Diagnosis (%)		
CHD	2.4	4.3
Diabetes	4.5	9.2
Hypertension	20.4	29.3
Angina	1.7	3.1
Myocardial infarction	2.3	4.1
Other heart diseases	5.2	7.4
Stroke	1.7	3.8
Asthma	8.9	10.1
Arthritis	17.7	24.6

Table 2: Regression analysis of total health care expenditure in all individuals (sample = 22,826; population = 188,000,000)

Variable	Coefficient	Robust standard error	*P*-value
Physically active	-591.86	97.65	<0.0001
Age	31.26	3.99	<0.0001
Female	592.33	98.84	<0.0001
Race			
White	Reference	Reference	Reference
Black	-385.94	153.90	0.013
Other race	-698.38	140.06	<0.0001
Education	17.16	18.45	0.353
Total individual income	-.0038	.0018	0.038
Holder of insurance	1435.01	81.44	<0.0001
BMI	-4.15	10.42	0.691
Smoking	-27.68	114.72	0.810
Diagnosis			
CHD	4051.03	729.78	<0.0001
Diabetes	2433.98	282.05	<0.0001
Hypertension	844.57	163.62	<0.0001
Angina	546.84	836.51	0.514
Myocardial infarction	3898.87	713.66	<0.0001
Other heart diseases	2703.72	371.24	<0.0001
Stroke	2829.08	656.74	<0.0001
Asthma	1582.93	198.08	<0.0001
Arthritis	1885.01	178.48	<0.0001
Constant	-759.81	354.62	0.033

that could affect physical activity or expenditures. In the current study, it was found that less than 50 % of the US population exercise regularly. Our results show that physically active individuals are healthier than their physically inactive counterparts. African-Americans and other races had fewer expenditures compared with Caucasians. This finding may be attributed to differences in the access to care and the possible differences in behavior.

Similar to previous studies [10-14], the current cross-sectional study demonstrated that the risk of hypertension was higher in those who were physically inactive compared with those who were physically active. Physical activity in all of the individuals was associated with significant decreases in the annual pharmaceutical and the total healthcare expenditures. Because the factors that could affect the physical activity or the expenditure were controlled in the analysis, the observed effect was attributed to the reduction in the use of medications and other healthcare services.

The reduction that was identified in the healthcare expenditure confirmed the findings of previous studies [15-17]. In Canada,

Table 3: Regression analysis of pharmaceutical expenditure in all individuals (sample = 22,826; population = 188,000,000)

Variable	Coefficient	Robust standard error	*P*-value
Physically active	-125.02	20.32	<0.0001
Age	6.70	.70	<0.0001
Female	143.06	18.22	<0.0001
Race			
White	Reference	Reference	Reference
Black	-175.57	27.52	<0.0001
Other race	-109.68	35.70	0.002
Education	8.068	3.28	0.015
Total individual income	-.0015	.0003	<0.0001
Presence of insurance	201.81	17.69	<0.0001
BMI	4.53	2.02	0.025
Smoking	82.13	25.97	0.002
Diagnosis			
CHD	329.12	99.90	0.001
Diabetes	1025.19	63.83	<0.0001
Hypertension	430.18	29.52	<0.0001
Angina	427.79	127.29	0.001
Myocardial infarction	478.56	99.10	<0.0001
Other heart diseases	390.30	60.02	<0.0001
Stroke	681.83	112.07	<0.0001
Asthma	520.23	52.68	<0.0001
Arthritis	463.40	35.07	<0.0001
Constant	-387.06	81.21	<0.0001

Table 4: Regression analysis of total health care expenditure in hypertensive patients (sample = 5,688; population = 45,779,791)

Variable	Coefficient	Robust standard error	*P*-value
Physically active	-1011.30	280.19	0.069
Age	19.44	6.98	0.108
Female	161.40	224.96	0.548
Race			
White	Reference	Reference	Reference
Black	-59.60	364.86	0.885
Other race	-971.43	471.67	0.176
Education	10.40	66.02	0.889
Total individual income	-.01	.006	0.216
Presence of insurance	2509.65	281.02	0.012
BMI	-35.03	31.22	0.378
Smoking	-296.49	167.73	0.219
Diagnosis			
CHD	3626.82	1213.51	0.096
Diabetes	2145.65	194.89	0.008
Angina	1256.09	787.21	0.252
Myocardial infarction	3791.10	821.16	0.044
Other heart diseases	3223.18	884.34	0.068
Stroke	2847.94	303.57	0.011
Asthma	2102.08	475.81	0.048
Arthritis	2143.85	344.83	0.025
Constant	1191.98	1266.43	0.446

approximately Can$2.1 billion (2.5 %) of the total direct healthcare costs were attributable to physical inactivity [16]. One cross-sectional study using the 1996 MEPS estimated that the direct medical expenditure of inactivity-associated cardiovascular disease was US$23.7 billion [18]. However, the authors did not control for other covariates, and weighting was not applied to obtain a national estimate [18].

In the current study, the physical activity of hypertensive patients was associated with a statistically insignificant decrease in the annual pharmaceutical and the total healthcare. The insignificant reduction is due to the high standard errors since the stratification design of the MEPS was not controlled for.

Table 5: Regression analysis of pharmaceutical expenditure in hypertensive patients (sample = 5,688; population = 45,779,791)

Variable	Coefficient	Robust standard error	*P*-value
Physically active	-195.80	51.95	0.064
Age	7.60	.74	0.009
Female	112.90	47.73	0.142
Race			
White	Reference	Reference	Reference
Black	-173.80	90.54	0.195
Other race	-135.70	108.98	0.339
Education	6.30	10.15	0.601
Total individual income	-.0020	.00045	0.035
Presence of insurance	432.30	103.13	0.052
BMI	7.39	1.65	0.047
Smoking	137.12	50.89	0.115
Diagnosis			
CHD	207.25	28.0	0.018
Diabetes	1107.40	141.54	0.016
Angina	544.20	48.50	0.008
Myocardial infarction	498.40	27.73	0.003
Other heart diseases	445.29	54.13	0.014
Stroke	575.18	138.52	0.053
Asthma	596.51	87.86	0.021
Arthritis	448.04	62.0	0.019
Constant	-236.46	64.95	0.068

The current study has limitations that should be considered when interpreting the results. First, the cross-sectional design of this study makes it difficult to establish a causal relationship between hypertension and increase in physical activity. Therefore, this study shows just association between these factors. Second, favorable selection bias is a major threat to the current study. Patients who exercise may be healthier compared with those who do not. Although several diseases that correlated with physical activity were included in the models, other variables were not included. Third, this study did not control for the stage of hypertension. This information about the disease stage was not available in the MEPS. Fourth, no information about the use of medications was collected to see if physical activity affected the dose or quantity of hypertensive medications used. Fifth, many variables in the MEPS, including physical activity, were self-reported by the individual. The effect of physical activity on blood pressure was also not assessed because blood pressure data is not available in the MEPS. Sixth, this study used MEPS database from the United States and the results may not be generalized internationally.

The results of the current study should impact clinical practice and research. Healthcare professionals need to stress to their patients the importance of physical exercise in reducing the risk of hypertension and its complications. Health policy makers and insurance companies need to allocate resources for programs that encourage patients to exercise regularly. Future studies need to use a panel design to establish causal association and to control for the severity of hypertension in the analysis.

CONCLUSION

The prevalence of hypertension was high in physically inactive individuals. Total healthcare and pharmaceutical expenditures decreased in physically active individuals. Future studies with a follow-up design are needed to confirm the results of the current study.

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REFERENCES

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