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Effect of Walking Distance on 8-Year Incident Depressive Symptoms in Elderly Men With and Without Chronic Disease: The Honolulu-Asia Aging Study

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Abstract

Objectives—To determine the effect of walking on incident depressive symptoms in elderly Japanese-American men with and without chronic disease

Design—Prospective cohort study

Setting—The Honolulu-Asia Aging Study

Participants—Japanese-American men aged 71 to 93 years at baseline

Measurements—Physical activity was assessed by self-reported distance walked per day. Depressive symptoms were measured with an 11-question version of the Centers for Epidemiologic Studies Depression Scale (CES-D) at the 4th exam (n=3196) and again at the 7th exam 8 years later (1999-2000, n=1417). Presence of incident depressive symptoms was defined as CESD-11 score ≥ 9 or taking anti-depressants at Exam 7. Subjects with prevalent depressive symptoms at baseline were excluded.

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Study concept and design: TLS, KHM

Acquisition of subjects and data: KHM, KF, GWR, HP, LRW

Analysis and interpretation of the data: TLS, KHM, KF, RDA, GWR, HP, PLB, LRW

Preparation of manuscript: TLS, KHM

Critical review of manuscript: KF, RDA, GWR, HP, PLB, LRW

Conflict of Interest

Dr. White was previously employed by the NIA.

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Results—Age adjusted 8-year incident depressive symptoms were 13.6%, 7.6% and 8.5% for low (< ¼ miles/day), intermediate (¼ to 1.5 miles/day) and high (> 1.5 miles/day) walking groups at baseline, p=0.008. Multiple logistic regression analyses, adjusted for age, education, marital status, cardiovascular risk factors, prevalent diseases and functional impairment found that those in the intermediate and highest walking groups had significantly lower odds for developing 8-year incident depressive symptoms (OR=0.52; 95% CI=0.32-0.83, p=0.006; and OR=0.61; 95% CI=0.39-0.97, p=0.04 respectively). Analysis found that this association was only significant in those without chronic diseases (CHD, CVA, Cancer, PD, Dementia or cognitive impairment) at baseline.

Conclusion—Daily physical activity (≥¼ mile/day) is significantly associated with a lower risk for 8-year incident depressive symptoms in elderly Japanese-American men who do not have chronic disease at baseline.

Keywords

Physical activity; aged; depressive symptoms; chronic disease

INTRODUCTION

Depressive symptoms are common in older individuals and have been identified in 8 to 20 percent of older community-dwelling residents and up to 35 percent of older primary care patients.[1,2] Depression has been associated with increased morbidity and mortality and increased risk for physical decline and onset of disability.[3-6] Depression worsens many medical conditions and is considered by some to be a risk factor for the development of cardiovascular disease.[7] The World Health Organization has highlighted the detrimental effects of depression on medical illnesses as one of its ten most important global public statistics for 2007.[8]

The benefits of physical activity have been well documented in the literature, including for older individuals. It has been shown to improve aerobic capacity, coordination, and flexibility.[9] It decreases the risk of chronic disease co-morbidity, slows the progression of disability and has been associated with lower cardiovascular and all-cause mortality.[10-11] In addition, walking has been shown to improve mortality in non-smoking retired men.[12]

Cross-sectional and longitudinal studies have shown the beneficial effects of physical activity on depressive symptoms in older cohorts.[13,14] Clinical trials have shown that exercise interventions show sustained reductions in depressive symptoms for up to 5 years of follow-up.[15] However, it is still not clear whether physical activity has a protective effect on the development of new depressive symptoms. To study this question, we used data from elderly Japanese-American men in Hawaii to examine the cross-sectional and longitudinal relationships between walking distance and incident depressive symptoms. We hypothesized that those who walked more would be protected against development of incident depressive symptoms, after adjustment for confounders.

METHODS

Study Design and Population

The Honolulu Heart Program (HHP) began in 1965 as a prospective population-based study of cardiovascular disease in 8,006 men of Japanese ancestry living on the island of Oahu, Hawaii. The men were born between 1900 and 1919. All men of Japanese ancestry identified by using World War II selective service registration cards were invited to participate. HHP cohort recruitment, design, and procedures have been described previously.

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[16] An expansion of the Honolulu Heart Program was launched with the fourth examination in 1991-1993 as the Honolulu-Asia Aging Study (HAAS), to evaluate dementia, depression and other diseases of aging.

The findings for this report are based on two time periods of data collection. The baseline for analysis was the fourth HHP-HAAS examination, which was conducted from 1991-1993 and included 3,741 men aged 71-93 years. The seventh examination was conducted from 1999-2000 and included 1518 men aged 79-100 years. There were 1,440 men who died between the two exam periods, 775 who did not respond and 8 who were unable to be located. For this report, we used walking distance as measured at the baseline examination (1991-1993) to predict incident depressive symptoms that was observed at the seventh examination (1999-2000).

Data Collection

Walking Distance—During the fourth examination (1991-93), the subjects were asked how many city blocks they walked each day. Blocks were then converted into miles using 12 blocks per mile as a conversion factor. This assessment of physical activity was developed from the Harvard Alumni Survey, and validity and reliability have been determined previously. [17,18]

Depressive Symptoms—Participants were screened for depressive symptoms using an 11-question version of the Centers for Epidemiological Studies Depression (CES-D) Scale questionnaire (Appendix 1). Participants who did not answer three or more of the 11 depression questions were excluded from this analysis, leaving 3,196 participants with a valid CES-D 11 at exam 4 (baseline). The standard 20-question CES-D Scale uses a cutoff score of 16 points for depressive symptoms 19.[19] In this 11-question version, a score of 9 or greater was used as a cutpoint (determined by extrapolation; $16/20 \times 11 = 8.8$, rounded up to 9). Shortened forms of the CES-D have been found to be comparable with the full-scale version.[20,21] Prevalent depressive symptoms were defined by a valid CES-D 11 score ≥ 9 or taking antidepressant medications at exam 4 (n=338/3196, 10.6%).

The CES-D 11 screening test was repeated during the seventh examination 8 years later, and again, subjects who did not answer 3 or more of the questions were excluded from the analysis. Subjects were defined to have 8-year incident depressive symptoms if they had a CES-D 11 score ≥ 9 or were taking antidepressant medications at exam 7. Subjects with prevalent depressive symptoms at exam 4 were excluded from the incidence analysis. Incident depressive symptoms were found in 126 of 1282 men (9.8%).

Covariates

Baseline covariates were selected because of their potential relationships with depressive symptoms or physical activity. Education was determined by self-report as total number of years of formal education. Marital status was determined by self-report (yes/no). Body mass index was defined as weight in kilograms divided by height in meters squared. Hypertension was defined as systolic or diastolic blood pressures of ≥ 140 or 90 mm Hg, respectively, or when a study participant was receiving medications for the treatment of hypertension. Diabetes mellitus was defined by the modified ADA criteria, as fasting glucose ≥ 126 mg/dl, or 2-hour post-load glucose ≥ 200 mg/dl, or taking medications (insulin or oral hypoglycemics).[22] Alcohol use was determined by self-report as ounces consumed per week. Smoking status was determined by self-report, and subjects were classified as ever or never smokers. Prevalent coronary heart disease, stroke and cancer were determined by hospital surveillance, with a final diagnosis made by consensus by a physician panel using standardized research criteria. Cognitive function was measured with the Cognitive Abilities

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Screening Instrument,[23] which was developed for cross-cultural and cross-national studies of dementia. A score on the Cognitive Abilities Screening Instrument of less than 74 defined cognitive impairment. This cut-point has a sensitivity of 80% and specificity of 90% for a diagnosis of dementia using DSM-III-R criteria. Prevalent dementia and Parkinson's disease were determined by an expert physician panel using standardized research criteria. Functional impairment was defined as self-reported difficulty walking a half mile.

Statistical Analysis

Subjects were divided into tertiles based on walking distance: Low < 0.25 miles/day, Intermediate 0.25-1.5 miles/day, High >1.5 miles/day. To determine statistical significance between groups, chi square tests were used to compare categorical variables and t-tests or general linear models were used to compare continuous variables.

Multiple logistic regression models were used to estimate the odds of having incident depressive symptoms in the Intermediate and High walking distance groups, using the Low walking distance group as reference. Adjustments were made for age, education, marital status, BMI, hypertension, diabetes, alcohol consumption, smoking status, prevalent coronary heart disease, stroke, cancer, Parkinson's disease, dementia or cognitive impairment and functional impairment. Analyses also modeled distance walked as a continuous variable.

Since chronic diseases may affect physical activity, analyses were also stratified by health status. Men were defined as “Sick” if they had prevalent coronary heart disease, stroke, cancer, Parkinson's disease, dementia or cognitive impairment at baseline, and “Healthy” if no chronic medical disease was present at baseline. Adjustments were made for baseline age, education, marital status, cardiovascular risk factors and functional impairment.

RESULTS

We compared means of baseline demographic factors, cardiovascular risk factors, and other co-morbid prevalent conditions by walking groups. On average, men who reported walking longer distances were younger than those who reported walking less ($p<0.0001$). After adjusting for age, men who walked longer distances were significantly more educated, had lower alcohol consumption, were less likely to be ever smokers, and had lower rates of prevalent stroke, dementia or cognitive impairment, and functional impairment. Men who walked longer distances also had significantly lower rates of prevalent and 8-year incident depressive symptoms (Table 1).

Additionally, we compared means of baseline demographic factors, cardiovascular risk factors, and other co-morbid prevalent conditions compared by prevalent depressive symptoms. Those who had depressive symptoms at baseline were significantly less likely to be married, have lower BMI, lower rate of hypertension, and higher rates of prevalent stroke, Parkinson 's disease, dementia, cognitive impairment and functional impairment (Table 2).

Logistic regression models were used to compare the odds for 8-year incident depressive symptoms separately in the Intermediate and High walking groups, using the Low walking group as reference. Logistic regression models were unadjusted, as well as adjusted for several potential confounders. After adjusting for age, education, marital status, cardiovascular risk factors, prevalent diseases and functional impairment, multivariate models found significantly reduced odds of development of 8-year incident depressive symptoms in both the High (OR=0.61, 95% CI=0.38-0.97, p=0.036) and Intermediate

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(OR=0.52, 95% CI=0.32-0.84, p=0.007) walking groups (Table 3). Subjects with prevalent depressive symptoms at baseline were removed from analyses of incidence.

Another logistic regression model was used to compare the odds for incident depressive symptoms in the Intermediate and High walking groups stratified for presence or absence of chronic diseases (Sick vs. Healthy), again using the Low walking group as reference. In multivariate models, adjusting for age, education, marital status, cardiovascular risk factors and functional impairment, those in the Intermediate group who were Healthy, had a significantly decreased odds of developing incident depressive symptoms (OR=0.39, 95% CI=0.21-0.71, p=0.002). There was a borderline significant difference in odds of developing incident depressive symptoms in the High walking group (OR=0.61, 95% CI=0.35-1.06, p=0.08). There were no significant associations between walking groups and depressive symptoms in the Sick group for either Intermediate or High walking groups (Table 4).

DISCUSSION

In this study, we investigated the association between self-reported walking distance and prevalent and 8-year incident depressive symptoms in a cohort of elderly Japanese-American men from the Honolulu Heart Program and Honolulu-Asia Aging Study longitudinal cohort. As expected, we found that those who walked the most had significantly lower rates of prevalent depressive symptoms in cross-sectional analyses. We also found that elderly men who walk longer distances per day were less likely to develop new depressive symptoms over 8 years of follow-up. There appeared to be a threshold effect in the protective effect of walking on the development of incident depressive symptoms, with not much difference between those in the Intermediate and High walking groups. Subjects in the highest walking group at baseline were 41% less likely to develop depressive symptoms 8 years later. Even after adjusting for potential confounding variables there was still a 39% reduction in the development of depressive symptoms. When stratified by chronic disease status at baseline, this association remained significant only in the healthy group of men with no chronic diseases at baseline.

Previous large longitudinal studies have examined the relationship between physical activity and depressive symptoms.[24,25] In the NHANES I Epidemiologic Follow-up Study,[24] self-reported physical activity was measured by questionnaire and depressive symptoms by the CES-D in 3016 men and women. Their findings suggested that recreational physical activity was an independent predictor of depression levels 8 years later for white women who were not depressed at baseline. There was no significant difference for white men who were not depressed at baseline. However, lower level of physical activity was a strong predictor of continued depression at follow-up.

The Alameda County Study was another large longitudinal study on 4828 men and women using a self-reported physical activity index and a depression questionnaire to evaluate the relationship between the level of physical activity and risk of subsequent depression.[25] They concluded that in a non-depressed population sample, men and women who reported low activity level at baseline were at a significantly greater risk for depression at follow-up (~9 years) compared to those who reported high activity levels at baseline.

More recently, the Rancho Bernardo Study examined the effects of physical activity on depressive symptoms in 2375 older men and women.[14] Subjects were interviewed about physical activity and used the Beck Depression Inventory to determine that individuals who were more physically active had lower depression scores at baseline and at follow up 8 years later. However, they did not find a long-term protective effect of exercise. Depression scores of participants who reported exercise at the earlier visit but not at the second evaluation were

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similar to those for participants who did not report exercise at either visit. A subsequent study on the same cohort attributed these results to the exclusion of disabled participants and found that a physical activity score is protective against development of incident major depression using DSM-IV criteria.[13]

Our results are in agreement with the findings of Strawbridge, et al and support the protective effect that physical activity has on incident depressive symptoms.[13] However, despite these results and our exclusion of those with depressive symptoms at baseline, this is an observational study and therefore we cannot infer that walking prevents depressive symptoms. Undoubtedly, depressive symptoms can lead to less physical activity and vice versa. It was our intent to add to the body of knowledge to the potential benefits of walking in elderly men and provide further information regarding which subjects seem to benefit the most from this level of physical activity.

A few mechanisms have been suggested that attempt to explain the association between physical activity and depressive symptoms. Physiologically, the prominent hypothesis is that exercise increases the availability of brain neurotransmitters such as serotonin, dopamine and norepinephrine. These same neurotransmitters are decreased in depressed patients and increased in the plasma following exercise. However, it is still unclear if this actually leads to an elevated level in the brain in humans. [26,27]

Our analysis of subjects with and without chronic disease at baseline has not been examined previously and is unique to our study. It suggests that walking can contribute to less depressive symptoms in a healthy group of elderly but that this potential benefit might not be enough to compensate for the effects of chronic disease.

LIMITATIONS AND STRENGTHS

Our study population included only elderly Japanese-American men in Hawaii. Therefore, these findings may not be generalizable to women or other ethnic groups or settings. There may be some concern that we excluded participants because of incomplete or invalid answers on the 11-item CES-D Scale questionnaire. It is possible that some of these invalid depression scales may have been due to more severe cognitive impairment and/or medical burden. It is likely that these subjects may have had higher depressive symptoms because of this. The elimination of these participants could have skewed our evaluation of depressive symptoms mainly in the group who walked less than 0.25 miles/day.

Strengths of the study are that it is a large, population-based cohort that has had excellent follow-up since 1965. Out-migration rates are low, and follow-up examinations have had excellent response rates. Hospital surveillance for chronic diseases is essentially complete, since this is an island population. Longitudinal analyses were possible, and the follow-up period for incident depressive symptoms was relatively long. The study sample of retired elderly men living in the mild climate of Hawaii had the advantage of more reliably assessing self-reported physical activity. As opposed to other climates, Hawaii allows for year round walking and thus more accurate and consistent recollection of distance walked by the subjects. We can also propose that it is more likely that the activity level of these elderly, retired men was of low intensity considering that most reasons for walking would be for domestic or leisure activities.

CONCLUSIONS

In summary, our study confirmed the hypothesis that daily physical activity, specifically walking, is strongly independently protective for the development of depressive symptoms over 8-years of follow-up in elderly Japanese-American men without chronic disease. Even

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a low level of daily physical activity in elderly individuals has protective effects for the development of depressive symptoms. These effects are likely to occur in a healthier subset of the elderly population. Activities that promote physical activity, particularly activities that are well tolerated and easily instituted are beneficial to this population. Future research should aim to further define other forms of physical activity and the effect they have on the development of depressive symptoms. A randomized clinical trial of walking in elderly subjects would provide more definitive data on the cause and effect relationship between physical activity and depression.

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Appendix

Appendix 1

Centers for Epidemiologic Studies Depression Scale Questionnaire (11-item version)

CES-D (11) QUESTIONNAIRE				
Below is a list of the ways you might have felt or behaved. Please indicate how often you have felt this way during the past week.				
Would you say in the last week...	**Rarely or none of the time (less than 1 day)**	**Some or a little of the time (1-2 days)**	**Occasionally or a moderate amount of the time (3-4 days)**	**Most of the time**
1. You were bothered by things that usually don't bother you.	0	1	2	3
2. You did not feel like eating, your appetite was poor.	0	1	2	3
3. You had trouble keeping your mind on what you were doing.	0	1	2	3
4. You felt that everything you did was an effort.	0	1	2	3
5. You felt depressed.	0	1	2	3
6. You felt hopeful about the future.	3	2	1	0
7. You felt fearful.	0	1	2	3
8. Your sleep was restless.	0	1	2	3
9. You were happy.	3	2	1	0
10. You felt lonely.	0	1	2	3
11. You could not get going.	0	1	2	3

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Table 1

Baseline characteristics according to distance walked per day.

Characteristics	Distance Walked, Miles/Day			p-value
	< 0.25 (n = 1090)	0.25 – 1.5 (n = 1160)	> 1.5 (n = 946)	
Age (yrs)	77.8	77.5	76.4	< 0.0001
Education (yrs)*	10.4	10.8	10.9	0.0022
Married (%)*	83.0	83.1	83.1	0.9543
BMI (kg/m^2)*	23.5	23.6	23.6	0.2841
Hypertension (%)*	73.1	75.3	75.8	0.1672
Diabetes (%)*	31.3	30.0	27.8	0.0905
Alcohol (oz/day)*	20.5	18.7	15.2	0.0027
Ever Smokers (%)*	65.1	62.0	59.8	0.0149
Prevalent CHD (%)*	22.0	20.8	23.5	0.4052
Prevalent CVA (%)*	5.5	4.0	3.2	0.0087
Prevalent Cancer (%)*	13.6	13.8	12.6	0.5288
Prevalent Parkinson's Disease (%)*	1.3	0.5	0.8	0.2471
Prevalent Dementia or Cognitive Impairment (%)*	13.7	8.8	7.6	<0.0001
Prevalent Functional Impairment (%)*	23.7	13.7	4.3	<0.0001
Prevalent Depressive Symptoms (%)*	12.2	11.2	7.9	0.0051
8-Year Incident Depressive Symptoms (%)*	13.6	7.6	8.5	0.0077

yrs = years

% = percent

BMI = Body Mass Index

kg/m^2 = kilogram per meter squared

oz/day = ounces per day

CHD = Coronary Heart Disease

CVD = Cerebrovascular Attack

* adjusted for age.

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Table 2

Baseline characteristics according to depressive symptoms at baseline.

Characteristics	Prevalent Depressive Symptoms		p-value
	Absent (n = 2858)	Present (n = 338)	
Age (yrs)	77.3	77.6	0.1741
Education (yrs)	10.7	10.8	0.7019
Married (%)	83.8	76.9	0.0014
BMI (kg/m^2)	23.6	23.1	0.0027
Hypertension (%)	75.2	70.1	0.0426
Diabetes (%)	29.9	29.0	0.7476
Alcohol (oz/day)	18.2	19.2	0.6558
Ever Smokers (%)	37.5	38.3	0.8589
Prevalent CHD (%)	21.7	24.9	0.1801
Prevalent CVA (%)	3.9	7.4	0.0028
Prevalent Cancer (%)	13.1	16.0	0.1350
Prevalent Parkinson's Disease (%)	0.7	2.1	0.0093
Dementia (%)			
Prevalent	2.7	4.4	0.0630
Incident	9.4	15.6	0.0202
Cognitive Impairment (%)			
Prevalent	9.5	15.4	0.0007
Incident	25.7	34.0	0.0319
Prevalent Functional Impairment (%)	13.4	21.8	<0.0001
Distance Walked (Exam 4) (%)			0.0051
< 0.25 mi	33.5	39.4	
0.25 – 1.5 mi	36.0	38.5	
> 1.5 mi	30.5	22.2	

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Table 3

Logistic regression models showing relationships between depressive symptoms and distance walked per day with adjustments for confounding variables.

Walking Distance (Low is reference)	8-Year Incident Depressive Symptoms		
	OR	95% CI	p-value
Model 1			
Intermediate vs. Low	0.53	0.33-0.83	0.006
High vs. Low	0.59	0.38-0.92	0.018
Model 2			
Intermediate vs. Low	0.52	0.32-0.83	0.006
High vs. Low	0.61	0.39-0.97	0.038
Model 3			
Intermediate vs. Low	0.52	0.32-0.84	0.007
High vs. Low	0.61	0.38-0.97	0.036

Model 1 – Unadjusted

Model 2 - Adjusted for Age, Education, Marital Status, BMI, Hypertension, Diabetes, Alcohol Use, Smoking Status, Prevalent Coronary Heart Disease, Stroke, Cancer, Parkinson's Disease, Dementia, Cognitive Impairment and Functional Impairment.

Model 3 – Adjusted for Age, Education, Marital Status, BMI, Hypertension, Diabetes, Alcohol Use, Smoking Status, Prevalent Coronary Heart Disease, Stroke, Cancer, Parkinson's Disease, Dementia, Cognitive Impairment and Functional Impairment, and 8-year Incident Dementia or Cognitive Impairment.

OR = Odds ratio

CI = Confidence Interval

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Table 4

Logistic regression models showing relationships between 8 year incident depressive symptoms and distance walked per day, stratified by presence or absence of chronic diseases.

Walking Distance (Low is reference)	8 Year Incident Depressive Symptoms		
	OR	95% CI	p value
Healthy*			
Intermediate vs. Low	0.39	0.21 – 0.71	0.002
High vs. Low	0.61	0.35 – 1.06	0.08
Sick†			
Intermediate vs. Low	0.99	0.45 – 2.21	0.99
High vs. Low	0.64	0.28 – 1.48	0.30

Adjusted for age, education, marital status, cardiovascular risk factors and functional impairment.

† Sick (N = 1316/3196, 41.2%) = prevalent CHD, stroke, cancer, Parkinson's Disease, or dementia/cognitive impairment at baseline

* Healthy (N = 1880/3196, 58.8%) = absence of any of the above chronic diseases at baseline