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Feature Article

Physical activity and depressive symptoms in older adults

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ABSTRACT

Objectives: Depressive symptoms are prevalent in older adults, and physical activity (PA) may have beneficial effects on depression. The purpose of this study was to explore the association between physical activity and depressive symptoms, taking into account demographic factors, and the associations between selected demographic factors and physical activity levels in community-dwelling older adults (age $\geq$ 60 years).
Methods: Data were drawn from the National Health and Nutrition Examination Survey 2005–2006. Descriptive statistics and logistic models were used in data analysis.
Results: Four percent of participants reported moderate depressive symptoms, and 24% of subjects exhibited sedentary PA. Factors associated with increased risk of moderate depression included age, sedentary PA, and chronic medical conditions ($ps < 0.05$). Sedentary PA was significantly associated with age, race, education, BMI, smoking status, alcohol use, and taking psychotropics ($ps < 0.05$).
Discussion: PA is a protective factor for depression in older adults, and clinical implications to encourage PA are discussed.

Introduction

Depression is a chronic mental illness, placing a burden on families and the health care system in addition to the individual suffering it causes. Major depression reportedly affects 1–5% of older adults,[1,2] increasing many negative consequences such as an increased risk of morbidity and mortality from comorbid conditions (e.g., cardiovascular disease). The risk for mortality in elderly patients diagnosed with depression doubles when the patients are followed over 3 years.[3]

Although much of this research has focused on major depression, clinically significant depressive symptoms, which are more prevalent than major depression as they affect 3–26% of community-dwelling old adults, have received little attention in the literature.[2] Although depressive symptoms do not meet the diagnostic criteria for major depression and thus are not considered to be as severe, the consequences of significant depressive symptoms, including functional impairment, medical morbidity, and increased health care costs, are quite similar to those of major depression.[4,5]

Physical activity has been shown to have an inverse relationship with depression in the elderly. Among recently published observational studies[6–12] and clinical trials[13–16] in which physical activity and depression in older adults were examined, an inverse relationship was reported in the majority of them.[7–10,12,13] Although these studies concluded that physical activity was protective for depression, methodological issues make it difficult to draw firm conclusions. For example, in one of the aforementioned clinical trials, physical activity was investigated as just one component of a broader psychosocial intervention, precluding conclusions about the direct contributions of physical activity to mental health outcomes. In several observational studies, physical activity data was collected via self-report, which is subject to overestimation[17] due to social desirability bias,[18] and is thus not capable of capturing the precise relationship between physical activity and depression. Additionally, depressive symptoms such as decreased energy or fatigue may directly affect self-reports of

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physical activity.[19] Only one study in Japan has used a form of objective measurement (an accelerometer) to assess physical activity, and this study reported a significant negative relationship between depressive mood and physical activity.[12] Pedometer is another tool for measurement of physical activity commonly used in other studies; however, it is not sensitive to slow activity or shuffling gaits[20,21] and it also motivates physical activity,[22,23] so it may either under or overestimate physical activity in older adults.

In sum, very few studies have examined the association between objectively-measured physical activity and depression, and in particular, depressive symptoms, in the older adults. The primary aim of the current study was to utilize objectively-measured physical activity to determine more precisely the relationship between physical activity and depressive symptoms in older adults (age $\geq$ 60 years). In addition to physical activity, several demographic variables have been shown to be related to depression and depressive symptoms. These include age, gender, chronic medical conditions, household income, race/ethnicity, living situation (married vs. living alone), education, BMI, smoking and alcohol use.[24–30] Several of these variables are also known to be associated with physical activity.[31–35] In the current study, we included demographic factors in the analyses in order to assess the independent contribution of physical activity to depressive symptoms. We hypothesized that higher levels of physical activity would be associated with significantly lower odds of moderate depressive symptoms. In addition, a secondary aim of the current study was to explore associations between selected demographic factors and physical activity. If physical activity is indeed a protective factor for depressive symptoms in older adults, it is imperative to identify demographic variables that may act as barriers to physical activity in this population. It is only by understanding *both* the precise relationship between physical activity and depressive symptoms *and* other characteristics that may act as risk factors for low physical activity levels that comprehensive, targeted interventions can be developed.

Methods

Secondary data analysis of the National Health and Nutrition Examination Survey (NHANES) was performed. The NHANES is designed with a complex sampling method (stratified multistage probability sample design) that oversamples certain groups in order to develop sample weights so that the data are representative of the civilian, non-institutionalized U.S. population.[36] Detailed information about this survey and public use data files can be found at http://www.cdc.gov/nchs/nhanes.htm. This study specifically used NHANES data from 2005 to 2006 because this was the year that accelerometer-determined step data were first released. The NHANES 2005–2006 included a total of 10,348 individuals across the life span. In this study, we focused on 805 adults age 60 and older who completed both objective physical activity measurement with an accelerometer and depression screening. Institutional Review Board approval requirements were waived because data from NHANES are publicly available and participants are de-identified.

Measures

Depressive symptoms

Depressive symptoms were measured by the Patient Health Questionnaire (PHQ)-9. The PHQ-9 refers to the previous 2-week interval and consists of nine items, each scored on a scale of 0–3, asking about depression symptoms, with one follow-up question on functional impairment. The symptom score was calculated as the total of the nine symptom items (possible range 0–27), and a score $\geq$10 represented a moderate level of depressive symptoms. Sensitivity of 88% and a specificity of 88% for major depression with the PHQ-9 score were reported.[37]

Physical activity

Physical activity was recorded with the accelerometer Actigraph AM-7164 (manufactured by ActiGraph of Ft. Walton Beach, Florida, USA) for 7 consecutive days. Subjects with at least one valid day of monitoring in which the accelerometer was worn for at least 10 h were included in analysis. Accelerometer data processing followed SAS programs released by the National Cancer Institute.[38] Daily step counts were used as the primary measurement in this study and the average of the daily step count was calculated. Daily steps were also classified based on previous calibration studies where pedometer-determined physical activity cut-off points for healthy adults were reported.[21,23] Participants were classified as sedentary if their average step count was less than 5000 steps per day, low if the average count was between 5000 and 7499 steps/day, and active/high if the average count was greater than 7500 steps/day.[21,23]

Sociodemographic information

Demographic information collected included age, gender, race/ethnicity, marital status, education, annual household income, chronic medical conditions, and body mass index (BMI). Race/ethnicity was classified into four categories: non-Hispanic white, non-Hispanic black, Mexican-American, and other race. Living situation was classified using two categories (living alone; married or living with partner). Annual household income ($<$\$45,000 vs. $\geq$\$45,000), highest achieved education level ($<$high school, or $\geq$high school), and BMI (underweight, normal weight, overweight, or obese, as determined by the National Institute of Health BMI categories) information was also elicited. Information about chronic conditions and psychotropic medication use was also gathered. Respondents were asked to report any physical health conditions that had ever been diagnosed by a doctor or other health professional. Chronic medical conditions included asthma, diabetes, arthritis, coronary heart disease, angina, myocardial infarction, congestive heart failure, stroke, emphysema, chronic bronchitis, any kind of cancer, any thyroid problem, or any kind of liver condition. Prescribed psychotropic medications included antidepressants, anxiolytics/hypnotics, antipsychotics, and acetylcholinesterase inhibitors. Smoking status was defined as non-smoker or current smoker; alcohol use was defined as non-drinker (reported consuming no alcoholic beverages in the past 12 months) or drinker (reported drinking at least some alcohol in the past 12 months).

Statistical analysis

All analyses were conducted using STATA 10 (Stata Corporation, College Station, TX) and accounted for the complex sample design and sample weights of the NHANES data. Because the objectives of the study included examining predictors of both physical activity and depressive symptoms, as well as their relation to one another, we conducted four sets of analyses, two assessing predictors of physical activity and two assessing predictors of depressive symptoms. First, a series of binary logistic regression analyses were performed to assess predictors of moderate depressive symptoms, including physical activity as well as aforementioned demographic variables. Next, a similar series of bivariate logistic regressions examined predictors of sedentary physical activity. Variables that were found to be significantly associated with depressive symptoms and/or physical activity at the bivariate level were retained for use in multivariate logistic regression models. Results were reported as odds ratios (OR) with a 95% confidence interval (CI).

Results

Demographic characteristics of the sample are reported in Table 1. The sample size varies slightly across variables due to missing data. The sample included 810 individuals age 60 and older, with an average age of 70.37 (95% CI: 69.75–71.00) years. Participants were approximately 55% female and largely Caucasian (86.34%). Approximately 4% of the sample met criteria for moderate depressive symptoms (≥10 on the PHQ-9) and 17% of the sample reported taking psychotropic medications. The average physical activity step count was 7759.12 (95% CI: 7324–8194) steps/day; 48.16% of the sample was classified as active/high active, 27.69% as low active, and 24.15% as sedentary.

Table 2 presents bivariate logistic regressions depicting associations of demographic and health variables with participants' risk of moderate depressive symptoms and risk of sedentary lifestyle adjusting for age. For the models predicting moderate depression, it was found that the continuous age variable was not linear in the logit, violating logistic regression assumptions. Rather, risk of moderate depressive symptoms declined somewhat from 60 to 72 years old and increased thereafter. Thus, a quadratic term was included in these models to adequately adjust for the effects of age. Adjusting for age, active/high active physical activity was significantly associated with decreased depressive symptoms. Participants who engaged in active/high active physical activity were over 80% less likely to have symptoms indicative of moderate depression (OR = 0.19; 95% CI: 0.06–0.61), as compared to sedentary individuals. Low activity was also associated with a decreased risk of depression, though at the trend level (OR = 0.38; 95% CI: 0.11–1.23; $p < 0.10$). Several other significant predictors emerged as well. Participants who had any chronic medical conditions were 7.6 times more likely to have moderate depressive symptoms (OR = 7.60; 95% CI: 1.98–29.16) than individuals without any chronic medical conditions and individuals with low annual household income (<$45,000) were about 3.5 times more likely to have moderate depressive symptoms (OR = 3.51; 95% CI: 1.01–12.13) than those with higher annual household income (≥$45,000). Also, taking psychotropic medications was associated with a 3-fold increase in the odds of having moderate depressive symptoms (OR = 3.19; 95% CI: 1.23–8.33).

With regard to bivariate models predicting risk of sedentary physical activity, older age (OR = 1.12: 95% CI: 1.09–1.15), being non-Hispanic black (OR = 2.64; 95% CI: 1.62–4.32), higher BMI (OR = 1.10, 95% CI: 1.05–1.15), smoker (OR = 2.80; 95% CI: 1.31–6.00), having any chronic medical condition (OR = 1.92; 95% CI: 1.11–3.30), low income (OR = 1.80; 95% CI: 1.14–2.84), and taking psychotropic medications (OR = 1.64; 95% CI: 1.20–2.24) were significantly associated with increased risk of sedentary. Male gender (OR = 0.63; 95% CI: 0.52–0.78), having a high school education (OR = 0.53; 95% CI: 0.34–0.84), and alcohol user (OR = 0.46; 95% CI: 0.33–0.66) were significantly associated with a decreased risk of sedentary.

In two multivariate logistic regression analyses, one predicting moderate depressive symptoms and the other predicting risk of sedentary lifestyle, we combined factors that were statistically significant at the bivariate level into a single model (see Table 3). In the model predicting depression, however, we did not include psychotropic medications, as these are likely to be a result of depression rather than a predictor.

In the final multivariate model predicting depression, the odds of having moderate depressive symptoms were still significantly reduced by over 70% (OR = 0.28; 95% CI: 0.09–0.91) in individuals who were active/highly active as compared to sedentary after adjusting for age, chronic conditions, and annual household income (all of which were also significantly or marginally predictive of moderate depression). In the model predicting sedentary activity, as in the binary models, age, BMI, non-Hispanic black race, smoker, and taking psychotropic medications were significantly associated with increased risk of sedentary, whilst Hispanic race, high school education, and alcohol use were associated with decreased risk of sedentary. Male gender and chronic conditions were associated with sedentary only at the trend level.

Table 1
Demographic and socioeconomic characteristics of the study population, National Health and Nutrition Examination Survey, 2005–2006.

Variable	% or mean (95% CI)	*N*
Gender		810
Female	54.85 (51.20–58.50)	
Male	45.15 (41.50–48.80)	
Age	70.37 (69.75–71.00)	810
Race		810
Non-Hispanic white	86.34 (81.71–90.97)	
Non-Hispanic black	06.45 (03.46–09.45)	
Hispanic	04.69 (02.71–06.67)	
Other	02.52 (01.10–03.93)	
Married or living w/a partner	65.63 (59.32–71.94)	810
High school educated	77.64 (73.11–82.18)	809
BMI		805
Underweight (<18.5)	01.90 (01.25–02.55)	
Normal weight (18.5–24.9)	30.71 (25.23–36.19)	
Overweight (25.0–29.9)	37.87 (33.29–42.46)	
Obese (≥30.0)	29.51 (25.27–33.76)	
BMI (continuous)	27.94 (27.41–28.46)	
Smoker (vs. non-smoker)	13.69 (09.57–17.81)	810
Alcohol user (vs. non-drinker)	55.11 (49.36–60.86)	810
Household income <$45,000	57.38 (49.66–65.10)	784
Taking psychotropics	17.34 (14.03–20.64)	810
Moderate depression	03.99 (02.17–05.82)	810
Walking steps (total)	7759 (7324–8194)	810
Physical activity		810
Sedentary (<5000 steps/day)	24.15 (20.18–28.13)	
Low activity (5000–7499 steps/day)	27.69 (24.24–31.14)	
Active/high active (≥7500 steps/day)	48.16 (44.14–52.18)	
Any chronic medical conditions	77.98 (75.42–80.55)	810

Ns vary slightly across variables due to missing data.

Table 2
Bivariate analysis for odds of moderate depression and sedentary PA.

Selected demographic factors	Moderate depression	Sedentary
	OR (95% CI)[a]	OR (95% CI)[b]
Physical activity		
Sedentary (ref.)	–	–
Low activity	0.38 (0.11–1.23)†	–
Active/high active	0.19 (0.06–0.61)**	–
Age	0.73 (0.52–1.03)†	1.12 (1.09–1.15)***
Age^2	1.01 (1.00–1.01)*	–
Male (vs. female)	0.79 (0.34–1.81)	0.63 (0.52–0.78)***
Race		
Non-Hispanic white (ref.)	–	–
Non-Hispanic black	1.47 (0.48–4.49)	2.64 (1.62–4.32)**
Hispanic	1.31 (0.56–3.08)	0.56 (0.25–1.22)
Other	1.48 (0.13–16.79)	0.86 (0.20–3.59)
Living alone (vs. married or living w/a partner)	1.34 (0.73–2.46)	1.75 (0.99–3.11)†
High school educated (vs. not)	0.36 (0.09–1.39)	0.53 (0.34–0.84)*
BMI	1.01 (0.94–1.09)	1.10 (1.05–1.15)***
Smoker (vs. non-smoker)	1.74 (0.50–6.04)	2.80 (1.31–6.00)*
Alcohol user (vs. non-drinker)	0.38 (0.12–1.23)	0.46 (0.33–0.66)***
Any chronic medical conditions	7.60 (1.98–29.16)**	1.92 (1.11–3.30)*
Taking psychotropics	3.19 (1.23–8.33)*	1.64 (1.20–2.24)**
Household income <$45,000	3.51 (1.01–12.13)*	1.80 (1.14–2.84)*

†$p < 0.10$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.
[a] Effects adjusted for linear and quadratic effects of age.
[b] Effects adjusted for linear effect of age.

Table 3
Multivariate analysis of risk of moderate depression and sedentary PA by selected demographic factors.

Selected demographic factors	Moderate depression	Sedentary
	OR (95% CI)	OR (95% CI)
Physical activity		
Sedentary (ref.)	–	–
Low activity	0.43 (0.13–1.38)	–
Active/high active	0.28 (0.09–0.91)*	–
Age	0.68 (0.49–0.95)*	1.15 (1.11–1.18)***
Age^2	1.01 (1.00–1.01)*	–
Male (vs. female)	–	0.74 (0.52–1.03)†
Any chronic medical conditions	6.94 (2.00–24.08)**	1.70 (0.94–3.05)†
Household income <$45,000	3.10 (0.84–11.50)†	1.23 (0.72–2.08)
Race		
Non-Hispanic white (ref.)	–	–
Non-Hispanic black	–	1.98 (1.02–3.85)*
Hispanic	–	0.41 (0.17–1.00)*
Other	–	0.75 (0.15–3.87)
High school educated	–	0.64 (0.42–0.99)*
Living alone (vs. married or living w/a partner)	–	1.21 (0.60–2.42)
BMI	–	1.09 (1.05–1.14)***
Smoker (vs. non-smoker)	–	3.71 (1.80–7.66)**
Alcohol user (vs. non-drinker)		0.62 (0.41–0.94)*
Taking psychotropics		1.54 (1.12–2.12)*

†$p < 0.10$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Discussion

The purpose of this study was to investigate physical activity, depressive symptoms, and demographic variables in community-dwelling older adults. Our study indicated that approximately 4% of this older adult sample reported moderate depressive symptoms, similar to rates reported by previous studies.[1,2] Interestingly, though, 17% of the population reported the use of psychotropic medications (see Table 1), which may suggest that respondents underreported depressive symptoms, perceive certain somatic symptoms (such as fatigue) as a consequence of chronic conditions or the aging process, or that respondents may have had other mental health issues.

The mean number of steps per day in this sample was 7759.12 and nearly half of the sample (48.16%) presented with active/high active physical activity levels, although the present study did not measure long-term adherence (i.e., more than a week) to physical activity. The entire 2005–2006 NHANES group of adults exhibited a higher number of steps per day (mean = 9676; SD = 107)[23] than this older adult sample, displaying the decrease in physical activity with increasing age.

The finding of a significant relationship between physical activity and depressive symptoms, even when controlling for other factors, suggests that engaging in physical activity acts as a protective factor in depression in line with existing research.[11,39]

Age and chronic medical conditions were also significantly predictive of depressive symptoms in both bivariate and multivariate analyses, consistent with prior studies.[40,41] Some studies have indicated that the prevalence of depression declines from midlife to older adulthood.[27] This was partially supported in the current study, as the quadratic age trend indicated that the odds of moderate depressive symptoms declined somewhat from age 60 to 72 and only increased thereafter. Low income was also found to be related to increased depressive symptoms, although only in the bivariate analyses. Low income may act as a stressful event in later life or may affect older adults' accessibility to treatment or resources.[27]

With regard to other demographic factors, prior studies have found that depression is more prevalent in women than men, but this gap is not always displayed in older adults.[26,27] In the current study, although rates of moderate depressive symptoms were slightly lower in men, they were not significantly lower than rates in women. Second, findings regarding racial differences in the prevalence of depression have been inconsistent. In the current study, we did not find significant associations between race and depression, consistent with some previous work,[42] although other studies have found that community-dwelling older adult whites[29] and African Americans highly reported depressive symptoms.[28,30] Living alone, education, and BMI were not associated with depression in bivariate analysis in contrast to prior studies.[11,34] Smoking and alcohol use were also not associated with depression in older adults in a bivariate analysis unlike other studies.[24,25] This may be due to the small number of subjects out of the 4% with moderate depression who reported alcohol use or smoking.

Moving to findings regarding sedentary behavior, older age, race, education, BMI, smoking, alcohol use, and taking psychotropic medications exhibited significant associations with sedentary in both bivariate and multivariate models. These findings are consistent with recent studies which found associations between sedentary behavior and increased age,[35] being African American,[31] low level of education,[34] increased BMI,[34,43] and smoking.[34] The Hispanic group was less sedentary compared to non-Hispanic whites.[32] Interestingly, alcohol users appeared to be more active compared to non-alcohol users as observed in a prior study.[44] It is worth noting that the vast majority of alcohol users in the sample reported drinking 1 or fewer alcoholic beverages per day. These results may not apply to heavier drinkers, of which there were too few in the sample to analyze separately. Thus, further investigation of how alcohol consumption affects physical activity is needed. We found a significant relationship between taking psychotropic medications and sedentary behavior, as expected. Subjects may limit their activity level due to side effects of such medications, and this may be compounded by the direct effects of the mental illness itself on physical activity.

Such findings lend support to several strategies to improve physical activity in the older adults. As mentioned, older adults often have chronic conditions and thus need to see their health care providers often. These providers are well-positioned to encourage older adults to engage in and maintain physical activity and can provide a personalized physical activity plan based on the individuals' health conditions.

Emerging evidence indicates that exercise administered via a prescription (e.g., written advice regarding exercise types, intensity, duration, frequency, and progression)[38,39] as a medical treatment,[45,46] in addition to verbal advice, would more likely promote physical activity in the general population.[47] Although many health care providers do not frequently provide advice regarding physical activity due to several reasons, such as limited reimbursement for such counseling,[48,49] it is noteworthy that health care providers can exert significant influence on physical activity in older adults.

Physical activity should be encouraged for older adults in easily implemented and affordable ways considering age and physical and monetary resources. Regarding walking, instead of a goal of 10,000 steps/day as is recommended for healthy adults, different goals such as a range of 7000–10,000 steps/day for healthy older adults and a range of 6500–8500 steps/day for individuals with chronic illness or disability could be recommended.[50] Pedometers can also be used to motivate walking.[22,23] Group walking can be considered because participants can minimize safety concerns (e.g., falling) with peer support.[51]

There are some caveats in interpreting the results. First, individuals who are already more highly active are more inclined to wear the accelerometer for more days than those who are less active, and thus some more sedentary individuals may have been screened out due to incomplete physical activity data. Therefore,

the percentage of active/highly active individuals (48.16%) may be exaggerated. Individuals with depression may be underrepresented in the study because their mood may be associated with poor participation in the NHANES survey or wearing the accelerometer. Second, the data include only community-dwelling populations and conformed to a cross-sectional design, so generalizability of the results is limited. We included limited factors to explain depression because the number of individuals exhibiting depression was too low to support many predictors in the models. The observed relationships among physical activity, depression, and selected demographic variables need to be further analyzed longitudinally and in larger samples.

In conclusion, depressive symptoms are common in older adults, and health care providers should receive education regarding demographic characteristics and comorbidities that often occur with depressive symptoms in order to be better equipped to identify depressive symptoms in older adult patients. Physical activity is a demonstrated protective factor for many physical conditions, and the current study contributes to a growing body of evidence linking physical activity to mental health outcomes as well.

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