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Lower Odds of Poststroke Symptoms of Depression When Physical Activity Guidelines Met: National Health and Nutrition Examination Survey 2011–2012

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Abstract

Background—One-third of individuals with stroke report symptoms of depression, which has a negative impact on recovery. Physical activity (PA) is a potentially effective therapy. Our objective was to examine the associations of subjectively assessed PA levels and symptoms of depression in a nationally representative stroke sample.

Methods—We conducted a cross-sectional study of 175 adults in the National Health and Nutrition Examination Survey 2011–2012 cycle. Moderate, vigorous, and combination equivalent PA metabolic equivalent (MET)-minutes per week averages were derived from the Global Physical Activity Questionnaire, and .the 2008 Physical Activity Guidelines/American College of Sports Medicine recommendations of ≥500 MET-minutes per week of moderate, vigorous, or combination equivalent PA were used as cut points. Depression symptoms were measured using the Patient Health Questionnaire-9.

Results—Meeting moderate PA guidelines resulted in 74% lower odds of having depression symptoms ($P < .0001$) and 89% lower odds of major symptoms of depression ($P = .0003$). Meeting vigorous guidelines showed a 91% lower odds of having mild symptoms of depression ($P = .04$). Participating in some moderate, vigorous, or combination equivalent PA revealed the odds of depression symptoms 13 times greater compared with meeting guidelines ($P = .005$); odds of mild symptoms of depression were 9 times greater ($P = .01$); and odds of major symptoms of depression were 15 times greater ($P = .006$).

Conclusions—There is a lower risk of developing mild symptoms of depression when vigorous guidelines for PA are met and developing major symptoms of depression when moderate guidelines met. Participating in some PA is not enough to reduce the risk of depression symptoms.

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Keywords

Patient Health Questionnaire-9; Global Physical Activity Questionnaire; MET-minute/week

There has been a steady decline in stroke incidence and mortality over the last few decades due to better medical treatments; still, every year approximately 800,000 people experience a stroke, with 610,000 of these occurrences being first attacks.[1–3] Two-thirds of individuals who have experienced a stroke remain with some amount of permanent disability that requires rehabilitation, placing stroke as the leading cause of serious long-term disability.[1,4–6] Physical difficulties are the primary concern and focus for treatments but it is common for this population to experience neuropsychiatric complications (ie, emotion, behavioral, and cognitive disorders).[7] These complications have been shown to have a negative effect on motor functioning, social functioning, and overall quality of life.[7–10] Of the many psychiatric complications, depression is one of the most frequently reported.[11]

Of all individuals with stroke, approximately one-third of patients are depressed, with 35% of outpatient populations experiencing minor depression and 23% experiencing major depression.[1,11,12] Patients who are depressed 3 months after stroke are more likely to be in inpatient care or rehabilitation longer than nondepressed patients.[9] This increase in time spent in rehabilitation can be due to patients emotionally withdrawing from rehabilitation and a lack of motivation to regain function.[13–16] Pharmacological therapy, psychotherapy, and antidepressants are commonly used for treatment of depression in stroke; however, results show no clear effects, and there is an increased risk of experiencing adverse events with antidepressant medications.[17–19] Because current treatments are inconclusive and depression prevalence is so high, additional treatments are needed.

There is strong evidence that exercise reduces the risk of developing depressive symptoms and reduces the symptoms of depression, as well as has a large positive effect when baseline depression is severe in nonstroke individuls.[20–22] A recent meta-analysis in poststroke subjects found that exercise may lead to less depressive symptoms immediately after programs and showed positive effects across subacute and chronic stages of recovery. In addition, a larger effect was seen with “higher exercise intensities,” defined as sessions administered at least 3 times per week, a minimum of 4 weeks, and graded training.[23] Although promising, the positive effects of exercise on depression in individuals with stroke are still unconvincing since these studies were not powered with depression as the primary outcome, did not include antidepressants as a confounding factor, and included exercise prescriptions that were broad and inconsistent (eg, physical therapy, occupational therapy, aerobic exercise, resistance training, or a combination).

The benefit of exercise training on reducing depressive symptoms in individuals with stroke is encouraging. However, the feasibility of delivering training to large groups of subjects is low, both from the logistical and cost-based perspective. As a surrogate to exercise training interventions, differing intensities and amount of physical activity (PA) may provide insight into the possible antidepressant effects of exercise in a large cohort of poststroke individuals. For this reason, this study focused on PA, which is an umbrella term used to describe any bodily movement produced by skeletal muscles that results in energy expenditure, as

exercise is a subset of PA that is planned, structured, and repetitive with a final or intermediate objective to improve or maintain physical fitness.[24] To date, no population-based studies have examined associations between depressive symptoms and PA following a stroke.

The primary objective of this study was to use the 2011–2012 National Health and Nutrition Examination Survey (NHANES) to examine the associations between individuals who reported having had a stroke with symptoms of depression and subjectively reported amounts of PA in individuals who reported meeting national PA guidelines. The secondary objectives were to explore the severity of depression symptoms with subjectively reported amount of PA who met national PA guidelines, as well as the severity of depression symptoms and participation in PA but not meeting guidelines.

Methods

Study Sample

The 2011–2012 NHANES cycle included a nationally representative sample of a noninstitutionalized US civilian population. Data collection consisted of a household interview and an examination conducted in a mobile examination center (MEC) by trained individuals. Written informed consent was obtained from each participant for both in-home interviews and examinations in the MEC. Since this data comes from a public database and has been de-identified, the Institutional Review Board of the Medical University of South Carolina deemed this study as nonhuman research. There were 9756 participants sampled in this cycle, with 229 adult participants (≥20 years of age) reporting they had been told they had a stroke. Of these 229 participants, 54 were excluded from analysis because they did not complete the Global Physical Activity Questionnaire (GPAQ) and Patient Health Questionnaire-9 (PHQ-9). There were 175 participants included in analysis who represent 5,410,265 individuals in the US population (732,739 individuals meeting mild symptoms of depression criteria and 1,029,927 individuals meeting major symptoms of depression criteria, equaling a general depression group of 1,762,666 individuals) after accounting for the complex sample survey design used in NHANES.

Depression

Depression levels were assessed using the PHQ-9, which has good reliability, validity, and clinical utility and is commonly used in clinical settings to screen for diagnose, monitor, and measure the severity of depression in individuals with stroke.[25–27] However, the use of the instrument in this study was to score and set criteria for the severity of depression symptoms and was not used as a diagnosis tool. This questionnaire is a 9-item screening instrument that includes questions about the frequency of depression symptoms over the past 2 weeks. Response categories for the instrument were “not at all,” “several days,” “more than half the days,” and “nearly every day,” with each question scored 0 to 3. A total score was based on the sum of the points for each question and ranged from 0 to 27. A cut point for inclusion into depression group was a score of ≥5, which indicates having mild symptoms of depression or greater. Of the 70 individuals meeting symptoms of depression criteria, 31

individuals met mild symptoms of depression criteria of having a score between 5 to 9, and 39 individuals met major symptoms of depression criteria of having a score ≥10.

PA Level Determination

The GPAQ was used to determine the moderate, vigorous, and combination equivalent PA levels of participants. The GPAQ included questions related to daily, leisure time, and sedentary activities. Moderate activity included work activities, walking or bicycling, and recreational activities. Moderate work activity was described as activities that cause small increases in breathing or heart rate, such as a brisk walking or carrying light loads. Walking or bicycling was used for how the individual usually goes to and from places, for example, to work, shopping, or school. Moderate recreational activities includes sports, fitness, or activities that cause a small increase in breathing or heart rate, such as brisk walking, bicycling, or swimming. Vigorous work activity was described as PA causing large increases in breathing or heart rate at work. Vigorous recreational activities include sports, fitness, or recreational activities that cause large increases in breathing or heart rate, like running or basketball. All activities must have been done for at least 10 minutes continuously.

Moderate PA levels were calculated by multiplying the number of days per week by minutes of activity per day for 3 activity categories: work, walking/bicycling, and recreational activities. The 3 categories were added to get an estimated total of PA minutes per week. PA minutes per week were then multiplied by 4 metabolic equivalents (METs) (criteria for moderate level of work and recommended MET value for this dataset by NHANES) to get an average of MET-minutes per week. Vigorous PA levels were calculated by multiplying the number of days per week by minutes of activity per day for 2 activity categories: work and recreational activities. The 2 categories were added to get an estimated total of PA minutes per week. PA minutes per week were then multiplied by 8 METs (criteria for vigorous level of work and recommended MET value for this dataset by NHANES) to get an average of MET-minutes per week.[28]

The 2008 Physical Activity Guidelines and American College of Sports Medicine (ACSM) Recommendations were used to determine cut points to define meeting PA levels or not.[24,29] The cut points for meeting moderate PA (MPA) guidelines was ≥500 MET-minutes per week or the equivalent to ≥150 minutes per week, and vigorous PA (VPA) was ≥500 MET-minutes per week or the equivalent to ≥75 minutes per week. If total moderate, vigorous, and/or combination equivalent PA MET-minutes per week ranged from 1 to 499 they were considered low levels of PA (LMVPA). The LMVPA group did not included individuals who did not engage in any PA.

Potential Confounders

Demographic characteristics (age, gender, ethnicity, education, and marital status), comorbidities (arthritis, cancer, coronary heart disease, diabetes, and emphysema), antidepressant use, and physical functioning difficulties (house chores, leisure at home activities, and work; Table 1) are reported as frequency counts, except age was reported as mean ± standard error of the mean (SEM). These measures were conducted in the subject's home by trained interviewers using the Computer-Assisted Personal Interviewing (CAPI)

system. Smoking was assessed using serum cotinine levels, with ≥3.08 ng/mL being the cutoff for a smoker,[30] A body mass index (BMI) of <25 kg/m^2 was considered normal, and ≥25 kg/m^2 considered overweight/obese. Blood draws and subjects weights were measured in the MEC.

Statistical Analysis

SAS version 9.4 (SAS Institute, Inc, Cary, NC) was used for analysis. Data were weighted to the US population using complex survey sampling analysis methods. Binary logistic regression analyses were used to examine the associations of MPA, VPA, and LMVPA with depression and major depression. MPA, VPA, and LMVPA were all ran in separate models, which totaled 3 depression models, 3 mild depression models, and 3 major depression models. For each of the 9 models, MPA, VPA, and LMVPA were not entered into the same models because they were not mutually exclusive and, therefore, cannot be included as independent variables in the model. To determine which covariates remained in the final model, the smallest Akaike Information Criterion (AIC) method was used. All possible covariates were placed in the model, and if variables were nonsignificant they were removed. If *P* values were borderline (>.05–.07) the covariates were removed, and if the AIC increased the covariates were placed back into the model.

The analyses were run first without imputation of missing values and then by imputing values for missing data by giving subjects the more conservative values for personal characteristics (eg, considered smokers, overweight/obese, etc). There were little differences in the odds ratios, therefore the imputation method was used in analysis. Within the 9 models, the models that were missing the most observations were MPA and VPA in the major depression group, which was missing 19% of the 175 samples, however, a majority of the missing variables were in the nondepression group, with 83 out of 105 remaining in the nondepression group and 59 out of the 70 remaining in the depressed group. In addition, being that it was weighted to the population there were still >4.7 million people represented in this models analysis. The model missing the next highest number of observations was 14% in the MPA and VPA major depression group, with the rest of the models only missing only around 1% of observations. Therefore, the presented models using the imputation method described are statistically sound.

For the continuous variables (age, years poststroke, BMI), a 2-tailed paired sample *t* test was used to test for differences between depression and comparison groups. For discrete variables (gender, ethnicity, education, marital status, smoking, weight, comorbidities, physical functioning difficulties, and PA levels), the Wilcoxon rank sum test was used to compare individuals with depression to the comparison group. Results were reported as odds ratios (ORs) with 95% confidence intervals (CIs) and *P* values. Statistical significance was set at $P < .05$.

Results

Participant Characteristics

In the nationally represented population, 40% met criteria for mild symptoms of depression or greater; 16% met mild symptoms of depression criteria, and 24% reported meeting major symptoms of depression or greater criteria. The significant differences in the depressed group compared with individuals not meeting criteria of mild symptoms of depression or greater group for participant characteristics were education, comorbidities (emphysema, diabetes, and arthritis), and all physical functioning tasks, as well as MPA and LMVPA. The mild symptoms of depression group compared with the no symptoms of depression group showed a significant difference in diabetes. The major symptoms of depression group compared with the no major symptoms of depression group showed significant differences in marital status, BMI, antidepressants, comorbidities (emphysema and arthritis), and all physical functioning tasks, as well as MPA (see Table 1 and Online Supplementary Tables 3, 4, and 5).

Associations With MPA and VPA

Meeting MPA was associated with reduced odds of depression symptoms ($P < .0001$) and major symptoms of depression ($P = .0003$). Significance still remained when all the covariates were removed from the model. Meeting MPA was not significantly associated with reduced odds of mild symptoms of depression Participants who reported engaging in at least 500 MET-minutes of MPA per week were associated with a reduced odds of 74% in depression symptoms and 89% reduced odds of major symptoms of depression compared with individuals with stroke who did not meet MPA guidelines. In the unadjusted model, meeting MPA guidelines was associated with reduced odds of 61 % in depression symptoms ($P = .04$) and 78% in major symptoms of depression ($P = .01$). Meeting VPA guidelines was associated with a 91% reduced odds of mild symptoms of depression ($P = .04$). This significance did not remain in the unadjusted model ($P = .07$) (Table 2.) Nonimputed values are reported in Online Supplementary Table 6.

Associations With LMVPA

Engaging in LMVPA, but not meeting guidelines, was associated with increased odds of depression symptoms nearly 13 times greater compared with meeting guidelines ($P = .003$) (see Online Supplementary Table 3). In the unadjusted model, depression symptoms were associated with increased odds 6 times greater when compared with meeting guidelines ($P = .04$). LMVPA was associated with increased odds of mild symptoms of depression 9 times greater ($P = .01$), however this did not remain significant in the unadjusted model ($P = .15$). Increased odds of major symptoms of depression were 15 times greater ($P = .006$) when compared with meeting guidelines, however, this did not remain significant in the unadjusted model ($P = .08$).

Discussion

To our knowledge, this is the first study to examine the associations of subjectively assessed PA levels with symptoms of depression, along with exploring associations of PA levels and

different severities of depression symptoms in a nationally representative stroke population. It extends on previous research of depression in the general population of adults and older adults, as well as other neurological conditions, by examining not only symptoms of depression but also more specifically mild and major symptoms of depression separately in a large sample of individuals who have had a stroke.[31–33]

The results of this cross-sectional study indicate that meeting the 2008 Physical Activity Guidelines/ACSM Physical Activity Recommendations greatly reduced the odds of having major symptoms of depression in individuals with stroke. Specifically, meeting moderate PA guidelines was strongly associated with reduced odds of major symptoms of depression when compared with not meeting guidelines. However, meeting vigorous guidelines was significantly associated with a reduced risk of mild symptoms of depression. Similar results were shown in a review by Adamson et al,[33] with their findings suggesting that exercise may improve depressive symptoms in adults with neurological disorders, especially when PA guidelines have been met. In this review there were only 2 stroke studies included in analysis, with 1 study using a treadmill aerobic-exercise training program and the other using a strength-training program.[34,35] Even though these 2 studies are more exercise-focused and our study is PA-based, making it difficult to make direct comparisons, the important conclusion is that meeting guidelines showed significant benefits in reducing depressive symptoms and amount may be more important than modality of PA/exercise.

Interestingly, subjects that did not report engaging in at least 500 MET-minutes per week of moderate, vigorous, or combination equivalent PA was associated with increased odds of major symptoms of depression when compared with individuals who did met guidelines. Similar results were seen by Boschloo et al,[36] who found low levels of PA, defined as not meeting 600 MET-minutes per week of moderate and vigorous PA, resulted in low PA being a strong independent risk factor for depression and/or anxiety disorders. These results further confirm the theory that the amount of time spent engaging in moderate and/or vigorous PA is important and beneficial in reducing the risk and possibly preventing depression and major depression.

Hornnes et al[37] found that over the course of the first year after a stroke, the frequency of patients that are physically inactive increases by 25%. This reduction in PA increases the risk of having another stroke, which may contribute to 30% of recurrent strokes each year.[1] It has been established that physical inactivity is an actual cause of chronic disease that leads to an increased odds of morbidity and mortality; so PA and exercise are treatments to prevent and reduce the occurrence and reoccurrence of most chronic diseases.[38,39] Reduced PA levels after stroke can lead to disuse atrophy of muscles, cardiovascular deconditioning, social isolation, and associated physiological factors causing individuals who have experienced a stroke to be at a greater risk for secondary cardiac complications and recurrent stroke.[40,41] Getting stroke patients to become more physically active and meet guidelines can reduce the numerous complications frequently occurring after stroke within the cardiovascular, muscular, and neurological systems and may be extremely beneficial in reducing these secondary complications and recurrent strokes.

The results of this study, in combination with the results of the previous articles discussed, indicate that it may be a combination of frequency, intensity, and time spent engaging in PA that has the biggest impact on reducing depression in individuals after stroke and current recommendations for this population are too low. Future directions should focus on finding an optimal dose of PA and exercise by manipulating frequency, intensity, and time so that the dose is feasible, efficient, and specific to this population. Studies should be conducted with more objective assessments to reduce variability in results and increase validity and reliability. In addition, studies need to be conducted to find the barriers and facilitators to PA so that recommendations can meet the needs of this population and hopefully increase compliance and consistent participation. All of these considerations together can help clinicians or exercise physiologists to properly prescribe exercise and individualize training to optimize recovery. There needs to be an understanding within this field of study that there is no one-size-fits-all dose that targets all problems justifying the need for further patient centered outcomes research.

Limitations

This study has several strengths, including a sample weighted to the US population representing >5 million individuals, as well as ample data of subject demographic, behavioral, medication, comorbidity and physical functioning characteristics for analysis. There are also limitations to this study, with the most prominent being the use of a cross-sectional design. However, to conduct this study at this sample size would be difficult but this study gives validation and justification for future research. Because a questionnaire to determine average PA MET-minutes per week was used, there may have been some underestimation or overestimalions reported by individuals, therefore, it was decided not to use continuous variables for PA levels. We believe that we controlled for this variability to the best of our ability by dichotomizing the PA MET-minutes per week by meeting guidelines or not. This greatly reduced the variability within the results and reduced the individual's overestimate of their participation. In addition, we decided not to include a group of “no PA” because of the small sample size and because it was not a focus for our study question. The use of the PHQ-9 to assess depressive symptoms instead of having clinically confirmed diagnoses of depression may influence the outcomes. Additional clinical information that would further benefit this study would be the level of stroke severity and better outcomes for clinical functional ability. However, reliable and easily translatable information was not reported in the NHANES questionnaires specifically relating to stroke. To help give an idea of physical functioning levels we included questions about difficulties in completing chores at home, leisure activities at home, and work. These results would be strengthened and validated by conducting a randomized control trial.

Conclusions

These finding suggest that meeting the 2008 Physical Activity Guidelines/ACSM Recommendations for moderate activity level is associated with reduced likelihood of major symptoms of depression, and vigorous levels of activity are associated with a reduced likelihood of mild symptoms of depression among adults in the United States who have reported having had a stroke. In addition, there is evidence from these results that the

amount of PA plays an important role in lowering the odds of depression symptoms, and it may not be enough to just engage in any amount of PA. Participating in PA may be an important therapeutic target since additional and substantial benefits may exist in reducing secondary complications, recurrent stroke, and functional limitations experienced after stroke. In addition, due to these findings there is merit to continue further research of this topic with the focus of finding a proper "dose" for depression, as it may not be the same as other complications post-stroke. Current PA recommendations for individuals with stroke may need to be reevaluated because they are below the 2008 Physical Activity Guidelines/ ACSM Recommendations and may not be enough to reduce depression.

References

1. Go AS, Mozaffarian D, Roger VL, et al. Heart disease and stroke statistics—2014 update: a report from the American Heart Association. Circulation. 2014; 129(3):e28–e292. [PubMed: 24352519]
2. Koton S, Schneider AL, Rosamond WD, et al. Stroke incidence and mortality trends in US communities, 1987 to 2011. JAMA. 2014; 312(3):259–268. [PubMed: 25027141]
3. Poisson SN, Glidden D, Johnston SC, Fullerton HJ. Deaths from stroke in US young adults, 1989-2009. Neurology. 2014; 83:2110–2115. [PubMed: 25361783]
4. Bronstein KS. Psychosocial components in stroke. Implications for adaptation. Nurs Clin North Am. 1991; 26(4):1007–1017. [PubMed: 1945933]
5. Algurén B, Fridlund B, Cieza A, Sunnerhagen KS, Christensson L. Factors associated with health-related quality of life after stroke: a 1-year prospective cohort study. Neurorehabil Neural Repair. 2012; 26(3):266–274. [PubMed: 21825005]
6. Palmcrantz S, Widen Holmqvist L, Sommerfeld DK. Young individuals with stroke: across sectional study of long-term disability associated with self-rated global health. BMC Neurol. 2014; 14:20. [PubMed: 24472373]
7. Koivunen RJ, Harno H, Tatlisumak T, Putaala J. Depression, anxiety, and cognitive functioning after intracerebral hemorrhage. Acta Neurol Scand. 2015; 132(3):179–184. [PubMed: 25639837]
8. King RB. Quality of life after stroke. Stroke. 1996; 27(9):1467–1472. [PubMed: 8784114]
9. Kotila M, Numminen H, Waltimo O, Kaste M. Post-stroke depression and functional recovery in a population-based stroke register. The Finnstroke study. Eur J Neurol. 1999; 6(3):309–312. [PubMed: 10210911]
10. Mayo NE, Wood-Dauphinee S, Cote R, Durcan L, Carlton J. Activity, participation, and quality of life 6 months poststroke. Arch Phys Med Rehabil. 2002; 83(8):1035–1042. [PubMed: 12161823]
11. Chemerinski E, Robinson RG. The neuropsychiatry of stroke. Psychosomatics. 2000; 41(1):5–14. [PubMed: 10665263]
12. Hackett ML, Yapa C, Parag V, Anderson CS. Frequency of depression after stroke: a systematic review of observational studies. Stroke. 2005; 36(6):1330–1340. [PubMed: 15879342]
13. Brown C, Hasson H, Thyselius V, Almborg AH. Post-stroke depression and functional independence: a conundrum. Acta Neurol Scand. 2012; 126(1):45–51. [PubMed: 21992112]
14. Dam H, Pedersen HE, Ahlgren P. Depression among patients with stroke. Acta Psychiatr Scand. 1989; 80(2):118–124. [PubMed: 2801159]
15. Kijowski S. Difficulties in post-stroke gait improvement caused by post-stroke depression. Chin Med J (Engl). 2014; 127(11):2085–2090. [PubMed: 24890157]
16. Gainotti G, Antonucci G, Marra C, Paolucci S. Relation between depression after stroke, antidepressant therapy, and functional recovery. J Neurol Neurosurg Psychiatry. 2001; 71(2):258–261. [PubMed: 11459907]
17. Hackett ML, Anderson CS, House A, Halteh C. Interventions for preventing depression after stroke. Cochrane Database Syst Rev. 2008; 3:CD003689.
18. Hackett ML, Anderson CS, House A, Xia J. Interventions for treating depression after stroke. Cochrane Database Syst Rev. 2008; 4:CD003437.

19. Starkstein SE, Mizrahi R, Power BD. Antidepressant therapy in post-stroke depression. Expert Opin Pharmacother. 2008; 9(8):1291–1298. [PubMed: 18473704]
20. Cooney GM, Dwan K, Greig CA, et al. Exercise for depression. Cochrane Database Syst Rev. 2013; 9:CD004366.
21. Mammen G, Faulkner G. Physical activity and the prevention of depression: a systematic review of prospective studies. Am J Prev Med. 2013; 45(5):649–657. [PubMed: 24139780]
22. Teychenne M, Ball K, Salmon J. Physical activity and likelihood of depression in adults: a review. Prev Med. 2008; 46(5):397–411. [PubMed: 18289655]
23. Eng JJ, Reime B. Exercise for depressive symptoms in stroke patients: a systematic review and meta-analysis. Clin Rehabil. 2014; 28(8):731–739. [PubMed: 24535729]
24. Garber CE, Blissmer B, Deschenes MR, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc. 2011; 43(7):1334–1359. [PubMed: 21694556]
25. de Man-van Ginkel JM, Gooskens F, Schepers VP, Schuurmans MJ, Lindeman E, Hafsteinsdottir TB. Screening for poststroke depression using the patient health questionnaire. Nun Res. 2012; 61(5):333–341.
26. Burton LJ, Tyson S. Screening for mood disorders after stroke: a systematic review of psychometric properties and clinical utility. Psychol Med. 2015; 45(1):29–49. [PubMed: 25066635]
27. Kroenke K, Spitzer RL. The PHQ-9: a new depression diagnostic and severity measure. Psychiatr Ann. 2002; 32(9):509–515.
28. Prevention SaP-B. Global Physical Activity Questionnaire (GPAQ). World Health Organization; http://www.who.int/chp/steps/resources/GPAQ_Analysis_Guide.pdf [Accessed June 10, 2015]
29. US Department of Health and Human Services. Physical Activity Guidelines Advisory Committee Report, 2008. Washington, DC: US Department of Health and Human Services; 2008.
30. Benowitz NL, Bernert JT, Caraballo RS, Holiday DB, Wang J. Optimal serum cotinine levels for distinguishing cigarette smokers and nonsmokers within different racial/ethnic groups in the United States between 1999 and 2004. Am J Epidemiol. 2009; 169(2):236–248. [PubMed: 19019851]
31. Strawbridge WJ, Deleger S, Roberts RE, Kaplan GA. Physical activity reduces the risk of subsequent depression for older adults. Am J Epidemiol. 2002; 156(4):328–334. [PubMed: 12181102]
32. Vallance JK, Winkler EA, Gardiner PA, Healy GN, Lynch BM, Owen N. Associations of objectively-assessed physical activity and sedentary time with depression: NHANES (2005-2006). Prev Med. 2011; 53(4-5):284–288. [PubMed: 21820466]
33. Adamson BC, Ensari I, Motl RW. Effect of exercise on depressive symptoms in adults with neurologic disorders: a systematic review and meta-analysis. Arch Phys Med Rehabil. 2015; 96(7): 1329–1338. [PubMed: 25596001]
34. Sims J, Galea M, Taylor N, et al. Regenerate: assessing the feasibility of a strength-training program to enhance the physical and mental health of chronic post stroke patients with depression. Int J Geriatr Psychiatry. 2009; 24(1):76–83. [PubMed: 18613281]
35. Smith PS, Thompson M. Treadmill training post stroke: are there any secondary benefits? A pilot study. Clin Rehabil. 2008; 22(10-11):997–1002. [PubMed: 18955431]
36. Boschloo L, Reeuwijk KG, Schoevers RA, P BWJH. The impact of lifestyle factors on the 2-year course of depressive and/or anxiety disorders. J Affect Disord. 2014; 159:73–79. [PubMed: 24679393]
37. Hornnes N, Larsen K, Boysen G. Little change of modifiable risk factors 1 year after stroke: a pilot study. Int J Stroke. 2010; 5(3):157–162. [PubMed: 20536611]
38. Blair SN, Powell KE, Bazzarre TL, et al. Physical inactivity. Workshop V. AHA Prevention Conference III. Behavior change and compliance: keys to improving cardiovascular health. Circulation. 1993; 88(3):1402–1405. [PubMed: 8353908]
39. Ekelund U, Ward HA, Norat T, et al. Physical activity and all-cause mortality across levels of overall and abdominal adiposity in European men and women: the European Prospective

Investigation into Cancer and Nutrition Study (EPIC). Am J Clin Nutr. 2015; 101(3):613–621. [PubMed: 25733647]

40. Rand D, Eng JJ, Tang PF, Jeng JS, Hung C. How active are people with stroke? Use of accelerometers to assess physical activity. Stroke. 2009; 40(1):163–168. [PubMed: 18948606]
41. Billinger SA, Arena R, Bernhardt J, et al. Physical activity and exercise recommendations for stroke survivors: a statement for healthcare professionals from the American Heart Association/ American Stroke Association. Stroke. 2014; 45(8):2532–2553. [PubMed: 24846875]

Table 1

Demographic, Behavioral, Comorbidity, Physical Functioning, and Physical Activity Characteristics of Participants

	Overall (N = 175)	Depression[a] (n = 70)	Mild depression[b] (n = 31)	Major depression[c] (n = 39)
Age	64 (1.3)	61.3 (1.3)	63.3 (2.6)	59.9 (2.4)
Years poststroke	10.9 (1.4)	11.5 (1.4)	10.8 (1.8)	12.0 (2.0)
Gender				
Male	84 (44.1)	29 (35.7)	13 (42.0)	16 (31.2)
Ethnicity				
Non-Hispanic white	74 (62.9)	34 (63.4)	13 (58.2)	21 (67.1)
Non-Hispanic black	59 (16.3)	20 (19.2)	11 (25.4)	9 (14.8)
Mexican American	14 (6.1)	5 (6.8)	2 (5.3)	3 (7.8)
Other	28 (14.7)	11 (10.6)	5 (11.1)	6 (10.3)
Education				
≤ High school graduate	114 (60.1)	52 (69.8)	23 (62.6)	29 (74.9)
Some college	44 (25.1)	16 (27.6)	7 (36.0)	9 (21.6)
College graduate	17 (14.9)	2 (2.6)	1 (1.4)	1 (3.5)
Marital status				
Married	69 (46.7)	21 (32.9)	11 (37.6)	10 (29.5)
Divorced	34 (14.7)	17 (22.3)	5 (13.6)	12 (28.5)
Other	72 (38.6)	32 (44.8)	15 (48.8)	17 (42.0)
Smoke[d] (ng/mL)	55 (33.1)	35 (50.9)	15 (50.8)	20 (50.9)
Body mass index (kg/m^2)	29.1 (1.0)	30.3 (0.9)	28.3 (1.1)	31.8 (1.1)
Overweight/obese	117 (69.9)	55 (77.9)	24 (72.3)	31 (81.8)
Antidepressant	32 (20.0)	15 (22.9)	4 (7.3)	11 (33.9)
Medical conditions				
Arthritis	90 (47.8)	47 (68.1)	18 (56.9)	29 (76.0)
Cancer	36 (15.4)	18 (24.4)	8 (23.7)	10 (24.9)
Coronary Heart Disease	25 (16.5)	13 (18.6)	7 (27.2)	6 (12.4)
Diabetes	49 (25.1)	29 (41.9)	16 (52.6)	13 (34.2)
Emphysema	13 (7.4)	9 (19.1)	2 (12.5)	7 (23.8)
Physical functioning difficulties				
House chores	88 (49.0)	48 (71.4)	21 (62.8)	27 (77.6)
Leisure at home activities	29 (15.0)	20 (29.6)	9 (25.8)	11 (32.3)
Work	108 (59.4)	57 (80.5)	24 (70.7)	33 (87.6)
Physical activities[e]				
MPA	60 (39.2)	20 (25.0)	13 (38.9)	7 (15.1)
VPA	14 (12.2)	6 (6.0)	1 (1.6)	5 (9.1)
LMVPA	22 (8.8)	12 (17.1)	4 (15.2)	8 (18.4)

Note. Table presents mean (SEM) for continuous measures and n (%) for categorical measures, n is a frequency count out of 175 overall participants. Means, SEM, %, and *P* values are weighted to the US population representative of 5,410,265 individuals overall; 1,762,666 individuals in group with depression symptoms, 732,739 individuals meeting mild depression symptoms, and 1,029,927 individuals meeting major depression symptoms. *P* values were derived from statistical tests of

[a] depression symptoms (n = 70) to no depression symptoms (n = 105),

[b] mild depression symptoms (n = 31) to no depression symptoms (n = 105), and

[c] major depression symptoms (n = 39) to less than major depression symptoms (n = 136).

[d] Based on cotinine level (≥3.08 ng/mL considered smoker)[30]

[e] n (%) of participants that met physical activity guidelines of ≥500 MET-minutes per week (MPA, VPA) or participated in some moderate and/or vigorous physical activity (LMVPA) of 1 –499 MET-minutes per week but did not meet guidelines.

Abbreviations: CHD, XXX; LMVPA, low moderate and/or vigorous physical activity; MET, metabolic equivalent; MPA, moderate physical activity; SEM. standard error of the mean; VPA, vigorous physical activity.

Table 2

Adjusted and Unadjusted Odds of Depression, Mild Depression, and Major Depression Symptoms

Physical activity levels	Adjusted	*P* Value	Unadjusted	*P* Value
OR (95% Cl) for depression				
MPA[a]	0.26 (0.14–0.50)	**<.0001**	0.39 (0.16–0.94)	**.04**
VPA[b]	0.57 (0.14–2.36)	.44	0.36 (0.10–1.30)	.12
LMVPA[c]	12.88 (2.59–64.11)	**.005**	6.22 (1.29–30.13)	**.04**
OR (95% Cl) for mild depression				
MPA[d]	0.51 (0.19–1.34)	.17	0.74 (0.25–2.25)	.60
VPA[e]	0.09 (0.01–0.86)	**.04**	0.09 (0.01–1.19)	.07
LMVPA[f]	9.34 (1.90–45.90)	**.01**	4.12 (0.64–26.38)	.15
OR (95% CI) for major depression				
MPA[g]	0.11 (0.03–0.36)	**.0003**	0.22 (0.07–0.72)	**.01**
VPA[h]	1.79 (0.28–11.34)	.54	0.68 (0.16–2.88)	.60
LMVPA[i]	15.46 (2.94–81.28)	**0006**	6.30 (1.02–38.74)	.08

Note. Boldface indicates statistical significance at $P < .05$.

[a]MPA for depression symptoms adjusted for age, marital status, smoking, emphysema, cancer, diabetes, and difficulties at work.

[b]VPA for depression symptoms adjusted for age, marital status, smoking, diabetes, difficulty with chores at home, and difficulty functioning at work.

[c]LMVPA for depression symptoms adjusted for age, marital status, arthritis, diabetes, and difficulty functioning at work.

[d]MPA for mild depression symptoms adjusted for age, ethnicity, marital status, smoking, and diabetes.

[e]VPA for mild depression symptoms adjusted for age, arthritis, and diabetes.

[f]LMVPA for mild depression symptoms adjusted age, ethnicity, marital status, smoking, and diabetes.

[g]MPA for major depression symptoms adjusted for age, marital status, arthritis, emphysema, and difficulty functioning at work.

[h]VPA for major depression symptoms adjusted for age, antidepressants, emphysema, cancer, and difficulty functioning at work.

[i]LMVPA for major depression symptoms adjusted for age, marital status, antidepressants, arthritis, and difficulty functioning at work.

Abbreviations: Cl, confidence interval; LMVPA, low moderate and/or vigorous physical activity; MPA, moderate physical activity; OR, odds ratio; VPA, vigorous physical activity.